

**COMPUTERIZED TRADING: WHAT SHOULD THE
RULES OF THE ROAD BE?**

HEARING
BEFORE THE
SUBCOMMITTEE ON
SECURITIES, INSURANCE, AND INVESTMENT
OF THE
COMMITTEE ON
BANKING, HOUSING, AND URBAN AFFAIRS
UNITED STATES SENATE
ONE HUNDRED TWELFTH CONGRESS
SECOND SESSION
ON
EXAMINING COMPUTERIZED TRADING

SEPTEMBER 20, 2012

Printed for the use of the Committee on Banking, Housing, and Urban Affairs



Available at: <http://www.fdsys.gov/>

U.S. GOVERNMENT PRINTING OFFICE

80-168 PDF

WASHINGTON : 2013

For sale by the Superintendent of Documents, U.S. Government Printing Office
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THURSDAY, SEPTEMBER 20, 2012

U.S. SENATE,
SUBCOMMITTEE ON SECURITIES, INSURANCE, AND
INVESTMENT,
COMMITTEE ON BANKING, HOUSING, AND URBAN AFFAIRS,
Washington, DC.

The Subcommittee convened at 10:03 a.m., in room 538, Dirksen Senate Office Building, Hon. Jack Reed, Chairman of the Subcommittee, presiding.

OPENING STATEMENT OF CHAIRMAN JACK REED

Chairman REED. Let me call the hearing to order. I want to thank all of you for joining us today, especially our witnesses, and thank my colleague, Senator Crapo.

As everyone in the room knows, computer trading has changed markets in fundamental ways, not the least of which is the speed at which trading now occurs. The benefits of automated trading for retail investors include access to real-time market data and being able to execute orders within a fraction of a second. The explicit costs of trading have also decreased. In one study that focused on pre- and post-decimal trading in the New York Stock Exchange listed stocks, average effective spreads decreased significantly for both small and large trades. The market is also more efficient, processing large volumes of data and more accurately setting market prices based on sometimes minute changes and market additions.

However, since the May 6, 2010, Flash Crash, there have been a series of high-profile computer trading errors that highlight some of the dangers and costs of fast-moving computer-driven trading. In March, a computer glitch scuttled the initial public offering of one of the Nation's largest electronic exchanges, the BATS Global Markets, Inc. In May, computer problems at the NASDAQ Stock Market plagued the initial public offering of Facebook stock. And last month, the Knight Capital Group, a brokerage firm at the center of the Nation's stock market for almost a decade, nearly collapsed after it ran up more than \$400 million of losses in minutes because of errant technology.

Taken together, these failures in electronic trading appear to be affecting investor confidence in the U.S. market structure. Most of us consider American capital markets to be the best in the world. Our markets are known for their strength and resiliency, their openness and transparency, and their fairness to all market par-

ticipants. But our marketplace has been evolving very quickly and it is not clear that our rules have kept up.

In particular, we need to focus on whether markets have the ability to avoid systematic failure triggered by a computer problem. Are our markets still fair? Is everyone playing by the same set of rules? And perhaps most importantly, are our markets still focused on long-term capital formation and the creation of jobs?

Following the Knight Capital incident in early August, the SEC announced it would convene a roundtable of trading technologists in an effort to determine if brokers and exchanges are in control of their trading systems. SEC Chairwoman Mary Shapiro said she had asked staff to, quote, “accelerate ongoing efforts to propose a rule that would require trading venues to maintain the capacity and integrity of their systems,” and this roundtable is scheduled for October 2, 2012.

Clearly, recent market events caused by technology-related issues have sharpened the debate on market infrastructure and the need to limit the broader impact of computer trading errors. However, in light of the enormous growth of high-frequency and algorithmic trading, there is a growing consensus that the entire regulatory scheme surrounding high-frequency trading firms and their algorithms should be assessed.

Do current regulations reflect the impact of high-frequency algorithms on trading? Or can computer algorithms be programmed to operate properly in stressed market conditions? What challenges face firms when they are testing and implementing new systems?

In addition, just last week, on September 14, the SEC settled first of its kind charges against the New York Stock Exchange for compliance failures that gave certain customers an improper head start on trading information. Computer issues, which include both disparities in the design of the New York Stock Exchange hardware systems and software problems, resulted in some customers receiving stock pricing trading data several seconds ahead of the general public. The SEC order marks the first ever SEC financial penalty against an exchange.

The order and fine involving the New York Stock Exchange highlight another set of issues I hope we can discuss at today’s hearing. In effect, should the exchanges have control over the collection, aggregation, and distribution of market data? Should data be available to everyone at the same time, or should enriched data be provided more quickly to those who are willing to pay for it?

We look forward to hearing your testimony on all of these topics. The capital markets are a public good, much like a highway. We need to have clear rules about the speed limits, who can use the HOV lanes. With our rapidly evolving capital market structure, we need to make it clear what the rules of the road are.

Now, let me turn to my colleague, Senator Crapo, for his comments. Senator.

STATEMENT OF SENATOR MIKE CRAPO

Senator CRAPO. Thank you, Mr. Chairman.

More than half of all U.S. households, 57 million, according to one study, participate in our markets through either stocks or mutual funds, and the health and competitiveness of these markets

have an immediate and direct effect on our broader economy as well as on the wealth and prosperity of the American people.

Over the last several decades, new forms of competition, technology, global growth in trading, and broader investor participation have integrated and interconnected the world's capital markets and the financial services industry as never before. According to a 2010 study by James Angle of Georgetown, Larry Harris of the University of Southern California, and Chester Spatt of Carnegie Mellon, technological innovations have led to major improvements in market quality. Their study found that execution speeds have increased, making it much easier for retail investors to monitor execution. In addition, retail commissions have significantly dropped and bid/ask spreads have narrowed.

However, as Chairman Reed outlined, there have been too many technological failures in our market infrastructures since the Flash Crash of 2010.

I thank Chairman Reed for holding this important hearing on a topic that has clearly captured the attention of academics, practitioners, and regulators.

Yesterday, Georgetown University hosted a conference on financial market quality and the question of what is the empirical evidence on the role of alternative trading systems, algorithmic trading, high-frequency trading, dark pools, and new trading technology on market quality. In October, as has been indicated, the SEC will be holding a technological roundtable to discuss how to minimize trading errors and market malfunctions as well as how to respond to them in real time when they do occur.

As we look at ways to help fortify our markets, especially during times of market stress, it is important that we examine all of the relevant empirical evidence in order to make informed policy decisions. I hope the witnesses at today's hearing can provide some of that much needed evidence and I look forward to hearing their testimony.

Thank you, Mr. Chairman.

Chairman REED. Thank you very much, Senator Crapo.

Let me now introduce our panel. I want to thank the panel for joining us today. We are extraordinarily lucky to have such qualified and insightful witnesses.

Our first witness is Mr. David Lauer. Mr. Lauer is a Market Structure and High-Frequency Trading Consultant at Better Markets. He has helped financial service firms deploy high-performance trading infrastructure. He has also worked as a quantitative analyst and high-frequency trader himself. Thank you, Mr. Lauer.

Mr. Larry Tabb is the founder and CEO of TABB Group. The financial markets research and strategic advisory firm focuses exclusively on capital markets. Founded in 2003, TABB Group analyzes financial market issues. Thank you, Mr. Tabb, for being here.

Mr. Chris Concannon is currently a partner in Virtu Financial, where he serves as an Executive Vice President and is the Chief Compliance Officer at Virtu Financial BD. Prior to joining Virtu in 2009, Mr. Concannon spent 6 years as Executive Vice President of the NASDAQ OMX Group. Thank you, Chris.

Mr. Andrew Brooks is Vice President of T. Rowe Price Group and T. Rowe Price Associates. He has served as head of U.S. equity

trading for the firm since 1992. Thank you very much, Andy, for joining us today.

We will begin with Mr. Lauer and then just go right down the panel. Please try to limit your testimony to 5 minutes. Your complete written testimony will be made part of the record, so feel free—in fact, I encourage you to summarize. Mr. Lauer.

STATEMENT OF DAVID LAUER, MARKET STRUCTURE AND HIGH-FREQUENCY TRADING CONSULTANT, BETTER MARKETS

Mr. LAUER. Good morning, Chairman Reed, Ranking Member Crapo, and Members of the Subcommittee. Thank you for the invitation to Better Markets to testify today, and thank you very much for holding this hearing on such a critical issue to our financial markets and our economy.

Better Markets is a nonprofit, nonpartisan organization that promotes the public interest in financial markets. I will not take the time to go over all that we do today, but you can find it at bettermarkets.com. My name is David Lauer. As you indicated, I am a Market Structure and High-Frequency Trading Consultant to Better Markets. I also consult for IEX Group, a new private company that is developing an investor-focused equity market.

Prior to consulting, I worked as a high-frequency researcher and trader at two of the largest HFT firms in the industry. And before that, I worked at a technology vendor that provided high-performance hardware to many high-speed trading desks on Wall Street.

I would like to start with a story and tell you about my experience during the Flash Crash in May of 2010. The Flash Crash, as you know, caused the market to drop by a trillion dollars, nearly a trillion dollars, and then bounce back inexplicably within 20 minutes. I was on the trading floor that day as the market crashed and I witnessed something, quite frankly, unthinkable. The market simply disappeared. It was gone. We had no idea what was happening and we had no idea what would happen next.

Our firm, like other HFT firms, immediately withdrew our liquidity from the market because we had no idea what was happening. We did not trust the information from our data feeds. And we had no obligation to remain in the market. More than half of the liquidity in the stock market was pulled in a matter of seconds and that dramatically worsened an already unstable situation. Anybody who seeks to minimize the role that HFT played in the Flash Crash either was not on a trading floor that day or is incentivized to maintain the status quo.

Remarkably, since the Flash Crash, there have been no substantial changes in market structure. The U.S. equity markets are in dire straits. We are truly in a crisis right now. The past decade of technology revolution on Wall Street has been marked by two primary trends, extreme marketplace fragmentation and the rapid growth of HFT as the primary supplier of liquidity. Complexity is the hallmark of this market, whether from the fragmentation of 13 exchanges and over 50 dark pools or the interaction between algorithms listening to high-frequency market data. While complex systems can often provide elegant solutions to intractable real world problems, they can also spin out of control at any moment and in completely unexpected ways.

There is no doubt that electronic trading has tremendous value to offer, enhancing the smooth functioning of the stock market and increasing competition, thus driving down the cost of trading. What we must be concerned with is whether the pendulum has swung too far and whether the nearly unregulated activity of 50 to 70 percent of the stock market should be allowed to continue unabated.

A quick look at today's markets reveal that stock market volatility has increased. Spreads have increased. Catastrophic event frequency has increased. IPOs have dramatically dropped. And retail investors are fleeing the stock market.

As my written testimony demonstrates, the micro structure of the equity market has been altered by HFT and extreme market fragmentation, resulting in an excessively fragile market. This fragility is apparent in the impact that a single firm or even a single computer can have on the market at large, whether accidental or nefarious and predatory.

I believe the market is so fragile because of structural inefficiencies, including the proliferation of the maker-taker business model and pay for order flow deals, the disappearance of affirmative market making obligations, the fragmentation of equity markets into lit and unlit venues with little regulation of the unlit venues, and the rubber stamp approval of exotic order types without proper study or justification.

So what are we to do? Here are my suggestions, just a few of them, for rules of the road. I believe we need to unify trading rules regardless of lit or unlit venue, and the bar must be raised on off-exchange execution standards. In order to receive a rebate from any venue, market makers must be registered and subject to affirmative market making obligations. A unique identifier should be assigned to every supervisory individual and attached to every quote. This would provide a contact person in emergencies and remove the cloak of anonymity that has allowed for manipulative behavior. We must eliminate pay for order flow practices. The SEC should pilot a 50-millisecond minimum quote time. And strong market technology standards are needed and regular audits to ensure they are being followed.

In addition, I would like regulators to try a novel approach to surveillance and enforcement inspired by the Internet and open access and standards. Regulators could open up access to market data and incentivize independent programmers with prizes similar to how the X Prize functions, or percentage of fines like their whistleblower program, to help design better surveillance and enforcement tools for regulators. This can be part of advancing the SEC's technology capabilities with a substantial investment in technology and personnel to bring the SEC into the 21st century.

Thank you very much, and I am happy to answer any questions.
Chairman REED. Thank you very much.

Mr. Brooks, please.

**STATEMENT OF ANDREW BROOKS, HEAD OF U.S. EQUITY
TRADING, T. ROWE PRICE**

Mr. BROOKS. Good morning, Chairman Reed, Ranking Member Crapo, and distinguished Members of the Senate Subcommittee on Securities, Insurance, and Investment. Thank you for the oppor-

tunity to testify today on behalf of T. Rowe Price regarding the effects of recent significant changes in trading technology and practices on market stability.

My name is Andy Brooks. I am a Vice President and Head of U.S. Equity Trading at T. Rowe Price Associates, Incorporated. I joined the firm in 1980 as an equity trader. I assumed my current role in 1992. This is my 33rd year on the T. Rowe Price trading desk.

T. Rowe Price is celebrating its 75th year anniversary of advising clients. We are a Baltimore-based global advisor with over \$540 billion in assets under management as of June 30, 2012, and more than three million client accounts. We serve both institutional and individual investors. We welcome the opportunity for discussion regarding the industry and market practices.

Our firm is particularly focused on the interests of long-term investors. We appreciate the role other types of investors can have in creating a dynamic marketplace. However, as we talk with our clients, there is a growing distrust of the casino-like environment that the marketplace has developed over the past decade. We worry that the erosion of investor confidence can undermine our capital markets, which are so important to the economy, job growth, and global competitiveness. Reaffirming a strongly rooted commitment to fairness and stability in the market's infrastructure is critically important.

Over the past two decades, the markets have benefited from innovation and from new technology and competition. Generally, markets open on time, close on time, and trades settle. However, there are problems below the surface. Here are some of the things we find concerning.

Order routing practices. We question the nature of various order routing practices. The maker-taker model, payment for order flow, and internalization of orders all seem to present a challenge to order routing protocols. Are order routing practices and incentives—are they an impediment to the over-reaching requirement to seek best execution on all trades?

Colocation and market data arbitrage. We believe that the widespread use of colocation creates an uneven playing field that favors those who can and will pay for it. We question whether this has produced a market that values speed over fair access. In no other regulated industry is one party allowed a head start in exchange for payment. Our understanding is the current colocation practices allow for a market data arbitrage where some investors get quotations and trade data faster than others. This advantage is traded upon, causing some participants to believe they are victims of front running, or at the least, disadvantaged.

Speed and impact on market integrity. Our sense is the almost myopic quest for speed has threatened the very market itself. It also seems to many that high-frequency trading strategies are designed to initiate an order to simply gauge the market's reaction, then quickly react and transact faster than other investors can. This seems inherently wrong. Our understanding is that the continued push for speed is not producing any marginal benefit to investors and, in fact, may be detrimental. This pursuit of speed as

a priority is in direct conflict with the pursuit of market integrity as a priority.

Inaccessible quotes and high cancellation rates. The growth of HFT has led to increased volume. However, whether the corresponding volume is good or bad deserves analysis. Volume does not necessarily mean liquidity for large institutional investors. When you combine high HFT volumes and even higher cancellation rates, these forces can combine to undermine market integrity and cause deterioration in the quality and depth of the order book. We feel that this volume is transitory and misleading.

Challenges to the national market system. We believe the original construct of Regulation NMS was laudable and designed to encourage competition. However, we do not believe this regulation contemplated today's highly fragmented marketplace, where we have 13 different exchanges and over 50 unregulated dark pools. In such a fragmented market, can one really be confident that achieving best execution, given the explosion of market data traffic? We question the market's ability to process the overload of market data.

Conflicts of interest. We question whether the functional roles of an exchange and a broker-dealer have become blurred over the years and could warrant regulatory guidance regarding the inherent conflicts of interest. It seems clear that since exchanges have migrated to for-profit entities, a conflict has arisen between seeking volume to grow revenues and their obligation to assure an orderly marketplace for all investors.

HFT trading strategies. Professional proprietary traders often have divergent interests from those investors concerned about the long term. Whether the average holding period for such traders is measured in seconds as opposed to months or years, we have destabilized the market. Given recent market volatility, more study is warranted to assess the impact of the exponential growth of short-term trading strategies. Most rules and regulations seem to further enable those with short-term profit incentives, as evidenced by the proliferation of new order types suggested by exchanges and approved by regulators.

Suggestions. We believe it is time to step back and examine the market structure and how it impacts all investors. A good first step might be to experiment with a number of pilot programs to examine different structural and rule modifications. We suggest a look at the appropriateness of colocation as a general practice and enhanced oversight of high-frequency trading and other strategies that might be unduly burdensome to overall market functionality. We would like to see a pilot program where all payments for order flow, maker-taker fees, and other inducements for order flow routing are eliminated. We envision a pilot where there are wider minimum spreads and mandated times for quotes to be displayed to render them truly accessible. These programs can include a spectrum of stocks across market caps and average trading volumes, among other factors. We also suggest a pilot program of imposing cancellation fees for unacceptable trade-to-cancellation ratios.

A key question is, should we foster consolidation in this fragmented market? At a minimum, should we raise the barrier for be-

coming an exchange? In our opinion, requiring a more robust testing for new software would seem to make sense.

In conclusion, T. Rowe Price Associates appreciates all the efforts of the SEC and Congress as we strive to make the markets better and fairer for all participants. The consolidated audit trail, large trader ID, limit up-down initiatives are all improvements. We suggest any regulatory proposals be aligned with the goal of making the markets simpler, more transparent, and less focused on speed. We applaud the Committee's interest in making sure the right questions are asked. There are currently over 1,000 order types to express your buy and sell interest and we suggest that a simplified model may be more efficient for all investors.

The issues we face are enormously complex and we certainly do not have all the answers. We believe it is time to revisit the historic responsibility to provide a fair and orderly market. Thank you.

Chairman REED. Thank you very much, Mr. Brooks.
Mr. Concannon, please.

**STATEMENT OF CHRIS CONCANNON, PARTNER AND
EXECUTIVE VICE PRESIDENT, VIRTU FINANCIAL, LLC**

Mr. CONCANNON. Chairman Reed, Ranking Member Crapo, Members of the Subcommittee, I want to thank you for the opportunity to appear before you today. My name is Chris Concannon and I am the Executive Vice President of Virtu Financial.

Virtu Financial is a global electronic market maker. We are a market maker on over 100 markets around the globe. We make markets from our offices in New York, L.A., London, Dublin, Singapore, and Sydney. The company's market making activity spans across multiple asset classes, including cash equities, fixed income, currencies, futures, options, energy products, metals, and other commodities.

Virtu operates as a registered broker-dealer in the U.S., as a registered investment firm in Europe and in Asia. We are also a market maker on the NYSE, the NASDAQ Stock Market, the BATS Exchange, NYSE Arca, and NYSE Markets. And in Europe, we are a market maker on the London Stock Exchange, the Swiss Stock Exchange, Euronext, and Deutsche Bourse.

In discussing the state of the U.S. equity market, I start from the premise that our equity markets are the most dynamic and the most efficient markets in the world. My firm trades across all major financial markets and no market can compare to the U.S. equity market in terms of pricing efficiency and liquidity. Over the last 4 years, I have witnessed an unprecedented number of claims that our markets are horribly broken, unfair, and dangerous. These claims tend to be short on facts and evidence, but long on press coverage and book deals.

Let me be clear. Our markets are not perfect. It has flaws and unnecessary complexity. The U.S. equity markets is overly fragmented and likely over-engineered. Stocks in the U.S. trade electronically on 13 national securities exchanges and over 50 dark pools. If we had a blank canvas and we were able to redraw our entire market structure, it would never look like the model that we use today.

I would like to focus on three areas that I believe deserve further review: First, our choice of a single market structure for all listed securities; second, our market's failure to enhance market maker obligations; and finally, the industry's current risk management standards.

First, our market is currently designed as a one-size-fits-all. What I mean by that is that most of our major market structure rules do not distinguish between the size, the market capitalization of the listed company, or the trading characteristics of their stock. Our markets are designed to execute all stocks, regardless of shape or size, using the same market mechanism. A stock that trades once per day is traded in the same market structure as a stock that trades one million times per day. It is like we are putting a bicycle on the fast lane on a highway and wishing it luck. I believe we should revisit our current market structure in order to create a better pricing mechanism for all stocks of different shapes and sizes.

My second area of focus is our market's failure to enhance market maker obligations. While my firm is a market maker and it is easier for me to call for enhanced market maker obligations, I fundamentally believe that we need to increase obligated liquidity in our markets. Flash crashes, miniflash crashes, and other market disruptions demonstrate the need for additional obligated liquidity in our market. However, I believe enhanced market maker obligations should be targeted where they are most needed, and that is in the less liquid stocks.

My final area of focus is the industry's current risk management standards. In light of recent events, I believe that the industry should explore ways to improve its risk management standards. First, pretrade risk management limits are already required by the Securities and Exchange Commission under the market access rule. Under that rule, which has been in effect for over a year, firms are required to establish pretrade credit limits for every customer account, and more importantly, for the firm's own proprietary account. These credit limits are a firm's primary defense against unwanted trading activity by the firm or its clients.

Second, the industry is currently exploring specialized kill switches that would be administered by the exchanges. These kill switches would be a systematic shut-off of a firm if it exceeded prescribed or preset trading limits. Kill switches would not be a primary defense but rather a secondary defense to backstop the failure of other risk management measures operated by the firm. Kill switches have operated effectively in the futures exchanges for many years. Such a kill switch would have severely limited the damage done on August 1.

The third component to enhanced risk management is one of the most important, I believe. A simple feature referred to in the industry as drop copies should be required as a risk management tool. Drop copies are separate and distinct connections offered by exchanges and other markets. Drop copies, which are widely used by the industry, provide a real time echo or copy of a firm's trading activity on a given exchange.

A good example of how drop copies work is if you are on Amazon or iTunes and you click that "purchase" button, you get a confirm that pops up in your window. At the same time, an email is sent

to you. That is exactly how a drop copy works in our industry, and these drop copy emails are actually very helpful. I recently had my 12-year-old daughter—she actually became a rogue trader on iTunes. So luckily, the drop copy emails informed me that she was a rogue trader and I put in a kill switch.

[Laughter.]

Mr. CONCANNON. While I believe firms should have a robust process for developing and testing new software, the industry must have advanced risk management systems to limit the risk of unintended trading activity by a firm or by its clients. We know with certainty that software has bugs, hardware crashes, and networks go down. The industry must build risk protections that assume the worst while a robust development and testing process avoids the worst. Pretrade risk checks, kill switches, and real time drop copies protect us from the worst events.

Thank you again for the opportunity to be here. I would be happy to take questions.

Chairman REED. Thank you very much, Mr. Concannon.

Mr. Tabb, please.

**STATEMENT OF LARRY TABB, FOUNDER AND CHIEF
EXECUTIVE OFFICER, TABB GROUP**

Mr. TABB. Good morning, and thank you, Chairman Reed, Ranking Member Crapo, distinguished Senators. I am Larry Tabb, founder and CEO of the TABB Group, a financial markets research firm. We provide research and advisory services to financial markets firms regarding how the markets operate and how investors perceive the markets and the brokers who serve them. I am also a member of the CFTC High-Frequency Trading Committee. I would like to thank the Committee for this opportunity to present my views on computerized trading and equity market structure.

Unfortunately, the structure of the U.S. equity markets has come under scrutiny, from high-frequency trading, to the Flash Crash, to Facebook and BATS IPO challenges, to the latest Knight Capital Group technology issue. Market professionals as well as the general public are concerned that the U.S. equities markets are not functioning effectively.

I have submitted a 20-page paper answering the six questions that the Committee has defined to that end. I will only summarize my answer to question six. What, if any, policy changes should be considered by regulators, Congress, in order to better protect investors, maintain fair, orderly, and efficient markets, and facilitate capital formation?

My first statement is do no harm. The U.S. markets are the deepest and most liquid on the globe. The markets are also complex and interrelated. Small changes can cause significant impact. So, first, do nothing radical. A radical shift of market structure will unquestionably hurt investors. Radical changes provide incentives to traders to analyze rule changes and profit off of them. This will only cease once investors pressure brokers and brokers develop better countermeasures. It can take years to restore this equilibrium.

To that extent, what I would do, first, defragment the market. While we do not want to limit competition too much, 13 equities exchanges, 50 or so ATSS, and who knows how many internalizing

brokers is too many. Stop granting new exchanges and ATS licenses immediately. Determine the optimal number of exchanges, ATSS, and internalizing brokers, and as these entities go bankrupt, merge or consolidate exiting firms and reduce the number of licenses.

Second, better manage broker ATS solicitations. An order for 50,000 shares can easily be executed in 200 trades across various venues. Understanding what happens to this information is very, very difficult. While institutions typically receive execution information, it is more difficult to tell where these orders were routed and not executed. Where these orders were not executed leaks information into the market. Between brokers soliciting the other side, ATSS routing to each other, and exchanges routing to ATSS, virtually all professionals that have wanted to trade against this order have seen it before it is displayed to the public.

Third, better manage MPVs, minimum price variations. Currently, we have a minimum 1-cent MPV for all stocks over a dollar. I would follow the direction of the JOBS Act in implementing a test program to widen spreads for less liquid and smaller capitalized stocks.

Fourth, greater transparency of order types and routing mechanisms. Currently, most exchanges post their order types. However, these descriptions are not intuitive. Exchanges, ATSS, ECNs, internalizers, and even brokers need to begin to provide greater transparency, descriptions, and concrete examples how each order type works, how fees and rebates are generated, where in the order book orders show up, how and when orders are routed, and how these orders change under various market conditions.

Five, develop a market-wide consolidated audit trail for equities, futures, and options. Develop incentives that will facilitate the cooperation of the SEC, CFTC, and various SROs to ensure harmonious oversight. Develop clear rules on what manipulative behavior is in electronic markets. Provide regulators the tools and people who can understand the market, find the people and/or machines that are driving manipulative behavior, and give the regulators the power to stop, fine, and jail manipulators. If we had confidence that our regulators were able to effectively police the market, it would give the public more confidence that pernicious behavior was being flagged, challenged, and resolved. It would provide investors with the assurance that our markets are safe again for trading, investing, and raising capital.

I would like to thank the Committee for allowing me to present TABB Group research and my personal thoughts on how to fix the U.S. equities market structure. If there are questions, I would enjoy answering them at this time.

Chairman REED. Thank you all very much for excellent testimony. I think what you have made very clear is this is a complex issue, that you have raised extraordinarily important questions. It is going to take us a while, I think, to come to the answers, but this is the first step. In fact, in collaboration with my colleague, I would assume we would entertain other hearings in this regard because this issue is not a one-stop and quick fix and move on.

But in that spirit, one of the issues—I was particularly struck by Mr. Brooks' comments about the issue of speed in conflict with

market integrity. And this issue has been raised in many different venues, even by people back home in Rhode Island. Are these markets just too fast now? Are we losing something bigger? And let me pose this to all the panelists, your thoughts briefly on that. We will do a 7-minute first round and then we will come back for a second round and more, and we have the luxury of asking some questions.

So this whole issue of speed. Are things too fast, and if that is the case, how do you slow it down? Mr. Lauer, do you want to comment first, and then Mr. Brooks, and Mr. Concannon.

Mr. LAUER. I would love to. Thank you, Senator. I think that the issue of speed is a critical one, absolutely. And the idea of slowing things down is difficult. These are, as you said, complex issues. I think that speed for speed's sake is now being well proven to create very little social welfare and utility.

There is an interesting study that came out on the externalities of high-frequency trading and they examined two consecutive technology shocks which increased—or decreased latency from microseconds to nanoseconds. And while they found that it dramatically increased trading speed and the cancellation ratio, there was no impact on trading volume, spread, depth, or pricing efficiency. So I think we have found a limit to the benefits of speed, and this is well supported empirically.

There are some ideas around. One of those is a minimum quote life, as I mentioned in my oral testimony and my written testimony, as Mr. Brooks has, as well. I think that that is an interesting first step and I think it is worth a pilot program. I completely agree with Mr. Brooks that we need to be trying new ideas out. We need to be going through some pilot programs and finding out what the impact of these things would be, because we can simply surmise on what the impact of a 50-millisecond quote life would be, but we do not really have a perfect sense.

That same study found that between 30 to 40 percent of market data was—are quotes that were put into the market and canceled within 50 milliseconds without being traded on, and the cancellation rates on quotes that are out there for less than 50 milliseconds is, I believe, over 96 percent. So I do believe that is one area that we can look at.

Chairman REED. Mr. Brooks, and then I am going to make sure everyone has a chance to answer this question.

Mr. BROOKS. Thank you. I think our sense and what we hear from our clients is really that the marginal return for investors is perhaps negative with the increasing speed. So it begs the question, why do we need to be faster? Who benefits from that? And I think our question and our concern is, who is the speed for? We do not think it is for investors. So that means someone else is interested in speed and maybe their interest is not as genuine, if you will, when you think about who are the markets supposed to serve.

So it is a very complex issue. I appreciate the Chairman acknowledging that as we work together to find solutions. But there is a concept that speed kills on the highway. You referenced the highway analogy. So I think speed causes us great anxiety.

Chairman REED. Mr. Concannon, please.

Mr. CONCANNON. Thank you. I think speed is—and I agree with the panelists that it is one of the more difficult issues to address,

because if you do conclude that we need to regulate speed, we then are left with the question, at what speed should we all move at? And we then may move to the slowest common denominator in terms of speed. Speed and the ability to post a quote and cancel a quote, they all, in turn, are frictions in the market. And we have reduced frictions to the most extreme levels to create what is the most efficient market around the planet.

We see today—we do not need a pilot—we see markets that we trade in that have minimum quote life, and the impact is spread. If you are posting a quote in the market as a market maker, you are taking risk. You are posting actually an option to the market, a free option for them to execute against you when the intrinsic value of that asset changes. That free option will be adjusted based on the life of that option, which ultimately is the minimum quote life. And so there is an actual impact to our market structure when we slow down the market.

Do I think we have reached an equilibrium in speed? Yes. I do not think moving mics—one or two mics further—is adding any value to the investing public. But of more concern is slowing down the market to some common denominator.

Chairman REED. Thank you.

Mr. Tabb, please.

Mr. TABB. My issue, my concern, is that—I agree with the panel that we have gotten faster than we can probably handle. The challenge is, how do you actually stop it, and what happens if you stop it?

So the first issue would be, is, OK, so I have a 50 millisecond or even microsecond minimum quote life. What happens and who manages that? So if I am a trader and I have a minimum quote life, am I constantly pinging the exchange to take me out, take me out, take me out, and they say, no, no, no, no, no, and I say, take me out, take me out, take me out, and they say, no, no, no, and finally 50 microseconds happens and then all of a sudden we have created all this extraneous traffic that bogs down the rest of the market, just all these messages to get me out and how is that managed.

The second issue becomes, is we constantly have folks like, you know, Intel and IBM and Cisco and networking companies speeding up the clocks like with chips. Do we just say, OK, you cannot use the best computers anymore, and how do you manage that and who governs? Do we go to, like, a stock car race where everybody needs to trade out of the same computer, and how does that work and operate?

And then once you get two or three levels behind, you know, behind actually operating specifically on the exchange, do I actually know what my customers are doing or their customers are doing and how do I manage that, as well?

So there are a lot—yes, we have kind of gotten to the point where the market is too fast, but to a certain extent, maybe the answer is that the folks like Andrew need to actually complain to their brokers to have them do a better job of managing the execution of their orders. And if they do not like the execution, fire their broker.

Chairman REED. I am going to yield to Senator Crapo, but I have another series of questions, because I think there are some major issues here that the whole panel ought to address and I would like the comments. Just to sort of preview, one is the issue of fragmentation, the issue of market maker obligations, and there are probably a couple of others. And Mike, if you want to get into them, be my guest, but Senator Crapo, please.

Senator CRAPO. Thank you very much, Mr. Chairman.

I have a question, first, for Mr. Concannon. What kind of a system does your company have in place to avoid erroneous events?

Mr. CONCANNON. Thank you. Well, we have a number of systems in place, what we call filters, and filters will trigger a lockdown to our trading system. So if we place an order that the filter determines is out of range from the price of the market, it will stop that order from entering the market and it will shut down the actual trading strategy, and that works all day long, and it has been in existence for many years. It is actually a component of the SEC's market access rule, so it is now technically required to have in place. Every time you send an order, whether it is for your own account or your client's account, you have to filter for an erroneous order entering the market.

Senator CRAPO. So this is basically an industry standard at this point?

Mr. CONCANNON. Absolutely. It is an industry standard.

Senator CRAPO. My next question is—I would like you to answer, Mr. Concannon, but also, I would like to have the entire panel weigh in on this, if you would. Yesterday, there was a *Wall Street Journal* article about order types called slide and hide. The article suggested this order type allows high-speed firms to trade ahead of less sophisticated investors, potentially disadvantaging them and violating regulatory rules. What is your perspective on this?

Mr. CONCANNON. That is a great question. First of all, our firm does not generally allow exchanges to slide our orders. I do not know if you have noticed, but—

Senator CRAPO. How does this work?

Mr. CONCANNON. Sure. The way it would work would be you would place an order that locks the market, and what that means is it is an order that would otherwise execute against a quote in the market and that order would be restricted from being posted and locked. So the order type, the slide order type, would slide your order back to what is a compliant price and post it at that price.

The problem with that order type is it is not permitted for any broker to take an investor's order and slide it. So it is not actually an investor-used order. So there is no broker that says, I have an order that is marketable, because it will lock the market, and I am going to have an exchange slide it back to a different price. That is a violation of Best X and they cannot use it that way. So that order type—they would actually have to, because it is a marketable order, they would have to execute it, or execute it against the quote in the market.

That order type is mainly used for professional traders. So the issue is, does that slide order used by a professional trader, have they read the rules that the exchange filed with the SEC that were published and did they understand the order type that they were

using? It is not that investors, retail investors or even Mr. Brooks' firm using that order and being disadvantaged. His broker cannot use that order and slide his orders when they would otherwise execute at the market price. So it is really an issue of professional trader versus professional trader, trying to understand how the order types work.

Senator CRAPO. Mr. Lauer.

Mr. LAUER. Yes. Thank you, Senator Crapo, if I may. I think that hide, not slide, and many other order types are great examples of complexity in the marketplace, and at times, not necessarily complexity for complexity's sake but perhaps unjustified complexity. I think that the bar for approving new order types needs to be revisited, and I think that it would be a great service to reinstilling some confidence in the marketplace if it was easier for the average person to get their head around what these order types mean.

And the fact that we need so much explanation for just this one order type, let alone—I mean, there are, as Mr. Brooks said, a thousand order types if you take individual ones at each market center. There are so many order types that it just—it is something that people who are not in the business have a very difficult time with and there is absolutely no reason they should not have a difficult time with that.

Normally, the bar for regulating and passing rules is very high. It demands a lot of study and justification as to the utility of a new rule or regulation, and I think that that same standard should be applied to all of these exotic order types. And there should be, at this point, a great amount of evidence as to the utility of these order types because they have been around for a while now. I think that that would be an interesting exercise to go through.

Senator CRAPO. Mr. Brooks or Mr. Tabb, do either of you want to weigh in?

Mr. BROOKS. Thank you. I think the only thing we might suggest is that we might refer to the point Mr. Lauer made, and that is it really has added complexity to the marketplace and we are wondering why. Why is someone trying to make things more complex? And at the Georgetown conference yesterday that you all referenced, there was some discussion about whether it would make sense to have a moratorium on approval of new order types until the marketplace can really come together and get their arms around, what are we doing here? Why do we need so many ways to express trading interest? And is there something else going on? So it is a question that is troubling and we are not sure what the answers are.

Senator CRAPO. Mr. Tabb.

Mr. TABB. I do not disagree. I think that—and in my written testimony, or my oral testimony, I presented, I think, that we need much more transparency on these order types. Should the SEC be looking over these in more detail? I think, yes. I think that many of the order types that are out there are not well known, even to professional investors. And I think that greater transparency and reducing the number would probably be a good thing.

Senator CRAPO. Yes, Mr. Concannon.

Mr. CONCANNON. On the topic of order types, I mean, I do agree that we have way too many order types, but before Reg NMS, be-

fore that rule was installed in our marketplace, we had very few order types. We had market orders and limit orders. It was with the complexity of Reg NMS that interconnected all of our markets and gave us 50 dark pools that we ended up with all these order types.

And I do have to disagree. I heard—I read in testimony of a rubber stamp approval at the SEC. I personally filed order types. There was no rubber stamp approval. It would take 6 months or longer to get these order types approved, and people like Robert Cook and David Shulman and Bob Colby are far from rubber stamping order types and they have never rubber stamped order types. So it is a difficult process to get these things approved. They are analyzed. There are far too many. But those order types all came because of Reg NMS.

Senator CRAPO. Thank you.

Chairman REED. Well, thank you, Senator Crapo, and again, the questions are, I think, right on target and the answers are not only interesting, but provoke further questions.

Let me take up some of the issues that were suggestive of some additional testimony. I go back to the issue of fragmentation, of which you all commented upon, and just give you an opportunity to add anything further that you might want to say with respect to the issue of the fragmentation.

One of the ironies is that the national markets were put in place because there was an oligopoly operating, and now we have—have we created—sort of gone too far in the other direction. I think, Mr. Tabb, you could begin.

Mr. TABB. I think we have gone too far. I think that while it does not sound like a bad thing to fragment the markets and have multiple places to trade and have competition, every time a message pings off a market, a dark pool, an internalizer, it releases information. And so with trying to find the other side of the trade, information is bouncing all over the place that investors do not really even know that is occurring. And I think, to a certain extent, it disenfranchises the investor and leaks information.

That said, on the other side, there are organizations who spend a lot of time, money, and effort building up their liquidity pools and their businesses. You cannot really just say, OK, tomorrow, they do not exist. I am not sure eminent domain would be a great idea.

So the question then becomes is how do you defragment them and how do you do it in a fair way, and I do not know the answer to that, but I think we clearly have too many places to trade.

Chairman REED. Mr. Concannon.

Mr. CONCANNON. Well, when we take a look at our market and we see 13 exchanges, 50 dark pools, you have to understand that in every stock, there is a bid or an offer finding its way in one of those liquidity zones. And what that does is it thins out our overall liquidity. So on a normal day, it works. On a day of high volatility, like May 6, that thin layer of liquidity is easily pierced. When it is not consolidated in one place, you can pierce through that liquidity and you have the volatility that we saw that day. So fragmentation has caused increased volatility, but I agree with Larry. It is very difficult to consolidate that market. Again, on an average day, there are dealers that are professionals that try and consolidate

that market and it is a very liquid market despite the fragmentation. It is really those days that we have shocks and events.

Chairman REED. Mr. Brooks, do you have any comments? Mr. Lauer? Mr. Brooks.

Mr. BROOKS. Senator, if I might, I do not think we know the answer in terms of what the perfect number of exchanges or dark pools might be, but we do wonder and hear others question whether the system, with all these different venues, can process the data that is being generated. I mean, there is just an enormous amount of data, and some of that data gums up the system and slows it down and that is troubling.

And, two, to pick up on Mr. Concannon's point, it is awfully hard to figure out the supply demand equation in the stock today when there are so many different places that trading interests reside. So if you are trying to find out if there is more to buy or more to sell, good luck. It is tough today.

Chairman REED. Mr. Lauer, a comment, and then I have another question.

Mr. LAUER. Yes. I think that what we have seen with this massive fragmentation and internalization and dark pools, as Mr. Concannon alluded to, is what is called adverse selection. As order flow goes from place to place, from retail institutional investors, before it makes itself—before it gets to the lit exchange, it is picked off at every step of the way by internalizers, by dark pools, by high-frequency traders, proprietary trading desks. And, therefore, the flow that eventually gets to the lit exchanges is what we refer to in the industry as toxic flow that nobody wants to trade with. And what we have done is we have reduced the number of natural buyers and sellers in the market, as Mr. Concannon said when he was just answering. So I think that that has been one of the dramatic effects of fragmentation, internalization and dark pools.

There was a study out of Rutgers that demonstrated that because of all the off-exchange executions, spreads are widening in lit exchanges by an average of 1.28 cents on the New York Stock Exchange, and that is a dramatic effect and it is a direct result of this adverse selection because it becomes harder to be a profitable market maker in such a scenario.

I think that we can take a cue from other countries in this regard and we can raise off-exchange execution standards. We can say that you must meaningfully price improve in order to internalize, and meaningful price improvement does not mean a tenth of a cent. In Canada, they have one standard that says at least a tick size, a minimum tick size, and if the spread is one penny, then at least half a tick size. They also have a minimum order size. So if you are going to internalize or execute on a dark pool, it has to be an especially large order. That is why you have dark pools and that should be the reasoning behind that.

I also think that eliminating pay for order flow is an important step in order to combat this adverse selection problem.

Chairman REED. Thank you. Let me raise another topic, and that is this issue of market making. Mr. Concannon, your firm is a market maker in several different venues. And related to this, and it might not be precisely related, is another issue that we hear about and was referred to in the testimony is people coming into markets,

making a bid and then canceling it within fractions of a second, sort of probing, which creates more information but is not the traditional, what people think what markets are, where someone really wants to buy something and they are looking for the best price and when they get it, they are going to close the deal.

So this whole issue of market making obligations on everyone, which I think you raised in your testimony, can you comment upon it? Then I will ask Mr. Tabb and then everyone else who wants to make a comment. Please.

Mr. CONCANNON. Sure. I think if we go back 20 years and we look at our market makers, they had fairly strict obligations, people like specialists on the floor, but they had exceptional benefits. They had exclusive rights to the market and the incoming order, and that was worse than the benefits that they provided as market makers. So we made a decision and we changed our markets to be an all to all.

And I do believe in some products that all to all model, where anyone can be a market maker or market maker obligations are light, at best, we lose a little bit in terms of liquidity. And so there are stocks that I do not necessarily think they need obligations and market makers all day long, every minute of the day, but the good majority of our market really needs to be supported by market makers with real obligations to be at the best bid or offer.

The most important thing for me in terms of market maker obligations that do not exist is that not only should you be at the best price, but you should be at the next best price and one more price below that. You need to provide—a real market maker makes depth of liquidity markets, not just a thin layer at the best bidder offer.

Chairman REED. Mr. Tabb, your comments.

Mr. TABB. I agree. I think that we should have some sort of market maker obligations. Now, that said, market maker obligations is not a panacea. If we wind up having some sort of crash, people will not step in front of a train, catch a falling knife, whatever analogy you want to make. They are not going to go out of business because they have an obligation. But that said, in the general market or general interday volatility, I believe we should have stronger market making obligations.

Chairman REED. Thank you. Comments, Mr. Brooks, Mr. Lauer? Mr. Lauer.

Mr. LAUER. Yes. Thank you, Senator. I believe that—I completely agree with Mr. Concannon and I think that market making obligations should be the cornerstone of any new efforts. And I believe strongly that they should be tied to receiving a rebate on any venue in which securities are transacted, be they an exchange, ATS, ECN, dark pool. Any place that somebody can receive a rebate, that rebate should be tied to an obligation to make markets.

And as I explained in my written testimony, one of the better studied and more beneficial models is what is called the maximum spread model. I think the way obligations have been done in the past is normally something like a 90 percent of the time you need to be in the market. There are other models, but that is a standard one, and both Mr. Concannon and Mr. Tabb are correct that that would not address the issues of a crash or a flash crash, which is

why I think we need to examine much more stringent market making obligations. And some studies have developed some models for that that do demonstrate they would prevent flash crashes and that the market makers in some instances would have to be compensated for their losses. But the overall improvement in social welfare far outweighs the cost to that compensation.

Chairman REED. Mr. Brooks, you have a comment, and then I will yield.

Mr. BROOKS. I do. Thank you. I guess our thought would be that if you are going to receive a benefit as a market maker, you have to provide one, as well.

Chairman REED. Thank you.

Senator Crapo.

Senator CRAPO. Thank you, Mr. Chairman.

As I listen to the different issues being raised here and the potential solutions, a question occurs to me. This is a broad question and I would like to ask each of you to just weigh in on it, if you would. What do you think the top two or three issues or solutions to these issues that we are discussing here should be, the SEC should consider in its October roundtable? What are the top areas of focus we should recommend to the SEC or see them consider? We will just start over here. Mr. Lauer.

Mr. LAUER. Thank you, Senator. The roundtable is a technology roundtable, and as such, the number one thing should be market technology standards, policing, the kill switch that has been referred to on the panel, these types of issues. As I pointed out in my written testimony and my oral testimony, I think we should also—we need to get more creative. The SEC is, I believe as Senator Reed said, hopelessly outgunned. They need a pretty dramatic improvement in their technology capabilities. The market is a market based on technology. I am a technologist. I would never argue to move backwards. I would only argue to move forwards.

But the SEC needs to take a market-wide approach to surveillance and enforcement. They need to build a strong market data plan. And if they could open access to market data, which is a controversial issue, they could really inspire some novel approaches, some creative thinking by independent programmers, a model that has been demonstrated time and again to be very successful for developing really interesting applications and inspiring new innovation, and that is something—a change in mindset that I would be very pleased to see.

Senator CRAPO. Thank you.

Mr. Brooks.

Mr. BROOKS. I think our sense would be that perhaps three things for the technology crowd to look into. One would be order routing practices. Why are orders going where they are? What is driving that?

Payment mechanisms, so maker-taker payment for order flow internalization. At some point, it is all about the money, so I think that is an important conversation to have regarding technology.

And finally, we are concerned and our clients are concerned about the sense of unfair advantage that market data aggregators are giving to others and the sense that you get a view of the horse

race's finish before anybody else, and I think technology needs to address that.

Senator CRAPO. Thank you.

Mr. Concannon.

Mr. CONCANNON. Well, obviously, this roundtable was scheduled because of the summer of technology mishaps that we experienced. I think the focus will largely be on the proper testing that we deploy, the processes that we put around our new code that we roll into production, both exchanges and broker-dealers.

But I hope the focus will be more around what happens when something goes wrong. We will always have bugs in our code. We will always have network gear breakdown. We will have networks flat. Those all cause disruptions that we have to build risk management procedures around. So we will never get rid of the bugs. We will never get rid of the mishaps. But it is how we respond to them that is more critical.

I actually think a very simple adjustment to the SEC's rule on market access is all that needs to be made. If we—we already have pretrade covered, so if everyone complied with pretrade, we are going to protect ourselves from what goes out the door. If we install these kill switches at the exchanges that are not that difficult to deploy, we can make the kill switch setting part of your market access obligation. So a broker has to justify his setting in the kill switch to the SEC when they come in and inspect.

And the final piece that I mentioned, the drop copy piece, that covers your post-trade. So even if you miss something, even if an exchange creates risk for you because of an outage, you will still know on your post-trade, your drop copy, that there is someone trading in your name and you can check that against your risk procedures.

And all three items would be part of the market access rule and would be all part of your procedures that you roll out for the SEC when they examine you.

Senator CRAPO. Thank you.

Mr. Tabb.

Mr. TABB. I agree with a lot of what Mr. Concannon said about the kill switches and risk issues. One of the other issues, though, is that to a certain extent, some of these rules that the SEC has put in actually have not done—have not been specified properly and actually do not really work. And so I think the SEC really needs to do a better job in terms of how they specify some of their rules, like the direct access rule did not help Knight. It is supposed to be across asset class, but nobody has got cross-asset class capability now.

Linked markets—it is very easy to do pretrade risk in a single market, but once you start trading across 50 markets, it becomes very hard to manage all that pretrade risk and you wind up with people raising their credit limits just so that they do not have to deal with it.

The large trader rules were specified out of the wrong part of the data base that does not actually have trade data from the dealers. It would be nice if they actually took the time to actually understand what they are specifying.

So, now, getting back to my other thought of defragmenting the market, so if you look at market data, the issue is if I have a market and I am a market maker, even if no one trades there, I have got to quote every name that I am going to quote. So if I have two markets, all of the liquidity is here but I decide to quote over here, as well, so I have got all of a sudden twice as many quotes, which is kind of on a logarithmic scale in terms of amount of market data. So if we start pruning back the number of exchanges and licenses, we will wind up actually minimizing some of the market data challenges.

And last is we really do need a consolidated audit trail and a set of regulators that can actually look over this stuff, because at the end of the day, if the SEC is bringing people to task, we will have a little bit better confidence that they have their eye on the switch, you know, their eye on the wheel.

Senator CRAPO. Thank you very much.

Mr. LAUER. Senator, if I may, just a quick comment—

Senator CRAPO. Yes.

Mr. LAUER. —along the lines of the consolidated audit trail, another important idea. The problem with the consolidated audit trail, while it is a fantastic idea and critically needed, it is years away. If we right away said, from now on, when you put a quote into the market, you have to include a unique ID number, either on a per account basis, like the consolidated audit trail specifies, or on a supervisory individual basis, and that ID number is propagated not publicly but down to regulators, into their market data plan, it would have a dramatically chilling effect on manipulative behavior and it would allow regulators to quickly reconstruct what happened within the markets. It would allow them to enforce the existing rules. And it would also provide a contact point to quickly identify what is going on in an emergency. And I believe, technologically, that is a very easy task for current exchanges and their customers to take.

Senator CRAPO. Thank you.

Chairman REED. Thank you very much, Senator Crapo. I have a few other questions. My colleague has to depart for an interview, but I want to thank him. I thought it was an excellent question, to try to focus on the SEC panel. As you point out, it is generally a technology focus.

We have talked about technology, but also really important policy issues, the number of orders that are available, et cetera, and I just have two general questions. And first, Mr. Tabb and others that might want to comment, one of the things that has happened over the last several years is the proliferation of these dark pools and it raises the question of should there be a sort of uniform set of rules or conduct or behavior that apply to the dark pools as well as to the lit exchanges, and just any thoughts you might have.

Mr. TABB. A very good question. They are definitely regulated in separate ways and the exchanges would certainly like an even playing field. And to a certain extent, I agree with that.

The one challenge academically, and to a certain extent—and I think Mr. Brooks was talking a little bit about this, I think, earlier—I think it was Mr. Brooks—is that what Reg NMS did was infuse a single kind of market structure, a fast market priority over

slow markets, and what winds up happening is that once you wind up having a trade-through rule and you wind up having the same priorities across markets, in effect, what happens is the markets become tighter, more tight, more closely linked together, and problems can cascade through them. And so by then even tying together the dark pools with the exchanges in a trade-through mechanism, what you are going to—you might even create more fragility because then everything has to work exactly the same way, and keeping, you know, 13 exchanges and 50 dark pools lined up like that may be really difficult.

One of the answers may actually be to get rid of the trade-through rule and let markets develop a little bit more naturally. I think that was Mr. Brooks. Maybe it was Mr. Concannon was talking about that earlier. And that one market structure actually does not fit all. What you may want to actually do is actually what Mr. Lauer said, is have some sort of trade-at rule which basically says, you know, you cannot have de minimis price improvement and you need to price improve at least a half a tick or something like that to bring more liquidity into the market centers.

But, by and large, it is a complicated—it is a complicated issue. I do not know what the right answer is.

Chairman REED. I concur.

[Laughter.]

Chairman REED. Any other comments on this question, and then I have one more general question. Mr. Concannon.

Mr. CONCANNON. Sure. I am actually fairly sympathetic to the exchanges' situation. They are—they do have competition in the market called the dark pool. They are subject to heightened obligations as an exchange. But dark pools are registered. They are registered ATSS. They are subject to Regulation ATS. So they do have some of the components of the exchange regulation on them, as well.

I think the one thing I am a little bit cautious about is the innovation in our market actually came from—not from the traditional exchanges, but from the original ATSS in our market. And today, those exchanges are actually former ATSS that were purchased by the exchanges. So I am concerned if we put too much regulation in the over-the-counter market for ATSS or dark pools that you will dampen that innovation in a market that we have enjoyed for many years.

The other concern I have around dark pools is that it is a place for the buy side, people like Mr. Brooks, to feel comfortable about how their orders are handled and traded and not being pushed into the displayed market where people can find their orders and have an impact on the market. So there is a protective mechanism sitting inside the dark pool that is valued by the buy side and needs to be protected.

Chairman REED. Mr. Brooks, you have a comment.

Mr. BROOKS. I do, and I appreciate that, Mr. Concannon, because we do need protection because our orders are larger and a lot of the marketplace today is trying to identify our order flow and trade against it. So we are paranoid about that, and we should be, and I would suggest we have always been paranoid about that. So that is not new news.

But in a perverse way, the dark pools' execution size, I believe, is not much greater than the lit markets, 200 shares. So what it was designed for, which might be to rest and hide order flow but be willing to trade, not get picked off, not be identified, it is not really accomplishing that for the most part. So that begs the question of what is going on in dark pools, and again, I think we all are somewhat challenged by truly understanding what is happening there and that needs further examination by all parties.

Chairman REED. Thank you.

If you have a quick comment, then I have one more question, Mr. Lauer.

Mr. LAUER. Sure. I would just agree that I do believe that some unification of rules is necessary across venues. I think that is very important. And I think that, as I said before, the burden to execute on a dark pool should be much greater than executing on a lit exchange because you are removing information and liquidity from the public domain and lit exchanges.

Chairman REED. You talked about the dark pool. Let us shift focus to the exchanges, which now are for-profit enterprises with proprietary operations, et cetera. And there have been some questions, concerns raised about proprietary data feeds, customers getting advantages over other traders, and the whole issue I think you raised, Mr. Brooks, in terms of your testimony, just about the standard of behavior that grew up in what was a utility more than anything else and now is a for-profit enterprise. So any comments that you might have, and I will begin with you, Mr. Brooks, about any things that we should do given the nature of these exchanges as for-profit vehicles and their issues of proprietary feeds, colocation, access. That was brought up. Any comments.

Mr. BROOKS. So, again, you have picked a very tough question to pose to everybody in the industry. We certainly do not have the answers here, but it is challenging when exchanges have a for-profit motive and are interested in growing volume, and investors are not really interested in volume. They are interested in liquidity. And so those are two really different things.

I am certain that exchanges can be profitable and can work well as a for-profit enterprise, but perhaps we need to understand really what their role should be going forward, who they should be serving, and by the way, what is the role of a broker-dealer today. These lines, as we stated earlier, have really become blurred and we need some guidance here. We need to bring together some great minds to really think through what does it mean to have these different roles and how should the—it is sort of a Glass-Steagall question. What is appropriate to be separate?

We are troubled by the blurring of the lines. We are troubled by market data aggregation and dissemination selectively. Certainly, I can understand that data should be gathered and it can be sold and we are OK with that, but equal access important.

You know, when we think about things, when we talk to clients and shareholders, we are interested—they are interested in fairness and a sense of balance, and our Chairman, Brian Rogers, always says, how do we get back to fairness and balance? And I think that is a good question to always be asking yourself. Are things as fair as they could be?

You know, we have a group of terrific, dedicated traders every day trying to find fairness in the marketplace for our investors and they do not feel so good about things. Things are moving on us. Things are—we are getting identified. People are taking advantage. There is opportunity being taken away from investors. It is the worst I have ever seen in my career, and I have seen a lot, not maybe as much as you have or others, but we have seen a lot of different things and it is a troubling time.

Chairman REED. Other comments? Mr. Concannon.

Mr. CONCANNON. I agree that it is a very difficult question around proprietary trading—proprietary feeds that come out of the exchanges. If you look around the world, most markets do not have a consolidated feed. It is all—Europe is all based on the feed that comes from the exchange and the direct exchange. And so, commercially, people consolidate those feeds.

I am encouraged when we think about in the U.S. that the proprietary feeds are being consumed by investors. Some of the biggest consumers of those proprietary feeds are some of the retail online firms. They do push those proprietary feeds onto their Web site. They do do a form of consolidation. And when those retail orders come into the market, they are executed based on the proprietary feed. So there is some fairness being in terms of how the proprietary feeds make it out to the investing public and how their orders are treated under the proprietary feeds.

But what that leaves me with a question, is then what is the value of our consolidated feeds, and I was more shocked that—I think the fact that they were so slow and went unnoticed by the industry kind of speaks volumes in terms of their value to the industry.

Chairman REED. Anyone else? Mr. Tabb.

Mr. TABB. Yes. I kind of agree with Chris. I think that most professional investors—and I am not as familiar with the retail side, Chris would be much more familiar with it. On the institutional side, most of the large brokers who are servicing the large institutions use proprietary feeds. A lot of their algos and technologies are based off that. I do not know necessarily who uses the consolidated, the aggregated feed, the sites, things like Yahoo!.

As we start getting issues around colocation and governance of that speed, I am—even if we ban—let us say we ban proprietary feeds and we only use the aggregated SIP feed. The issue also then becomes is where is it being intercepted and read, and with the speed of light, someone who reads it in New Jersey is always going to get it before someone who reads it in California and how do you manage that. And I am not sure how you wind up delaying it so everybody gets it exactly at the same time.

Chairman REED. Your testimony was a good lesson in physics, so thank you very much.

Mr. Lauer, you get a final comment, and then I will summarize.

Mr. LAUER. Yes. I think as far as colocation goes, there is a case to be made for eliminating colocation. The argument that is often made against it is exactly what Mr. Tabb has said. I think that, right now, if you can think about it, though, colocation has a very small radius of equality. You know, it is a very limited area in which people are equal. So if you eliminate that, you at least ex-

pand the boundary and widen the opportunity to many more participants. You can reduce the costs, as well.

I do think there is a case to be made for it. As Mr. Brooks said in his opening statement, which I thought was illuminating, there is no other regulated industry in which access to information is sold for an advantage by somebody who can act before someone else. To me, colocation in some ways does reek of nonpublic information. I have a server. It is moving very fast. I can receive a piece of market data, analyze it, and act on it before many people have even received that piece of market data. And again, in my written testimony, there are several studies that have demonstrated that this race to zero is having no effect—no beneficial effect on market quality.

I think as far as the number of exchanges in the for-profit exchange model goes, I think what we need is a diversity of business models. Right now, there is pretty much only one business model in the marketplace. That is the maker-taker model. And so I think that it is—the environment is ripe for innovative ideas, and, of course, in my work with IEX Group, that is what we are working on. But I would like to see many more like that. So we could have different forces of defragmentation reducing identical business models, but coming up with innovative new ways that really appeal to the investor community rather than the trader community, and that is what the maker-taker model does. The incentive structure is very skewed toward high-speed trading and volume rather than liquidity, which is a major distinction that needs to be drawn.

Chairman REED. I have just one final question which my staff reminded me, and this is in the wake of the volatility we have seen in the oil commodities markets. The inference in a lot of what we talked about today were equity markets, et cetera, but the interaction of electronic funds trading, commodity markets, high-frequency trading, et cetera, raises another issue about volatility.

And this always comes up in the context, I think, particularly of oil and commodities. Is there a way to manipulate these markets, and either wittingly or unwittingly, is there the possibility, the potential, or the reality of manipulation, particularly given the incentive of oil to everything we do? And you might want to comment, Mr. Lauer, and then I will ask Mr. Tabb.

Mr. LAUER. Yes. The answer is simply, yes. Absolutely, there is a way to manipulate prices and markets, especially with the current speed of systems right now, and what we see sometimes, which are these what are called illiquidity contagions or these miniflash crashes. There is well-documented evidence of practices such as quote stuffing, which is to slow down the channel of a direct proprietary feed in order to pick off participants that are slower or unable to keep up with a high volume of data.

It is, in fact, well documented in one study that we see what is called comovement of message flow within channels, which is a rather shocking conclusion. Channels from a proprietary feed perspective are alphabetically distributed and, therefore, completely random, and you should expect to see no movement in the A through C channel. You would expect to see comovement of stocks in the same industry or exposed to the same macroeconomic factors. But the idea that there is going to be movement on a stock

because of the letter it begins with is perfect evidence that there is manipulation going on. That also leads to things like stop hunts, very manipulative behavior, and there is no way to figure out who is perpetrating that, which is one reason why I think this unique identifier attached to quotes is an absolutely critical issue and something that could be moved on very quickly.

Chairman REED. Mr. Tabb, you have a comment, and then I will conclude.

Mr. TABB. The way I want to answer that is yes and no. I think what Mr. Lauer is saying is absolutely true in the short term, very, very short term. I think there is an ability to manipulate stocks, especially in low liquid environments. But, generally, that manipulation is only going to take a little bit of—a short period of time from the electronic trading crowd, because, generally, the length of time they are holding a position is pretty short. So if they are buying 1 minute, they are selling the next minute. So they are only locking in small increments.

That said, there are people who can push markets. The people who push markets actually are not the short-term holders. They are longer-term holders or intermediate-term holders because they have capital at stake. They are willing to push a position for, you know, days or weeks, and those tend to be more hedge fund-oriented type organizations. But if you are thinking of the traditional short-term electronic trading guy, I think to have an impact over a couple of minutes, yes. Impact over a day, pretty hard. You know, if you are going to have impact over a day, it has got to be somebody with much deeper pockets.

Chairman REED. Thank you.

Gentlemen, thank you for excellent testimony. I think what you have really exposed is the complexity of these issues, and there are not just one or two. There is a series of interrelated issues. And I think, also, the need to begin to act promptly to address all of these issues, to give the investing public confidence that the system is operating fairly. I think this notion that you said very well, Mr. Brooks, about fairness, I mean, we have recognized benefits, obviously, from the increased liquidity, from the decreased spreads, that now we have to sort of step back and see at what cost and how do we make improvements, not just simply keep pressing along.

I must say, though, I did get some reassurance, with a 5½-year-old daughter, that iTunes does provide a drop copy. Thank you, Mr. Concannon.

[Laughter.]

Chairman REED. I am making a note of that so that we have accomplished one objective today.

But I think, again, just to say, this is an issue that will not go away. In fact, with technology, it will get even more complicated. I am pleased that the SEC is undertaking the technological roundtable, but I would like to be able to, with the concurrence of my colleague, Senator Crapo, do additional hearings, because I think you have raised some extraordinarily complicated issues in a very thoughtful way and we have to do a lot more work, along with the regulators, to come up with sensible responses.

Mr. Tabb, your point, I think, is always well made. Try to do no harm. Try to prioritize changes that are the least disruptive and the most effective, and that is always good advice, so thank you for that.

But, gentlemen, thank you so much. I have one other statement to make for the record.

First of all, I want to thank all of our witnesses for testifying today.

[Laughter.]

Chairman REED. We appreciate both the time and effort that you have made. That should be obvious. Thank you so much.

Now, if you have additional written statements, please feel free to submit them. You may receive additional questions from my colleagues. Please respond as rapidly as possible. I will ask my colleagues to submit their questions no later than next Thursday, September 27, and please respond as quickly as possible to that. If any of my colleagues want to make a statement for the record, it will be included by unanimous consent in the record.

In addition, I ask the statement of Public Citizen be included in the record, and hearing no objection, so ordered.

Chairman REED. With that, thank you very much, gentlemen. The hearing is adjourned.

[Whereupon, at 11:28 a.m., the hearing was adjourned.]

[Prepared statements, responses to written questions, and additional material supplied for the record follow:]

PREPARED STATEMENT OF DAVID LAUER

MARKET STRUCTURE AND HIGH-FREQUENCY TRADING CONSULTANT, BETTER MARKETS

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 Web site, 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 U.S. 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 U.S. 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.

U.S. 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 percent and 75 percent of the market, and the Dark Pools, with 18 tracked by Rosenblatt, account for 12 percent–15 percent. 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 nonlinear systems is difficult or impossible to predict. In the U.S. equity market, we have seen first-hand glimpses of what can happen as overly complex systems interact in nonlinear 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 percent 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 3 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 2011.¹ 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 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 percent–70 percent 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.

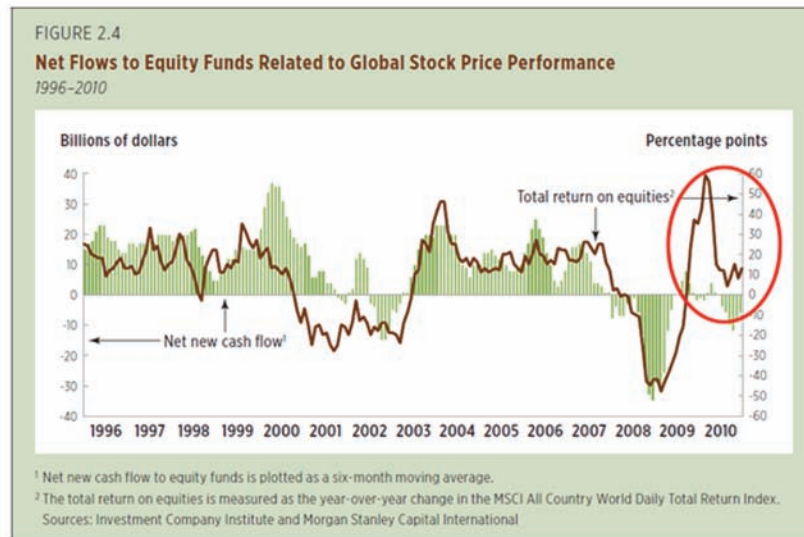
What we must be concerned with is whether the pendulum has swung too far, and whether the nearly unregulated activities of anywhere from 50 percent–70 percent of stock market volume should be permitted to continue down this path. For the proponents of HFT to make the case that the market is functioning well, or that only incremental reforms are needed rather than wholesale changes, they must make the case unequivocally that the market satisfies the aforementioned charac-

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

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

teristics 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.

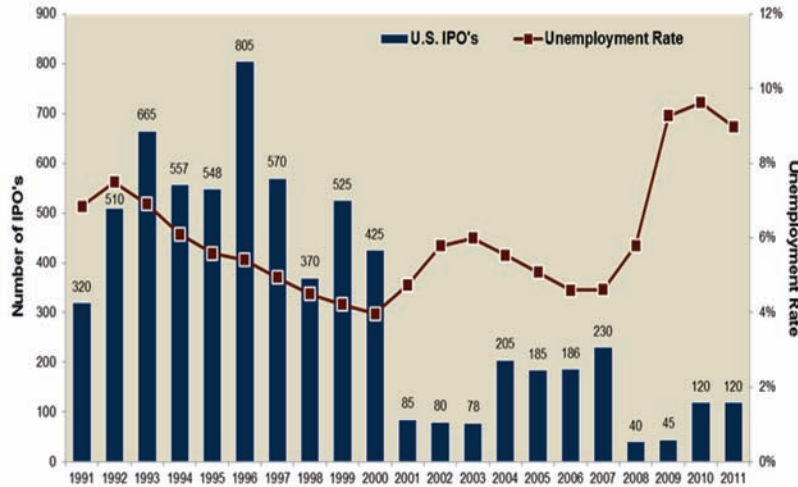
Despite the large quantity of HFT-funded research touting the benefits of HFT (lower spreads, increased liquidity, lower volatility), there are also many research studies that prove the opposite. However, a higher-level debate on the impact of HFT on today's market should also consider the fact that 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 nonexistent, with only 15 percent of the public expressing trust in the stock market in the latest Chicago Booth/Kellogg School Financial Trust Index—8 percent lower than those 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 percent.

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 nonmarket 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 U.S. 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 U.S. 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 time scales, 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 be-

³Smith, Reginald, "Is High-Frequency Trading Inducing Changes in Market Microstructure and Dynamics?" (June 29, 2010). Available at: http://arxiv.org/PS_cache/arxiv/pdf/1006/1006.5490v1.pdf

⁴The 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.

comes 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 nonlinear 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 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 nondeterministic behavior. The “mini flash crashes” that Nanex documents on a regular basis are excellent examples of this nondeterministic 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 nondeterministic consequences, including positive feedback loops in which liquidity is rapidly withdrawn from the market.

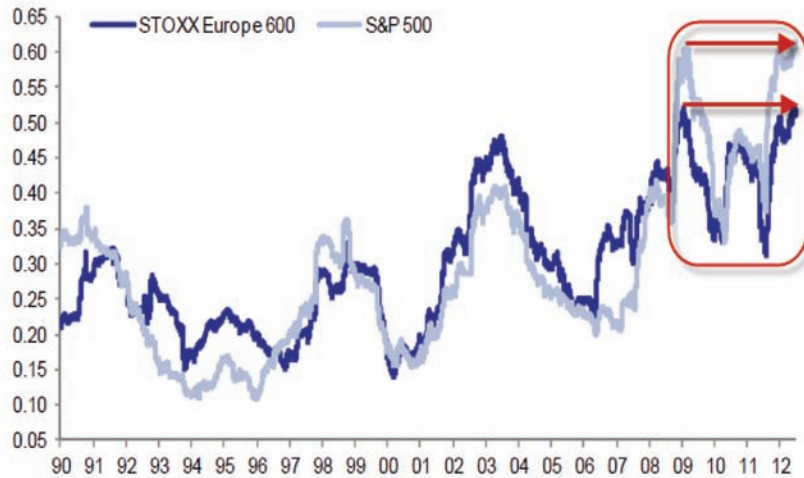
Giovanni Cespa and Thierry Foucault wrote a paper in March, 2012, calling this type of phenomenon an “Illiquidity Contagion.”⁶ They noted that the same type of positive feedback loop I have discussed here can cause a sudden drop in market liquidity, and shift the market to a new equilibria characterized 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:

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

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 JPMorgan, 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 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 em-

⁷JPMorgan, “Why We Have a Correlation Bubble”, <http://www.cboe.com/Institutional/JPMDerivativesThemesCorrelation.pdf>, October 5, 2010.

ployee 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 percent. 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 percent.
- 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 percent, explaining that “78 percent 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 percent.”⁹
- 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 percent to around 4–5 percent now.¹³ They believe the primary reason for this is that the percent of volume attributable to natural buyers and sellers has declined by 40 percent 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

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

⁹ *Ibid.*

¹⁰ Cartea, Alvaro, and Penalva, Jose, “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.

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 percent in the period 2001–2006 to 29 percent since 2008, a decline of 40 percent.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.

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 following:¹⁵

- 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

¹⁴*Ibid.*

¹⁵Ye, 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.*

- 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
- 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 comovement 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 percent 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 comovement 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 percent 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.

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, antifraud 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.

¹⁷ *Ibid.*

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>.

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 uninformed orders for the nondiscriminating dealers to spread their informed losses over. The result of this is a widening of spread charged by the nondiscriminating 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 U.S. 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 the morning, inciting markets around the world to crash, or at 3:45 p.m. 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 U.S. 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

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

²¹*Ibid.*

²²*Ibid.*

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 model:²³

- 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 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.

²³Bessembinder, 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>.

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 one-sixth 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 roll-out, 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 Street is winning easily right now. While the SEC has obvious budgetary constraints, they can get creative about bonuses, potentially offering percent 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.

PREPARED STATEMENT OF ANDREW BROOKS

HEAD OF U.S. EQUITY TRADING, T. ROWE PRICE

SEPTEMBER 20, 2012

Introduction

Chairman Reed, Ranking Member Crapo, and distinguished Members of the Senate Subcommittee on Securities, Insurance, and Investment, thank you for the opportunity to testify today on behalf of T. Rowe Price¹ regarding the effects of recent significant changes in trading technology and practices on market stability. My name is Andrew (Andy) M. Brooks. I am Vice President and Head of U.S. Equity Trading of T. Rowe Price Associates, Inc. I joined the firm in 1980 as an equity trader and assumed my current role in 1992. This is my 33rd year on the T. Rowe Price trading desk.

T. Rowe Price is celebrating its 75th year of advising clients. We are a Baltimore-based global adviser with over \$540 billion in assets under management as of June 30th, 2012, and more than 3 million client accounts. We serve both institutional and individual investors.

We welcome the opportunity for discussion regarding the industry and market practices.

¹T. Rowe Price Associates, Inc., a wholly owned subsidiary of T. Rowe Price Group, Inc., together with its advisory affiliates (collectively, "T. Rowe Price"), had \$541.7 billion of assets under management as of June 30, 2012. T. Rowe Price has a diverse, global client base, including institutional separate accounts;

T. Rowe Price sponsored and sub-advised mutual funds, and high net worth individuals. The T. Rowe Price group of advisers includes T. Rowe Price Associates, Inc., T. Rowe Price International Ltd, T. Rowe Price Hong Kong Limited, T. Rowe Price Singapore Ltd., T. Rowe Price (Canada), Inc., and T. Rowe Price Advisory Services, Inc.

Our firm is particularly focused on the interests of long-term investors. We appreciate the role other types of investors can have in creating a dynamic marketplace. However, as we talk with our clients, there is a growing distrust of the casino-like environment that the marketplace has developed over the past decade. We worry that the erosion of investor confidence can undermine our capital markets, which are so important to the economy, job growth, and global competitiveness. Reaffirming a strongly rooted commitment to fairness and stability of the market's infrastructure is critically important.

Over the past two decades the markets have benefited from innovation from new technology and competition. Generally, markets open on time, close on time, and trades settle. However, there are problems below the surface.

Here are some things we find concerning:

Order Routing Practices

We question the nature of various order routing practices. The maker-taker model, payment for order flow, and internalization of orders all seem to present a challenge to order-routing protocols. Are order routing practices and incentives an impediment to the overarching requirement to seek best execution on all trades?

Colocation/Market Data Arbitrage

We believe that the widespread use of colocation creates an uneven playing field that favors those who can and will pay for it. We question whether this has produced a market that values speed over fair access. In no other regulated industry is one party allowed a head start in exchange for payment. Our understanding is that current colocation practices allow for a market-data arbitrage where some investors get quotations and trade data faster than others. This advantage is traded upon, causing some participants to believe they are victims of front-running or are at least disadvantaged.

Speed and Impact on Market Integrity

Our sense is that the almost myopic quest for speed has threatened the very market itself. It also seems many high frequency trading (HFT) strategies are designed to initiate an order to simply gauge the market's reaction and then quickly react and transact faster than other investors can. This seems inherently wrong. Our understanding is that the continued push for speed is not producing any marginal benefit to investors and in fact may be detrimental. This pursuit of speed as a priority is in direct conflict with the pursuit of market integrity as a priority.

Inaccessible Quotes and High Cancellation Rates

The growth of HFT has led to increased volume; however, whether the corresponding volume is "good" or "bad" deserves analysis. Volume does not necessarily mean liquidity for large institutional investors. When you combine high HFT volumes and even higher cancellation rates, these forces can combine to undermine market integrity and cause deterioration in the quality and depth of the order book. We feel that this volume is transitory and misleading.

Challenges to the National Market System (Regulation NMS)

We believe the original construct of Regulation NMS was laudable and designed to encourage competition. However, we do not believe this regulation contemplated today's highly fragmented marketplace, where we have 13 different exchanges and over 50 unregulated "dark pools." In such a fragmented market, can one really be confident in achieving best execution given the explosion of market data traffic? We question the markets' ability to process the overload of market data.

Conflicts of Interest

We question whether the functional roles of an exchange and a broker-dealer have become blurred over the years and could warrant regulatory guidance regarding the inherent conflicts of interest. It seems clear that since the Exchanges have migrated to "for-profit" entities, a conflict has arisen between seeking volume to grow revenues and their obligation to assure an orderly marketplace for all investors.

HFT Trading Strategies

Professional and proprietary traders often have divergent interests from those of investors concerned about the long-term. When the average holding period for such traders is measured in seconds as opposed to months or years, have we destabilized the market. Given recent market volatility, more study is warranted to assess the impact of the exponential growth of short-term trading strategies. Most rules and regulations seem to further enable those with short term profit incentives as evidenced by the proliferation of new order types suggested by exchanges and approved by regulators.

Suggestions

We believe it is time to step back and examine market structure and how it impacts all investors. A good first step might be to experiment with a number of pilot programs to examine different structural and rule modifications. We suggest a look at the appropriateness of colocation as a general practice and enhanced oversight of high frequency trading and other strategies that might be unduly burdensome to overall market functionality. We would like to see a pilot program where all payments for order flow, maker-taker fees, and other inducements for order flow routing are eliminated. We envision a pilot where there are wider minimum spreads and mandated time for quotes to be displayed to render them truly accessible. These programs can include a spectrum of stocks across market caps and average trading volumes, among other factors. We also suggest a pilot program of imposing cancellation fees for unacceptable trade to cancellation ratios. A key question is should we foster consolidation in this fragmented market? At a minimum, should we raise the barrier for becoming an exchange? In our opinion, requiring a more robust testing for new software would seem to make sense.

Conclusion

T. Rowe Price appreciates all the efforts of the SEC and Congress as we strive to make the markets better and fairer for all participants. The Consolidated Audit Trail, Large Trader ID, limit up/down initiatives are all improvements. We suggest any regulatory proposals be aligned with a goal of making the markets simpler, more transparent, and less focused on speed. We applaud the Committee's interest in making sure the right questions are asked.

There are currently over 1,000 order types to express your buy and sell interest and we suggest that a simplified model may be more efficient for all investors. The issues we face are enormously complex. We certainly do not have all the answers. We believe that it is time to revisit the historical responsibility to provide a fair and orderly market.

T. ROWE PRICE ASSOCIATES, INC.

WWW.TROWEPRICE.COM



PO. Box 89000
 Baltimore, Maryland
 21289
 100 East Pratt Street
 Baltimore, Maryland
 21202-1009
 Phone 410-345-2000

August 30, 2010

Elizabeth M. Murphy
 Secretary
 Securities and Exchange Commission
 100 F Street, N.E.
 Washington, D.C. 20549-1090

Re: Ms. Murphy

Dear Ms. Murphy:

T. Rowe Price Associates, Inc. and its affiliated registered investment advisers (collectively, "T. Rowe Price")¹ appreciate the opportunity to provide the Securities and Exchange Commission ("SEC" or "Commission") with thoughts and concerns regarding the conditions we currently see in U.S. and Global markets, especially in light of the events of May 6th. Besides the significant erosion to investor confidence, this event exposed a troubling lack of a market-wide commitment to fairness and equal access.

T. Rowe Price believes the current market structure is increasingly oriented towards short-term traders. These traders appear to have little motivation to contribute to what efficient and reliable capital markets were designed for: transferring capital from investors to businesses.

Below we identify some of the issues that have made us increasingly concerned about both the fairness and quality of our markets.

Liquidity and High-Frequency Trading (HFT)

The growth of High-Frequency Trading ("HFT") has led to increased liquidity; however whether the corresponding liquidity is "good" or "bad" deserves analysis. HFT volumes are estimated to account for 73%² of total daily trading volume. This volume does not represent liquidity in the traditional sense. We feel that its very nature is transitory and

¹ T. Rowe Price Associates, Inc., a wholly-owned subsidiary of T. Rowe Price Group, Inc., together with its advisory affiliates, had \$391.3 billion of assets under management as of June 30, 2010. T. Rowe Price has a diverse, global client base, including institutional separate accounts; T. Rowe Price sponsored and sub-advised mutual funds, and high net worth individuals. The T. Rowe Price group of advisers includes T. Rowe Price Associates, Inc., T. Rowe Price International, Inc., T. Rowe Price (Canada), Inc., and T. Rowe Price Global Investment Services Limited.

² See Rob Iati, *The Real Story of Trading Software Espionage*, *AdvancedTrading.com*, July 10, 2009 ("For example, high-frequency trading firms, which represent approximately 2% of the 20,000 or so trading firms operating in the U.S. markets today, account for 73% of all U.S. equity trading volume.")

misleading. This may lead to an erosion of confidence and exacerbates uncertainty in the market.

HFT traders also have an exceptionally high cancelation rate (over 90%),³ which can lead to market dislocation during “fast markets”. We suggest a system whereby fees for cancelled orders are imposed. As HFT has grown, we are of the opinion there has been a corresponding deterioration in the quality and depth of the order book, which is detrimental to both the market and long term investors. The fees assessed for cancelled trades could be scaled and become more punitive as cancellation rates are found to be systematic or persistent. Currently 4 options exchanges (NYSE AMEX, PHLX, CBOE, and ISE) charge members for cancellations in excess of customer orders. We would encourage the commission to analyze the potential impact of instituting this type of policy within the equities market.

Latency and Co-Location

We believe the widespread use of co-location creates an uneven playing field that favors those who can and will pay for it. Though we certainly support innovation, we question whether such progress has produced a market that values speed over fair access. In no other regulated industry is one party allowed a head start in exchange for payment. Our understanding is current co-location practices allow for a market-data arbitrage where some investors get quotation and trade data faster than others. This advantage is traded upon, causing some participants to feel they are victims of front-running or are at least disadvantaged. One suggestion might be to impose rules to increase minimum time quotes that must be displayed.

Transparency

We strongly believe that regulators must be able to reconstruct a day’s trading events across multiple asset classes in a timely manner. The current lack of transparency leads to a convoluted picture of market structure. We found it very troubling that no regulatory body could recreate the events that led up to May 6th’s flash crash in specific names. An end-of-day, consolidated audit trail, which captures all trade orders, trade venues, trades in correlated instruments, and trader identities, is a necessity. This would allow regulators to monitor markets for illegal activity harmful to investors and identify firms utilizing predatory trading strategies. The information should only be made available to those entities responsible to regulate the markets. Furthermore, the SEC should consider the impact of single stock circuit breakers on equity derivative products (ETF’s, Futures, Index Options).

Order Routing Practices

The Maker/Taker model, payment for order flow, and internalization of orders all seem to present a challenge to order-routing protocols. We question whether or not this incentive

³ <http://www.sec.gov/rules/concept/2010/34-61358fr.pdf>


challenges best execution obligations. The activity on May 6th may suggest there is a disconnect between the quest for speed of execution, and best execution. We would especially like to bring attention to the conflicting incentive that Maker/Taker pricing creates for brokers. By having such a large difference in trade execution economics, we ask the commission whether brokers will continually be routing client orders to seek best execution or possibly be swayed by the pure economics of the Maker/Taker model.

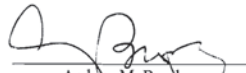
Conclusion

As we work together towards an environment committed to fairness and equal access, it is important to remind ourselves that both practitioners and observers are frustrated by the current workings of equity markets. Order routing practices, quote volatility, and unequal dissemination of market data have caused investors to fear front running and other manipulative practices. We believe that it is time to revisit the historical responsibility of how to provide a fair and orderly market in an electronic, screen-based marketplace.

It is critical for us to avoid a repeat of May 6th. We further urge you to work with international regulators so we can all improve market structure on a global basis and across asset classes. Global cooperation would help ensure that this commitment to fairness and access is adopted more broadly. We appreciate the opportunity to comment on overall market structure and share the Commission's goal of fair and orderly markets.

Sincerely,


 Clive Williams
 Head of Global Equity Trading


 Andrew M. Brooks
 Head of US Equity Trading


 Christopher P. Hayes
 Sr. Legal Counsel

cc: Robert W. Cook, Director of Trading and Markets
 Buddy Donahue, Director of Investment Management Division

PREPARED STATEMENT OF CHRIS CONCANNON
PARTNER AND EXECUTIVE VICE PRESIDENT, VIRTU FINANCIAL, LLC
SEPTEMBER 20, 2012

Chairman Reed, Ranking Member Crapo, and Members of the Subcommittee, I want to thank you for the opportunity to appear before you today. My name is Chris Concannon and I am an Executive Vice President for Virtu Financial, LLC.

Virtu Financial ("Virtu" or the "Company") is a global electronic market maker. Virtu is an active market maker on more than 100 markets around the globe. Virtu makes markets from our six offices in New York, Los Angeles, London, Dublin, Sydney, and Singapore. The Company's market making activity spans across multiple asset classes, including cash equities, fixed income, currencies, futures, options, energy products, metals and other commodities. Virtu, through its subsidiaries, is directly registered as a broker dealer or investment firm and operates as a registered market maker on most primary markets around the globe. In the U.S., Virtu operates two registered broker dealers that are also registered as market makers or designated market makers on the NYSE, Nasdaq, BATS Exchange, NYSE Arca, and NYSE MKT. In Europe, Virtu operates a registered investment firm that is also registered as a market maker on the London Stock Exchange, the Swiss Exchange, Euronext, and the Deutsche Bourse Exchange. Obviously, Virtu believes in the benefits of market making and is committed to providing continuous, obligated liquidity in the markets we serve.

In discussing the state of the U.S. equity market, I start from the premise that our equity market is the most dynamic and efficient market in the world. The U.S. equity market is a special asset that should be celebrated. Our markets are envied by Nations and financial centers around the globe. Our U.S. equity market is also the most liquid and robust pricing mechanism on the planet. My firm trades across all of the major financial markets and no market can compare to the U.S. equity market in terms of pricing efficiency and liquidity. Companies listed on our U.S. markets enjoy the most efficient and liquid market which contributes to higher returns for their investors. Over the last 4 years, I have witnessed an unprecedented number of claims that our markets are horribly broken, unfair and dangerous. These claims tend to be short on facts and evidence, but long on press coverage and book deals. Our market is not perfect. And it has recently experienced some dramatic mishaps. But, despite its flaws, it is a market that has withstood the most unprecedented volatility and repricing of equity values in our lifetime while maintaining the same levels of pricing efficiency.

Let me be clear, our market is not perfect. It has flaws and unnecessary complexity. The U.S. equity market is overly fragmented and, likely, over engineered. Stocks in the U.S. trade electronically on 13 national securities exchanges and over 40 dark pools. The current state of our equity market is not one that we would set out to design if we did it all over again. The U.S. equity markets began evolving into a fully electronic market during the 1990s. For the last decade, our markets have been largely automated. That means every exchange and every market in the U.S. is a fully automated, electronic destination. Virtually every order arrives at its intended exchange in electronic form. The automation that exists in our market today is not a new phenomenon. Technology has been operating our markets for the last 15 years.

With fragmentation and technology comes complexity. Our market is one of the most complex securities markets on the planet. It is not naturally complex. It is complex because of the number of major regulatory reengineering events that have taken place in the U.S. over the last 15 years. For example, the list of major market structure rule changes includes the Limit Order Display Rule, Regulation ATS, Decimalization, T+3 Settlement Cycle, Regulation NMS, Regulation SHO, Single Stock Circuit Breakers and, more recently, the Market Access Rule. Each of these major regulatory reengineering events required substantial technological enhancements to be delivered by all industry participants and exchanges. These were not simple software programming endeavors. These were all major technology projects completed across the industry.

I would like to focus on three areas that I believe deserve further review: (1) our choice of a single market structure for all listed companies; (2) our markets failure to enhance market maker obligations; and (3) the industry's current risk management standards.

First, our market is currently designed as a "One-Size-Fits-All" market. What I mean by this is that most of our major market structure rules do not distinguish between the size or market capitalization of the listed company, or the trading characteristic of its stock. Our markets are designed to execute all stocks, regardless of

shape or size, using the same market mechanism. As the list of public companies continues to grow, a more diverse number of public companies trade on our market while subject to the same market structure. A stock that trades once per day is traded in the same market structure as a stock that trades one million times per day. Our market is solely designed for Cisco, Microsoft, and Bank of America and not for a stock that trades by appointment. I believe we should revisit our current market structure in order to create a better pricing mechanism for all stocks of different shapes and sizes. This One-Size-Fits-All approach is further exacerbated by an expansion of the portfolios of our largest investors. As institutional holdings expand further into less liquid stocks, like Russell 2000 stocks, our largest institutions are struggling to trade in our poorly designed market structure for those types of stocks.

My second area of focus is on our markets' failure to enhance market making obligations. While my firm is a market maker and it is easier for me to call for enhanced market making obligations, I fundamentally believe that we need to increase obligated liquidity in our markets. Flash crashes, miniflash crashes and other market disruptions demonstrate the need for additional obligated liquidity in our market. However, I believe enhanced market maker obligations should be targeted where they are most needed and that is in our less liquid stocks. And so, my earlier point about our flawed, single market structure should be considered with enhanced market making obligations as a component of a new market model. New market models for less liquid stocks should be accompanied with enhanced market maker obligations.

My final area of focus is the industry's current risk management standards. In light of recent events, I believe that the industry should explore ways to improve risk management standards. Industry participants have already identified several areas of risk management enhancements that should be implemented and could be delivered in short order. First, pretrade risk management limits are already required by the Securities and Exchange Commission (SEC) under SEC Rule 15c3-5 (also known as the "Market Access Rule"). Under the Market Access Rule, which has been in effect for over a year, firms are required to establish pretrade credit limits for every customer account and for the firm's own proprietary account. The credit limits required by the Market Access Rule must be administered in real-time and at all times. These credit limits are a firm's primary defense against unwanted trading activity by the firm or by its client.

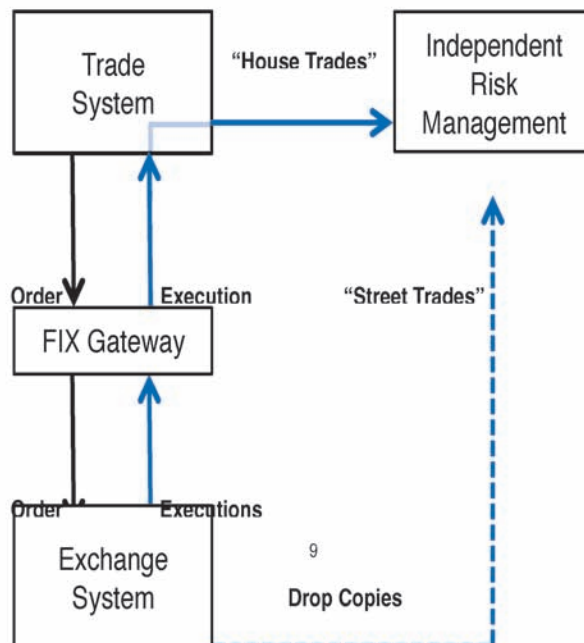
In addition, the industry is currently exploring specialized "Kill switches" that would be administered by exchanges. These "Kill switches", as currently being discussed, would provide a systematic shut-off of a firm if it exceeded prescribed or pre-set trading limits. "Kill switches" would not be a primary defense, but rather, a secondary defense to back stop the failure of other risk management measures operated by a firm. Kill switches have operated effectively on futures exchanges in the U.S. for many years. These same trading limits could be implemented across all U.S. equity exchanges. Like the futures exchange limits, firms would be required to establish limits on each equity exchange. Such a kill switch would have severely limited the damage done on August 1st of this year.

The last component to enhanced risk management is one of the most important. We believe a simple feature referred to in the industry as "drop copies" should be required as a mandatory risk management tool. "Drop copies" are separate and distinct connections offered by exchanges and other markets. Drop copies, which are widely used by the industry, provide a real-time echo, or copy, of a firm's trading activity on a given exchange. Drop copies are primarily used by the industry to run reconciliations that compare a firm's known trading activity against what the exchange believes was traded by the firm. This is commonly referred to as a "*Street vs. House*" comparison. If such a drop copy comparison is conducted in real-time by systems that are independent from the firm's trading system, a firm will always have an accurate assessment of its positions and trading activity, including both intended and unintended activity (See, Exhibit I).

While I believe firms should have a robust process for developing and testing new software, the industry must have advanced risk management systems to limit the risk of unintended trading activity by a firm or its client. We know with certainty that software has bugs, hardware crashes and networks go down no matter the robustness of a firm's development and infrastructure process. The industry must build risk protections that assume the worst while a robust development and testing process avoids the worst. Pretrade risk checks, "Kill switches" and real-time drop copies protect us from the worst events.

Thank you again for the opportunity to be here today to speak on this subject. I would be pleased to answer the Committee's questions.

Exhibit I



PREPARED STATEMENT OF LARRY TABB
FOUNDER AND CHIEF EXECUTIVE OFFICER, TABB GROUP
SEPTEMBER 20, 2012

Written Testimony to the
United States Senate
Committee on Banking, Housing, and Urban Affairs
Washington, DC

September 20, 2012

By
Larry Tabb
CEO
TABB Group

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Question One:

What are the benefits of automated trading of securities in our marketplace? Are there any disadvantages?

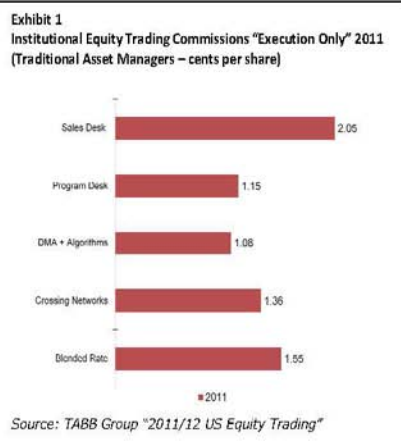
First, virtually all equity trading in the US is automated. From the 100-share order entered via the online broker to the million-share order executed by the largest global asset managers, each and every order goes through a very sophisticated electronic execution process that encompasses: (1) a complex market data aggregation process; (2) the routing of the order from the investor to a broker; (3) the possible electronic internalization of that order at the broker; and (4) a sophisticated smart-order-routing process to send unexecuted orders to Automated Trading Systems (ATSs) and/or exchanges for execution. In addition, there is a very sophisticated and electronic market-making process that allows investors, traders, and market makers to interact with incoming orders so they are executed efficiently and smoothly.

Advantages

The benefit of this electronic execution framework is the efficiency and the cost. Institutional investors pay in the area of 1.08 cents per share for more self-directed orders and 2.05 cents for orders that need more assistance (see Exhibit 1). Retail online investors are paying \$8 to \$10 a trade, regardless of the number of shares traded. The timeliness of execution is currently measured in milliseconds (thousandths of a second) and increasingly in microseconds (millionths of a second). Prior to the implementation of Reg NMS in 2007, the execution speed of the NYSE was greater than 5 seconds. While the difference between milliseconds and

microseconds may not seem significant, the difference between milliseconds and seconds can be huge. Many things can happen in 5 seconds, and most of them are good for investors. Today, even online retail investors can obtain real-time market data, and can execute orders within a small fraction of a second. Unless the order is very large, it can receive sub-second execution at or better than the best bid/offer (NBBO) displayed in the market and all for under \$10 a trade. This could not happen without significant automation.

In addition, the electronic marketplace has made the marketplace overall more efficient, measured by volume traded. High-speed computers are continuously analyzing millions of quotes a second and looking for incorrectly priced assets, buying the theoretically cheaper ones, and selling the more expensive ones to bring prices in line. This is done on a millisecond basis between index futures and ETFs, equity options, and their underlying equities.



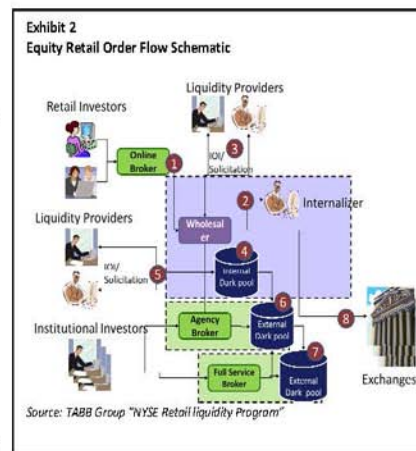
This process, when markets are not in turmoil, efficiently absorbs both news and supply-and-demand information and effectively prices assets according to market conditions. Automation is the lubricant that makes this process efficient and seamless.

Disadvantages

Complexity

Our fully automated markets are overly complex. There are 13 registered stock exchanges and 30 or more major ATs, as well as four major wholesalers (brokers that buy orders from retail brokers) and a number of internalizing brokers. Getting buyers and sellers to effectively meet (trade) becomes a very complex and sophisticated task, when there are dozens of venues that could house the buyer to your seller, or vice versa. Brokers need sophisticated smart-order-routing technologies to find the other side of the trade.

This execution process typically includes: (1) determining if the broker wants to trade against the order (which is legal, as long as the execution price is at or better than the NBBO); (2) matching the order in the broker's ATS (dark pool); (3) soliciting other clients to trade against the client order; (4) routing the order to other brokers' ATSs; and (5) having other brokers solicit possible contra orders. If all else fails and the broker cannot find the other side of the trade, they then send that order to an exchange. If the exchange can't match the order at the best price, the exchange is mandated to route that order to the exchange displaying the best price (see Exhibit 2).



While this process is overly complex, the time scale of this activity typically happens sub-second. While complex this process is efficient, cheap, and fairly effective.

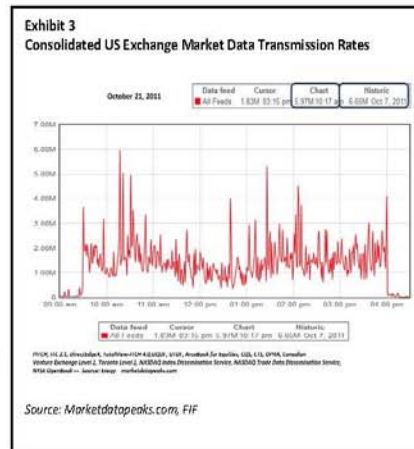
The downside to this electronic messaging is threefold:

- 1) **Information leakage.** Because orders are pinged around various brokers, ATs, clients, and subsequently exchanges, at each place that a message stops, it disseminates a little information. If you are listening to this information, you can discern trends very quickly. When you can spot a large buyer, it becomes easier to aggressively buy ahead of the investor, pushing the price away from that investor, and then subsequently sell it to the investor at a higher price. The same process works for sellers as well. Now this process does not generally impact retail investors, as their orders are generally not large enough to push

the market; however, it is very impactful to larger investors (which actually invest the bulk of individuals' assets through mutual funds, pension funds, and professionally managed accounts).

2) Market data distribution and management.

The amount of market data that is processed on any given day is voluminous. Currently, on an average day the US exchanges can produce a peak level of 4 million to 5 million messages per second (over a minute). The peak messages-per-second level was hit on 10/7/11 at approximately 6.6 million messages (see Exhibit 3). This data must be managed, analyzed, and stored. In addition, if one of the exchanges has market data problems (the feed can go down, incorrect time stamps, etc.), it can create catastrophic problems, as people are no longer analyzing data and submitting orders; machines are spitting out orders automatically depending upon the market data. If the market data is wrong, unless the data is really wrong, the trading engines assume it is right and trade accordingly. This was a contributing factor to the May 6th 2012 Flash Crash¹.



- 3) Market data arbitrage. Because the markets are fully electronic, small time increments, irrelevant to humans, become trading opportunities. These opportunities are hard, if not impossible to eliminate. It takes light (data through fiber optics) approximately 1 millisecond to go 100 miles, or 1 microsecond to go about 0.1 mile. Given that the NYSE and NASDAQ data centers are about 41 miles apart, it takes about 0.4 milliseconds for data to get from one venue to the other. For humans, this gap would be infinitesimal; however, for machines, it becomes an opportunity, and for some investors this gap can be a significant challenge. Firms that are co-located (have their trading technology at or very close to the exchange) and obtain data directly from that exchange, will have at least a 0.4 microsecond advantage over a firm that uses the aggregated market data feed provided by the Consolidated Tape Association/Securities Information Processor (CTA/SIP). The aggregated feed will always be slower than a direct feed, because the aggregated feed receives data from *all* the exchanges, aggregates and normalizes that data and distributes it. The aggregated feed must wait to obtain data from all sites before it distributes it, while a

¹ Findings Regarding The Markets Events of May 6th 2010, REPORT OF THE STAFFS OF THE CFTC AND SEC TO THE JOINT ADVISORY COMMITTEE ON EMERGING REGULATORY ISSUES - <http://www.sec.gov/news/studies/2010/marketevents-report.pdf>

direct feed just pumps data out of the exchange directly from the matching engine (where it is created). Even if direct feeds were banned, firms that were closer to the dissemination point (because of the speed of light issue) would be able read and act on this data faster than a firm with a data center a mile away, 6 miles away, or 3,000 miles away in California.

In addition, given the message pinging that occurs, once a trend is spotted, there is ample time for very quick trading machines to react to this information.

Fragmentation and Time Priority

The fragmentation of the markets has been both good and bad. Historically, when the NYSE had the dominant share of NYSE-listed market activity, the NYSE acted like a monopoly. Execution times were long, costs were high, and institutional investors were not happy with their execution quality. In 2004, TABB Group did our first study of institutional investors, and 71% of the institutional investors' traders we interviewed responded that the NYSE specialist and market structure was their most significant challenge in trading the US markets (see Exhibit 4). Monopolies do not have any incentive to be efficient.

The implementation of Reg NMS changed this. It forced the NYSE to compete against other exchanges for market share. This caused the NYSE to lower cost, streamline their technologies, and expedite their average execution time from approximately 11 seconds, circa 2005, to under a millisecond today. This is a good thing.

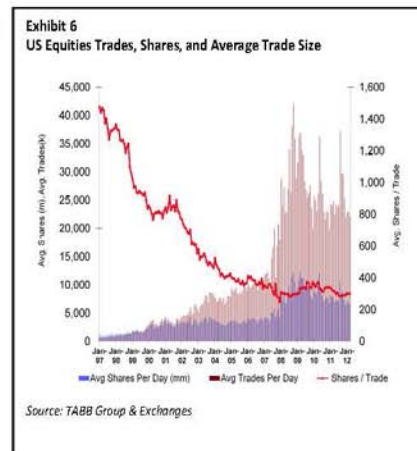
The problem, however, is that once there are multiple places to trade, liquidity gets spread out among exchanges, the time arbitrage play becomes more significant, trade size declines, and time priority becomes meaningless.



If there is only one order book, the trade at the top of the book needs to be cleared (fully executed) before the next trade can be started. This incentivizes larger orders, because the only way to go around the large order is to pay more or sell for less. Once there are two places to trade, the large order can be easily bypassed (see Exhibit 5). This changes the incentive structures. Once there are two places to trade and an order no longer has primacy, then size is no longer an incentive, speed is. If an order can be traded around, then orders will become smaller, so it is harder for others to guess my intention. Orders will also need to be more nimble; execution infrastructures will need to analyze the different venues to determine where it is easier to be on the top of the book, and which orders also have a higher probability of being executed.

With the creation of multiple trading venues comes a need for market synchronization or arbitrage. This process ensures that the price of an asset trading over multiple venues is consistent. In this day of computers and high-speed connectivity, a fragmented market means that high-speed, low-latency machines are needed to trade between the markets in order to keep prices aligned.

This market structure also forces trade size to decline and message speed and rates to increase. This is exactly what we have seen in the US markets. The average trade size currently is approximately 300 shares, down from about 1,500 shares per trade in 1997 (see Exhibit 6). This trend also highlights the perverse issue that the large orders we see in the market are most typically retail individual investor orders, instead of orders from large investment managers who typically slice and dice their hundred-thousand and million-share orders into 100-share and 200-share lots.



The challenge is, what level of fragmentation is appropriate? Do we want a monopoly that has no incentive to lower price and increase efficiency? Or do we want a single venue to promote a more fair and egalitarian market? These are very challenging questions without a right or wrong answer.

The real question becomes, if we do remain fragmented, how do we promote innovation, without creating an unfair playing field?

Averages Cover a Multitude of Issues

Market makers and many traders with short time horizons are typically profiting by capturing a spread. They try to buy at the bid and sell at the offer. Traders using this strategy are more interested in the volume of shares traded than the actual price of the stock. A stock that trades 10 million shares is better than a stock that only trades 1,000 shares, even if the spread of the less-liquid stock is \$0.25 or even a full \$1.00, while the spread of the more-liquid stock may only be \$0.01. That is because 10 million x \$0.01 (\$100,000) is a lot more than 1,000 x \$0.25 (\$250) or 1,000 x \$1.00 (\$1,000). So market makers tend to be more active in higher volume (more-liquid) stocks.

Historically, when the exchanges had more control of which firms had the best trading economics, the exchanges forced these firms (which were market makers) to cover both more- and less-liquid stocks. They tended to make money on the more-liquid stocks, break even on stocks with a moderate amount of liquidity, and they lost money on less-liquid stocks (no matter how wide the spread).

As the economics of trading has changed, and exchanges have moved from industry utilities to for-profit exchanges, new non-market-maker electronic traders have been able to trade as efficiently, and in many cases more efficiently than traditional market makers.

This creates problems for less-liquid stocks. Because the economics are better for highly-liquid names, non-market-maker electronic trading firms quickly moved into the more-liquid names and ignored the less-liquid names. This undercut the profitability of formal market makers by hurting their profitability in their most profitable names (stocks). If market makers can't make money in their most profitable names, then they surely can't make money in their least-liquid stocks. This makes it difficult for traditional market makers to survive, making it harder to provide liquidity for less-liquid/small-cap names.

This creates a market structure where the most liquid names are traded very efficiently, with tight spreads and low costs. This is good. Because these are the most liquid names it also makes the overall market statistics look very good. However, the less-liquid names become very hard to trade. The least bit of activity causes significant price volatility, and makes it harder for investors to either get into or out of these stocks.



The more difficult to get into or get out of these stocks, the harder it is for larger institutions to take positions in these stocks, and hence they shy away from buying them altogether.

While this should create buying opportunities for undervalued stocks, unfortunately, for whatever reason, it has caused a consolidation of the number of publicly traded companies. The number of publicly traded companies has declined from approximately 10,000 in 1997 to under 5,000 today (see Exhibit 7). Now there are many other reasons why companies are not going public besides market structure issues; however, there have been a number of papers written on this impact and the recently passed JOBS Act tasked the SEC to investigate widening the spread for less-liquid stocks to better understand this challenge².

Exchange Rebates and Sub-Pennies

Part of the market structure debate is the exchange rebate strategy. But to understand rebates, one needs to understand limit orders. Limit orders are like advertisements reinforced by regulatory edict. The customer looking to execute in the market is obliged by regulation (Reg NMS) to go to the exchange displaying the best advertised price. Even if the customer goes into the wrong store looking to buy the product at a higher price, the store is not only obliged to direct that customer to the store with the cheapest price, but they are mandated to actually take them to the competing store with the best price (or at least a store matching the best price). This was the key Trade-Through mandate implemented as part of Reg NMS.

Having the best price is a critical aspect of exchange competition and can significantly swing exchange market share.

Exchange competition is so fierce (see Exhibit 8), that many exchanges pay their merchandisers a small fee to advertise at their store. The equities market is so efficient (especially in highly liquid names) that this small fee can tip market makers' and High Frequency Traders' (HFT) profitability. In addition, the fee/rebate structure also creates incentives to brokers to route their orders to various exchanges.



² "A wake-up call for America," By David Weid and Edward Kim, November 2009, Grant Thornton, http://www.gt.com/staticfiles/GTCom/Public%20companies%20and%20capital%20markets/gt_wakeup_call.pdf "Market Structure Issues and Impact On Initial Public Offerings", SEC Advisory Committee on Small and Emerging Companies, June 8, 2012 - http://www.sec.gov/news/otherwebcasts/2012/weid_060812.pdf

Many people fault the rebate structure and align it with the increase in high-frequency trading. Personally, I look at the rebate structure as a way to populate exchanges' order books and promote exchange competition. If exchanges didn't offer rebates, the traders would just widen their spreads to capture the same amount of profit.

Another way to look at exchange rebates is through the lens of sub-penny pricing.

Under Reg NMS the SEC banned the listing of limit orders in sub-penny increments (e.g., \$ 10.002). Depending upon the aggressiveness of the market makers, quoting the fee/rebate dictates the net spread capture the market maker can achieve. So by having a 28-mil (28 cents per 100 shares) take fee and a 25-mil rebate means that the actual spread is no longer 1 cent and that the realized liquidity provisioning spread is 1 cent plus \$0.25 x 2 or 1.5 cents (1 penny spread plus two 25-mil rebates) and the realized take spread is 1.56 cents (1 penny spread plus two 28-mil take fees) with the exchange pocketing the \$0.06 cents.

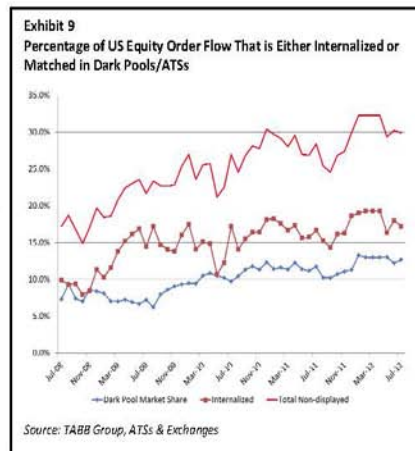
These rebates allow the market makers, liquidity providers or HFTs to quote more aggressively. So even if they both buy and sell at the same price, if they provide liquidity on both the buy and the sell, they can still make 5 cents per 100 shares. Most institutional and individual investors, however, do not pay this fee. This fee generally goes to the broker who routes that order.

Does this rebate promote more trading? Yes it does. But it promotes the posting of limit orders, which is like inventory and advertising to a store. A store without anything on its shelves or no way to advertise will have a harder time attracting customers. And it is the customers who benefit from the tight pricing and the full shelves.

Dark and Internalized Order Flow

Approximately 30% of US Equity order flow is executed off exchange. This is up from approximately 18% in July 2008. This flow is either being internalized by brokers or being matched in ATSS/dark pools (see Exhibit 9).

A significant amount of retail order flow is internalized by wholesalers, meaning that the broker responsible for executing these orders can buy (or sell) the retail order as it comes from the investor, at or better than the prevailing price (see Exhibit 2). Over the past year or two, the amount of flow that brokers internalize



has hovered in between 15% and 20% of total US equity volume. In addition, approximately 13% of order flow is matched in ATSS or dark pools. ATSS are automated matching systems that allow a broker's customer's order flow to interact, meaning two customer orders (buy and sell) can match directly within the ATSS. While many ATSS cater to the matching of illiquid stocks, the largest ATSS have become so significant that as much as 50% of the volume of some of the most liquid equities are traded in the dark.

Many institutional investors prefer that their order flow be matched in the dark (which mostly happens outside of exchanges – even though exchanges can match), because it disseminates less information. In addition, since brokers (and hence ATSS) see orders before they reach the exchange, brokers and hence investors who trade in dark pools have access to order flow in advance of the exchange. This is all perfectly legal under SEC rules.

ATSS and dark pools were initially created to help institutions match larger orders, however the average order size in many ATSS is approximately the same size as orders in traditional exchanges. In addition, many of the largest ATSS do not let their competitors into each other's ATSS directly, they do let many non-competitive liquidity providers in and they do let competitors in via third-party independent brokers so increasingly, ATSS and exchanges look very similar, except that exchanges have a much higher regulatory obligation than ATSS and internalizing brokers.

While exchanges cannot quote in increments smaller than 1cent, ATSS have a much easier time matching at sub-penny increments. In addition, ATSS do not need to publish their matching rules, order types, or even their volumes, in fact, ATSS anonymity is protected by SEC under Reg ATS, so there isn't a single consolidated list of ATSS and the SEC will only provide the information under a Freedom of Information Act filing.

For-Profit Exchanges

For-profit exchanges are another aspect of our markets. In the era of member-owned exchanges, the members owned the exchange. While exchanges could make rules that benefited the owners (and many times they did), they were not profit-oriented. They made rules that benefited the members, which had diversified business models: some were specialists, some were brokers, some were agency traders, and some traded for their own accounts. They had a collective interest in a diversified book of business which represented their true businesses (retail and institutional brokerage as well as investment banking), not just their trading businesses. This pushed the exchanges to care about trading across the large, medium and small-capitalized stocks, as well as promoting the development of new companies within the markets and growing smaller companies into larger ones.

Now exchanges are public for-profit entities. They don't have members; they have shareholders, to whom the exchanges are responsible to maximize returns. In this era of fewer IPOs, it means that exchanges make money from trading, market data, and selling technology. Since the bulk of the trading is generated by the high-frequency

traders in the most highly-liquid stocks, the exchange has the incentive to ignore less-active traders and less-liquid stocks.

Now, I would virtually guarantee that no exchange will say that they are ignoring vast market segments; however, when they change pricing strategies, create new markets, or add new order types, they are not discussing these issues as thoroughly with investors (who are not exchange customers) as they are with their largest "liquidity providers" (who are more likely direct exchange customers) and provide the majority of their quotes.

Order Types

An order type is an electronic message that tells the exchange how to handle a specific order. The simplest orders are limit orders and market orders. A market order tells the exchange to buy a product at the current price. A limit order tells the exchange to only trade this order at a specific price and to display that price out to the market. While market orders and limit orders are the simplest order types, there are dozens of order types that range from hidden (non-displayed), floating (move with the market), midpoint (trade between the best bid and offer), and others. Some order types are very straightforward and easy to understand. Some are not.

Some of these message types are very arcane, and while the exchanges are obliged to post these order types, many are not thoroughly described and may not behave like you would think they would. Depending upon the exchange and order type, there may be clear advantages and/or disadvantages to using them and unfortunately, learning the intricacies of some of the more arcane order types is not easy and anything but straightforward.

Dark Pool Order Types and Matching Priorities

While order types and price/time priority in exchanges may be complex, arcane and not thoroughly described, the matching methodologies in ATSs are not even posted. ATSs are not required to post or even describe to their clients their matching or routing methodologies. TABB Group has been following many of the dark pools in the US markets for years many of whom report their volumes to us on a monthly basis, and never has a single ATS or dark pool been 100% transparent (to our level of confidence) as to how their ATS precisely operates. Many of the ATS/dark pool operators believe that their matching methodologies are proprietary and hence confidential, so that they don't let us know exactly how they operate. Most firms, however, do have discussions with their largest clients about routing and matching methodologies. However, if you are not in that small cadre of highly prized clients, it is very difficult to follow how orders are matched within ATSs and where orders are routed if they are not matched.

Question Two:

Does the current market structure allow all investors to participate in the market meaningfully and fairly? Why or why not? Are additional measures needed and appropriate to improve the integrity of our market structure?

Fairness of the Current Market Structure

The current market structure benefits smaller investors. It also benefits technologically sophisticated institutional investors, and investors that choose/partner with more technologically sophisticated brokers.

Smaller individual investors (those placing their own orders into the marketplace via online brokers) have never had a more efficient and inexpensive marketplace. Many studies have stated that not only are equity commission rates very low (under \$10) but spreads in the US markets (up until this year), are historically low. Individual investors, as long as they are not buying sizable positions receive quick and inexpensive executions.

Day traders are completely disadvantaged. Any individual (without very sophisticated infrastructure) looking to trade the market with a relatively short time horizon (minutes, hours, and maybe even a few days) is completely out-gunned. Day traders are competing with a large number of sophisticated traders and investors armed with the fastest computers, and very sophisticated analytics. The chances of a day trader consistently profiting off the market, is very small. They would have better luck doing fundamental analysis and making more intermediate and longer-term investments.

Larger investors (who are managing the bulk of individual investors' assets through mutual funds, pensions, and professionally managed accounts) do not have it so easy. As mentioned above, because of the fragmentation of the markets, it becomes easier to spot larger investors, and to disadvantage their execution.

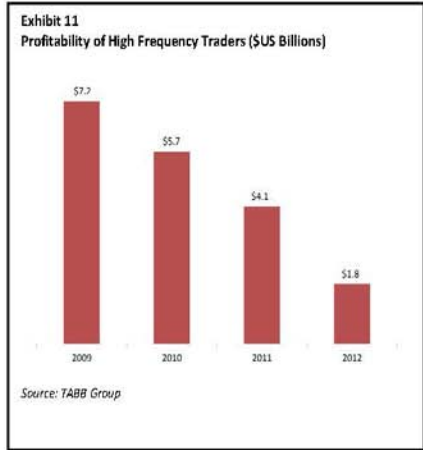
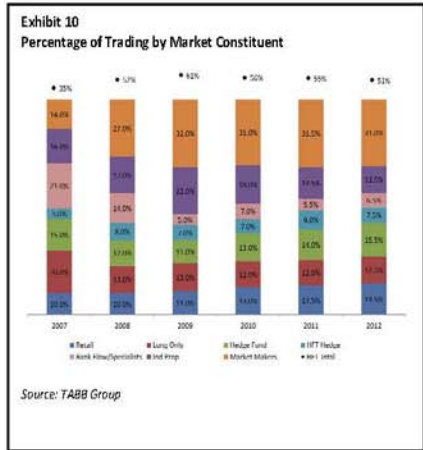
However, increasingly, there are tools that help larger investors better manage their executions. There are ATSS to help institutional investors hide from more aggressive traders; there are also sophisticated trading algorithmic technologies which can outfox pernicious trading machines. But understanding these tools takes time, patience, careful transaction cost measurement, and technology.

In some ways this is how a market should work. Initially a trader creates a profitable trading strategy which may disadvantage an unsophisticated investor. Eventually, that investor (or their broker) realizes that they are being disadvantaged and complains to their broker. If enough people complain, the broker fixes the problem. If they don't, the investor switches accounts and the broker suffers. If the broker fixes the problem, they keep the customer.

Regulatory Change Creates Trading Opportunities

Most profitable trading strategies are generated out of major market structure change typically created by a regulatory shift. Regulators change the rules, the sophisticated traders figure out how to profit from these changes, investors are disadvantaged, complain, and brokers respond and take away that opportunity.

The TABB Group has estimated the amount of spread capture that sophisticated traders (high-frequency traders) have captured. The high water level of high-frequency trading profit in the US equity markets was in 2009, when HFT players generated approximately \$7.2 billion and accounted for approximately 61% of US equity volumes (see Exhibits 9 and 10). Since that time, HFT profitability has declined to \$1.8 billion and comprises approximately 51% of share volumes (see Exhibits 10 and 11). While \$1.8 billion seems like a lot, it is only about 0.3 basis points of US equity dollar volume traded, or accounts for only 0.3 cents (\$0.003) per \$100 traded. This is down from approximately 1.3 basis points in 2009 or 1.3 cents per \$100 traded.



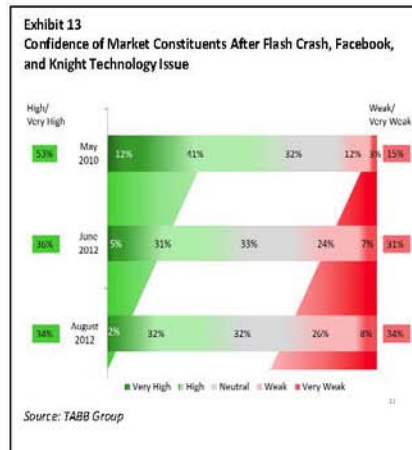
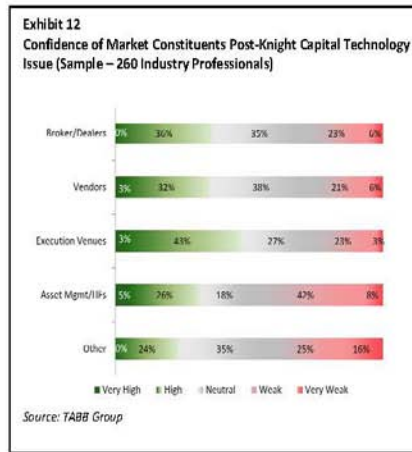
Question Three:

Have the high-profile computer trading failures over the past year, such as the recent trading problem at one firm that sent stocks sharply higher and then lower over a period of minutes, discouraged ordinary investors from participating in the stock market? Have these failures and recent volatility with initial public offerings discouraged companies from taking advantage of the capital markets?

Yes, these high profile trading glitches have reduced confidence in the market. TABB Group has surveyed the market and has tracked market confidence post-Flash Crash, Facebook, and Knight fiascos. We sampled 260 market professionals, or vendors that serve market professionals, and the confidence is not good (see Exhibit 12). Overall market confidence of these professionals has dropped significantly. Post flash crash (May 2010) 53% of Industry professionals ranked their confidence in the US equities markets either high or very high, however post Knight the high/very high confidence ranking dropped 19% points to 34%. Conversely those ranking confidence either poor or very poor went from 15% post Flash Crash rose 19% points to a whopping 34% two weeks after the Knight debacle (see Exhibit 13).

While the confidence of market professionals has dropped, and I wouldn't doubt the same is true of individual investors, I am not sure that there is a direct correlation between this drop in confidence and the long-term trend of decreasing equity ownership, a reduction in IPOs and lack of trading volume across virtually all financial products. There are just too many other factors that would influence investor and corporate behavior besides equity market structure including:

- The election – going back over previous election cycles from 1950, third-quarter equity trading volume during election years is down an average of 17% compared to the first half of the year. In non-election

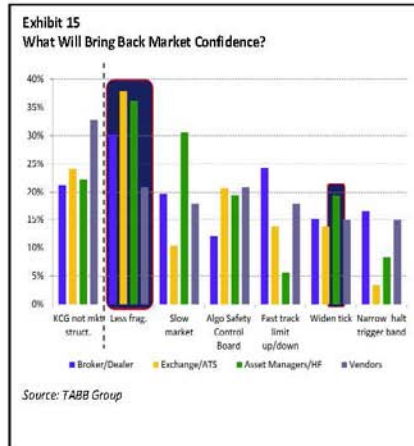
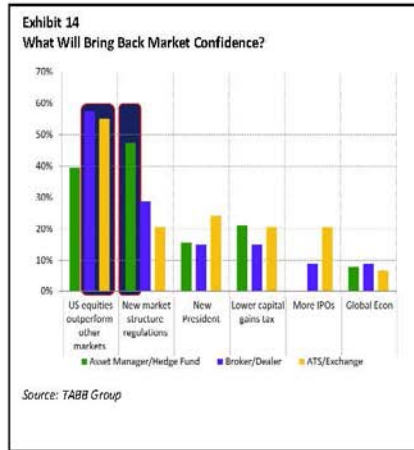


years, it is down only 4%. Volume in the fourth quarter during election years is down 5% from the first 3 quarters, while fourth-quarter volume during non-election years is only down 3%.

- Washington unease – the debt ceiling, the fiscal cliff, tax rates, and credit rating downgrades have investors uncertain about how to plan for the future.
- Regulations – with Dodd Frank and many European regulatory initiatives in the works, it is hard for financial institutions to know how to plan.
- Sarbanes-Oxley – raises the cost of becoming a public company. This was addressed in the JOBS Act for smaller organizations.
- Research settlement/research business model – Because of the Spitzer Research Settlement, it becomes harder to fund equity research, and without equity research (even biased research), it becomes harder to discover opportunities in smaller companies.
- Basle III – new capital requirements increase the cost of capital, and with interest rates so low it is hard for banks to generate an adequate return. This makes it harder for banks to provide capital to the market.
- Europe – with the Euro zone threatening to break up, investors do not know how to react or invest.
- Risk on-Risk off/high correlations – with all of the macro risk in the market, investors are not investing in companies, they are investing in sectors and geographies via ETFs. So investors are not worried about Coke or Pepsi or Ford or GM, they are worried about US or China, technology or health care. They are then using ETFs to express those strategies. Because ETFs are generally index-driven, they don't buy undervalued assets and sell overvalued assets – they buy all the assets in an index in relation to the weighting of stocks in the index. Those trading strategies then drive the correlation of assets within the index toward 1.00. Instead of one stock appreciating and the other depreciating, both begin to move in the same direction. This hurts single-stock investors who then switch their investing strategy away from single names to trading sectors, or global macro themes.
- Low interest rates – with interest rates so low, and declining over the past 30 years, at some level it becomes more beneficial to borrow money instead of issuing stock and diluting owners' capital.
- Demographics – baby boomers are retiring and want to secure their retirement by moving assets out of equities into fixed income or into savings accounts
- Bank consolidation – with bank/broker/investment bank consolidation, the fees generated on smaller IPOs become immaterial. As banks get bigger, they need bigger transactions to move the dial.
- Private equity – is tapping institutional money to invest in private companies because the return on public companies is so low and interest rates are so low. Tax treatment of PE firms may also play into this.

What Will Bring Back Confidence?

Industry professionals believe that two major things will bring back confidence in our markets: US equity market performance, and new market structure regulations (see Exhibit 14). When asked to pick among a number of changes that would enhance confidence in the market, besides many of our respondents saying that Knight was not a market structure issue, the preponderance of professionals believed that reduced market fragmentation would be their first choice. In addition, 30% of asset managers and hedge funds thought that slowing down the market would benefit confidence and approximately 20% of this same demographic thought widening the tick size would help (see Exhibit 15). This is a surprising response given that it is a money manager’s job to reduce trading cost, and tick size is a major component of trading cost.



Question Four:

What changes need to be made to help fortify our markets, especially during times of market stress? In particular, is it possible to minimize the systemic effects of a flawed algorithm or a computer strategy gone awry?

The best insulation from a rogue algorithm or trading model run amok are:

- 1) Circuit breakers (limit up/limit down). These rules need to be implemented as robustly as possible, covering as much of the trading day as possible, as soon as possible. Trading halts will stop a cascading market as long as they are operative. They also need to be harmonized across markets and to some extent across asset classes, especially between index futures and options and their underlying stocks.
- 2) Ban trade breaks. Breaking trades reduces the incentive to ensure properly implemented and monitored trading strategies. They provide less incentive for investors to trade during turbulent times. If a traders/investor takes the other side of a trade during a period of stress, then hedges it or sells it only to find out that one of the trades is broken and hence unhedged/exposed, the market is clearly penalizing the trader/investor for jumping into the breach. We want a market that incentivizes providing liquidity in turbulent times, otherwise when volatility roils the markets, fewer traders/investors step in and volatility is exacerbated and not absorbed. Make firms responsible for their trading errors. If they blow up, then the firm goes out of business, or their investors become diluted.
- 3) Capital and liability – hand in hand with no do-overs means that firms need to have an adequate capital base not only compared with their overnight trading exposure but with their intraday exposure and possibly their trading capabilities. Because if someone blows up, there needs to be enough capital behind the firm, their clearing firm, and the central clearing house to make all other participants whole. In addition, there need to be ways of protecting individuals. Currently, individual investors using stop losses can be taken advantage of during whipsaw markets. Individual investors need to be able to get satisfaction through their broker. Or maybe stop loss orders should be turned into stop losses with collars so that a stop loss may trigger in a falling market at the stop loss price, but if the market is plummeting it doesn't trigger at \$0.01, and if it does they can go back to the broker for satisfaction.
- 4) Stop buttons – every trading machine needs a stop button. Why the stop button was not triggered during the last fiasco, I don't know. But there is no excuse. An electronic trading problem is only an electronic trading problem for at most a minute – after that it is a human problem. Why didn't the human stop it? What happened to the monitoring process?
- 5) Direct access rules – The SEC issued direct access risk gateway rules. Those rules, I would assume, should have stopped this. I am not sure why they didn't. One reason the direct access rules didn't stop this problem was they were never implemented as specified, because implementing them as specified is next to impossible. But that said, the SEC should first ensure that their rules will solve the problems that they

are targeting, and once they have specified and drafted the proper rules they should test and enforce them.

Again – we need to be careful not to over-regulate our markets. The unintended consequences may be tremendous. That said, liability and responsibility are important to the marketplace and should not be vacated.

Question Five:

Do regulators have adequate tools to identify and limit manipulative or abusive strategies?

No they don't. This is a key aspect of investor confidence, and the challenge of better understanding the impact of high-frequency trading. The regulators need two major tools: first, an accurate and technically robust audit trail that captures all of the market information (bids, offers, cancellations, modifications, orders, and executions). Second, they need the appropriate tools and sophistication to understand what is going on, and who is trading what. They need to understand spot manipulators (actually, first they need to define manipulative trading strategies), piece together sliced and diced orders, and place this information in context with not only news and events but with trading activity happening in other markets.

If the regulators had these capabilities, and we could be assured that the regulators understood market structure, analyzed the markets, and caught the misbehavers, much of this discussion of high-frequency trading would be moot. However, the regulators do not have the tools. When they create rules, they specify them incorrectly (like Large Trader), or create rules that are impossible to implement (e.g., Direct Access), or don't have the sophistication to understand how to put large orders that get sliced into thousands of little pieces back together, or the complexity of how proprietary trading engines work.

Question Six:

What, if any, policy changes should be considered by regulators or Congress in order to better protect investors; maintain fair, orderly, and efficient markets; and facilitate capital formation?

First, Do No Harm

My first statement is to do no wrong. As you can see, the markets are very complex and interrelated. Small changes here can cause a huge impact there. For example, the implementation of penny spreads killed market maker profitability; forced markets to automate; enabled (created) the fragmented trading environment, which filled HFT coffers; forced firms to invest millions in infrastructure; and has been blamed for the destruction of equity research, the IPO, investor confidence, and the downfall of corporate America including the inability of US companies to create jobs. Of course, that is a bit hyperbolic, but from the research, blogs, and talking with many market participants, I know that these sentiments are in the market and have heard many of these stories in discussions with industry professionals.

So first do no harm, and that means do nothing radical. A radical re-shifting of the market will actually hurt investors and not help them. Radical changes will provide incentives to traders to thoroughly read the rules and learn how to profit off of less-astute investors or traders. This opportunity will only close once investors pressure their brokers and the brokers to develop counter-measures.

What I Would Do

- 1) Start defragmenting the market. Stop granting new exchange and ATS licenses immediately. Also create a new license or structure which limits the number of internalizing brokers. Maybe grant every internalizing broker a license but grant no others.
 - a. Determine the optimal number of exchanges, ATSs, and internalizing brokers. As these entities go bankrupt, merge, or consolidate, reduce the number of licenses.
 - b. Maybe grant a maximum number, and say anything over that number can't even be transferred and must be retired.
 - c. We need to be careful; we don't want to limit competition too much, but 13 equities exchanges, 50 or so ATS licenses, and who knows how many internalizing brokers is too many.
- 2) Manage broker/ATS solicitations. Currently it is very difficult to understand what happens to your order and where it goes. Larger orders are being executed in smaller pieces. A 50,000-share order can be executed in more than 200 trades. While this information is provided to many institutional money managers, it is much more difficult to tell them where their order was routed but not executed. This information may actually be more important than where it was actually executed. An order may be seen by 50 to 100 firms before it is routed to an exchange for execution. Between brokers soliciting the other

side, ATSS routing to each other, and exchanges routing to ATSS – virtually everyone that may have wanted to trade against an order will have seen it before it is executed.

- 3) Better manage Minimum Price Variations (MPVs or spreads). Currently, we have a minimum of 1 cent MPV for stocks over \$1. We should follow the direction of the JOBS Act and try to widen the spreads for less liquid stocks (small caps). This may also extend to high-priced stocks, too, as why should Apple priced at almost \$700 a share trade at the same MPV as BankAmerica trading at \$10. A penny spread in BankAmerica is 10 basis points, while the same spread in Apple is only 0.143 basis points. We need to think about appropriate spreads for appropriate pricing bands, liquidity characteristics, and capitalization levels.
- 4) Provide greater transparency of order types and routing mechanisms. Currently, most exchanges post their order types; however, the descriptions of what they do and how they work are not tremendously intuitive. Exchanges, and for that matter ATSS, ECNs, internalizers and even brokers need to begin to provide greater transparency, descriptions, and concrete examples of how each order type works, how fees/rebates are generated, where they show up in the book queue, how and when they route out, and how these order types change under the various market conditions. If these entities are not willing to be more transparent, then maybe that is one way to limit the number of matching licenses.
- 5) Quickly develop a marketwide consolidated audit trail for equities, options and futures markets. Develop incentives that will facilitate the cooperation of the SEC, CFTC and various SROs to ensure harmonious oversight. Develop clear rules on what is manipulative behavior in an electronic marketplace and have it updated frequently. Provide regulators with the tools and people who can develop ways to understand the market and find people and/or machines that are driving manipulative behavior. These people and organizations should be stopped, fined, or imprisoned. If we had confidence that our regulators had the tools and capabilities to surveil our markets, it would give the public more confidence that pernicious behavior was being flagged, challenged, and resolved. It would provide investors with the assurance that our markets are safe again for trading, investing, and raising capital.

About TABB Group and Larry Tabb

TABB Group

TABB Group is a financial markets research and strategic advisory firm focused exclusively on capital markets. Founded in 2003 and based on the methodology of "first-person knowledge," TABB Group analyzes and quantifies the investing value chain from the fiduciary, investment manager, broker, exchange and custodian. Our goal is to help senior business leaders gain a truer understanding of financial markets issues and trends so they can grow their businesses. TABB Group members are regularly cited in the press and speak at industry conferences. For more information about TABB Group, go to www.tabbgroup.com.

Larry Tabb

Larry Tabb is the founder and CEO of TABB Group, the global financial markets strategic advisory and research firm focused exclusively on capital markets. TABB Group helps senior leaders throughout the industry make critical decisions about their business.

Larry is a member of the CFTC High-Frequency Trading Sub-Committee of the CFTC Technology Advisory Committee.

Larry has published industry research analyzing both US and European market structure; central clearing; fixed income, equity and foreign exchange trading; financial markets trading and processing systems; analytical trading tools; grid and cloud computing; financial markets infrastructure; and trading technologies.

Quoted extensively and in virtually all industry and general news publications, he has been cited in The Wall Street Journal, Financial Times, The New York Times, Associated Press, CNN, Bloomberg, CNBC, Reuters, Dow Jones News, Barron's, Forbes, Financial News, Wall Street & Technology, Securities Industry Monitor, and Waters. He continues to be a featured speaker at major industry and business conferences throughout the US, Europe, Asia and Canada.

Before founding TABB Group, he was vice president and founder of TowerGroup's Securities & Investments practice where he managed research across the capital markets, investment management, retail brokerage and wealth management segments. Prior to joining TowerGroup, he managed business analysis for Lehman Brothers' Trading Services Division and was in charge of capital markets technology planning.

He began his career managing various operations for the North American Investment Bank of Citibank, where he managed front office trading and finance operations, various back-office money market operations and, for US Treasury debt, proprietary trading clearance and settlement operations.

**RESPONSES TO WRITTEN QUESTIONS OF CHAIRMAN REED
FROM DAVID LAUER**

Q.1. Germany is considering legislation that would impose new rules on high-frequency trading. It is my understanding that this legislation would require traders to register with Germany's Federal Financial Supervisory Authority, collect fees from those who use high-speed trading systems excessively, and limit the number of orders that may be placed without a corresponding trade. The new rules would also grant the regulator the power to compel firms to detail their trading practices.

Similar European-wide legislation is being considered by the Committee on Economic and Monetary Affairs of the European Parliament. These measures include a requirement for orders to rest on the exchange order book for a minimum of half a second and the testing of algorithms that allow preprogrammed trading.

Canada began increasing the fees charged to firms that flood the market with orders earlier this year, with firms charged for all the orders they cancel, not just the trades they execute. Additional rules are expected to cut the amount of trades going to dark pools. Starting in October, the pools will be allowed to take orders only if they offer a significantly better price than the public exchange.

What is your view of these various reform proposals? Would these measures make the U.S. markets more or less fair and efficient? Would these measures be feasible in the U.S. markets? Why or why not?

A.1. Adoption of several of these reforms would help make U.S. markets more fair and efficient. All of them are feasible, but that does not mean that they are advisable.

I think many of the reform proposals are commonsense ideas with substantial empirical support. Requiring traders to register is an excellent idea and one that I continue to advocate for. This is part of the idea I presented in my written testimony requiring firms to register trading strategies and tag all of their orders with a strategy-level ID. This would deter nefarious activity and help regulators enforce existing regulations.

I presented studies in my written testimony that attempt to quantify the negative externalities that HFT generate. Part of that is from excessive order rates and order cancellation rates. At the moment the cost of these externalities is not being borne by the producers. Germany and Canada's move to change that dynamic with cancellation fees is laudable.

Finally, the Canadian rules are exactly the type of rules I argued for in my written testimony. Increasing the requirements for off-exchange execution is critical to restoring natural liquidity in the lit markets. These requirements should include substantial price improvement and a minimum execution size.

I would not advocate for the European-wide legislation. I do not believe a Financial Transaction Tax would have the intended consequences. We have seen dramatic evidence of fleeing liquidity in those markets that have adopted this tax, although the market quality implications of that flight are still under study and may not be as dire as the liquidity flight would appear. A minimum resting period of a half second also seems extreme and not supported by empirical evidence. I have advocated for a pilot program to test a

50 millisecond holding period based on academic studies. I now believe that such a policy would only be advisable if it were done across all affected asset classes, include equities, options, and futures.

Q.2. In discussing the use of a “hide not slide” order type, there was testimony that stated that such an order is mainly used by professional traders and that it is not permitted for a broker to take an investor’s order and slide it. Can anyone other than a professional trader use this order type? For example, can a broker-dealer acting on behalf of institutional investors use a “hide not slide” order? Why or why not?

A.2. Anyone can use this order type who has a direct connection to an exchange, and control over the flags that they are setting in the order that is sent to the exchange. A broker-dealer can use this order type, although generally they only use the simplest order types when sending out orders on behalf of investors (or rebate-maximizing order types). Customers would have to specifically request that this order type is used, and ordinarily they would not do that.

**RESPONSES TO WRITTEN QUESTIONS OF SENATOR HAGAN
FROM DAVID LAUER**

Q.1. High-speed trading is an issue that has received considerable attention from market regulators throughout the world.

On September 26, 2012, German Chancellor Angela Merkel’s cabinet approved draft rules that would require high-speed traders to register with securities regulators and would mandate that automated orders be labeled as such when submitted to regulators. Can you evaluate the strengths and weaknesses of the approach taken by Germany?

A.1. As covered in my written testimony, I believe that registration of High-Frequency Traders is a simple, critical first step to regulating their activities. I also believe that the German proposal does not go far enough, as I would like to see registration of individual trading strategies with unique ID’s assigned to them. These ID’s should be placed in every order sent by these traders for regulatory tracking purposes, and also to support the function of enhanced, adaptive kill switches.

Q.2. In August, the Australian Securities & Investment Commission (ASIC) proposed reforms to automated share trading that are intended to prevent market disruptions. The proposal would require high-speed traders to put in place pretrade “filters” and to limit or suspend automated orders that would “interfere with the efficiency and integrity of the market.” This mandate is coupled with a fine on traders that could not trace orders and trading messages. Can you evaluate the strengths and weaknesses of the approach taken by Australia?

A.2. I believe it is important to unify risk controls across the industry, and Australia’s efforts here are a good first step. What they are lacking is a centralized means of enforcing these regulations on a real-time basis, instead relying on analysis and fines after-the fact. In the U.S. most individual firms already have some risk controls

in place, but regulators can do a better job of following Australia's example and unify these requirements. I don't believe that static kill switches are the answer however, and I don't believe that individual market centers should have this responsibility. Market activity cannot be analyzed by individual market centers, and therefore a centralized approach is necessary. The SEC can take on this role on a real-time basis, provided these firms are registered and tagging their orders with unique ID's.

Q.3. In July, Hong Kong's Securities and Futures Commission (SFC) released a proposal targeting automated trading. The SFC's proposal would require intermediaries to have "appropriate policies, procedures and controls . . . when they conduct electronic trading," example include pretrade risk management controls and post-trade monitoring. Can you evaluate the strengths and weaknesses of the approach taken by Hong Kong?

A.3. I believe Hong Kong's proposal suffers from the same weaknesses as Australia's. Individual firms can have an inordinate impact on the market, and therefore fining firms after-the-fact will not help to protect the market during a stressful event.

Q.4. Given that a wide range of countries have pursued changes that address computerized trading, how will the competitiveness of U.S. financial markets be impacted by a failure to adopt similar reforms?

A.4. The U.S. markets are developing a poor reputation because of our failure to properly regulate HFT. While some of the international reforms are knee-jerk reactions, and therefore inadvisable, many of them are sensible and will help to restore trust. These include registration of HFT firms, attempts to quantify negative externalities and shift the cost of those to the producer via cancellation fees, and increasing the hurdle for off-exchange executions.

Q.5. In an October, the Federal Reserve Bank of Chicago released a letter titled "How to keep markets safe in the era of high-speed trading." The letter outlines several risk controls that could improve market structure and investor confidence. Please discuss the costs and benefits of the following controls:

Intraday position limits.

A.5. This is a reasonable control, and is one most firms have already implemented.

Q.6. Limits on the number of orders that can be sent to an exchange within specified period of time.

A.6. This has similar problems to static kill switches. While it seems like a reasonable approach for a normally operating market, during times of market stress this could lead to severe problems.

Q.7. Automated trading is a logical extension of technology in a competitive market that may provide benefits such as increased transparency and better execution for market participants. What would happen to price discovery, transparency, and execution prices if high-speed trading ceased or declined?

A.7. It is important to distinguish between technology advances and high-frequency trading. Generally, most of the benefits to in-

vestors of increased liquidity and tighter spreads came before 2007 and the advent of high-frequency trading. In fact, several studies have shown increased spreads over the last couple of years, and no comprehensive studies have been done on execution costs overall. Spreads can be a poor proxy for execution costs, as so much liquidity in the market is fleeting (up to 40 percent according to one study cited in my written testimony). That being said, it is clear that in the near-term, market quality, price discovery and execution prices would all be harmed if high-speed trading were to cease, as it has become the primary supplier of liquidity in the market. We should instead take a measured approach to reducing nefarious activity, reining in certain practices, and evening the playing field. Many of the recommendations I make in my written testimony would be incremental approaches to confronting these issues, rather than blunt instruments such as a transaction tax.

Q.8. In the United States the Minimum Price Variation (MPV) for all stocks over one dollar is one penny. In Europe MPVs are less uniform.

How do MPVs impact high-speed trading?

A.8. They have little impact on high-speed trading. Computers are very good at adjusting to this type of variable. They do help to reduce competition to high-speed traders, as smaller MPV's in low-priced or less liquid stock make it less profitable for regular market makers to provide liquidity. The reason is that when a market maker offers stock in a less liquid name, with an MPV of \$0.01, a high-speed trader can simply step in front of them. While this may mean the appearance of a tighter spread, as market makers are driven out of business, spreads in these names widen again, and market depth suffers.

Q.9. What factors should be considered when determining the appropriate MPV?

A.9. An interesting proposal is to simply allow a firm to choose its own MPV, under the advice of an investment bank or other fiduciary. Barring this free market approach, market capitalization and liquidity should be the main factors.

Q.10. Should there be different MPV's for stocks of varying price or trading volume?

A.10. I agree that a one-size-fits-all approach to MPV has harmed smaller capitalization and less liquid companies. Alternatives should be explored and a pilot program would be an excellent first step.

Q.11. Several witnesses mentioned the proliferation of order types that are designed for high-speed traders.

How do the order types available to trades in the United States compare to those available in markets abroad?

A.11. Foreign markets have a much smaller set of order types. Many order types are a result of Reg NMS requirements, and therefore other markets do not require such an extravagant set.

Q.12. How do exotic order types advantage or disadvantage retail investors, institutional investors, exchanges, and high-speed traders?

A.12. High-frequency traders thrive on complexity. They make it their business to understand the nuances of every order type, and the exchanges often cater to them by providing access to the developers of the logic, or consulting with them when creating a new order type. HFT firms use exotic order types to segment order flow so that they don't interact with certain types of traders, or to play tricks to jump the queue. In addition, a lack of sophistication by institutional investors means that they can end up using order types that disadvantage them in terms of cost or priority.

Q.13. Please list those order types that you believe could be eliminated without doing harm to markets.

A.13. Post-only, PNP, PL Select, Hide-Not-Slide and the retail price improvement orders that have recently been approved.

Q.14. The increased fragmentation of exchanges and dark pools complicates the task of developing a market wide approach to data aggregation and analysis by regulators.

What type of technology investments could advance the ability of the Securities and Exchange Commission and the Commodity Futures Trading Commission to better monitor markets and develop a market wide approach to data?

A.14. I have developed and presented a full proposal in my written testimony for a real-time, cross-asset monitoring system. This strikes me as the bare minimum that the regulators need to understand and stay on top of the current market. The Consolidated Audit Trail is important, but will fall far short of what is needed on a real-time basis. Markets are moving too quickly for regulators to always be a day or more behind. Regulators can take a balanced approach, including some investments in technology and leveraging the existing investments exchanges have already made. This real-time, market-wide surveillance system combined with a firm-level or strategy-level registration system would allow regulators to finally do their job, and enforce existing regulations properly.

**RESPONSES TO WRITTEN QUESTIONS OF CHAIRMAN REED
FROM CHRIS CONCANNON**

Q.1. Germany is considering legislation that would impose new rules on high-frequency trading. It is my understanding that this legislation would require traders to register with Germany's Federal Financial Supervisory Authority, collect fees from those who use high speed trading systems excessively and limit the number of orders that may be placed without a corresponding trade. The new rules would also grant the regulator the power to compel firms to detail their trading practices.

Similar European-wide legislation is being considered by the Committee on Economic and Monetary Affairs of the European Parliament. These measures include a requirement for orders to rest on the exchange order book for a minimum of half a second and the testing of algorithms that allow preprogrammed trading.

Canada began increasing the fees charged to firms that flood the market with orders earlier this year, with firms charged for all the orders they cancel, not just the trades they execute. Additional rules are expected to cut the amount of trades going to dark pools.

Starting in October, the pools will be allowed to take orders only if they offer a significantly better price than the public exchange.

What is your view of these various reform proposals? Would these measures make the U.S. markets more or less fair and efficient? Would these measures be feasible in the U.S. markets? Why or why not?

A.1. Virtu Financial, LLC, (Virtu) is a global electronic market maker and active in more than 150 markets around the world. Virtu actively is actively engaged in dialogues with regulators around the Globe. Virtu actively supports global market reforms that include:

1. Registration requirements for active trading firms;
2. The ban on “Naked-sponsored” access;
3. Increased capital standards for market makers;
4. Implementation of market access and risk controls;
5. The establishment of real-time credit limits;
6. Limit-up/Limit-down Trading Controls;
7. The establishment of exchange kill switches;
8. Modernization of the U.S. surveillance systems and mechanism; and
9. Enhanced market making obligations.

However, rules or restrictions which limit technology or alter micromarket structure should be studied and have a measurable benefit. Our current market complexity was the result of micro-market structure changes implemented over the last 15 years. Those changes were not adequately studied and were driven by other initiatives.

**RESPONSES TO WRITTEN QUESTIONS OF SENATOR HAGAN
FROM CHRIS CONCANNON**

Q.1. Automated trading is a logical extension of technology in a competitive market that may provide benefits such as increased transparency and better execution for market participants. What would happen to price discovery, transparency, and execution prices if high-speed trading ceased or declined?

A.1. Our markets converted to automated markets 15 years ago. Since that conversion was made, trading costs of declined materially for all investors large and small. During this evolutionary change that benefited investors, our market intermediaries had to change as well. Our markets’ market makers are automated out of the need to survive in an automated world. The elimination or decline of our electronic liquidity providers would directly impact price discovery and execution quality. Investors would ultimately be harmed by introducing unnecessary frictions into our markets.

Q.2. Several witnesses mentioned the proliferation of order types that are designed for high-speed traders. How do the order types available to traders in the United States compare to those available in markets abroad?

A.2. The implementation of regulatory changes over the last 15 years, such as Regulation ATS and Regulation NMS, has resulting

in greater market fragmentation and increased market complexity. It is this unique fragmentation and market complexity that has resulted in the proliferation of order types in the United States.

Q.3. In the United States the Minimum Price Variation (MPV) for all stocks over one dollar is one penny. In Europe MPVs are less uniform.

How do MPVs impact high-speed trading?

A.3. MPVs impact all trading participants. MPVs set the minimum spread for quoting and trading of an instrument. Therefore, MPVs determine the price that all investors pay, both large and small, when entering or exiting the market. An MPV set too high will introduce substantial costs to investors. An MPV set too low can lower displayed liquidity and cause the appearance of increased price volatility.

Q.4. What factors should be considered when determining the appropriate MPV?

A.4. As I stated in my written testimony, our market is currently designed as a “one size fits all” market. More regulatory flexibility around MPV and other market structure features should be considered in order to accommodate the wide spectrum of publicly traded stocks in our market.

Q.5. Should there be different MPV’s for stocks of varying price or trading volume?

A.5. Yes. “One size fits all” market structures are not appropriate.

Q.6. Several witnesses mentioned the proliferation of order types that are designed for high-speed traders.

How do the order types available to trades in the United States compare to those available in markets abroad?

A.6. U.S. markets are highly complex and fragmented as a result of regulatory changes. Market participants have requested a variety of order types to address their unique needs to deal with this highly complex and fragmented market. These order types are filed with the Securities and Exchange Commission and approved by the SEC.

Q.7. How do exotic order types advantage or disadvantage retail investors, institutional investors, exchanges, and high-speed traders?

A.7. A variety of order types have been designed and made available to investors, both retail, institutional, and professional. These order types, which range from simple to complex, have been designed, delivered, and accessible to meet the unique needs of these investors.

Q.8. Please list those order types that you believe could be eliminated without doing harm to markets.

A.8. Because many order types have been designed to meet the unique needs of investors both large and small, such an analysis would require the solicitation of views from a very broad audience to ensure that certain order types are not mistakenly eliminated.

Q.9. The increased fragmentation of exchanges and dark pools complicates the task of developing a market wide approach to data aggregation and analysis by regulators.

What type of technology investments could advance the ability of the Securities Exchange Commission and the Commodity Futures Trading Commission to better monitor markets and develop a market wide approach to data?

A.9. The two agencies seem to recognize that market structure and technology advancement issues present challenges to monitoring our modern markets. Consequently, the agencies have been openly discussing these market surveillance issues with interested parties including Virtu. We believe the design and implementation of a multimarket surveillance system is very achievable and will deliver the long term benefits needed to protect our markets.

ADDITIONAL MATERIAL SUPPLIED FOR THE RECORD

STATEMENT OF SENATOR CARL LEVIN

I would like to thank Chairman Jack Reed, Ranking Member Crapo, and all my colleagues on the Securities, Insurance, and Investment Subcommittee for holding this hearing.

Millions of American workers and their pension funds have long put their savings into the U.S. capital markets in hopes of a better retirement and better future. In recent years, though, a number of headline-grabbing events have raised serious questions about our markets in the minds of ordinary Americans, sophisticated investors, policy makers, and regulators.

- Are our markets too fragile and vulnerable to collapse?
- Are our markets fair for all investors?
- And are investors, who we need to fund the growth and development of our companies and our economy, fearful about subjecting their savings to these markets?

Nearly 2 years ago, some of you joined with members of the Permanent Subcommittee on Investigations, which I chair, in a joint hearing to examine the efficiency, stability, and integrity of the U.S. capital markets. At that hearing, held in the wake of the so-called Flash Crash, experts raised a number of important issues, and we highlighted a number of potential regulatory improvements.

I am pleased that the SEC took some steps to limit dangerous holes in our market regulation, such as unlimited, unsupervised direct market access. And just recently, the SEC finally issued a rule that will someday create a consolidated audit trail. These and other recent steps are a good start, but they are little more than Band-Aids. As anyone who has watched or participated in the markets in recent years knows, more must be done.

It is time for a broad reexamination of the actual workings of our markets. When the horse and buggy gave way to the automobile, our national infrastructure needed an upgrade. During these tumultuous times, while we as a country learned how to take advantage of this great new innovation, there were innumerable horrific accidents: cars running into older horse-drawn vehicles; cars running off the edges of unpaved roads; and cars simply crashing into one another.

What our country learned is that everything needed an upgrade. The roads themselves needed upgrades. They needed to be wider and more stable to bear the heavier traffic. The cars themselves needed to be safer. And the drivers needed an upgrade. They needed to adopt and follow “rules of the road,” like when to make a left hand turn and what to do when an emergency vehicle drives by. These upgrades needed to be enforced. Roads need to be inspected, as did the cars driving on them. Drivers needed to be tested, and police officers needed to ensure that drivers followed the rules.

As the cars got faster over the next several decades, the benefits and needs for upgrades grew as well. We needed seatbelts and airbags. Roads needed to be wider, straighter, and bridges sturdier. Drivers needed to be smarter too. Those driving unique vehicles, like tractor trailers and busses, needed further training. And enforcement also needed upgrades. Because police officers can’t be everywhere at once, speed cameras and red-light cameras have started to pop up.

The goals of all of these innovations were simple: (1) minimize the number of crashes, and (2) make the crashes that do occur less harmful.

In recent years, our capital markets have undergone a transformation that is no less stunning. The old New York Stock Exchange floor has been hollowed out. The screaming that once typified the floor is now replaced with the whir of computers. Traditional market makers have given way to computer trading firms with servers located right next to the computers of the trading venues.

Computerized traders use automated trading systems to very quickly place and cancel orders—more than 90 percent are canceled—to make markets and arbitrage very small price differences between markets. In this very competitive industry, milliseconds can be the difference between millions in profits and significant losses. Because of that, computerized trading firms now pay thousands of dollars a year for the right to special proprietary data feeds from exchanges and other execution venues. Many rent space, for another hefty sum, to collocate their servers at execution venues. Doing this reduces the response time by a few milliseconds, which is worth millions of dollars to these firms. Orders to buy or sell stock are diced by computers into small bits, routed in milliseconds to any of several dozen venues, and executed in fractions of a second. All while other computerized trading programs are looking to sniff out those orders, and sneak in front of them for a profit.

Investors who hold onto stocks for weeks, months, and years comprise less of the market than ever, giving way to computer trading programs holding onto stocks for fractions of a second.

It is not surprising that this rapid development has resulted in more than our share of crashes, the most notable of which was the Flash Crash. And there are plenty of lessons to be learned from just that event.

But, since then, numerous other crashes and technological errors have roiled the markets. Many investors were shocked to see the failure of the IPO of BATS Global Markets. BATS is itself a major exchange on which investors trade more than 500 million shares a day. Yet, due to a computer glitch on BATS's own systems, its IPO went haywire and ultimately had to be shelved.

Just a few months later, another high profile IPO faced a different set of technical glitches. This time, trading glitches at Nasdaq left investors who tried to buy shares of Facebook, one of the most well-known and valuable IPOs in recent memory, with no idea whether their trade had been completed for hours, and, reportedly in some cases, days. Now, Facebook stock is worth barely half of its initial value, and lawsuits continue to be filed as Nasdaq, the underwriters, and investors fight over the damage.

Still another computerized trading error occurred last month. This time, Knight Capital, one of the largest market makers, nearly collapsed when a rogue trading program went unchecked for just about 40 minutes. Despite new rules intended to stop wild price swings, millions of unintended trades flung prices and volumes in about 150 stocks all out of whack. Ultimately, a seemingly small programming glitch cost Knight about \$440 million and forced them to sell off a 73 percent stake in the company, nearly wiping out existing shareholders.

These accidental trades were one of the first significant tests of the rules that the SEC put in place after the Flash Crash. Most of those protections weren't triggered. While this is certainly a warning to other firms about the dangers of a single software error, it should also be a warning to regulators about the strength and security of our markets.

And these incidents don't include the dozens of "mini-crashes" that have occurred in single issuers. For a company and their employees, it must be more than a bit discomfiting to watch your stock price spike and plummet over minutes, often for no discernible reason. It's past time for some more upgrades.

Regulators don't yet have effective systems to stop catastrophic collapses, and they lack the ability to see all of the activity that's occurring in all of the venues in a way that lets them understand what's going on. The consolidated audit trail was proposed years ago. It doesn't cover nearly enough activity, and is still years away from being a reality.

Regulators don't seem to know what the traders are really doing. While so-called "naked access," wherein traders are given unfettered access to the trading markets without real oversight, is banned, there are still no driving tests for these traders. There are still no licenses for these traders, unless they opt into them.

System failures are not the only concerns with our markets. There are very real questions about whether our U.S. capital markets are fair. Since the joint PSI/Securities Subcommittee hearing in 2010, there have been a number of high-profile instances where some market participants have been given preferences over ordinary investors, and where our opaque market structure has allowed trading abuses that have victimized unwitting investors to go otherwise undetected.

Recently, the *Wall Street Journal* reported how some exchanges have created special order types that allow sophisticated algorithmic traders to jump the line and take advantage of ordinary investors. In some cases, exchanges are creating order types for sophisticated traders to use that are designed not to trade. Some are hidden from few. These orders aren't about maintaining fair and transparent markets. Just the opposite.

Also recently, the NYSE settled charges by the SEC that it sent its data feeds to certain customers faster than the data it provided to other market participants. Collectively, these reports show that some traders seem to be given a leg up on the rest of us. They get information faster. They process it faster. And they are given tools to take advantage of that information to the detriment of the rest of the market.

One of the more offensive examples of this type of favoritism is in so-called "flash orders," where a venue "flashes" an order to a select group of favored customers before showing that order to the rest of its members. What's to prevent one of those favored customers from taking advantage of that information to the detriment of the customer whose order was flashed? Not much. Senator Schumer and I, and others, have called for the banning of this practice. But, years later, that still hasn't happened.

There are other fairness risks. Given the complexity of order routing, and the incentives of the current “maker/taker” model, brokers are often faced with a conflict of interest. They can send an order to a venue with the best price, or they can send it to the venue which gives them the most profit. If these decisions were made by humans, we could ask them why they make particular decisions. But they aren’t. These decisions are buried deep within the codes of smart order routers. Institutional traders and ordinary investors alike should wonder whether the smart order router is really working for them or their broker. To be sure, many brokers are fulfilling their duties to their customers and getting the best executions, but how is the customer to know? How is a regulator going to know?

Another significant challenge is the lack of transparency in the off-exchange trading venues. In a case last year, the SEC fined Pipeline Trading Systems, a dark pool operator, for trading in front of customers, taking advantage of their role in the center of the marketplace. While Pipeline was supposed to be matching up buyers and sellers, it was secretly trading against its customers, often for a profit. Is this type of activity happening at other dark pools? Most of them disclose that the firm itself may take the other side of a trade. So should it be ok if the customer knows that he’s likely to be taken advantage of? What’s his alternative? Is it to post the order on the New York Stock Exchange and be taken advantage of there?

I look forward to today’s hearing, and we should all look forward to pressing our regulators to address these questions. For more than a century, American markets have been the envy of investors across the world. We must continue to examine the regulations and structure that has been put in place to ensure that today’s equity market is fair for all and has the right protections in place to prevent technical glitches from causing a collapse.

Once again, I wish to thank Chairman Reed and Ranking Member Crapo for holding this important hearing today. I hope this hearing will lead to a strengthening of our markets to ensure that they remain the best in the world in coming years.

**STATEMENT OF MICAH HAUPTMAN, FINANCIAL CAMPAIGN
COORDINATOR, PUBLIC CITIZEN'S CONGRESS WATCH DIVISION**

Written Testimony of

Micah Hauptman

Financial campaign coordinator, Public Citizen's Congress Watch division

before the

COMMITTEE ON BANKING, HOUSING, AND URBAN AFFAIRS SUBCOMMITTEE ON
SECURITIES, INSURANCE, AND INVESTMENT

United States Senate

Computerized Trading: What Should the Rules of the Road Be?

September 20, 2012



Chairman Reed, Ranking Member Crapo, and members of the subcommittee:

Thank you for the opportunity to present written testimony on computer-driven trading, and its effects on investors and market stability. I am Micah Hauptman, financial campaign coordinator of Public Citizen's Congress Watch division. Public Citizen is a national nonprofit organization with more than 300,000 members and supporters.

INTRO

Our financial markets are not serving their intended purpose. Markets are supposed to function as intermediaries, connecting investors who provide capital with producers who are able to put that capital to work most efficiently. Such a model serves our long-term economic interests, spurring new innovations and job creation. Yet under our current framework, short-term, often predatory, speculation increasingly drives our financial activities, while long-term, productive investment takes a back seat.

Computer-driven high-frequency trading is exacerbating this misallocation of resources. A few market participants have been able to obtain special access and, in turn, reap favored treatment at traditional investors' expense. Additionally, high-frequency trading imperils the financial system.

The prevalence of high-frequency trading is a relatively new phenomenon, having taken off in the last five years or so. But in its short lifespan, we've already seen the potentially disastrous consequences that can occur because of it. The May 6, 2010 flash crash—in which almost 1,000 points were erased from the Dow Jones Industrial Average and one trillion dollars in wealth momentarily vanished—is the most alarming example. But the August 1, 2012, Knight Capital algorithm “glitch,” in which roughly 150 stocks suffered massive fluctuations, provided another chilling reminder of the lurking dangers that high-frequency trading presents.

We must therefore consider ways to level the playing field so that unfair advantages are not gained and our financial security is safeguarded. One solution that should be considered is a financial speculation tax (FST), also known as a financial transactions tax. A minuscule FST on the sale or transfer of stocks, bonds, and derivatives, such as one called for by the Wall Street Trading and Speculators Tax Act (S. 1787, H.R. 3313), introduced by Sen. Tom Harkin (D-Iowa) and Rep. Peter DeFazio (D-Ore.), would help to accomplish these goals. It would “throw sand in the gears” of high-frequency trading operations by making their activities less profitable, ultimately reducing the likelihood of such operations distorting markets. Taking the additional step of placing a financial speculation tax on cancelled high-frequency trading orders would make traders pay for their extreme levels of cancellations, which are used to glean crucial market information

that can then be exploited. With altered incentives, short-term speculative trading would decline and traditional long-term investment would flourish.

An additional benefit that must not be overlooked is that an FST has the potential to raise hundreds of billions of dollars. For example, the nonpartisan Joint Committee on Taxation (JCT) scores the Harkin-DeFazio bill as generating \$352 billion in 9 years. Some of this money could be spent to improve regulatory supervision and enforcement of trading activities and market abuses.

1. Basics of High-Frequency Trading

A. Paying for Technological Access

High-frequency trading requires state-of-the-art computers, software, and bandwidth to trade faster than other market participants. Trades are orchestrated by sophisticated quantitative- and algorithm-based programs, which can execute orders in a span of microseconds (millionths of seconds).¹

Essentially, high-frequency trading operations pay exchanges and alternative trading platforms for faster access to information and trade execution speeds. Traders are then able to exploit high-speed data access to gain a competitive advantage over those who have not similarly paid for that access.² For example, traders often rent space from trading platforms to co-locate their computers near the platforms' servers. Doing so takes advantage of physics: being closer to the source means traders are able to send and receive orders faster than others.³

Traders also pay for access to high-speed fiber-optic cable networks. One such network, known as Project Express, is currently being built across the Atlantic Ocean. Once complete, the round-trip journey between New York and London will be shortened by five milliseconds—from roughly 65 to 60 milliseconds.⁴ As a frame of reference, the average time of a human eye blink is between 300 and 400 milliseconds.⁵ The cable will not be

¹ Benoît Lallemand, *Investing not betting: Making financial markets serve society*, FINANCE WATCH, April 2012, <http://bit.ly/KamSkX>.

² Just this week, the NYSE agreed to pay a \$5 million settlement to the Securities and Exchange Commission (SEC) for providing valuable trading data to some customers ahead of others. Jenny Strasburg and Scott Patterson, *NYSE Is Fined in Data Probe*, THE WALL STREET JOURNAL, September 14, 2012, <http://on.wsj.com/R57juH>.

³ Kristi Oloffson and Stephen Gandel, *High-Frequency Trading Grows, Shrouded in Secrecy*, TIME, August 5, 2009, <http://ti.me/3wo2bC>; Ivy Schmerke, *High-Frequency Trading Shops Play the Colocation Game*, ADVANCED TRADING, October 5, 2009, <http://bit.ly/T0YoVZ>.

⁴ Matthew Phillips, *High-Speed Trading: My Laser Is Faster Than Your Laser*, BUSINESS WEEK, April 23, 2012, <http://buswk.co/JKhrcT>.

⁵ Scott LaFe, *Mindsight: Eye-tracking reveals not just what you're looking at, but how hard you're thinking about it*, THE SAN DIEGO UNION TRIBUNE, September 13, 2007, <http://bit.ly/Pp17DQ>.

publicly available, however. Because of the “steep fees” associated with the \$300 million project, only a small group of traders will have access to the network.⁶

B. In Exchange for Access, Profits are Virtually Guaranteed

High-frequency trading is an extremely profitable industry in the United States, estimated to be between \$8 billion and \$21 billion in annual profits, according to the Tabb Group.⁷ Profit margins on each trade may be very small, but when billions of trades are executed in the aggregate, that money adds up quickly. High-frequency traders generally make their money two ways, through rebate trading and proprietary trading.

1. Rebate Trading

Because there is intense competition for business between the different trading platforms⁸—there are more than 50 trading platforms in the U.S. equity market, for example—the platforms entice customers by waiving trading fees and providing so-called “liquidity rebates.” Liquidity rebates can be ¼ penny per share traded, regardless of how the security performs.⁹ This means that if a trader buys a share of stock at \$20.00 and sells it a second later for \$20.00, he can still earn ½ penny (¼ each time it was traded), despite the absence of change in the security’s value. If he performs the same trade with 1,000 shares, he can earn \$500.00. Such a payment-structure incentivizes trading for its own sake, which increases trading volume.

Predictably, high-frequency trading volume has exploded.¹⁰ While high-frequency trading comprised about 15 percent of the daily volume of equity trading in the mid-2000s, it now is estimated to comprise between 50 and 75 percent.¹¹ While growth has occurred

⁶ Matthew Phillips, *Stock Trading Is About to Get 5.2 Milliseconds Faster*, BUSINESS WEEK, March 29, 2012, <http://buswk.co/HuK38P>.

⁷ Michael Peltz, *Inside the Machine: A Journey into the World of High-Frequency Trading*, INSTITUTIONAL INVESTOR, May 5, 2012, <http://bit.ly/KVIDr7>.

⁸ The four biggest exchanges are NASDAQ, NYSE, DirectEdge, and BATS, but there are other non-exchange alternative trading systems including unregulated dark pools. Duncan L. Niederauer, *It's time to bring 'dark pools' into the daylight*, FINANCIAL TIMES, July 4, 2012, <http://on.ft.com/N0i1aF>.

⁹ Sal L. Arnuk and Joseph Saluzzi, *Toxic Equity Trading Order Flow on Wall Street: The Real Force Behind the Explosion in Volume and Volatility*, THEMIS TRADING, December 17, 2008, <http://bit.ly/Uuo1q>.

¹⁰ Reuters financial blogger Felix Salmon's recent Chart of the Day links to an animation from Nanex that shows the growth of trading activity. The chart reveals relatively low levels of trading in 2007 but a distinct increase thereafter. Felix Salmon, *Chart of the Day, HFT edition*, REUTERS, August 6, 2012, <http://reuters/Rt3qIT>.

¹¹ Sal Arnuk and Joseph Saluzzi, *What Ails Us About High Frequency Trading?*, ADVANCE TRADING, September 30, 2009, <http://bit.ly/A9lojh>; Nelson D. Schwartz and Louise Story, *Surge of Computer Selling After Apparent Glitch Sends Stocks Plunging*, THE NEW YORK TIMES, May 6, 2010, <http://nyti.ms/S42Ull>.

primarily in the equity market, there has also been an expansion of high-frequency trading volume in the futures, options, bond, and foreign exchange markets.¹²

2. Proprietary Trading

High-frequency traders also engage in a variety of proprietary—and often predatory—trading strategies to make money on securities' price changes. The profits often come at other market participants' expense.

One common strategy involves detecting, then trading ahead of, institutional clients, such as mutual and pension funds. Institutional clients that trade large orders must break up those orders into smaller amounts so that their trades do not move the market. They use their own algorithms to trade amounts over time, setting parameters based on price, volume, and time.¹³ However, those algorithms are relatively simple and the trading patterns are easily detected. For example, a mutual fund might seek to buy 10,000 shares of a given stock at between \$24.95 and \$25.00. So as not to move the price of the stock, the mutual fund may split the 10,000 shares into 100 or 500 share portions, with a limit of \$25.00 per share. Periodically, the mutual fund will trigger its purchases, according to its set parameters.¹⁴ Once high-frequency traders spot the patterns and know the limit at which the fund is willing to buy, they can then execute trades fast enough that when the stock drops to \$24.95, they buy, then turn around to sell when the share price rises to \$25.00.¹⁵

High-frequency traders are often able to detect the parameters for institutional investor trades by using a technique called "pinging," which involves issuing a lot of small orders to test the waters of how high or low an institutional client is willing to buy or sell a security. If an order is not accepted, it means that the price is outside the limits, and the trader immediately cancels the order. It is estimated that more than 90 percent of high-frequency trading orders are cancelled, with no adverse consequences for the traders.¹⁶ The extreme level of cancellations suggests that high-frequency traders are merely undertaking creative tactics to glean as much information as possible. It also indicates the ease with which high-frequency traders can engage in potential market abuse.

¹² Benoît Lallemand, *Investing not betting: Making financial markets serve society*, FINANCE WATCH, April 2012, <http://bit.ly/KamSkX>; Anuj Agarwal, *High Frequency Trading: Evolution and the Future*, CAPGEMINI, February 29, 2012, <http://bit.ly/OYkDby>.

¹³ Benoît Lallemand, *Investing not betting: Making financial markets serve society*, FINANCE WATCH, April 2012, <http://bit.ly/KamSkX>.

¹⁴ *Id.*

¹⁵ Sal L. Arnuk and Joseph Saluzzi, *Toxic Equity Trading Order Flow on Wall Street: The Real Force Behind the Explosion in Volume and Volatility*, THEMIS TRADING, December 17, 2008, <http://bit.ly/Uuo1q>.

¹⁶ *Id.*

While the previous examples demonstrate how high-frequency traders detect, and then trade around, other market participants, high-frequency traders also engage in strategies to actively bid up or down the prices of securities, so they can capitalize on the movement of those securities. Many institutional algorithmic orders are “pegged” to the National Best Bid or Offer (NBBO). Under this system, when one trader makes a trade, others follow at that same price. High-frequency traders can thus trade ahead of institutional orders to artificially push the price of a security up or down momentarily, knowing the price change will not hold.¹⁷ Because a high-frequency trader will already know the institutional client’s trading parameters (described in the previous paragraph), he will know exactly what price to push the institutional client to. Immediately after pushing the price to the limit, the high-frequency trader will reverse course and capture the profits from the artificially imposed price movement. Returning to the previous example, by “pinging,” a high-frequency trader would know that the mutual fund’s limit is \$25.00, but the stock might be trading at \$24.95. Taking advantage of the “pegged” NBBO system, the trader will buy shares at \$24.96 and the mutual fund will follow with a similar bid. The trader will then buy shares at \$24.97 and the mutual fund will again follow suit. The trader will push the price up to \$25.00, knowing that is the limit that the mutual fund is willing to pay. Immediately after artificially pushing up the price of the stock, the high-frequency trader will short it.¹⁸

2. High-Frequency Trading Harms Traditional Investors

As is evidenced above, high-frequency traders engage in a variety of predatory strategies to make money at others market participants’ expense. Some have even described their activities as technological front-running schemes that impose a “hidden tax” on traditional investors.¹⁹ This is especially true when traders bid up or down the price of securities, because then, institutional and pension fund investors are forced to purchase at higher prices and sell at lower prices than they ordinarily would. While high-frequency trading proponents may argue that this is a matter of a few cents here and there, that is a poor justification. Conceivably, traditional buy-and-hold investors with 401(k)s, IRAs, pension funds, and the like, could pay a few cents extra per share bought and sold over a thirty-year investment horizon. Those cents could add up to real money over time.

More damaging is the growing perception that the market is rigged, that a level playing field does not exist for all market participants, and that a handful of insiders are able to game the system to extract money at everyone else’s expense.²⁰ A clear indication of such a

¹⁷ *Id.*

¹⁸ *Id.*

¹⁹ High Frequency Trading, *Interview, with Joseph Saluzzi, Themis Trading and Irene Aldridge, Able Alpha Trading*, CNBC POWER LUNCH, July 24, 2009, <http://bit.ly/Pp35nv>; High Frequency Traders are Stealing from You, WEST COAST ASSET MANAGEMENT, October 2010, <http://bit.ly/S3zldO>.

²⁰ Benoît Lallemand, *Investing not betting: Making financial markets serve society*, FINANCE WATCH, April 2012, <http://bit.ly/KamSkX>.

glum view of the market would be if traditional investors decided to no longer participate in it, and the evidence suggests that this may be the case. While a causal connection to high-frequency trading has not been proven, investors have withdrawn more than \$300 billion from long-term mutual funds in the roughly two years since the May 2010 flash crash.²¹

3. High-Frequency Trading Harms the Financial System

High-frequency trading distorts markets, generates false trading signals, and impairs price discovery such that fundamental values of securities are not always apparent. In some cases—such as when traders bid up or down prices—the price differences may be only a few cents. In other cases—such as the May 2010 flash crash or the recent Knight Capital debacle—prices can vary widely. According to the joint Commodity Futures Trading Commission (CFTC)-Securities and Exchange Commission (SEC) report on the May 2010 flash crash, “Over 20,000 trades across more than 300 securities were executed at prices more than 60% away from their values just moments before. Moreover, many of these trades were executed at prices of a penny or less, or as high as \$100,000 before prices of those securities returned to their ‘pre-crash’ levels.”²² And, according to the market research firm Nanex’s analysis of the Knight Capital debacle, roughly 150 stocks suffered drastic price fluctuations in a matter of minutes, many of them household names, including Nokia (9.12 percent change), Harley Davidson (10.47 percent change), RadioShack (20.27 percent change), Pandora Media (9.11 percent change), and Allergan (9.07 percent change).²³

Yet as bad as these events were, they could have been worse. CFTC commissioner Bart Chilton has highlighted the possible global contagion and amplification effects that could occur if a flash crash were timed slightly differently. He said, “If the Flash Crash had taken place in the morning on May 6th, when E.U. markets were open, it could have instigated a global economic event. Since it took place in the mid-afternoon, it was primarily limited to U.S. markets.”²⁴ Senator Carl Levin (D-Mich.) and former-Senator Ted Kaufman (D-Del.) have similarly “sounded the alarm,” warning that it may be “only a matter of time before the Big One.”²⁵

²¹ Jerry Adler, *Raging Bulls: How Wall Street Got Addicted to Light-Speed Trading*, WIRED, August 3, 2012, <http://bit.ly/PNoOCR>.

²² *Findings Regarding the Market Events of May 6, 2010*, REPORT OF THE STAFFS OF THE CFTC AND SEC TO THE JOINT ADVISORY ON EMERGING REGULATORY ISSUES, September 30, 2010, <http://1.usa.gov/cF6GSI>.

²³ *Knightmare on Wall Street, List of affected symbols showing #Trades, Volume, and High, Low, Last data*, NANEX, August 1, 2012, <http://bit.ly/T13OrT>.

²⁴ Keynote Address of Commissioner Bart Chilton to the 13th Annual Structured Trade and Finance in the Americas Conference, “Interconnectedness,” March 15, 2011, <http://1.usa.gov/OJ7VTm>.

²⁵ Edward E. Kaufman and Carl M. Levin, *Preventing the Next Flash Crash*, THE NEW YORK TIMES, May 5, 2011, <http://nyti.ms/S45RCL>; Ted Kaufman, *Ominous Rumbblings on Stock Exchanges*, HUFFINGTON POST, April 16, 2012, <http://huff.to/IRxhTw>.

Moreover, contrary to the claims of its proponents, high-frequency trading does not add liquidity to markets. In fact, the opposite is true. Liquidity is defined as the ability for a market participant to buy and sell easily, with minimum market impact.²⁶ High-frequency traders exploit liquidity in good times (adding excess liquidity when it is not needed),²⁷ and drain liquidity when it is needed most. This is because the more liquid a security, the easier it is to trade. To be able to continue to “pass the hot potato,”²⁸ traders depend on prices being predictable.²⁹ But when prices are no longer predictable, high-frequency traders do not want to risk being burned, so they stop playing the game.³⁰

High-frequency traders really just add trading volume, which is as discussed above, largely a function of liquidity rebates. While volume gives the appearance of liquidity, it can disappear at the first hint of instability. Faced with uncertainty, traders cancel all of their buy orders and liquidate the remainder of their portfolios, but this creates a “vacuum” in which there is a “vicious sell-off that chases itself down and no one is there to stop it.”³¹

Proponents of high-frequency trading also claim that it makes markets more efficient, but a recent study by New York University finance professor Thomas Phillipon suggests otherwise. Phillipon shows that the cost of intermediation,³² measured as the sum of all

²⁶ Benoît Lallemand, *Investing not betting: Making financial markets serve society*, FINANCE WATCH, April 2012, <http://bit.ly/KamSkX>.

²⁷ Dallas Mavericks owner and businessman has wryly observed: “By definition they can’t go into an equity unless there already is liquidity. To say they’re adding liquidity is like saying spitting in a thunderstorm is adding liquidity.” Scott Patterson, *Mark Cuban: High-Frequency Traders Are the Ultimate Hackers*, THE WALL STREET JOURNAL, June 26, 2012, <http://on.wsj.com/Myvw2h>.

²⁸ Research by Professor X Frank Zhang of Yale School of Management suggests that once the share of high-frequency trading exceeds 50 percent of total trading volume, they are not providing liquidity to the market, and are instead rapidly passing the same positions back and forth like a “hot potato.” X Frank Zhang, *High-Frequency Trading Increases Stock Volatility*, YALE SCHOOL OF MANAGEMENT, September 1, 2011, <http://bit.ly/rnF3oH>.

²⁹ In *The General Theory* (1936), John Maynard Keynes recognized speculation as a “scarcely avoidable outcome” of excessively liquid secondary markets. He proposed a financial transactions tax to decrease excessive liquidity and incentivize long-term investment. Roni Mann, *The regulatory road not taken: The proposed financial transaction tax in a historical context*, WZB MITTEILUNGEN, September 2012, <http://bit.ly/PQNuz5>; Benoît Lallemand, *Investing not betting: Making financial markets serve society*, FINANCE WATCH, April 2012, <http://bit.ly/KamSkX>.

³⁰ This structure is in stark contrast to the previous system, in which market-makers (also known as “specialists”) had a duty to maintain a fair, orderly, and efficient market by providing liquidity in both good and bad times. Their job was to buy when no one else was buying and sell when no one else was selling to maintain market equilibrium. Under the current system however, “market-making” high-frequency traders collect “liquidity rebates” when conditions suit them, but have no obligation to trade when conditions do not suit them. Cristina McEachern Gibbs, *As Market Volatility Continues, the Blame Game Heats Up*, ADVANCED TRADING, December 15, 2008, <http://bit.ly/0m0M6o>.

³¹ *Id.*

³² Financial intermediation costs include “the sum of all spreads and fees paid by non-financial agents to financial intermediaries, and it is also the sum of all profits and wages in the finance industry” to “produce, trade and settle financial contracts that can be used to pool funds, share risks, transfer resources, produce information and provide incentives.” Thomas Phillipon, *Has the U.S. Finance Industry Become Less Efficient?*

profits and wages paid to financial intermediaries, as a percentage of U.S. gross domestic product (GDP), has increased over the past 30 years—from roughly 5 percent of U.S. GDP in 1980 to almost 9 percent in 2010.³³ If the proponents' claims were true, there would likely be a decrease in the cost of intermediation, or at the very least, a rate that holds constant.

4. Financial Speculation Taxes Would Help Fix Many of the Problems that High-Frequency Trading Creates

Imposing an FST would raise transaction costs, thereby making high-frequency trading less profitable. Even a minuscule tax (0.03 percent, or 3 cents per \$100) on the transfer on stocks, bonds, and derivatives, as called for by the Wall Street Trading and Speculators Tax Act (S. 1787, H.R. 3313), introduced by Sen. Tom Harkin and Rep. Peter DeFazio,³⁴ would “throw sand in the gears” of high-frequency trading operations and slow them down. Such a proposal also has the potential to raise hundreds of billions of dollars to address our budget shortfall. The nonpartisan Joint Committee on Taxation scores the Harkin-DeFazio bill as generating \$352 billion in 9 years.³⁵ Some of this money could be used to bolster regulatory supervision and enforcement of trading activities and market abuses.

Taking the additional step of placing an FST on cancelled orders would make high-frequency traders pay for their extreme levels of cancellations. Doing so would disincentivize the use of “pinging” techniques that are used to glean information, which can be used at others market participants' expense. France recently approved such an FST proposal, which will apply to traders that, “(1) use computer algorithms to determine the price, quantity, and timing of their orders (2) use a device to process these orders automatically, and (3) transmit, modify, or cancel their orders within half a second (the half a second has been set by draft administrative guidance). The high frequency tax is .01% on the amount of stock orders modified or cancelled that exceeds 80% of all orders transmitted in a month (under the draft administrative guidance).”³⁶ Steven Rosenthal of the Tax Policy Center describes this as a “non-transaction” tax.³⁷ SEC Chairman Mary Schapiro has expressed interest in imposing fees on cancelled orders, but the SEC has yet to act.³⁸ NASDAQ has recently implemented its own excess order fee, but the thresholds for

On the Theory and Measurement of Financial Intermediation, NEW YORK UNIVERSITY STERN SCHOOL OF BUSINESS, February 2012, <http://bit.ly/NVrz7N>.

³³ *Id.*

³⁴ Bill Text, *S.1787 -- Wall Street Trading and Speculators Tax Act*, LIBRARY OF CONGRESS THOMAS, <http://1.usa.gov/S48yDO>.

³⁵ Memo: *Joint Tax Committee Finds Harkin, DeFazio Wall Street Trading and Speculators Tax Generates More Than \$350 Billion*, CONGRESSMAN PETER DEFAZIO, November 7, 2011, <http://1.usa.gov/OCN18C>.

³⁶ Steven Rosenthal, *France Collects a Financial Non-transaction Tax*, TAX POLICY CENTER, URBAN INSTITUTE AND BROOKINGS INSTITUTION, August 8, 2012, <http://bit.ly/NdAt00>

³⁷ *Id.*

³⁸ Scott Patterson and Andrew Ackerman, *SEC May Ticket Speeding Traders: High-Frequency Firms Face Fees on Canceled Transactions*, THE WALL STREET JOURNAL, February 23, 2012, <http://on.wsj.com/weD9YC>.

what are deemed excessive are so high that they are meaningless. According to the fee schedule, “if the order to trade ratio is greater than 100 to 1, but less than 1,000 to 1, a charge of half a penny per order is incurred. If the ratio is greater than 1,000 orders to a single trade, each excessive order incurs a charge of a penny.”³⁹

The idea of levying taxes on financial speculation is not new. In fact, economist John Maynard Keynes proposed a transaction tax in his book, *The General Theory* (1936) as a way to disincentivize short-term speculation and redirect financial activity to more socially productive purposes.⁴⁰ But even before Keynes wrote about curbing speculation, the United States had implemented a tax on the sale or transfer of stock. The tax was in place from 1914 until 1966.⁴¹

Currently, at least 29 countries have some form of financial transactions tax.⁴² The United Kingdom has a 0.5 percent transfer tax on stocks, as do other vibrant market centers such as Hong Kong, Singapore, Taiwan, South Korea, Australia, and Switzerland.⁴³ These examples are strong evidence that an FST in the United States would not harm our markets. Moreover, several countries in Europe, led by Germany, France, Spain, and Italy are making progress toward enacting an FST, and expect to implement one by the end of the year.⁴⁴

Prominent economic and financial experts, including Vanguard founder John Bogle, former Federal Reserve Chairman Volcker, and Nobel Laureate Paul Krugman, support the policy of taxing financial transactions.⁴⁵ And recently, more than 50 financial industry experts echoed support for the idea. Among others were: Marshall Auerback, Global Portfolio Strategist for Madison Street Partners LLC, a Denver-based hedge fund; John Fullerton, Founder and President, Capital Institute, and former Managing Director, JP Morgan; Leo Hindery, Jr., Managing Partner, InterMedia Partners LP, a media industry private equity

³⁹ Tom Steinert-Threlkeld, *Nasdaq Steps Up Penalty for Excessive Orders, Delays Start*, SECURITIES TECHNOLOGY MONITOR, June 1, 2012, <http://bit.ly/KezqKp>; Peter Chapman, *Nasdaq to Charge Heavy Quoters*, TRADERS MAGAZINE, March 8, 2012, <http://bit.ly/zydEx>.

⁴⁰ Roni Mann, *The regulatory road not taken: The proposed financial transaction tax in a historical context*, WZB MITTEILUNGEN, September 2012, <http://bit.ly/PQNuz5>.

⁴¹ *Facts and Myths About a Financial Speculation Tax*, CENTER FOR ECONOMIC AND POLICY RESEARCH, Updated December 2011, <http://bit.ly/nxQmiZ>.

⁴² *Id.*

⁴³ Hong Kong, Singapore, Australia, and Switzerland are four of the top five ranked countries in the conservative Heritage Foundation's 2012 Index of Economic Freedom. <http://heritagex42v1r>; Hong Kong imposes a “stamp tax” of 0.3 percent on stock trades, and received the top ranking in the index. Micah Hauptman, *A Lesson From The Heritage Foundation's Economic Freedom Index*, HUFFINGTON POST, <http://huff.to/O1CVVp>.

⁴⁴ *Eurozone's big four agree on financial transactions tax*, AFP, June 22, 2012, <http://bit.ly/PJXsQA>.

⁴⁵ *Statements of Support for a Financial Transaction Tax (FTT)*, CENTER FOR ECONOMIC AND POLICY RESEARCH, Updated June 2012, <http://bit.ly/b1LIYY>.

fund; and Dr. Paul Wilmott, proprietor, Wilmott magazine and the quantitative finance portal wilmott.com, and former partner, Caissa Capital (located in the United Kingdom).⁴⁶

Conclusion

Computer-driven high-frequency trading is not investment. Rather, it is betting, which harms traditional investors and the financial system. We must change incentives so that harmful and often predatory speculative activities decrease, and traditional long-term investment expands. Doing so will restore trust and confidence in our financial markets and our economy at large. We urge you to consider financial speculation taxes to achieve these goals.

⁴⁶ *Financial Professional Call for Speculation Taxes on Financial Transactions*, AMERICANS FOR FINANCIAL REFORM, June 21, 2012, <http://bit.ly/MsjuXz>.

STATEMENT OF CAMERON SMITH, PRESIDENT, QUANTLAB FINANCIAL, AND RICHARD GORELICK, CEO, RGM ADVISORS

Statement for the Record of

*Cameron Smith, Quantlab Financial, Houston, Texas
and
Richard Gorelick, RGM Advisors, Austin, Texas*

*Senate Subcommittee on Securities, Insurance, and Investment
“Computerized Trading: What Should the Rules of the Road Be?”*

September 20, 2012

Thank you Chairman Reed, Ranking Member Crapo, and Members of the Subcommittee for allowing us to submit this statement for the record in connection with this important hearing.

We are the President of Quantlab Financial and CEO of RGM Advisors, respectively, two Texas-based quantitative trading firms. Our companies each employ more than 100 people.

Our companies do business in multiple markets around the world – not just in equities – but other asset classes such as futures, options, treasuries and foreign currencies. We are proud of the role our firms play in the market and how our trading activities, in competition with a diverse array of other principal trading firms, lead to better prices for investors.

Modern Electronic Markets and Automated Trading Have Benefited U.S. Investors

In recent years, technology advancements coupled with regulatory changes have shifted the marketplace from an exclusive market, centered around the privileged few with seats on an exchange floor, to an open, competitive electronic market where orders are routed to exchanges using computers and prices are communicated to the public in real-time over telecommunications networks. As a result, virtually all trading on electronic markets is now automated in some fashion.

No matter whether automated or manual, markets need professional intermediaries to bridge gaps in supply and demand between investors. Historically, this function was provided by privileged intermediaries known as specialists, market makers, dealers, floor traders, or locals. The role of traditional market intermediary has been transformed and replaced in today’s open and automated markets. Today, automated professional traders are a diverse array of highly competitive firms that leverage technology to compete with each other, leading to better prices and lower transaction costs for all investors. Many are calling these market participants “high frequency traders” or “HFTs.”

After this transformation, by virtually every common measure of market quality, our markets have never been healthier. This has been demonstrated in numerous independent empirical academic studies that show that transaction costs have come down dramatically, price discovery has improved, and short-term volatility has been reduced. We have attached a copy of a recent review of the academic literature on the topic for the record ([Appendix A](#)). The intensely competitive market is also why the U.S. equity market is the largest and most efficient equity market in the world.

While the general trend of improving market quality and the important role that professional traders play in that improvement is clear, there still remains a great deal of misunderstanding around the role of professional traders, and so-called high frequency traders in particular. While different firms

will describe their trading approach in different ways, high frequency traders generally collect and analyze publicly available data, and determine their view of the instantaneous “fair value” of whatever they are trading. Different traders use their view of fair value in different ways. Some make markets by posting prices around their idea of fair value. Others, wait until their idea of fair value allows them to trade immediately based on prices in the market. Regardless of approach, the fierce competition between scores of professional intermediaries provides investors with the ability to buy or sell with low transaction costs.

Further, the general concept of competitive traders identifying and trading towards fair value explains why studies that have compared high frequency trading to the rest of the market find that it tends to improve price discovery and reduce, not increase, short term volatility. Recently, in a working paper titled “High Frequency Trading and Price Discovery,” Professors Terrence Hendershott at the University of California-Berkeley and Ryan Riordan at the Karlsruhe Institute of Technology in Germany concluded that high frequency traders “play a positive role in price efficiency by trading in the direction of permanent price changes and in the opposite direction of transitory pricing errors on average days and the highest volatility days.”

In sum, regulatory changes and technology advancements have led to an improved market that has benefitted all classes of investors, including retail and institutional, in the form of lower transaction costs, increased liquidity, and reduced volatility.

Additional Reforms Have Potential to Further Improve Market Quality

In recent months, we have witnessed a few high profile market technology failures. We must redouble efforts to reduce the likelihood and impact of similar errors in the future. In the aftermath of these events, we must take steps to enhance the industry’s risk management practices while, at the same time, preserving the market quality gains that have so benefited investors.

In this regard, we believe there are 4 areas of risk management that can be improved:

- Expand pre-trade risk management (with a focus on exchange side risk checks),
- Improve post-trade risk management (with a focus on improving the use of drop copies),
- Collaborate to improve the availability and scope of testing facilities, and
- Enhance communication procedures (on trading incidents and near misses)

All these areas will likely be thoroughly discussed by the SEC’s Technology Roundtable as well as other industry efforts that recognize the need for effective action in these areas. We look forward to contributing our expertise and assistance to ensure the discussions yield concrete proposals for each of the areas listed above.

In addition to improving risk management procedures, there are four other steps that should be advanced to enhance the integrity of our capital markets.

First, we must ensure that regulators have access to all the data they need to adequately surveil our markets and continue to ensure they operate with the highest integrity. One advantage of electronic markets over manual markets is the electronic audit trail that evidences all quoting and trading activity. However, regulators need the right tools and expertise to access this data efficiently. In this regard, we have consistently supported initiatives such as consolidated audit trails and trader

reporting systems. Further, we have encouraged the formation of industry working groups to offer technical assistance to regulators that must learn to analyze the richness of data that exists in electronic audit trails.

As regulators develop more robust market surveillance tools, however, it would be a mistake to focus attention solely on one group of market participants, as now seems to be the case with efforts by some to define “high frequency trading.” Instead, the programs should surveil the activities of all market participants, and then focus on specific activities of concern rather than focusing on essentially arbitrary categorizations.

Second, the SEC must continue its process related to the development of common sense market safeguards like circuit breakers or limit up/limit down protections. Many of the concerns expressed by critics of automated trading are really concerns, not about a specific trading style, but related to the threat of computer errors that undermine market integrity. While automation has improved market quality dramatically and eliminated many classes of historical trading errors, there is no question we must vigilantly protect against its unique risks. Therefore, in addition to enhanced risk management practices outlined above, we also support effective exchange administered circuit breakers or limit up/limit down protections. These “bumpers,” that prevent the market from moving outside of certain pre-determined parameters, are a critical component in protecting our markets from the effects of computer failures, software bugs or unintended interactions. The SEC’s proposals in these areas should enhance market stability while preserving the benefits of automation for investors.

Third, policymakers must continue to monitor and perhaps make some incremental changes to market structure to address the issue of market complexity. Fragmentation has been a longstanding concern in U.S. equity market structure. The challenge has long been to balance the many tangible benefits of open competition among trading venues against the complexities from fragmenting the market between too many trading venues. While a short time ago there were near monopolies in trading at incumbent exchanges, today, we need to examine whether there are just too many exchanges and trading platforms. It is worthwhile to explore whether, for example, different types of order flow being executed away from the public transparent markets, such as in dark pools or in other private order flow arrangements, could lead to a degradation of public market quality. We must also ensure that the current regulations don’t inadvertently contribute to excessive fragmentation by hindering the ability of public markets to compete with private markets.

In this regard, two simple adjustments to the current complex regulatory scheme are worth considering. First, consider allowing “locked” markets – that is, permitting quotes to be displayed when the “bid” price and the “ask” price are the same. While Regulation NMS banned locked markets, one impact of the ban was to limit the minimum quoted spread of the public market, thereby facilitating internalization and dark pool activity, which may be inhibiting the quality of lit markets. The ban on locked markets also has lead directly to the creation of more exotic order types, precisely the types of orders that have drawn press scrutiny of late. Those order types would not have been necessary in the absence of a locked market prohibition.

Second, policymakers should consider creating categories of stocks with different tick increments. While decimalization and penny increments have saved investors significant amounts in reduced transaction fees and other costs, a one size fits all approach regardless of whether a stock trades at \$5 or \$500 does not make sense.

Increments that are too wide reduce the efficiency of the public exchange markets relative to the private internalization markets. For example, when Citigroup stock was trading under \$5 per share, just that one stock constituted more than 30 percent of the private market volume. When the public markets cannot arrive at efficient prices due to tick increment constraints, it is relatively easier for off-exchange venues to siphon away order flow, contributing to fragmentation and potentially harming public market quality.

Fourth, and finally, we believe it is imperative for the market community to develop commonly accepted measures of market quality that are monitored consistently over time and provide a common ground for market structure discussions. Our capital markets are far too important to allow policymaking decisions to be driven by opinion and anecdote as to the current state of our markets. Certainly, discussions about market structure, including high frequency trading, could benefit from rigorous statistical analysis and greater awareness of empirical evidence on the topic. There are already many established metrics and methodologies for examining market quality, including measures of liquidity, price efficiency, market impact, volatility and cost. It should be a priority of the policymakers to develop and specify proper metrics before taking any significant steps toward altering the current market structure that has generally served investors so well.

Conclusion

Thank you for holding this hearing and fostering discussion as to the health of our equity markets. Despite a lot of criticism from some sectors, we believe that policy makers and regulators must not lose sight of the fact that we do have the world's leading equity markets and that the empirical evidence shows they have never been healthier. The U.S. has achieved this position by adhering to certain core values: transparency, open competition and the best interests of the investing public. Accordingly, when considering any future actions we must tread carefully and make sure that any actions are consistent with these values. While there are areas in need of improvement, we have a lot to be proud of.

We thank you for the opportunity to submit this statement.

Appendix A:
Literature Review

High Frequency Trading Literature Review
June 2012

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

Author(s) / Title	Dataset	Findings
Angel, Harris, Spatt "Equity trading in the 21st century", February 2010	U.S. equities, 1993 – 2009	Trading costs have declined, bid-ask spreads have narrowed and available liquidity has increased
RGM Advisors "Market Efficiency and Microstructure Evolution in US Equity Markets: A High Frequency Perspective", October 2010 March 2012 (Update)	U.S. equities, 2006-2011	Bid-ask spreads have narrowed, available liquidity has increased and price efficiency has improved
Credit Suisse "Sizing Up US Equity Microstructure", April 2010 "Who Let the Bots Out? Market Quality in a High Frequency World", March 2012	U.S. equities, 2003-2010 U.S. equities, 2004-2011	Bid-ask spreads have narrowed, available liquidity has increased and short-term volatility (normalized by longer term volatility) has declined, and the incidence of "mini" crashes has not increased
Hasbrouck, Saar "Low-Latency Trading", May 2011	U.S. equities, full NASDAQ order book June 2007 and October 2008	Low latency automated trading was associated with lower quoted and effective spreads, lower volatility and greater liquidity
Hendershott, Riordan "Algorithmic Trading and Information", August 2009	Automated vs. other trades. Deutsche Börse equities, January 2008	Automated trades made prices more efficient and did not contribute to higher volatility
Chaboud, Hjalmarsson, Vega and Chiquoine "Rise of the Machines: Algorithmic Trading in the Foreign Exchange Market", October 2009	Automated vs. other trades. EBS forex market, 2006-2007	Automated trades increased liquidity and may have lowered volatility
Markets Committee, Bank for International Settlements (BIS) "High-frequency trading in the foreign exchange market", September 2011	Various FX venues, notably Reuters and EBS, and various dates, notably May 6, 2010 and March 17, 2011	HFT is found to be beneficial during normal market periods, with similar behavior to traditional market participants during high volatility periods

Brogaard "High frequency trading and its impact on market quality", August 2010	HFT vs. other trades. U.S. equities on NASDAQ and BATS, various periods in 2008 – 2010	HFT helped to narrow bid-ask spreads, improved price discovery and may have reduced volatility
Brogaard "High Frequency Trading and Volatility", October 2011	HFT vs. other trades. U.S. equities on NASDAQ and BATS, various periods in 2008 – 2010	HFT activity tends to decrease idiosyncratic and intraday volatility.
Hendershott, Riordan "High Frequency Trading and Price Discovery" (working paper)	HFT vs. other trades. U.S. equities on NASDAQ, various periods in 2008 – 2010	HFT trades were positively correlated with permanent price changes and negatively correlated with transitory price changes, suggesting that HFT improves price discovery
Hirschey, Nicholas "Do High-Frequency Traders Anticipate Buying and Selling Pressure?"	HFT vs. other trades. U.S. equities on NASDAQ and BATS, various periods in 2008 – 2010	HFT trades were positively correlated with non-HFT trading, corroborating Hendershott and Riordan results
O'Hara, Yao, Ye What's Not There: The Odd-Lot Bias in TAQ Data	HFT vs. other trades. U.S. equities on NASDAQ, various periods in 2008 – 2010	Odd-lots and trades of 100 shares drive the majority of price discovery; HFT is more likely to trade with odd-lots
Jarnecic, Snape "An analysis of trades by high frequency participants on the London Stock Exchange", June 2010	HFT vs. other trades. LSE equities, April – June, 2009	HFT improved liquidity and was unlikely to have increased volatility
CME Group "Algorithmic trading and market dynamics", July 2010	Automated vs. other trades. CME futures, May 2008 – May 2010	Automated trading was associated with improved liquidity and reduced volatility
Kirilenko, Kyle, Samadi and Tuzun "The Flash Crash: The Impact of High Frequency Trading on an Electronic Market", May 2011	CME ES S&P-500 equities index futures contract, May 3 - May 6, 2010	HFT traders did not change their behavior during the flash crash; HFT was net buyer during the crash, net seller during the recovery; HFT trading may have induced more trading during the crash
Eurex AG, "Why high-frequency trading is a good thing", 2011	Eurex FDAX: DAX equities index futures contract August 25, 2011	During "FDAX flash crash", HFT acted "in a way that protects the market by placing a rapid succession of small, non-directional buy and sell orders, thus preventing abrupt price movements", improving market quality during a period of high stress
Menkveld "High Frequency Trading and the New-Market Makers", April 2011	Dutch equities traded on Chi-X and Euronext, 2007	A single high frequency trader played an important role in the development of a competitive market center, resulting in better liquidity and lower trading costs

Lepone "The Impact of High Frequency Trading (HFT): International Evidence", September 2011	HFT vs. other trades. Singapore Exchange (SGX), Australia Securities Exchange (ASX), NASDAQ and London Stock Exchange	HFT has become a major provider of liquidity, particularly during periods of market uncertainty
Hendershott, Jones, Menkveld "Does Algorithmic Trading Improve Liquidity?", February 2011	Automated quoting facility, NYSE equities, 2003	Automated trading narrowed bid-ask spreads, lowered trading costs, and improved price efficiency
Riordan, Storkenmairm "Latency, Liquidity and Price Discovery", 2009	Xetra high-speed trading system, Deutsche Börse, 2007	Higher system speeds led to increased liquidity and improved price discovery
Hendershott, Moulton "Automation, Speed and Stock Market Quality: The NYSE's Hybrid", February 2010	NYSE TAQ database plus others, June 1, 2006 - May 31, 2007	Introduction of automation via the NYSE hybrid system improved price discovery and made prices more efficient
Gomber, Arndt, Lutat, Uhle "High-Frequency Trading", March 2011	Various	Survey paper that highlights beneficial aspects of HFT, while noting that perceived problems are largely a result of U.S. market structure
Various BIS Foresight Project	Various European equities data sets	Generally stable or improving market quality over the past decade

This following studies measured improvements in overall market quality:

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

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

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

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

Hasbrouck and Saar (October 2010) explored the nature and impact of low-latency (algorithmic) trading on the NASDAQ exchange during June 2007, a 'nominal' market period, and October 2008, a volatile, uncertain period.⁴ They identified periods of high market activity due to algorithms and relate these to longer-term market quality metrics such as spread, effective spread and depth of liquidity. They observe in both periods “that higher low-latency activity implies lower posted and effective spreads, greater depth, and lower short-term volatility.”

² Castura, J., Litzberger, R., Gorelick, R., and Dwivedi, Y., 2010: “Market Efficiency and Microstructure Evolution in US Equity Markets: A High Frequency Perspective”,

<http://www.rgmadvisors.com/docs/MarketEfficiencyStudyOct2010.pdf>

Castura, J., Litzberger, R., Gorelick, R. 2012: “Market Efficiency and Microstructure Evolution in US Equity Markets: A High Frequency Perspective: Update March 2012”,

<http://www.rgmadvisors.com/docs/MarketQualityStudyMarch2012.pdf>

³ Credit Suisse, 2010: “Sizing Up US Equity Microstructure”,

<https://tradeview.csfb.com/edge/Public/Bulletin/Servefile.aspx?FileID=14377&m=1337434953>

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

⁴ Hasbrouck, J. and Saar, G, “Low-Latency Trading”,

http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1695460

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

Hendershott and Riordan (August 2009) reported on the impact of automated trading on the Deutsche Börse's Xetra market, an equity market where automated trading activity could be distinguished.⁵ The paper found that automated trading accounted for about half of the total volume in the top 30 volume stocks, and that automated trading was better than non-automated trading at driving prices toward efficiency. The authors also showed that automated trading "contributes more to the discovery of the efficient price than human trading." Furthermore, they find there is "no evidence of [automated trading] behavior that would contribute to volatility beyond making prices more efficient."

Similarly, in the foreign exchange market, **Chaboud, Hjalmarsson, Vega and Chiquoine (October 2009)** used a dataset that separately identified computer generated trades from human generated trades and showed that an increase in automated trading may be associated with less market volatility, and that automated traders tend to increase liquidity provision after exogenous market events such as macroeconomic data announcements.⁶

The Bank for International Settlements (September 2011) released a related study on the impact that growing HFT participation has had on the foreign exchange market.⁷ The authors based their findings on observations made from several banks and other foreign exchange markets, in addition to using historical data from Reuters and EBS, two of the largest FX trading platforms. They cited a general consensus that HFT benefits the markets under normal conditions, and therefore focused on two significant FX shocks: May 6, 2010 and March 17, 2011. In both cases, they found evidence suggesting that HFT did not withdraw from trading during the shocks, and that they may have been quicker to resume normal trading as the shocks stabilized than traditional market participants.

Brogaard (August 2010) investigated the impact of "high frequency trading" or "HFT" on US equity trading on the NASDAQ and BATS exchanges.⁸ Using a data set provided by the exchanges that labeled all activity as either 'HFT' or 'everything else', Brogaard examined the exact impact that HFT participants have on the market. His analysis used a well-known regression framework to isolate various factors in the market and how HFT impacts each of these. In particular, he shows that HFT activity contributes more to price discovery than other activity, that HFT quotes are at the best bid or best ask price about 50% of the time, that HFT reduces price impact (an important component of trading costs) for other participants, and that HFT activity reduces volatility.

⁵ Hendershott, T. and Riordan, R., 2009: "Algorithmic Trading and Information", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1472050

⁶ Chaboud, Alain, Hjalmarsson, Erik, Vega, Clara and Chiquoine, Ben, "Rise of the Machines: Algorithmic Trading in the Foreign Exchange Market" (October 2009). Federal Reserve Board International Finance Discussion Paper No. 980, <http://ssrn.com/abstract=1501135>

⁷ Bank for International Settlements, "High-frequency trading in the foreign exchange market" (September, 2011), <http://www.bis.org/publ/mktc05.pdf>

⁸ Brogaard, J., "High frequency trading and its impact on market quality", www.futuresindustry.org/ptg/downloads/HFT_Trading.pdf

Brogaard (October 2011) used the same data set to investigate the impact of HFT on volatility.⁹ He performed a series of measurements in an attempt to determine the causal nature of the relationship between HFT activity and volatility. He found evidence that HFT liquidity provision increases during times of short-term volatility, but decreases during periods of long-term volatility. Using the 2008 short-sale ban as an exogenous control variable of HFT activity levels, Brogaard found that restrictions that reduced HFT participation lead to higher volatility.

Hendershott and Riordan (2011) examined the impact of HFT on the price discovery process using the same NASDAQ dataset used in Brogaard (2010).¹⁰ Overall they found that HFT trades are positively correlated with permanent price changes and are negatively correlated with temporary pricing errors, thereby improving the price discovery process. By distinguishing trades initiated by HFT, the authors found that marketable high frequency trades actively drive prices towards fair value.

Hirschey (2011) used the same HFT-labeled NASDAQ dataset of Hendershott and Riordan (2011) to investigate how HFT used marketable orders.¹¹ He found that HFT traded with marketable orders in the direction of previous, contemporaneous and future non-HFT orders. This corroborates the Hendershott and Riordan results, showing that HFT trades in the direction of permanent price impact.

O'Hara, Yao and Ye (2011) used the same HFT-labeled dataset of Hendershott and Riordan (2011) to investigate the use of odd-lots in trading.¹² They found that that odd-lots contribute to 30% of the price discovery process, and that such trading can represent a significant fraction of all trades, particularly for higher priced stocks. They showed that HFT was more likely to trade with odd-lots. Finally, they raised the concern that the consolidated pricing feed does not account for odd-lots, and as such may not be as useful as it was intended.

A similar study done by **Jarnecic and Snape (June 2010)** used data provided by the London Stock Exchange (LSE).¹³ Like the NASDAQ data set, this set labeled all activity by participant type; HFT, investment bank, retail, etc., providing a finer granularity of participation rates and behaviors. The authors used a similar regression framework as Brogaard in order to isolate the impact of HFT on various market metrics. They found that HFT participants tend to provide liquidity when spreads are wide, demand liquidity when spreads are narrow, that they are more likely to "smooth out liquidity over time and are unlikely to exacerbate stock price volatility".

⁹ Brogaard, J., "High frequency trading and volatility", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1641387

¹⁰ Hendershott, T. and Riordan, R., 2011: "High Frequency Trading and Price Discovery", <http://faculty.haas.berkeley.edu/hender/HFT-PD.pdf>

¹¹ Hirschey, N. "Do High-Frequency Traders Anticipate Buying and Selling Pressure?", https://www2.bc.edu/~taillard/Seminar_spring_2012_files/Hirschey.pdf

¹² O'Hara, M. Yao, C. and Ye, M. "What's not there: The odd-lot bias in TAQ data", http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1892972

¹³ Jarnecic, E. and Snape, M., "An analysis of trades by high frequency participants on the London Stock Exchange", http://mfs.rutgers.edu/MFC/MFC17/MS/MC10~447_Snape_Jarnecic.pdf

The CME Group (July 2010) released a report on automated trading activity on the CME futures exchange.¹⁴ They labeled all participants as either “ATS” (automated trading system) or “non-ATS.” They compared trade volume and messaging rates for each participant against market measures such as liquidity and volatility. ATS’s impact on these measures varies by futures contract, but as a whole, they concluded that ATS-based “volume and message traffic tend to be associated with enhanced liquidity and reduced volatility”.

Kirilenko, Kyle, Samadi and Tuzun (May 2011) investigated the role that HFT played in the flash crash on May 6, 2010.¹⁵ With access to all trades and accounts for the S&P 500 e-mini futures contract that trades on the CME, they classified all participants by activity patterns, including a group of participants that they characterized as “HFT”. They found that these participants accounted for a large portion of trading and that they did not change their trading behavior before or during the flash crash. HFT participants were net buyers during the crash and net sellers during the recovery. The authors suggest that HFT trading during a brief period of the crash may have induced other participants into thinking there was more liquidity than was truly available.

Backes (2011), representing the Eurex futures group, performed a similar investigation around the flash crash of the FDAX futures contract on August 25, 2011, which shared many characteristics of the May 6, 2010 flash crash in the U.S.¹⁶ Analysis of the trading behavior of HFT during this time found that HFT played an important role in maintaining and providing liquidity during the sharp drop in the FDAX contract. The author stated that HFT acted “in a way that protects the market by placing a rapid succession of small, non-directional buy and sell orders, thus preventing abrupt price movements”.

Menkveld (April 2011) studied the development of the Chi-X European stock MTF in 2007 and the simultaneous entry of a large high frequency trading participant on Chi-X.¹⁷ He found that this new participant was largely responsible for the increase in market share of Chi-X and ultimately led to reduced spreads for the stocks that it traded.

Lepone (2011) summarized the results of a series of research conducted by the Australian organization Capital Markets Cooperative Research Centre (CMCRC).¹⁸ These papers examined the impact of HFT on market quality for exchanges based in Singapore, Australia, the U.S., and the United Kingdom. Their data allowed them to identify trading participants and classify them into HFT and non-HFT groups. Following a methodology similar to Brogaard (2010), each of these papers measured the impact of HFT on market quality metrics. The findings showed a consistent pattern of improved market quality coinciding with growing

¹⁴ The CME Group, “Algorithmic trading and market dynamics”,
http://www.cmegroup.com/education/files/Algo_and_HFT_Trading_0610.pdf

¹⁵ Kirilenko et al., “The Flash Crash: The Impact of High Frequency Trading on an Electronic Market”,
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1686004&rec=1&srcabs=2013789

¹⁶ Backes, “High-frequency trading in volatile markets - an examination”,
http://www.eurexexchange.com/download/documents/publications/factsheet_highfrequency.pdf

¹⁷ Menkveld, A., 2011: “High Frequency Trading and the New-Market Makers”,
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1722924

¹⁸ Lepone, A., 2011: “The Impact of High Frequency Trading (HFT): International Evidence”,
<http://www.cmcrc.com>

HFT participation. They also demonstrated that HFT is active during all volatility conditions and “become the primary providers of liquidity” in periods of high uncertainty.

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

Hendershott, Jones and Menkveld (2007) examined the impact on the NYSE of their auto-quoting facility introduced in 2003.¹⁹ This study showed that for all stocks, and particularly large-cap stocks, automated trading increased liquidity. It also demonstrated that the increase in automated trading caused a reduction in effective spreads, thereby reducing costs to investors.

Similarly, **Riordan and Storkenmairm (2009)** reported on how a 2007 upgrade to the Deutsche Börse’s Xetra trading system focused solely on latency reduction, positively affected market quality.²⁰ After latency reductions in the exchange’s trading systems, liquidity increased across market capitalization and trade sizes, and adverse selection and permanent price impact were dramatically reduced.

Hendershott and Moulton (February 2010) studied the introduction of the NYSE hybrid system in 2006, which moved the NYSE to a faster and more automated matching system.²¹ They found that prices became more efficient due to faster price discovery and reduced noise in prices.

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

Gomber et al. (March 2011) presented background information on HFT. Their paper analyzed HFT and “certain proposed regulatory measures.”²² They claimed that HFT is a technology rather than a strategy, and is a natural evolution in the market place. They highlighted the beneficial aspects that HFT can provide, and noted that perceived problems with HFT are largely a result of U.S. market structure rather than anything inherent in HFT itself. They provided several recommendations for policy makers that would maintain the beneficial aspects of HFT while providing markets with additional safety.

¹⁹ Hendershott, T., Jones, C.M. and Menkveld, A.J., “Does Algorithmic Trading Improve Liquidity?”, *Journal of Finance*, Volume LXVI, No. 1, February 2011

²⁰ Riordan, R. and Storkenmairm, A., 2009: “Latency, Liquidity and Price Discovery”, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1247482

²¹ Hendershott, T. and Moulton, P., February 2010: “Automation, Speed, and Stock Market Quality: The NYSE’s Hybrid”, http://www.hotelschool.cornell.edu/research/facultybios/research-papers/documents/AutomationSpeedHybrid_accepted.pdf

²² Gomber, P., Arndt, B., Lutat, M., and Uhle, T., March 2011: “High-Frequency Trading”, <http://www.frankfurt-main-finance.com/en/data-facts/study/High-Frequency-Trading.pdf>

The **Foresight Project** by the BIS was a study intended to “explore how computer generated trading in financial markets might evolve in the next ten years or more”, with a particular emphasis on stability, integrity, competition, efficiency and costs.²³ Most of the supporting papers were policy driven and speculative in the sense that they were not data-driven. One paper examined the changes in broad market quality in U.K. equities over the past decade and found that there are few trends of statistical significance. Volatility appeared to have peaked in 2008/2009, but had no discernable long-term trend. Liquidity and efficiency metrics appeared to have no significant trends, and there may be a positive link between competition and market quality.

²³ BIS Foresight Project: <http://www.bis.gov.uk/foresight/our-work/projects/current-projects/computer-trading>

SUMMARY AND EXCERPTS FROM “HIGH FREQUENCY TRADING AND PRICE DISCOVERY” BY TERRY HENDERSHOTT AND RYAN RIORDAN

**Summary and Excerpts from
“High Frequency Trading and Price Discovery”
by Terry Hendershott and Ryan Riordan**

The paper uses high quality data that actually segregates professional traders (HFT) from other market participants, and finds that HFT plays a positive role in price discovery and efficiency. It can be found here:

http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1928510

Key Findings:

- It seems the preference for posted liquidity and therefore algorithms that are engaged in “market making” is misplaced. This report shows that remove flow (active orders) provides more information to the market in terms of keeping stock prices around “fair value” and, therefore, dampens volatility more than posted liquidity.
- I think the conclusion to be drawn for regulators is that the market is a fragile ecosystem to and to favor one strategy (market making with two sided quotes) will certainly harm investors and is based on false assumptions rather than any empirical evidence.
- To better understand HFT’s role in price discovery during such times the report analyzes the most volatile days in the sample (e.g. September 2008 when Lehman failed) and the finding was that HFT “increased their participation somewhat” (certainly didn’t decrease!) the subsample of the highest-permanent volatility days. Further the report found that “HFT’s role in price discovery is qualitatively similar on high-permanent volatility days, which we interpret as high market stress times.”

Excerpts:

- “This indicates that when HFT initiate trades they trade in the opposite direction to the transitory component of prices, consistent with their trading reducing transitory volatility. The natural interpretation is that when prices deviate from their fundamental value HFT initiate trades to push prices back to their efficient levels. This reduces the distance between quoted prices and the efficient permanent price of a stock.” (Page 14)
- The fact that HFT increases their participation on high-permanent volatility days reveals that HFT continue to supply liquidity in times of market stress. This was a concern highlighted in the SEC concept release. (Page 15)
- “The negative coefficients show that HFT is generally trading in the opposite direction of the pricing errors.” (Page 13, showing it reduces transitory volatility)
- “The negative coefficients on show that HFT passive trading occurs in the direction opposite to permanent price movements. This relationship exists in models of uninformed liquidity supply where suppliers earn the spread but lose to informed traders.” (Page 13, shows passive trading doesn’t add as much price information as active)