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High-Frequency Trading and the Flash Crash: Structural Weaknesses in the Securities Markets and Proposed Regulatory Responses

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I. INTRODUCTION

On May 6th, 2010, a single trader in Kansas City was either lazy or sloppy in executing a large trade on the E-Mini futures market.[1] Twenty minutes later, the broad U.S. securities markets were down almost a trillion dollars, losing at their lowest point more than nine percent of their value.[2] Certain stocks lost nearly all of their value from just minutes before.[3] Faced with the blistering pace of the decline, many market participants opted to cease trading entirely, including both human traders and High Frequency Trading ("HFT") programs.[4] This withdrawal of liquidity[5] accelerated the crash, as fewer buyers were able to absorb the rapid-fire selling pressure of the HFT programs.[6] Within two hours, prices were back

1. REPORT OF THE STAFFS OF THE CFTC AND SEC TO THE JOINT ADVISORY COMMITTEE ON EMERGING REGULATORY ISSUES, FINDINGS REGARDING THE MARKET EVENTS OF MAY 6, 2010, at 5, Sept. 30, 2010, *available at* www.sec.gov/news/studies/2010/marketevents-report.pdf [hereinafter "FINAL REPORT"]; Graham Bowley, *The New Speed of Money, Reshaping Markets,* N.Y. TIMES, (Jan. 1, 2011), *available at* http://www.nytimes.com/2011/01/02/business/02speed.html?ref=highfrequency algorithmictrading&pagewanted=all; The E-mini futures contracts are tied to the value of the S&P 500 equity index, and is frequently used to hedge positions or to make directional bets on broad market movements. The E-mini futures contracts are tied to the value of the S&P 500 equity index, and is frequently used to hedge positions or to make directional bets on broad market movements.

2. David M. Serritella, *Recent Development: High Speed Trading Begets High Speed Regulation: SEC Response to Flash Crash, Rash*, 2010 U. ILL. J. L. TECH. & POL'Y 433, 433 (2010); Edward E. Kaufman Jr., Carl M. Levin, *Preventing the Next Flash Crash*, N.Y. TIMES, May 6, 2011, at A27.

3. COMMODITY FUTURES TRADING COMM'N & SEC, PRELIMINARY FINDINGS REGARDING THE MARKET EVENTS OF MAY 6, 2010, at 34 (May 18, 2010), *available at* http://www.sec.gov/sec-cftc-prelimreport.pdf [hereinafter "PRELIMINARY REPORT"].

4. *Id.* at 6, 8, 69.

5. "Liquidity reflects the ease with which certain amounts of an asset can be bought or sold without exerting a significant effect on its price. Higher market liquidity can be interpreted as a greater collective willingness to execute orders at given prices." PRELIMINARY REPORT, *supra* note 3, at 65.

6. PRELIMINARY REPORT, *supra* note 3, at 2–3.

near their pre-crash levels. It took the SEC more than five months of research to determine what sparked the crash.[7]

This precipitous market crash was made possible, if not inevitable, by the growing interconnectivity of the securities markets and the proliferation of high-frequency trading. These two factors combine to create a situation where trillions of dollars of wealth can be destroyed before human traders can react, often for reasons that are unknown even to the program's designers. As a result, extreme market movements can perpetuate themselves across the U.S. markets almost entirely without human involvement.

This note will illuminate the relatively unknown high-frequency trading industry. First, it will examine the state of the industry, in context with the flash crash of May 6th, 2010. Next, it will explain why the hodge-podge of regulations struggling to control this industry is entirely inadequate to prevent another crash. Finally, I will suggest a better solution—relatively noninvasive controls that could be put in place to prevent future flash crashes and restore investor confidence.

The initial cause of the crash in the futures market is simple. A trader seeking to sell more than $4 billion worth of futures contracts—which usually takes more than five hours to execute—chose to sell the contracts with an automated execution algorithm.[8] This type of algorithm is one of the simplest types of "automated trading": the trader enters a few criteria, usually price, time, and volume limitations for the trade, and the program then executes the trade without any further human involvement.[9] In this case, the trader did not limit his selling program in terms of price or time, and the program sold the entire order of 75,000 futures contracts in just twenty minutes.[10] This trade set off a domino effect of high-speed reactions from an army of high-frequency trading programs that has grown to dominate the markets

For such a large and aggressive trade to drive down the price of the futures contracts is nothing new. It is for this reason that careful traders take many hours to execute trades of this magnitude, hiding the size of their trade and seeking out pockets of liquidity that can absorb their sales.[11] As such, that this trade drove the e-mini futures market down three percent in four minutes is neither surprising nor particularly worrisome.[12] Rather, it is

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7. *See generally* FINAL REPORT, *supra* note 1.

8. *Id. See also* Matt Phillips, *Accenture's Flash Crash: What's an "Intermarket Sweep Order*," WALL ST. J. BLOG (May 7, 2010, 5:51 PM), *available at* http://blogs.wsj.com/marketbeat/2010/05/07/accentures-flash-crash-whats-an-intermarket-sweep-order/ (describing how this type of algorithmic works).

9. FINAL REPORT, *supra* note 1, at 14.

10. *Id.*

11. *Id.*

12. *Id.* at 15.

the ensuing market-wide crash and subsequent rebound that is worrying to investors and regulators alike. Most disturbingly, the flash crash, as the May 6th market event has come to be known, exposed fundamental structural weaknesses in the modern financial markets. The SEC has proven unable to address these weaknesses.

Part II of this note will examine the current structure of the domestic securities markets, including the changes over the last several years that have laid the groundwork for precipitous market events such as the flash crash. The most relevant of these changes is the rise of high frequency trading to a position of market dominance. Part III will evaluate the regulatory framework in place to prevent market breaks, both before and after the flash crash. Part IV will illustrate why the current and proposed regulations are inadequate to prevent future crashes. Finally, Part V will offer alternative solutions that could be used to render the markets safer, more predictable, and more worthy of investor confidence. The core of the suggested regulations is that whenever market volatility (as measured by the Chicago Board Options Exchange Volatility Index, or "VIX") reaches a point at which human traders withdraw from the market, rules should be triggered to slow the market to a speed that traders can follow.

II. THE CURRENT RISK: THE STRUCTURE OF THE MODERN MARKET AND THE RISE OF HIGH FREQUENCY TRADING

The modern securities market bears little resemblance to the markets of a decade ago, let alone the open-outcry trading forums from which they developed.[13] The transformation of market infrastructure has been dramatic and complete, and has enabled algorithmic trading programs to quietly assume a role of market dominance. While the average American may not have noticed the seismic shifts in terms of structure, regulation, and technology in the financial markets, he probably has noticed that his personal financial well being is now inexorably tied to their performance.[14] The middle class used to prepare for retirement by saving in bank accounts, but now the majority of Americans tie their futures to the health of the markets, with 401(k)s, mutual funds, and other investments seen as the only way to afford retirement.[15] This is an important change from as

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13. SECURITIES & EXCHANGE COMMISSION, RELEASE NO. 34-61358, CONCEPT RELEASE ON EQUITY MARKET STRUCTURE, (Jan. 21, 2010) [hereinafter "CONCEPT RELEASE"]; *see also* Jerry W. Markham & Daniel J. Hardy, *For Whom the Bell Tolls: The Demise of Exchange Trading Floors and the Growth of ECNs*, 33 J. CORP. L. 865, 866 (2008) (providing a comprehensive history of the evolution of the securities exchanges).

14. Arthur Kennickell et al., *Recent Changes in U.S. Family Finances: Results from the 1998 Survey of Consumer Finances*, 86 FED. RESERVE BULLETIN 1, 15 (table 6) (2000).

15. Markham & Hardy, *supra* note 13, at 866.

recently as 1983, when only one fifth of households held any stocks.[16]

Even if individuals are not directly invested in the markets, they are affected by the relationship between credit and the securities markets as was made so evident during the recent economic downturn.[17] As such, the securities markets affect business, housing, education, consumption, and nearly everything that is remotely related to money.[18]

This fundamental shift in the relationship between the markets and the lives of the average American makes it imperative that we carefully evaluate the evolution of the markets in the modern era.

A. SETTING THE STAGE FOR MARKET AUTOMATION

In the early stages of the equity exchanges, traders met face to face and agreed on transactions.[19] Such a system worked well in 1827, when the average daily volume on the New York Stock Exchange ("NYSE") was 100 shares,[20] but while traders and regulators have sung the praises of open-outcry trading as recently as 2007,[21] the automation of the markets was inevitable. The shift to electronic trading, motivated by concerns of efficiency, fairness, and competition, has led to a market that bears little resemblance to the trading pits from which they evolved.

Where equities used to be primarily traded on the exchange on which they were listed, such as the NYSE, today there is instead a dispersed network of highly automated trading centers through which market participants can execute trades, all of which offer incentives and compete with each other in order to attract liquidity.[22] In fact, contrary to what many investors might think, less than fifteen percent of domestic trading volume occurs on the NYSE exchange itself, and less than twenty percent on NASDAQ.[23] This is a dramatic shift from the dominating position of the exchanges, which executed more than seventy percent of transactions in listed stocks in 2005, and more than fifty percent as recently as 2007.[24] The

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16. INVESTMENT COMPANY INSTITUTE AND THE SECURITIES INDUSTRY ASSOCIATION, EQUITY OWNERSHIP IN AMERICA, 2005 (2005), at 1.

17. REPORT OF THE STAFF OF THE JOINT ECONOMIC COMMITTEE MAJORITY, FROM WALL STREET TO MAIN STREET: UNDERSTANDING HOW THE CREDIT CRISIS AFFECTS YOU (Oct. 3, 2008), *available at* http://jec.senate.gov/public/?a=Files.Serve&File_id=b2087603-5883-4777-b13e-6b30845d4265.

18. *Id.*

19. Markham & Hardy, *supra* note 13, at 869.

20. *Id.*

21. *Id.* at 896. (Then Federal Reserve Chairman Allan Greenspan asserting that open-outcry trading is "'the optimum model' because, while computers are useful, human beings always prefer personal interactions and that, therefore, open outcry markets will always be around.").

22. Graham Bowley, *The New Speed of Money, Reshaping Markets,* N.Y. TIMES, (Jan. 1, 2011), *available at* http://www.nytimes.com/2011/01/02/business/02speed.html?ref=highfrequencyalgorithmic trading&pagewanted=all; CONCEPT RELEASE, *supra* note 13, at 3594.

23. CONCEPT RELEASE, *supra* note 13, at 3597.

24. Markham & Hardy, *supra* note 13, at 910.

vast majority of trading now occurs on about a dozen Electronic Communications Networks ("ECNs"), such as Direct Edge and Better Alternative Trading System ("BATS"), as well as internal broker/dealer networks.[25]

Another key development that cleared a path for the current state of computer-driven trading was the decimalization of equity prices in 2001. Here, exchanges started listing prices at intervals of $0.01 rather than the previous interval of 1/16th of a dollar.[26] This policy change drastically reduced the advantage held by market makers,[27] increased liquidity, and created a much more favorable environment for HFT programs that can capitalize on these small price changes.[28]

The current electronic interconnection of ECNs and exchanges was cemented in 2005, when the SEC enacted Regulation National Market System ("Reg. NMS").[29] Congress enacted this bill on the assumption that liquidity and price stability would be improved by promoting competition between trading venues rather than allowing a few dominant exchanges.[30] Reg. NMS mandates that these widely dispersed networks work together as one "national market system."[31] As such, the exchanges must always route orders to the venue with the best price—and so a "buy" order filed on NYSE must be filled with the best available offer, regardless of whether the offer is on NYSE or one of the many other ECN's or exchanges.[32] All of this routing takes place in the blink of an eye, with minimal input from the trader.

Without being able to compete by offering better prices, the ECN's began to attract liquidity by offering low fees, extremely fast execution and

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25. Markham & Hardy, *supra* note 13, at 910; *Bats System Performance*, BATS (2011), http://batstrading.com/resources/features/bats_ exchange_Latency.pdf; Graham Bowley, *The New Speed of Money, Reshaping Markets,* N.Y. TIMES, (Jan. 1, 2011). *available at* http://www. nytimes.com/2011/01/02/business/02speed.html?ref=high

frequencyalgorithmictrading&pagewanted=all. Note that the SEC often refers to ECNs as Alternative Trading Systems ("ATSs") in their regulations.

26. Michael J. McGowan, *The Rise of Computerized High Frequency Trading: Use and Controversy*, 2010 DUKE L. & TECH. REV. 16, ¶3 (2010).

27. A "market maker" is a market participant with the affirmative responsibility to continuously offer two-sided quotes in given securities, serving as the buyer or seller of last resort. The role of market makers has diminished in the last decade, the implications of which are discussed *infra*, Part V.

28. *Id*.

29. Regulation NMS, 70 Fed. Reg. 37496, 37513 (June 29, 2005).

30. Securities Exchange Act of 1934, § 11A, 15 U.S.C. § 78k-1 (2006); *see also* PRELIMINARY REPORT, *supra* note 3, at 81.

31. Securities Exchange Act Release No. 51808, 70 Fed. Reg. 37496 (June 9, 2005), ("Regulation NMS Release").

32. *Id*. *See* SEC Report on the Market Events of May 6th, *supra* note 3; *Testimony Concerning the Severe Market Disruption on May 6, 2010 Before the H. Subcomm. On Capital Mkts*., 111th Cong. 8–9 (2010) (statement of Mary L. Schapiro, Chairman, U.S. Securities and Exchange Commission) [hereinafter Schapiro statement], *available at* http://www.sec.gov/news/testimony/2010/ts051110 mls.pdf.

latency times, and rebates for providing liquidity.[33] Now, traders who use these ECN's receive accurate pricing information in fewer than 250 microseconds, and can enter and exit trades thousands of times per second.[34] The liquidity rebates provided by the ECNs sometimes exceed the fees themselves, allowing HFT firms to trade with zero marginal cost.[35] This trading infrastructure has made it practical for market participants to trade on an extremely short timeframe, and with volume that would be shocking to previous generations of traders.

Trading firms unsatisfied with these extremely short latencies have shortened their trade times by physically locating their trading servers near the exchanges. Many firms buy up expensive real estate for the purpose of shaving microseconds off of their execution times (a practice referred to as "co-location").[36] The exchanges have reacted to this demand for collocation and low-latency trades, and have been scrambling to attract HFT firms to their exchanges. The ECNs profit from such arrangements by charging HFT firms access fees for low-latency market data (which accounts for about half of their total revenue) and renting out collocation space at prices of up to $25,000 per month for a single rack of servers.[37] With the importance of speed for HFT strategies, competing firms have been locked in what has been called a "technological arms race," in which they must constantly improve their systems in order to continue reaping their immense profits.[38]

The incredible speed and interconnectivity of the markets has allowed the proliferation of complicated automated trading strategies, such as cross-market or index arbitrage, where a program will buy or sell a derivative security while taking an opposite position in the underlying security—profiting when their values merge.[39] Thanks to electronic connectivity and price competition between exchanges, such trades can be done automatically, within a few millionths of a second, for a near-zero marginal cost.

One more crucial market development that laid the groundwork for the proliferation of High Frequency Trading is the dramatic increase in leverage in the market. Because most HFT strategies rely on very small price changes, they often take large or multitudinous positions in order to maximize their gains. The rise of this type of strategy, combined with the

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33. CONCEPT RELEASE, *supra* note 13, at 3594.

34. *See e.g.*, BATS, *Bats System Performance*, http://batstrading.com/resources/features/bats_exchange_Latency.pdf.

35. CONCEPT RELEASE, *supra* note 13, at 3599.

36. *Id.* at 3598.

37. Graham Bowley, *The New Speed of Money, Reshaping Markets,* N.Y. TIMES, (Jan. 1, 2011), *available at* http://www.nytimes.com/2011/01/02/business/02speed.html?ref=highfrequencyalgorithmic trading&pagewanted=all.

38. McGowan, *supra* note 26, at 16.

39. *Id*. at 9.

low cost of borrowing, has resulted in leverage ratios that—at their extreme—can reach 50/1.[40] To put this in perspective, the hedge fund Long Term Capital Management, the near collapse of which in 1998 threatened the entire western financial system, operated with a leverage ratio of around 25/1.[41] While most hedge funds claim that they are leveraged around or less than 10/1, the calculations are complicated by the fact that many of these funds invest their borrowed funds in products that are leveraged themselves.[42]

There are two major consequences of so much cheap leverage—trading volume greatly increases, and downward trends are exacerbated as leveraged funds are forced to sell in order to avoid wiping out their entire principal. Cheap leverage has also facilitated the rise of HFT firms and the leverage-dependant strategies they employ.

With the stage set, algorithmic trading ascended to a dominant position in the securities markets. Organizationally, some HFT firms are independent proprietary trading firms, some are hedge funds, and some are parts of larger broker/dealer firms.[43] While some HFT firms are registered as broker-dealers, many are not.[44] As such, they are not subject to reporting requirements, and indeed it is often impossible for the exchanges to ascertain their identity.[45]

B. THE RISE OF HIGH-FREQUENCY TRADING

For firms with the means to co-locate with exchanges and develop HFT algorithms, the current infrastructure makes it extremely profitable to make millions of these short-term low-latency trades every day.[46] For example, in 2008 it is estimated that HFT firms profited more than $20 billion.[47] Over the last few years, the prevalence of these automated HFT

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40. Nouriel Roubini, *Credit Derivatives, Hedge Funds and Leverage Ratio's of 50: The Credit House of Cards*, ROUBINI GLOBAL ECONOMICS. (Jan 20, 2007), http://www.roubini.com/roubini-monitor/173905/credit_derivatives_hedge__funds_and_leverage_ratios_of_50_the_credit_house_of_cards.

41. Franklin R. Edwards, *Hedge Funds and the Collapse of Long-Term Capital Management*, 13 J. OF ECON. PERSP., 189, 189 (1999); REPORT OF THE PRESIDENT'S WORKING GROUP ON FINANCIAL MARKETS, HEDGE FUNDS, LEVERAGE, AND THE LESSONS OF LONG-TERM CAPITAL MANAGEMENT, at 12, (1999).

42. Gillian Tett, *The Unease Bubbling in Today's Brave New Financial World*, FT.COM, (Jan. 19, 2007), *available at* http://www.ft.com/cms/s/0/92f7ee6a-a765-11db-83e4-0000779e2340.html#axzz 1Ff9UVqJz; HEDGE FUNDS, LEVERAGE, AND THE LESSONS OF LONG-TERM CAPITAL MANAGEMENT, *supra* note 41, at 5–6.

43. Schapiro statement, *supra* note 32, at 10–11.

44. *Id*.

45. CFTC-SEC ADVISORY COMMITTEE ON EMERGING REGULATORY ISSUES, RECOMMENDATION REGARDING REGULATORY RESPONSES TO THE MARKET EVENTS OF MAY 6, 2010 (2011) [hereinafter "SUMMARY REPORT"].

46. Schapiro statement, *supra* note 32, at 10.

47. "High-frequency traders generated about $21 billion in profits in 2008, the Tabb Group, a research firm estimates." Charles Duhigg, *Stock Traders Find Speed Pays, in Milliseconds,* N.Y.

trading programs has quietly grown to the point where they now dominate the worldwide equity securities markets.[48] Even though HFT firms represent only about two percent of trading firms, automated trading programs now account for between fifty percent and eighty percent of executed trading volume on domestic exchanges.[49]

Further, these programs are the source of a much higher percentage of offers and bids that are never executed, most of which are cancelled immediately upon being issued.[50] These orders are issued in order to ascertain hidden pricing information (known as "ping" orders), to slow down the systems of competing firms, and to serve as misinformation. For every 100 trades executed by an HFT firm, they issue up to one million of these false bids or offers.[51]

Nearly all trading today is electronic, and algorithmic "smart" orders speed transactions throughout the national market system. The terminology used to describe this algorithmic trading can be confusing, and is often used interchangeably. Accordingly, some definitions and delineations are warranted here.

"Algorithmic trading" has been used to refer to a wide spectrum of trading activity. At one of the spectrum are the simple transactional tools made necessary by the fragmented market system, such as intermarket sweep orders—used by traders to speedily execute trades across separate markets.[52] These types of algorithms allow traders to enter certain criteria into the program, such as pricing restraints, order size, time limitations, and volume limits. For example, a trader wishing to quickly sell 10,000 shares of an equity will enter his order into the algorithm, which will then split the order into smaller pieces and execute a number of small transactions on the various exchanges and ECN's, keeping within the limits specified by the trader.[53] Other simple algorithms that are widely used include pegged orders (which follow the price of the market, either matching or taking the best bid or offer) and other algorithms that keep much of the size of the order hidden in "reserve" until the displayed order is executed.[54] It was a simple algorithm such as one of the above that started the domino effect of

TIMES, (July 24, 2009), *available at* http://www.nytimes.com/2009/07/24/business/24trading.html?ref=charlesduhigg.

48. Duhigg, *supra* note 47

49. *Id.*; McGowan, *supra* note 26, at ¶ 4.

50. Duhigg, *supra* note 47.

51. Memorandum from Themis Trading, LLC by Sal L. Arnuk & Joseph Saluzzi on Toxic Equity Trading Order Flow on Wall Street: The Real Force Behind the Explosion in Volume and Volatility, http://www.themistrading.com/article_files/0000/0348/Toxic_Equity_Trading_on_Wall_Street_12-17-08.pdf.

52. Matt Phillips, *Accenture's Flash Crash: What's an "Intermarket Sweep Order,"* WALL ST. J. BLOG (May 7, 2010, 5:51 PM), http://blogs.wsj.com/marketbeat/2010/05/07/accentures-flash-crash-whats-an-intermarket-sweep-order/.

53. CONCEPT RELEASE, *supra* note 13, at N65.

54. PRELIMINARY REPORT, *supra* note 3, at Appendix A-4.

the May 6th flash crash.[55]

At the other end of the spectrum are the intricately complicated and ever-evolving HFT programs. These programs did not start the flash crash, but did cause it to accelerate across the national market system. There is no uniform definition for High Frequency Trading, but HFT firms generally execute a high number of trades, use computers to plan and execute the trades, base their strategies on short time-frames, enter a large number of orders that are immediately cancelled, and end each trading day in a neutral trading stance.[56] The relevant and dangerous characteristics of HFT programs are that they are extremely fast, dominate market volume, and do not rely on human traders to initiate trades.[57] These are algorithm driven trading programs that make use of the simpler transactional orders described above, but employ them in a much broader trading scheme. It is this type of algorithmic high frequency trading that poses systematic risks to the financial markets, as is discussed in Parts IV and V.

The strategies used by HFT firms vary widely. Many strategies are based purely on raw speed, in which the programs recognize imbalances or arbitrage opportunities, and trade against them before other market participants can access the liquidity.[58] These types of strategies require co-location of trading servers, extremely powerful computers, and constant tweaking of code in order stay ahead of competing firms.[59] While these firms currently measure their trade speeds in microseconds, insiders claim that soon they will be trading in picoseconds—one trillionth of a second.[60]

Other HFT strategies are based around the rebates offered by ECN's for providing liquidity. Here, the HFT programs offer two-sided quotes in given securities, and make their profit from the rebates rather than from big changes in price.[61] This type of strategy has particularly high volume of cancelled orders, with HFT firms canceling ninety percent of the orders they submit.[62]

Other strategies employed by HFT firms arouse more suspicion than do the market-making, arbitrage, or rebate strategies. For example, "momentum ignition" trades involve initiating, accelerating, or exacerbating rapid price movements and benefiting from the results.[63] This is accomplished by either "spoofing" other market participants into buying or selling aggressively, or else by triggering standing stop-loss orders that

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55. PRELIMINARY REPORT, *supra* note 3, at Appendix A-11.

56. *Id*.

57. *Id*.

58. McGowan, *supra* note 26, at ¶¶ 16–17 (2010).

59. *Id*.

60. Michelle Price, *The Rise of the Picosecond*, EFINANCIALNEWS.COM., (Mar. 3. 2011), http://www.efinancialnews.com/story/2011-03-03/rise-of-the-picosecond.

61. CONCEPT RELEASE, *supra* note 13, at 3607.

62. *Id*.

63. *Id.* at 3609; Schapiro, *supra* note 32, at 21.

the algorithm has detected.[64]

Similarly, "order anticipation strategies" involve detecting the presence of large buyers or sellers, and using the speed of the HFT programs to get into the market ahead of the large buyer or seller, thereby profiting when the larger buyer must drive up the price in order to fill their order.[65] Such HFT strategies have some commentators crying foul, accusing HFT firms of engaging in automated front-running.[66] Front-running is when firms trade on insider knowledge of customer orders by trading in advance of the order, and is already illegal. Whether such automated strategies are legal or not is a matter for debate, but is not the subject of this note. Rather, this note address the structural weaknesses created by the proliferation of HFT strategies.

The above HFT strategies, while often quite complicated, are still largely based on strategies that have been used by human traders for years. However, many HFT strategies have taken human discretion entirely out of the picture, relying on powerful artificial intelligence programs to determine how to trade.[67] These programs use a wide range of inputs in addition to market data, including news reports, twitter feeds, blog posts, and even close-captioned TV broadcasts.[68] A small cottage industry has been created to create feeds of such information than can be speedily consumed by these artificial intelligence HFT programs.[69] These artificially intelligent programs create and test their own rules and assumptions, and constantly evolve in reaction to the markets and their own continuing calculations.[70] As a result of these programs, a large portion of the trading volume in the U.S. is done without a single human knowing why. For example, in early 2011, market observers postulated that HFT programs were buying up Warren Buffet's Berkshire Hathaway stock whenever Anne Hathaway—who was about to host the Oscars—was mentioned in the news.[71] The HFT programs were apparently mistaking Oscar buzz for trading buzz, and moving vast sums of money accordingly.

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64. CONCEPT RELEASE, *supra* note 13, at 3609.

65. *Id*.

66. Robert Kuttner, *Wall Street on Speed*, HUFFINGTON POST, (July 26, 2009), http://www.huffingtonpost.com/robert-kuttner/wall-street-on-speed_b_245121.html .

67. Charles Duhigg, *Artificial intelligence applied heavily to picking stocks,* N.Y. TIMES, (Nov. 23, 2006), *available at* http://www.nytimes.com/2006/11/23/business/worldbusiness/23iht-trading.3647885 .html [hereinafter Artificial Intelligence].

68. Graham Bowley, *Computers that Trade on the News*, N.Y. TIMES, (Dec. 22, 2010), *available* at http://www.nytimes.com/2010/12/13/business/23trading.html?_r=1&sq=high%20frequency%20 tradi ng&st= cse&scp=3&pagewanted=print.

69. Bowley, *supra* note 68.

70. McGowan, *supra* note 26, at ¶ 23.

71. Alexis Madrigal, *Does Anne Hathaway News Drive Berkshire Hathaway's Stock?*, THE ATLANTIC.COM, (Mar. 18, 2011), *available at* http://www.theatlantic.com/technology/archive/2011/03/ does-anne-hathaway-news-drive-berkshire-hathaways-stock/72661/. Note also that a single share of this stock was worth more than $100,000 at the time.

When these programs combine with the staggering speed of the HFT networks at their disposal—which may soon be executing trades within *trillionths* of a second—the result is a market in which massively destructive price movements can occur before anyone can even begin to react.

C. DANGEROUS RESULTS OF THE RISE OF MARKET AUTOMATION

The markets have been transformed by the increase in the speed of trading, and by decreasing trading costs. Trading volume is many orders of magnitude higher than just decades earlier.[72] Tellingly, it is difficult to ascertain accurate volume information across the various exchanges, but the NASDAQ exchange—representing less than twenty precent of the equities market —has seen daily volumes of more than five billion shares.[73]

This dramatic increase in volume is driven by several factors. First, the ease, speed, and relative affordability of trading within the current market infrastructure allows a high rate of stock turnover. It is not unheard of, for example, for a stock's daily trading volume to exceed its float— meaning that more shares trade hands in one day than there are total shares in the company.[74] Indications suggest that turnover rates for mutual funds and traditional money managers have remained stable, but the rise of HFT strategies, often involving millions of trades within minutes, has driven trading volume ever upward.[75]

III. THE INADEQUATE REGULATORY FRAMEWORK FOR HIGH-FREQUENCY TRADING

High-Frequency Trading firms owe much of their success to the fact that they operate within a largely unregulated niche of the market. Despite their dominant role in day-to-day trading, they are not subject to the regulations or obligations affecting broker/dealers or market makers.[76]

However, since events such as the May 6th flash crash, HFT activity has come under increased scrutiny, both from the public and from regulators. Hoping to prevent such a flash crash from occurring again, the

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72. *See* Markham, *supra* note 13, at n.463 (stating that U.S. volume in futures markets quintupled between 1996 and 2006).

73. *Statistical Milestones,* NASDAQ.COM, http://quotes.nasdaq.com/aspx/StatisticalMilestones.aspx.

74. *See* Cindy Perman, *Dow Ends Up for Week Despite Bear Sell-Off,* CNBC.com, (Mar. 14, 2008), http://www.cnbc.com/id/23634788/Dow_Ends_Up_for_Week_Despite_Bear_Sell_Off (stating that Bear Stearns broke the NYSE record with 186 Million share daily volume on Friday, March 14, 2008).

75. *See Equity Brokerage Commission Averages Increase Slightly in the Major Markets and US Equity Trading Volume Remains High Despite a Significant Decline in Listed Equity Securities,* ELKINS MCSHERRY, LLC, (May 2010), https://www.elkinsmcsherry.com/EM/pdfs/.../May_2010_ newsletter.pdf.

76. CONCEPT RELEASE, *supra* note 13, at 3607; Schapiro, *supra* note 32, at 13–14.

SEC and the Commodities Futures Trading Commission ("CFTC") have launched inquiries into the traumatic market events of May 6th, and have recommended regulatory reform.[77]   Some changes have already been implemented after the flash crash, particularly where HFT firms had been exploiting loopholes that were particularly egregious,[78] whereas many more changes are still being pondered by the SEC.[79] As a result, it is helpful to examine both the regulations in place before the flash crash, and the proposed changes that have been suggested since. It is also useful to delineate between regulations affecting HFT firms directly, and regulations that affect the exchanges in a way that directly impacts HFT strategies.

A. REGULATIONS ON HIGH FREQUENCY TRADING FIRMS BEFORE THE FLASH CRASH

Before flash crash, HFT firms were not required to be registered as broker dealers.[80] As such, they were not compelled to maintain the same capital requirements as their registered peers, or to adhere to the risk-management regime required of registered broker/dealers.[81] Further, even when HFT firms engaged in market-making behavior ("making a market" in a security by offering two-sided quotes), they were not required to register, and were therefore not subject to the obligations that registered market makers face.[82]   These obligations include continuously offering two-sided quotes, to be the buyer or seller of last resort in times of great market volatility, and to refrain from trades that would adversely affect volatility.[83]

The obligations imposed on market makers has historically been justified by their advantageous position of having access to order-flow information, and being able to profit on the spread between the bids and offers, but such positions have become less lucrative since Regulation NMS decentralized order routing and allowed the HFT firms to outgun the market makers.[84] As such, HFT firms have largely displaced traditional market makers, reaping the profits without taking the responsibilities of the

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77. The Joint Commission has released three reports on the flash crash, a preliminary report (*supra* note 3), a final report on the market events of May 6th (*supra* note 1), and a summary report of recommended regulations (*supra* note 45).

78. For example, the use of "flash" orders and "stub quotes," both of which are manipulative on their face, has been discontinued. *See* Discussion *infra,* Part III.C.

79. *See generally* SUMMARY REPORT, *supra* note 45.

80. *Id*. at 6. However, a number of HFT entities are part of larger trading firms that are required to register. *See* McGowan, *supra* note 26, at ¶ 30.

81. McGowan, *supra* note 26, at ¶ 30.

82. Janet M. Angstadt, *What will be the legacy of the 'Flash Crash'? Developments in US equities market regulation*, 6 CAPITAL MARKETS LAW JOURNAL 1, 85 (2011). Note that some options exchanges require any HFT firm acting as a market maker to register as such.

83. SUMMARY REPORT, *supra* note 45, at 10.

84. *Id*. at 9–10.

traditional position.[85] This resulted in the mass withdrawal from the market of the HFT "market makers" during the May 6th crash.[86] This sudden exodus of liquidity, where previously market makers would be required to remain in the markets, exacerbated the downward fall.[87]

During the flash crash, many HFT firms directly accessed the exchanges and ECN's by being "sponsored" by a registered broker dealer, and using that dealer's identification code. This arrangement was referred to as "naked access," and worried regulators because it gives HFT firms immediate and direct access to the markets, without subjecting them to the controls and rules that regulate other direct participants.[88] Consequently, an HFT program could send out hundreds of thousands of faulty orders before the error is caught, which could result in a domino effect threatening the entire market.[89]

Because of naked access and the lack of a need to register, there were almost no meaningful affirmative regulations on HFT firms before or during the flash crash. They were not subject to any limitations in terms of leverage, exposure, or volume. Nor were they compelled to disclose their risk parameters or financial statements in the way that large institutional investors are. Accordingly, HFT firms were primarily constrained not by regulations on themselves, but by regulations on the markets.

B. REGULATIONS ON THE MARKETS BEFORE THE FLASH CRASH

The exchanges and ECN's are separate entities, operating under different rules.[90] They are subject both regulations from the SEC, and their own internal procedures. As such, the procedures in place to keep order during market volatility are not uniformly applied, and have enjoyed decidedly limited success. Even though a stock may be traded on ten ECN's, the NASDAQ, and the NYSE at once, these different venues will trigger different regulatory constraints at different times. As such, when markets become extremely volatile, market fragmentation worsens as, for example, NYSE slows down its order-matching and the other ECN's allow trading to continue unhindered.

Such an imbalanced response can make itself worse as exchanges cut off communications with the slowing exchange, using the "self help" remedy made available in Reg. NMS.[91] Here, exchanges and ECNs are

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85. CONCEPT RELEASE, *supra* note 13, at 3494.

86. *Id*. at 3494; Schapiro, *supra* note 32, at 5.

87. FINAL REPORT, *supra* note 1, at 15–17.

88. SUMMARY REPORT, *supra* note 45, at 7.

89. McGowan, *supra* note 26, at ¶ 41.

90. Schapiro, *supra* note 32, at 6. Reg. ATS applies only to ECNs, whereas NMS applies to all trading venues. Regulation Alternative Trading System, 17 C.F.R. § 242.300 (2007).

91. PRELIMINARY REPORT, *supra* note 3, at Appendix A-15.

permitted to block orders and bids from exchanges that they believe to be experiencing delays or malfunctions.[92] During the flash crash, two ECNs excluded the NYSE from their quotations using this remedy, further fragmenting the market and blocking off liquidity.[93]

Perhaps the best way to examine how these independent controls work together is to evaluate their individual reactions to the flash crash. The NYSE, the ECNs, and the Futures markets all took different steps at different times.[94] The SEC's examination of flash crash control measures suggests that some responses were more effective than others—but also that it is the decentralized nature of the response that was most problematic.[95]

The crash originated in the futures markets, where the E-mini futures contracts were sold so hastily by the Kansas City trader.[96] The SEC's investigations suggest that the countermeasures in place in the futures markets were among the most effective but were not sufficient to keep this selling pressure from spreading and multiplying across the system.[97] The futures market had in place a "trading pause," which is triggered whenever further trading would cause stop-loss orders[98] to drive down prices sixty basis points.[99] When triggered, as it was on 2:45:28 on May 6th, all trading in the security is paused for five seconds to allow buyers to reenter the market.[100] In the case of the flash crash, this trading pause had some success in the E-mini futures market, and the five second break resulted in buyers returning to the market, and prices quickly rebounded as soon as trading resumed.[101]

Even after prices recovered in the futures markets, the crash migrated to the equities market and continued to accelerate, even for products that should trade in lock-step with the E-mini.[102] This difference can be attributed to the exchanges' differing responses to volatility.

The NYSE uses a unique volatility control called liquidity replenishment points ("LRPs").[103] While based on the same principle as the aforementioned trading pauses, LRP's differ because they do not stop trading, but rather slow it down—stopping automated trades and allowing

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92. PRELIMINARY REPORT, *supra* note 3, at Appendix A-15.

93. *Id*. at 26, n.13.

94. *Id*. at 45.

95. *Id*.

96. *Id*. at 2.

97. *Id*. at 4.

98. A stop-loss order is a standing order to sell a security when it trades at a given price. Once triggered, the stop-loss order seeks to immediately sell, regardless of price. *See* Schapiro, *supra* note 32, at 7.

99. *Id*. at 12, n.20; SUMMARY REPORT, *supra* note 45, at 5.

100. SUMMARY REPORT, *supra* note 45, at 5.

101. *Id*. at 12.

102. SUMMARY REPORT, *supra* note 45, at 12–13.

103. *Id*. at 68; Schapiro, *supra* note 32, at 6.

the designated market maker to manually match up bids and offers with a degree of discretion.[104]   Another difference is their indefinite duration, in that LRPs do not have set time limits.[105] The trigger for these slow downs vary with the volume and price of the stock, but are simple to calculate and predictable.[106]   LRPs are quite common, with twenty to thirty stocks triggering significant LRPs daily, but on May 6th, more than 1000 stocks entered into extended LRP periods.[107]

Any utility of LRPs is completely destroyed by one obvious flaw: they only apply to the NYSE. Consequently, during such a self-imposed slowdown, trading continues unabated on the ECNs and other exchanges. Market participants are able to automatically route their orders away from the NYSE, completely sidestepping this measure.[108] In either case, the LRPs did little to stop the downward momentum in the equities markets, as market participants easily routed their orders to the willing ECNs.[109] The LRPs are credited for the NYSE's lack of cancelled trades, as contrasted with the high rate of cancelled trades on the ECNs, but it is likely that this is simply because trades were routed elsewhere when LRPs were in effect.

Another restraint on volatility in place on May 6th were cross-market circuit breakers.[110] These circuit breakers were established after the crash of October 27, 1987, with the hope of improving stability in the markets after that one-day decline of almost twenty-three percent.[111] These circuit breakers cease all trading when the Dow Jones Industrial Average drops by a given percentage.[112] At the time of the flash crash, the circuit breakers would only be triggered if the Dow Jones Industrial Average dropped ten percent—a level that was never reached during the crash.[113] As such, these circuit breakers, which would have halted trading in affected securities across all venues, were never deployed.

While not a restraint in the same sense as circuit breakers or short-selling rules, many investors withdrew from the markets during the flash crash because they feared that their transactions would be cancelled under the relatively vague trade cancellation rules.[114] Before the flash crash, trades were cancelled whenever they were determined by FINRA to have been "clearly erroneous."[115] For trades made during the flash crash,

104. FINAL REPORT, *supra* note 1, at 68.
105. *Id.*
106. *Id.* at 68, n.53.
107. *Id.* at 69.
108. *Id.*
109. *Id.*
110. PRELIMINARY REPORT, *supra* note 3, at Appendix C4.
111. *Id.* at Appendices C1, C3.
112. Schapiro, *supra* note 32, at 13.
113. *Id.* at 13.
114. FINAL REPORT, *supra* note 1, at 39.
115. *Id.* at 35.

executions that were at prices more than sixty percent away from the pre-crash value were considered to meet this threshold.[116] While there are guidelines for determining when trades were "clearly erroneous," there was a large degree of discretion allowed to the exchanges in making these decisions.[117] Many habitual liquidity providers, fearing that that cancelled trades would leave them with unintentional positions in the market, withdrew from the market entirely during the flash crash.[118]

C. REGULATORY FRAMEWORK AFTER THE FLASH CRASH

The massive volatility of May 6th, 2010, has led to calls for increased controls over market volatility and an increased sense of urgency for reform.[119] Many changes have been proposed by market observers and by the Advisory Committee established by the SEC and CFTC, and a small number of rule changes have already gone into effect.

The first rules to be established by the SEC since the crash have addressed practices that were previously legal, but widely seen as deceptive. The elimination of "stub quotes" is chief among these changes.

Stub quotes are bids or offers that are far removed from the best price available for a given security in a given market. For example, for a stock trading around $50, a bid of one cent or an offer of $100 would be considered a stub quote.[120] Prior to the rule change, stub quotes were used either by market makers who wanted to technically fulfill their obligations of maintaining two-sided quotes while avoiding any actual risk, or by HFT firms seeking to capitalize on momentary glitches in the NMS system that would allow hapless counter parties to execute against their quote.[121]

It was quotes like these that caused the most outlandish trades of the flash crash—such as Accenture trading at one cent, minutes after trading at $40, or Sotheby's selling for $99,999 minutes after selling for under $35.[122] Such transactions can occur when investors enter a market order, which must be executed at the best available price immediately.[123] In times of high volatility, systemic glitches, or low liquidity, such stub quotes can indeed be the best available price at the millisecond when the order must be executed, even if it is far removed from the prevailing market or the last price. This dynamic is intensified during downturns, as "stop loss" orders are triggered, which are market orders set to deploy when a certain price is

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116. FINAL REPORT, *supra* note 1, at 35.
117. PRELIMINARY REPORT, *supra* note 3, at 29.
118. FINAL REPORT, *supra* note 1, at 39.
119. Schapiro, *supra* note 32, at 1.
120. Angstadt, *supra* note 82, at 83; Schapiro, *supra* note 32 at 7.
121. Schapiro, *supra* note 32 at 7; FINAL REPORT, *supra* note 1, at 67–68.
122. PRELIMINARY REPORT, *supra* note 3, at 33–34, 54.
123. Schapiro, *supra* note 32, at 7.

reached.[124] There were more than 200 securities in which there were stub-quote executions during the flash crash.[125]

Stub quotes, while previously tolerated, are inherently disingenuous and were probably contrary to the preexisting requirement that all bids and offers be bona fide expressions of interest. The SEC has taken steps to curb their practice since the flash crash, by requiring that all quotes be within a given pricing range from the national best price.[126] While these new rules are only part of a pilot program, it is likely that the SEC will enact similar permanent rules eliminating exploitative stub quotes.

The SEC has already closed another obvious loophole by ending the practice of unfiltered "naked access," whereby HFT firms could interact directly with exchanges and ECN's by using a sponsoring broker's credentials.[127] Since the flash crash, the SEC has mandated that broker/dealers may not provide such unfiltered access to the markets, and requires those brokers who supply HFT firms with access, to put in place procedures and risk management devices to ensure regulatory compliance.[128]

An amendment to Regulation SHO—a regulation limiting short selling—went into force quickly after the flash crash. It aims to limit selling pressure on vulnerable stocks by limiting the ability of traders to sell stock that they do not already own.[129] Now, after an individual NMS security[130] decreases more than ten percent, market participants who do not already own the stock will be unable to sell it by taking liquidity away from the buy side, although they will remain free to sell by making offers.[131] This rule was intended to cut down on what was perceived as manipulative short-selling and deliberate deflation of already vulnerable securities.[132]

Another reform already made by the SEC is the adoption of market-wide circuit breakers for individual stocks.[133] In June, 2010, a pilot program was initiated whereby circuit breakers would be triggered across all venues if the price changes by ten percent or more within any five-

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124. Schapiro, *supra* note 32, at 7.

125. *Id*. at 10.

126. Angstadt, *supra* note 82, at 83; SUMMARY REPORT, *supra* note 45, at 3–4.

127. SUMMARY REPORT, *supra* note 45, at 7.

128. Press Release 2010-210, Securities Exchange Commission, (Nov. 3, 2010), *available at* http://www.sec.gov/news/press/2010/2010-210.htm.

129. Press Release 201-26, Securities Exchange Commission, 201-26, *available at* http://www.sec.gov/news/press/2010/2010-26.htm; Press Release 34-60388, Amendments to Regulation SHO, (July 27, 2009), *available at* http://sec.gov/rules/final/2009/34-60388.pdf.

130. For the purposes of this rule, "NMS security" excludes options, but includes stocks and futures. Press Release 34-6195, Securities Exchange Commission, Amendments to Regulation SHO, (Feb. 26, 2010), *available at* http://www.sec.gov/rules/final/2010/34-61595.pdf.

131. PRELIMINARY REPORT*, supra* note 3, at 55.

132. *Id*. at 60.

133. SUMMARY REPORT, *supra* note 45, at 3.

minute period between 9:45 a.m. and 3:35 p.m.[134] If the circuit breaker is triggered, trading in the affected security pauses in all markets for at least five minutes, allowing investors to evaluate the rapid market events, correct any errors, and allow liquidity to rebalance.[135] Importantly, these circuit breakers are only applied to the securities included in the Russell 1000 index and certain highly traded Exchange Traded Funds ("ETFs").[136] The Advisory Committee recognized that the circuit breakers will have limited effect unless they are more widely applied, and has recommended that they be expanded to cover "all but the most inactively traded listed securities, ETFs, and options and single stock futures on those securities."[137]

The Committee also recommended that a new procedure be enacted across the exchanges to supplement the new circuit breakers, dubbed a "limit up/limit down" process.[138] When triggered, the process would allow trading to continue in the affected security only within a given price band, although trading within that band would continue freely.[139] The limit would be lifted whenever contra-side liquidity appears outside of the band.[140]

While the SEC recognized that the future's market's existing "pause" procedure worked relatively well during the flash crash, it recommended that there be secondary measures put in place for circumstances where the five-second pause is insufficient to lure back liquidity to the markets.[141]

Another recommendation from the Committee that is likely to be implemented is that the preexisting market wide circuit breakers be triggered by movements of the S&P 500 index, rather than the Dow Jones Industrial Average, which was the benchmark during the flash crash.[142] The S&P 500 is now considered to be more representative of overall market sentiment than the Dow, and trades in lockstep with the important and high-volume securities such as the E-Mini futures and the SPY ETF.[143] In addition to this change of triggering index, the Committee suggested that the length of time of the trading halts be reduced, and that the halts should be allowed as late as 3:30 p.m., cutting deeper into the period of high volatility at the end of the trading day.[144]

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134. SUMMARY REPORT, *supra* note 45, at n.1. Note that this time window excludes the more volatility opening and closing periods, where trading volume is much higher.

135. *Id*.

136. *Id*. at 4.

137. *Id*.

138. *Id*. at 4–5.

139. *Id*. at 5.

140. *Id*.

141. *Id*.

142. *Id.* at 6.

143. *Id*. The SPY ETF is an exchange traded fund that tracks the S&P 500 index. It is used widely as a hedging device as well as diversified investment vehicle, as it represents the entire basket of S&P 500 stocks.

144. *Id.* at 6.

The Advisory Committee made clear that HFT firms were exacerbating influences on the flash crash. Accordingly, it recommended that the SEC and CFTC should assert their regulatory role and require HFT firms to demonstrate that their programs have been carefully tested, and would not create undue market volatility.[145] Specifically, the Committee recommended that this supervisory focus be directed at the sponsoring firms, rather than the HFT firms themselves.[146]

It should be noted that the SEC has also proposed a ban on "flash orders," which allow paying subscribers to access market data before other investors.[147] While the proposed rule change has not yet gone into effect, and has been fought by exchanges who profit from the fees and increased liquidity they provide, such orders have now been disabled at all exchanges except for the options exchanges.[148] These orders are often conflated with the wider practice of high frequency trading, perhaps due to their catchy name, and the media has attached their name to the flash crash. However, these flash orders are not considered by the SEC to be the main catalysts for their namesake market crash.

D. The Advisory Committee's Recommendations Directed at Improving Liquidity

Hoping to address structural issues that allow for liquidity to rapidly disappear from the markets, the Advisory Committee also made general recommendations for improving liquidity.[149]

The Committee's first volley at the liquidity problem was to suggest reform to the liquidity rebate system.[150] In the current system, exchanges and ECNs offer different fee structures and incentives for liquidity providers.[151] These fees and rebates incentivize market participants and HFT firms to add liquidity to the system—for example by using limit orders rather than market orders.[152] However, as the Advisory Committee noted, the incentives were not enough to keep these participants from fleeing the markets when volatility increased.[153] As a possible

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145. SUMMARY REPORT, *supra* note 45, at 6.

146. *Id.*

147. Press Release 34-60684, Securities Exchange Commission, Elimination of Flash Order Exception from Rule 602 of Regulation NMS, (Jan. 14, 2010), *available at* http://www.sec.gov/rules/proposed/2009/34-60684.pdf.

148. Nina Mehta, *Flash Order Debate Moves to Options After Direct Edge Bows Out*, BLOOMBERG, (Mar. 1, 2011), *available at* http://www.bloomberg.com/news/2011-03-01/flash-order-debate-moves-to-options-after-direct-edge-bows-out.html.

149. *Id.* at 8.

150. *Id.*

151. CONCEPT RELEASE, *supra* note 13, at 3599.

152. For the SEC's short explanation of varying order types see PRELIMINARY REPORT, *supra* note 3, at 94–95.

153. SUMMARY REPORT, *supra* note 45 at 9.

improvement, the Advisory Committee proposed that a "peak load" pricing model be adopted, where access fees and rebates both rise in volatile market conditions, incentivizing liquidity providers to stay in the markets.[154]

One of reasons that market participants withdrew from the market during the flash crash, according to interviews with the Advisory Committee, is that they feared that some of their trades would be cancelled after the fact, which could decimate their risk parameters and leave them with unwanted positions.[155] While the futures markets had in place clear guidelines as to when trades could be "busted," the equities markets were less clear.[156] Instead, the prevailing rule was for trades to be broken when they were "clearly erroneous."[157] The SEC has taken action to remove this ambiguity from the system, however, by establishing clear thresholds within which trades will not be broken.[158]

As noted previously, designated market makers have been largely pushed out of the markets by HFT firms who lack the obligations and responsibilities of the traditional position.[159] The committee noted that HFT firms profit greatly from their opportunistic market-making activities, but that they withdrew from their roles of liquidity providers during the flash crash, exacerbating the downturn.[160] However, the Committee also lamented that the majority of HFT firms engaging in market-making are not even registered as broker-dealers, and so it is difficult to regulate their obligations directly.[161] Nonetheless, the Committee recommended that incentives and rules be created to address this void in the market, created by the mass exodus of the designated market-makers after the rise of HFT strategies.[162]

The Committee also noted that HFT, despite its proponent's constant proclamations that they are driving costs down, actually create significant costs for all market participants because of the extremely high rate of orders that they issue and cancel.[163] This massive flow of orders requires all market participants to constantly upgrade their computers and server capacity. Some observers have claimed that this is a competitive tactic in the HFT arms race—whereby HFT firms, knowing that their powerful computers and co-location will allow them to handle the flow of data— pump massive amounts of immediatelycancelled orders into the system

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154. SUMMARY REPORT, *supra* note 45, at 9.
155. FINAL REPORT, *supra* note 1, at 39.
156. PRELIMINARY REPORT, *supra* note 3, at Appendix B.
157. FINAL REPORT, *supra* note 1, at 6.
158. Angstadt, *supra* note 82, at 83–84.
159. *See* discussion, *supra* Part III C.
160. SUMMARY REPORT, *supra* note 45, at 10.
161. *Id*. at 10-11.
162. *Id*. at 10.
163. *Id*. at 11.

purely to slow down their competitors' systems.[164] Even without such malicious motives, the high rate of cancelled orders imposes costs across the market.[165] Accordingly, the committee recommended that charges be assessed to market participants who enter a large number of order cancellations.[166]

The SEC and CFTC also addressed the practice of preferential routing, which they suggest worsened the flash crash.[167] In this practice, firms route their orders preferentially to broker-dealers, who then execute the orders against their own undisplayed liquidity for a price that is a few sub-pennies better than the best displayed price.[168] This seems to be in contravention of the order preference hierarchy established by Reg. NMS, but the firms have justified it by claiming that the price improvement justifies these trades.[169] As such, the committee recommended that rules be established by which this practice would only be justified in cases of "material" price improvement, or if the firms involved were required to provide liquidity during period of market volatility, under obligations similar to those of a traditional market-maker.[170]

On a similar note, the committee addressed the practice of "internalizing" order flow, by which a clearing broker-dealer can match an incoming order against its own liquidity even if there are preexisting orders at the same price displayed on the NMS system.[171] The Committee suggested a "trade at" rule that would bar this practice, although it would allow firms to match the orders as long as they improved the price.[172] Industry insiders, however, do not anticipate such a rule will ever be enacted.[173]

Noting that the speed of the markets allows liquidity imbalances to quickly spread disorder throughout the markets, the Committee also recommended that the SEC consider greater information reporting requirements on liquidity measures and imbalances.[174]

Finally, the Committee addressed the simple and ubiquitous problem that faces anyone who attempts to make sense of the markets: there is no

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164. *Analysis of the "Flash Crash",* NANEX, http://www.nanex.net/20100506/FlashCrashAnalysis_CompleteText.html (May 6, 2010).

165. SUMMARY REPORT, *supra* note 45, at 11.

166. *Id*. at 11.

167. *Id*. at 12.

168. *Id.*

169. *Id.* Orders are given priority first by price, then by time. Further, displayed liquidity is always given priority over non-displayed liquidity (for example the hidden reserve size in a reserve order), regardless of time.

170. *Id.*

171. *Id.*

172. *Id.*

173. Telis Demos, *Traders do not Anticipate 'Trade At' Rules*, FT.COM, (Mar. 3. 2011), http://www.ft.com/cms/s/0/06caa75c-4455-11e0-931d-00144feab49a.html#axzz1G8BipDHR.

174. SUMMARY REPORT, *supra* note 45, at 14.

consolidated source of market data.[175] With information spread throughout the various exchanges, ECNs, and market participants, it is near impossible to keep track of, much less effectively regulate, the markets. As such, the committee recommended that the SEC and CFTC implement a "consolidated audit trail" for the equity and futures markets.[176]

IV. WHY THE REGULATORY RESPONSE
TO FLASH CRASH IS INSUFFICIENT

The responses of the SEC and CFTC to the flash crash are steps in the right direction, but are ultimately insufficient to disarm the threat of another flash crash. The grab bag of regulations and suggested reforms addresses key symptoms of systemic weakness, but does little to address the underlying malady—the proliferation of high-frequency trading in a hyper-connected market.

Not everything that the SEC has done is useless. The elimination of stub quotes, the call for a consolidated audit trail, and the clarification of trade-break rules will all help ensure a more transparent and predictable market.

The stock-specific circuit breakers have the promise of effecting positive change, but they are too weakened to actually have the intended effect. First, they are only applied to major equities—even in the strengthened version recommended by the committee.[177] This leaves a substantial portion of the equities markets unaffected by this regulation, which will limit its ability to slow a crash as market participants will shift their orders to the unaffected securities. Further, this limited range of the circuit breakers will create untenable situations in which derivative securities—such as ETF's or futures contracts—continue to trade freely while the underlying security is halted.[178] Such a situation would therefore undermine the integrity of the markets without doing enough to protect them. However, if the procedural and practical hurdles were ironed out to the point where these circuit breakers could be uniformly and widely applied across the markets, they could serve to enhance market stability.

The proposals for a "limit-up/limit-down" band, combined with the revamped circuit breakers, could also improve market stability. However, this hybridized system would be limited by the efficacy of the circuit breakers. Such a system would do more to mitigate the weaknesses of circuit breakers than to actually prevent a crash. Functionally, in an extremely volatile market situation, these pricing bands would effectively

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175. SUMMARY REPORT, *supra* note 45, at 14.; Schapiro statement, *supra* note 32, at 3–4.

176. Schapiro statement, *supra* note 32, at 3–4.

177. *Id. at 3*.

178. Serritella, *supra* note 2, at 441.

work as circuit breakers, and are subject to the same problems facing such circuit breakers, such as their limited scope and the fact that they could halt derivates while not halting their underlying security.[179]

The limitations on naked access is also a positive step, and ensures that the number of entirely irresponsible HFT trading programs will decrease at least somewhat—as sponsoring firms will be required to vouch for the quality of the algorithms they host. It seems decidedly unlikely, however, that the already understaffed[180] SEC will be able to exercise effective oversight of HFT firms in this capacity, especially as the algorithms continuously evolve independent of human involvement.[181]

In general, the regulatory response to the flash crash has been scattered. Some of the proposed and enacted rule changes are indeed needed, and are likely to have a salutary impact on the markets and investor confidence. Other rules are too weak, riddled with exceptions, or easily circumvented to have any real effect. All of the proposed rules are aimed at the symptoms of the underlying structural weakness of the market. The SEC should instead focus on addressing the weakness itself.

V. A BETTER SOLUTION—VOLATILITY BASED TRADING RESTRICTIONS

Any reform that can disarm the threat of another flash crash must address the underlying issues that allowed the market disruption to spread like wildfire: the tremendous speed and interconnectivity of the markets, and the proliferation of high-speed automated trading.

The SEC should enact measures that slow down the market to speeds that human investors can follow whenever volatility is at risk of spiraling out of control. Such regulations could allow HFT firms to function as they presently do, as long as fear and volatility are within normal ranges. However, the rules should prohibit HFT programs from taking complete control of the market during rapid downturns, and return control to human traders. This could be easily accomplished by using a widely known index of investor confidence to trigger minimum time limits for holding positions and making orders.

Currently, the SEC uses percentage changes in equity indexes to determine when certain market controls will be triggered, such as circuit breakers and short-selling restrictions.[182] In establishing new market controls, the SEC should trigger them with changes in investor fear levels,

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179. Schapiro statement, *supra* note 32, at 4.

180. Robert Schmidt & Jesse Hamilton, *SEC 'Capacity Gap' Risks Oversight Lapses as Regulator's Targets Multiply*, BLOOMBERG, (Mar.6, 2011), http://www.bloomberg.com/news/2011-03-01/flash-order-debate-moves-to-options-after-direct-edge-bows-out.html.

181. McGowan, *supra* note 26, at ¶ 22.

182. For an explanation of the triggering factors see SUMMARY REPORT, *supra* note 45.

as measured by the "fear index": otherwise known as the Volatility Index ("VIX").[183] For example, a value of 30 on the VIX indicates that investors are beginning to worry about volatility, and a reading of forty (which was surpassed during the flash crash) indicates that investors are pulling out of the market en mass.[184] Accordingly, if the SEC were to trigger a market slowdown at a VIX reading of thirty-five, the controls could allow investors to reassess conditions and their market positions, rather than withdraw as they did during the flash crash.[185] This index is widely followed and transparently calculated. [186] Therefore, it would be simple for HFT firms to anticipate and plan for the constraints it would trigger.

One way to achieve this controlled market slowdown would be to enforce a minimum time limit on orders.[187] As noted previously, HFT strategies often rely on placing and immediately cancelling thousands of orders per second.[188] The reasons for placing these immediate-or-cancel orders are dubious—either to find hidden pricing information or to slow down opposing systems.[189] A time limit on such orders, for example requiring all orders to remain executable for at least one second, would have multiple beneficial effects in the market system. First, it would effectively eliminate the manipulative and expensive practice of "quote stuffing."[190] This would lower trading costs for all market participants who currently must consistently update their systems to keep up with the order flow that this practice produces. Second, and most importantly, it would slow the lightning-fast withdrawals from the market of HFT firms. If the SEC is unwilling to establish this time-limit as a permanent rule, it should consider triggering this rule when the VIX reaches a point where investor confidence is severely shaken.

As a corollary to the minimum order time limits, a minimum holding time would also be effective in slowing declines. For example, during the flash crash, HFT firms eagerly bought up thousands of the futures contracts being sold by the Kansas City mutual fund trader, only to immediately turn around and sell them—exacerbating the downward pressure.[191] Indeed, the practice of holding shares for extremely short time frames amplifies and

183. Robert E. Whaley, UNDERSTANDING VIX (Nov. 6, 2008), *available at* http://ssrn.com/abstract=1296743 (explaining the VIX index and how it is calculated); WHITE PAPER: THE CBOE VOLATILITY INDEX – VIX. *available at* www.cboe.com/micro/vix/vixwhite.pdf.

184. Schapiro statement, *supra* note 32, at 2.

185. *Id.*; Julianne Pepitone, *Fear Index Soars to 14 Month High*, CNN MONEY.COM (May 20, 2010) (reporting that the VIX surpassed the May 6th benchmark later in the month).

186. Whaley, *supra* note 183.

187. Themis, *supra* note 51.

188. CONCEPT RELEASE, *supra* note 13, at 23.

189. *Flash Crash Analysis*, NANEX, http://www.nanex.net/20100506/FlashCrashAnalysis_Complete Text.html (June 8, 2010).

190. Arnuk, *supra* note 51, at 5.

191. PRELIMINARY REPORT, *supra* note 3, at 3.

accelerates price volatility across the board.[192] However, were market participants compelled to hold onto their shares for longer—even for a few seconds—volatility would greatly decrease. Further, this would reduce the speed of the market to human levels, allowing human traders to evaluate market actions and decide what actions are appropriate.

These two constraints, establishing minimum time frames for orders and holding periods, would force trading to slow to a pace that humans could follow, while also minimizing any aggressive directional "momentum ignition" strategies[193] that could further disrupt a volatile market. This slowdown state could be triggered only when investors are considering fleeing the market, as indicated by the "fear index," allowing HFT firms to trade normally under normal conditions.

Constructed in this manner, the time limitations would not cause high-frequency trading to completely dry up, and would allow them to function normally during market conditions. As such, the HFT firms would be able to profit from normal market making and other activities, but not from accelerating massive volatility events such as the flash crash.

Alternatively, there is always the nuclear option for ensuring market stability: a transaction tax. Such a tax, even as small as $0.0025 cents per share, would effectively eliminate HFT trading. HFT trading strategies are only profitable because it is so cheap to enter and exit trades, even while highly leveraged. If the cost of trading were raised even at this marginal level, HFT programs would have to rely on bigger price moves, which would result in far fewer trades overall. In contrast, the average investor who buys 200 shares at a time would only see his costs rise by fifty cents. This cost could be easily absorbed by the broker, who would no longer be required to update its system on a monthly basis in order to keep up with HFT order flow.[194]

The constant argument against regulating trading has not changed in generations: the HFT firms argue that they are liquidity providers, and therefore are a stabilizing influence that would be destroyed by such rules. This argument is spurious. When the SEC banned floor traders after their role in the great depression, the traders and exchanges claimed that they were a boon to the average investor because they provided liquidity, despite having access to nonpublic information and being able to collude for their own benefit.[195] Today, HFT firms make the same claim. They point to statistics showing that they are responsible for more than half of the trading activity, and even more of the nontransaction pricing activity.[196] They claim that without their massive trading volume, retail investors

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192. Arnuk, *supra* note 51, at 4.
193. *See* discussion, *supra* Part II.
194. SUMMARY REPORT, *supra* note 45, at 11.
195. Markham, *supra* note 13, at 877.
196. *See* Schapiro statement, *supra* note 32, at 10–11.

would have fewer willing buyers or sellers, and volatility would increase.[197] However, multiple scholars and the SEC have noted that the massive volume created by HFT firms does not increase liquidity by itself.[198] As the SEC has noted, just because there is constant high-speed trading does not mean that there is any increase in liquidity or stability.[199] To the contrary, volatility in recent years has increased even as volume has skyrocketed.[200]

The biggest hole in the argument that HFT firms provide liquidity is the fact that they withdraw from the markets in period of high volatility, exactly when such liquidity is most needed to prevent serious downturns.[201] The flash crash is a stark example: firms that are usually happy to provide liquidity and make markets in low volatility all but pulled out of the markets.[202] With traditional market makers displaced by the HFT firms, there was nobody left to fill this liquidity void.[203] As such, it seems clear that in the current regulatory framework, HFT trading does little to increase liquidity, and has actually driven from the market the traditional liquidity providers such as designated market makers—leaving the liquidity landscape subject to their own whims.

Robbed of their primary defense, high frequency traders have little to justify the risks they pose. The more aggressive of the proposed regulations above may destroy the current state of high-frequency trading, but the average investor will not be harmed if this industry ceases to exist. To the contrary, without the potential destructive power of the HFT programs, long term investors will actually benefit from increased consumer and investor confidence.

VI. CONCLUSION

The domestic securities markets are highly and intrinsically interconnected, and that trend is not going to reverse. On a seemingly weekly basis, national exchanges are merging into international exchanges, and investors are yawning in response.[204] This interconnectedness is surely a good thing for investors, who have an unprecedented if daunting array of

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197. McGowan, *supra* note 26, at ¶¶ 47-52.

198. FINAL REPORT, *supra* note 1, at 3, 6; Serritella, *supra* note 2, at 438.

199. SUMMARY REPORT, *supra* note 45, at 2.

200. Arnuk, *supra* note 51, at 4.

201. FINAL REPORT, *supra* note 1, at 35–37.

202. *Id.*; Schapiro statement, *supra* note 32, at 15.

203. Schapiro statement, *supra* note 32, at 13–14.

204. Chris Nicholson, *BATS in Talks to Create Brazilian Bourse*, N.Y. TIMES, (Feb 15, 2011), *available at* http://dealbook.nytimes.com/2011/02/15/bats-in-talks-to-create-brazilian-bourse/; Michael J. De La Merced, *New York and German Exchanges to Merge in $10 Billion Deal*, N.Y. TIMES, (Feb 15, 2011), *available at* http://dealbook.nytimes.com/2011/02/15/new-york-and-german-exchanges-seal-deal/.

investment options available to them. However, this efficient and wide-ranging market has been abused to the point of systemic failure by the prevalence of high frequency trading.

On the individual level, few single HFT strategies are problematic.[205] Such innovation is inherent and healthy in a competitive market. Additionally, the automation of trading—especially with large orders or for cross market orders—is far more efficient and easy than it would be to make such trades manually. However, the aggregate effect of thousands of such programs, all locked in a technological arms race with trillion-dollar stakes, is a market system that can self-destruct because of a single trade or mistake.

The complicated interplay of these programs, combined with the rising prevalence of artificial intelligence-based systems, has resulted in a market that moves faster than humans can follow, for reasons that even the programmers do not fully understand.[206] Events such as the flash crash of May 6th, 2010, illustrate that this is not just a potential harm posed by these arrays of HFT firms—but rather a concrete and imminent danger of another substantial destruction of wealth and American economic stability.

It is clear that the interests of the HFT investors, who profit from short-term price movements at the risk of long-term stability, are not aligned with the interests of long-term investors. The SEC has a duty to protect the interests of such long-term investors when such a conflict arises, as it has repeatedly asserted.[207]

In this note, a solution is proposed in which high frequency trading could be slowed down in periods of crisis, while continuing to operate freely in normal markets.[208] Such a solution would not dramatically handicap the immensely profitable HFT industry, but the regulatory bodies should not be afraid of taking more drastic measures. To rebuild investor confidence, and to prevent another more devastating version of the flash crash, the SEC and CFTC should make assertive and comprehensive moves to contain the threats posed by high-frequency trading.

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205. This does not take into account controversial strategies such as "order anticipation" strategies or "momentum ignition" strategies, which many could consider to be inherently damaging to market integrity.

206. Duhigg, *supra* note 47.

207. CONCEPT RELEASE, *supra* note 13, at 3603.

208. *See* discussion, *supra* Part V.

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