Trading ad alta frequenza ed instabilità sistemica: il punto di vista dei regolatori e dell'industria sul Flash Crash

Fabrizio Lillo

Scuola Normale Superiore di Pisa (Italy), University of Palermo (Italy),
and Santa Fe Institute (USA)

Pisa, May 11, 2011

Outline

- The combined Commodity Futures Trading Commission-Security and Exchange Commission Report and its main empirical basis (Kirilenko et al. 2010)

- The point of view of a market participant: Nanex

The Flash Crash: The Impact of High Frequency Trading on an Electronic Market

Andrei Kirilenko,
Albert S. Kyle,
Mehrdad Samadi,
Tugkan Tuzun

http://ssrn.com/abstract=1686004

Note: all authors are affiliated to the Commodity Futures Trading Commission (CFTC)

FINDINGS REGARDING THE MARKET EVENTS OF MAY 6, 2010

REPORT OF THE STAFFS OF THE CFTC AND SEC TO THE JOINT ADVISORY COMMITTEE ON EMERGING REGULATORY ISSUES

U.S. Commodity Futures Trading Commission
Three Lafayette Centre, 1155 21st Street, NW
Washington, D.C. 20581
(202) 418-5000
www.cftc.gov

U.S. Securities & Exchange Commission
100 F Street, NE
Washington, D.C. 20549
(202) 551-5500
www.sec.gov

SEPTEMBER 30, 2010

May 6 events

- Major equity indices in both the futures and securities markets, each already down over 4% from their prior-day close, suddenly plummeted a further 5-6% in a matter of minutes before rebounding almost as quickly

- Many of the almost 8,000 individual equity securities and ETFs traded that day suffered similar price declines and reversals within a short period of time, falling 5%, 10% or even 15% before recovering most, if not all, of their losses. However, some equities experienced even more severe price moves, both up and down

- 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.

- By the end of the day, major futures and equities indices "recovered" to close at losses of about 3% from the prior day.

- E-mini S&P 500 futures

- Audit trail, transaction-level data for all outright transactions in the June 2010 E-mini S&P 500 futures contract

- For each transaction, they use date, time, **executing trading account, opposite account**
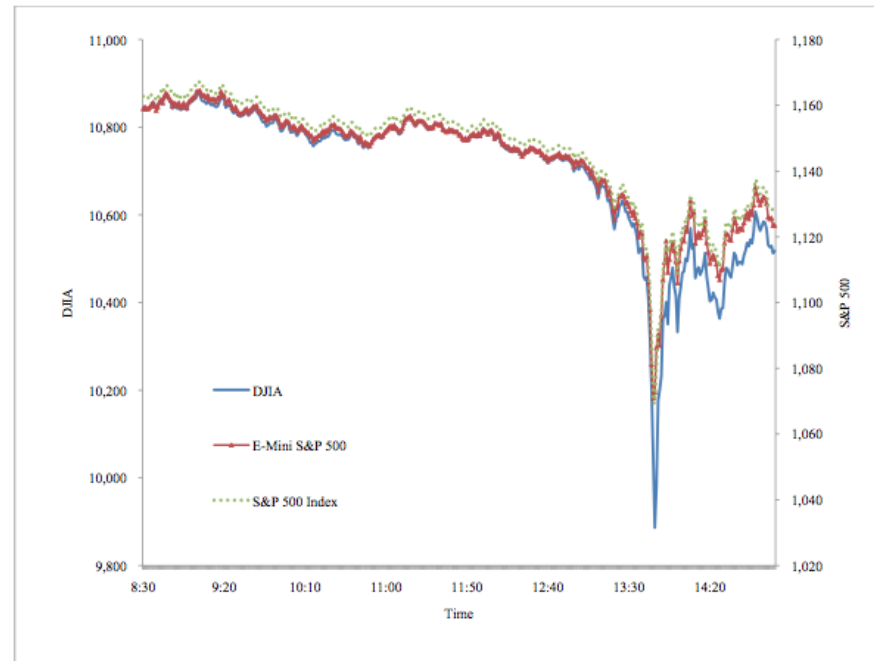
This figure presents end-of-minute transaction prices of the Dow Jones Industrial Average (DJIA), S&P 500 Index, and the June 2010 E-Mini S&P 500 futures contract on May 6, 2010 between 8:30 and 15:15 CT.

Classification of investors

- Intermediary if its trading activity satisfies the following two criteria. First, the account's net holdings fluctuate within 1.5% of its end of day level. Second, the account's end of day net position is no more than 5% of its daily trading volume

- High Frequency Traders as a subset of top 7% most active (in transactions) Intermediaries,

- Fundamental Traders (Buyers and Sellers) if end of day net position on May 6 must be no smaller than 15% of its trading volume on that day.

- Small Traders which traded no greater than 9 contracts on May 6

- We classify the remaining trading accounts as Opportunistic Traders.

Table II: Summary Statistics of Trader Categories

Panel A: May 3-5

Trader Type	% Volume	% of Trades	# Traders	Trade Size (Avg.)	Order Size (Avg.)	Limit Orders % Volume	Limit Orders % Trades	Agg Ratio Trade-Weighted	Agg Ratio Vol-Weighted
High Frequency Traders	34.22%	32.56%	15	5.69	14.75	100.000%	100.000%	49.91%	45.68%
Intermediaries	10.49%	11.63%	189	4.88	7.92	99.614%	98.939%	43.10%	41.62%
Fundamental Buyers	11.89%	10.15%	1,013	6.34	14.09	91.258%	91.273%	66.04%	64.09%
Fundamental Sellers	12.11%	10.10%	1,088	6.50	14.20	92.176%	91.360%	62.87%	61.13%
Opportunistic Traders	30.79%	33.34%	3,504	4.98	8.80	92.137%	90.549%	55.98%	54.71%
Small Traders	0.50%	2.22%	6,065	1.22	1.25	70.092%	71.205%	59.04%	59.06%

	Volume	# of Trades	# Traders	Trade Size (Avg.)	Order Size (Avg.)	Limit Orders % Volume	Limit Orders % Trades	Volatility	Return
All	2,397,639	446,340	11,875	5.41	10.83	95.45%	94.36%	1.54%	-0.02%

Panel B: May 6th

Trader Type	% Volume	% of Trades	# Traders	Trade Size (Avg.)	Order Size (Avg.)	Limit Orders % Volume	Limit Orders % Trades	Agg Ratio Trade-Weighted	Agg Ratio Vol-Weighted
High Frequency Traders	28.57%	29.35%	16	4.85	9.86	99.997%	99.997%	50.38%	45.53%
Intermediaries	9.00%	11.48%	179	3.89	5.88	99.639%	99.237%	45.18%	43.55%
Fundamental Buyers	12.01%	11.54%	1,263	5.15	10.43	88.841%	89.589%	64.39%	61.08%
Fundamental Sellers	10.04%	6.95%	1,276	7.19	21.29	89.985%	88.966%	68.42%	65.68%
Opportunistic Traders	40.13%	39.64%	5,808	5.05	10.06	87.385%	85.352%	61.92%	60.28%
Small Traders	0.25%	1.04%	6,880	1.20	1.24	63.609%	64.879%	63.49%	63.53%

	Volume	# of Trades	# Traders	Trade Size (Avg.)	Order Size (Avg.)	Limit Orders % Volume	Limit Orders % Trades	Volatility	Return
All	5,094,703	1,030,204	15,422	4.99	9.76	92.443%	91.750%	9.82%	-3.05%

This table presents summary statistics for trader categories and the overall market. The first column presents statistics prior to May 6 as the average over three trading days, May 3-5, 2010 from 8:30 to 15:15 CT. The second column presents statistics for May 6 from 8:30 to 15:15 CT.

- HFT are NOT liquidity providers (in the limit order sense)
- HFT effectively predict and react to price changes
- Opportunistic explains 30% of the volume
- 20% fundamental demand and 80% intermediation

The reconstruction of events

- Trading in the U.S opened to unsettling political and economic news from overseas concerning the European debt crisis. Financial markets opened to news concerning the Greek government's ability to service its sovereign debt.

- By 2:30 p.m. the S&P 500 volatility index ("VIX") was up 22.5 percent from the opening level

- Buy-side liquidity (market depth) in the E-Mini S&P 500 futures contracts declined by 55%, in the S&P 500 SPDR ETF by 20%

- At 2:32 p.m. a large fundamental trader (a mutual fund complex) initiated a sell program for 75,000 E- Mini contracts ($4.1 billion) as a hedge to an existing equity position. The program had an execution rate target set to 9% of the trading volume calculated over the previous minute, but without regard to price or time

- The execution of this sell program resulted in the largest net change in daily position of any trader in the E-Mini since the beginning of the year

- The Sell Algorithm chosen by the large trader to only target trading volume, and neither price nor time, executed the sell program extremely rapidly in just 20 minutes

- This sell pressure was initially absorbed by:
  - **high frequency traders ("HFTs") and other intermediaries in the futures market;**
  - **fundamental buyers in the futures market;**
  - **cross-market arbitrageurs who transferred this sell pressure to the equities markets by opportunistically buying E-Mini contracts and simultaneously selling products like SPY, or selling individual equities in the S&P 500 Index.**
- HFTs accumulated a net long position of about 3,300 contracts. However, between 2:41 p.m. and 2:44 p.m., HFTs aggressively sold about 2,000 E-Mini contracts in order to reduce their temporary long positions. At the same time, HFTs traded nearly 140,000 E-Mini contracts or over 33% of the total trading volume.
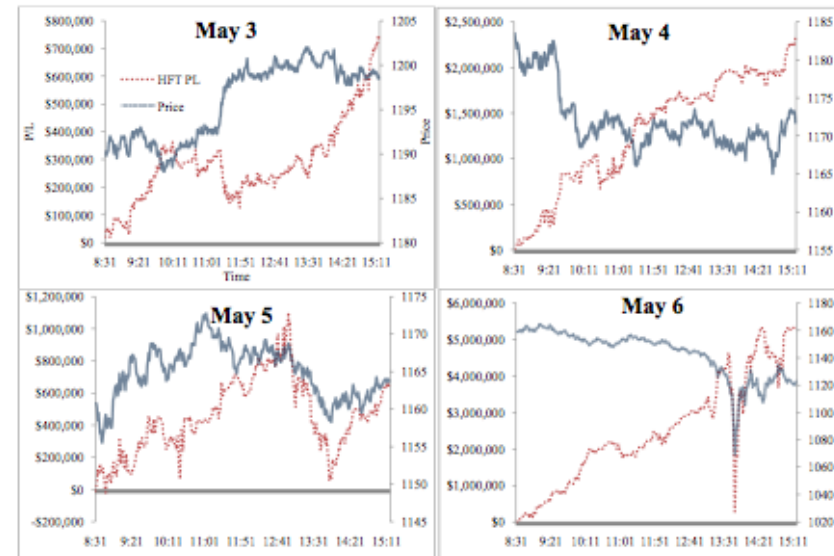
High Frequency Traders

Figure 4: Net Position of High Frequency Traders

Figure 6: Profits and Losses of High Frequency Traders
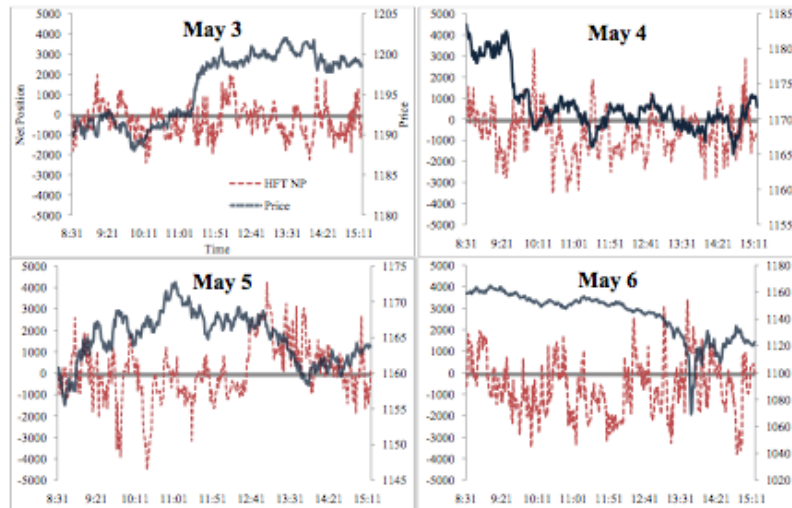
This figure presents the net position of High Frequency Traders (left vertical axis) and transaction prices (right vertical axis) in the June 2010 E-Mini S&P 500 futures contract over one minute intervals during May 3,4,5, and 6 between 8:30 to 15:15 CT. Net position is calculated as the difference between total open long and total open short positions of High Frequency Traders at the end of each minute. Transaction price is the last transaction price of each minute.
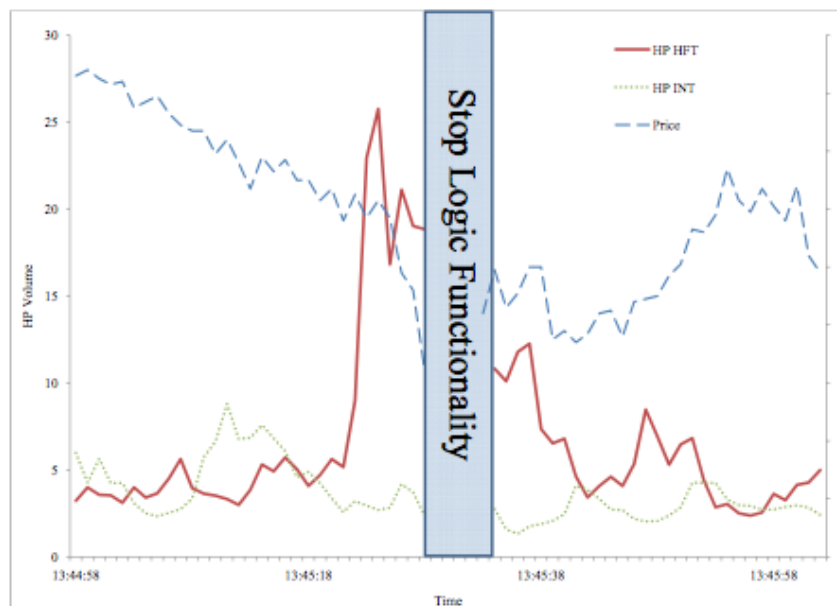
This figure presents the profits and losses of High Frequency Traders (left vertical axis) in the June 2010 E-Mini S&P 500 futures contract reported over one minute intervals during May 3,4,5, and 6 between 8:30 to 15:15 CT. Profits and losses are calculated by multiplying lagged net position by the change in price.

HFTs (and Intermediaries) did not change the trading behavior during the Flash Crash.

Figure 8: Hot Potato Volume

This figure shows the price and the scaled trading volume by HFTs and Intermediaries over one second intervals. Scaled trading volume is calculated as the 5 second moving average of contracts traded over absolute value net holdings. Price reflects the last transaction price during an interval. Prices and scaled trading volumes are reported from 13:44 to 13:46 CT.

Figure 5: Net Position of Intermediaries
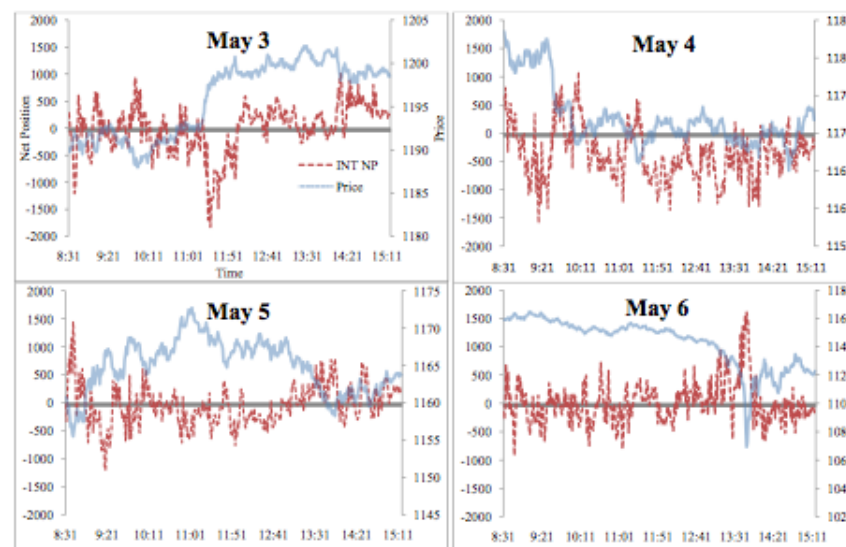
This figure presents the net position of Intermediaries (left vertical axis) and transaction prices (right vertical axis) in the June 2010 E-Mini S&P 500 futures contract over one minute intervals during May 3,4,5, and 6 between 8:30 to 15:15 CT. Net position is calculated as the difference between total open long and total open short positions of Intermediaries at the end of each minute. Transaction price is the last transaction price of each minute.

LIQUIDITY CRISIS IN THE E-MINI

- The combined selling pressure from the Sell Algorithm, HFTs and other traders drove the price of the E-Mini down approximately 3% in just four minutes from the beginning of 2:41 p.m. through the end of 2:44 p.m

- HFTs began to quickly buy and then resell contracts to each other – generating a "hot-potato" volume effect as the same positions were rapidly passed back and forth. Between 2:45:13 and 2:45:27, HFTs traded over 27,000 contracts, which accounted for about 49 percent of the total trading volume, while buying only about 200 additional contracts net ("Hot potato" effect)

- Buy-side market depth in the E-Mini fell to less than 1% of its depth from that morning's level

- As liquidity vanished, the price of the E-Mini dropped by an additional 1.7% in just these 15 seconds

- According to interviews with cross-market trading firms, at this time they were purchasing the E-Mini and selling either SPY, baskets of individual securities, or other index products.

- Between 2:32 p.m. and 2:45 p.m., as prices of the E-Mini rapidly declined, the Sell Algorithm sold about 35,000 E-Mini contracts (valued at approximately $1.9 billion) of the 75,000 intended. During the same time, all fundamental sellers combined sold more than 80,000 contracts net, while all fundamental buyers bought only about 50,000 contracts net, for a net fundamental imbalance of 30,000 contracts. This level of net selling by fundamental sellers is about 15 times larger compared to the same 13-minute interval during the previous three days, while this level of net buying by the fundamental buyers is about 10 times larger compared to the same time period during the previous three days.

- At 2:45:28 p.m., trading on the E-Mini was paused for five seconds when the Chicago Mercantile Exchange ("CME") Stop Logic Functionality was triggered

- When trading resumed at 2:45:33 p.m., prices stabilized and shortly thereafter, the E-Mini began to recover, followed by the SPY.

- The Sell Algorithm continued to execute the sell program until about 2:51 p.m. as the prices were rapidly rising in both the E-Mini and SPY.

LIQUIDITY CRISIS WITH RESPECT TO INDIVIDUAL STOCKS

- The second liquidity crisis occurred in the equities markets at about 2:45 p.m.
- Automated trading systems used by many liquidity providers temporarily paused in reaction to the sudden price declines observed during the first liquidity crisis. These built-in pauses are designed to prevent automated systems from trading when prices move beyond pre-defined thresholds in order to allow traders and risk managers to fully assess market conditions before trading is resumed
- Based on their respective individual risk assessments, some market makers and other liquidity providers widened their quote spreads, others reduced offered liquidity, and a significant number withdrew completely from the markets.
- Many over-the-counter market makers who would otherwise internally execute as principal a significant fraction of the buy and sell orders they receive from retail customers (i.e., "internalizers") began routing most, if not all, of these orders directly to the public exchanges
- As liquidity completely evaporated in a number of individual securities and ETFs, participants instructed to sell (or buy) at the market found no immediately available buy interest (or sell interest) resulting in trades being executed at irrational prices as low as one penny or as high as $100,000 (stub-quotes)
- By approximately 3:00 p.m., most securities had reverted back to trading at prices reflecting true consensus values

LESSONS LEARNED

- Under stressed market conditions, the automated execution of a large sell order can trigger extreme price movements, especially if the automated execution algorithm does not take prices into account.

- The interaction between automated execution programs and algorithmic trading strategies can quickly erode liquidity and result in disorderly markets

- May 6 was also an important reminder of the inter-connectedness of our derivatives and securities markets, particularly with respect to index products.

- Many market participants employ their own versions of a trading pause based on different combinations of market signals. While the withdrawal of a single participant may not significantly impact the entire market, a liquidity crisis can develop if many market participants withdraw at the same time.

- The events of May 6 clearly demonstrate the importance of data in today's world of fully-automated trading strategies and systems.

- As markets became electronic, a rigid distinction between market makers and other traders became obsolete

- High Frequency Traders exhibit trading patterns inconsistent with the traditional definition of market making. Specifically, High Frequency Traders aggressively trade in the direction of price changes. This activity comprises a large percentage of total trading volume, but does not result in a significant accumulation of inventory.

- In fact, especially in times of significant volatility, high trading volume is not necessarily a reliable indicator of market liquidity

- A fundamental questions arises. Why did it take so long for Fundamental Buyers to enter the market and why did the price concessions had to be so large? It seems possible that some Fundamental Buyers could not distinguish between macroeconomic fundamentals and market-specific liquidity events

A point of view from industry

Nanex

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Who is Nanex?

Nanex is the creator and developer of NxCore, a **streaming whole market datafeed** with an easy to use API. Nanex supports NxCore and develops applications that run on the NxCore platform.

What is NxCore?

NxCore (pronounced n'core) is a high-performance, **real-time streaming datafeed** (ticker plant) that brings the whole market to your workstation or desktop computer. NxCore excels in delivering and databasing all the quotes and trades transmitted by the exchanges, even in the hyper-active U.S. Option market (OPRA) which now transmits over 1,700,000 quotes per second, and 6 billion quotes per trading day.

NxCore has an easy to use API for developing trading software. No parsing required, it uses simple fixed structures and includes important and frequently used information in every quote and trade update. NxCore includes tools to help you visualize and understand data relationships in the feed. And NxCore lets you replay the data at blazing speeds (2 million+ updates/second) on inexpensive hardware. Converting from existing feeds becomes a trivial exercise.

NxCore databases everything; all quotes, trades and other real-

NxCore requires minimal resources . Unlike some datafeeds that require hardware costing over $10,000, NxCore can run on a low-end Pentium laptop (1.0 GHz, 256MB of RAM, 80GB IDE hard drive) and receive and database 1,400,000 quotes/second, over 6 billion/day; and CPU usage will remain under 5%

NxCore is extremely efficient in bandwidth utilization and will save you thousands of dollars in monthly communications costs. In a single T-1 (1.5mbps), it will fit 40,000 quote and trade updates

NxCore Status

NEWS

Is There Price Discovery in Equity Options?

A fascinating study conducted using data supplied by Nanex.

Choose the "**One-Click Download**" option.

The Nanex team has completed it's analysis of the events leading to the 'Flash Crash' of 05/06/2010.

Flash Crash Analysis

NxCore Access and API FAQ is now available! Check it out.

The NxCore Advanced Code Samples are now available! Ask about the NxCore Advanced Code Samples.

NxCore's API Basic Overview can be found here.

NxCore now supports C# and

www.nanex.net

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OCTOBER 8, 2010, 5:17 PM   LEGAL/REGULATORY

Casting Doubt on Single-Trade Spark in Flash Crash

BY GRAHAM BOWLEY

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Graham Bowley, a DealBook colleague, reports:

Another volley in the debate over the "flash crash": **Nanex**, the data provider, published a new analysis on Friday that contends that the single trade identified by regulators as touching off the stock market plunge on May 6 could not have been the cause.

Nanex says the sale of 75,000 futures contracts by **Waddell & Reed**, a mutual fund company based in Kansas, represented only a small fraction of the selling that took place on the afternoon of May 6.

What is more, most of Waddell & Reed's selling took place after the market had hit bottom and prices were recovering. Instead, Nanex points to other big trades that day that were much larger and should have been addressed by the Securities and Exchange Commission and Commodity Futures Trading Commission in their official report on the crash, but weren't.

The Wire

MAY 5, 5:21 PM AP	OSHA Cites DuPont, Contractor in Fatal NY Blast
MAY 5, 5:21 PM NYTIMES.COM	The Inevitability of a Greek Default
MAY 5, 5:01 PM WSJ.COM	Carrefour's Troubled Turnaround
MAY 5, 4:50 PM WSJ.COM	Kraft Profit Falls 58% Amid Year-Earlier Gain
MAY 5, 4:31 PM NYTIMES	World's Millionaire Ranks Seen Soaring Through 2020

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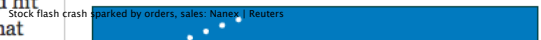
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Stock flash crash sparked by orders, sales: Nanex | Reuters   5/6/11 4:12 PM

ARTICLE   COMMENTS (3)

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Stock "flash crash" sparked by orders, sales: Nanex

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By Herbert Lash
NEW YORK | Mon Sep 27, 2010 4:47pm EDT

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(Reuters) - A surge in quote traffic immediately followed by heavy sales of key securities may have sparked the "flash crash" on U.S. stockmarkets on May 6, a firm that has provided key insights into that day's events said on Monday.

The sale of $125 million worth of Chicago Mercantile Exchange S&P500

The Atlantic

FRIDAY, MAY 6, 2011

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A **ALEXIS MADRIGAL** - Alexis Madrigal is a senior editor at The Atlantic. He's the author of *Powering the Dream: The History and Promise of Green Technology.* More

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Maybe the Flash Crash Wasn't Caused by 1 Dumb Trade

OCT 18 2010, 10:33 AM ET | 💬 1

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The big SEC/Commodity Futures Trading Commission report that came out two weeks ago pinned the blame for starting the May 6 Flash Crash on a single trade by a Kansas firm. The story went like this: the firm used an algorithm that traded a type of S&P future called an E-mini based on the volume of the market, without taking into account price or timing. As the trade began, high-frequency traders jumped into the market and -- for a set of complex reasons -- the volume exploded, leading the algorithm to accelerate its own trading. The speed spooked the market and because other futures are pegged to E-minis, everything went haywire.

This was a neat narrative, but now it is encountering opposition. The firm that people pegged as making the trade, Waddell & Reed, released its own trading data to the once-obscure research firm Nanex, which has made a name for itself analyzing the Flash Crash. They released a report, which sometime *Atlantic* Technology Channel author, Joe Flood, glossed for his day job at the institutional investing magazine, ai5000. The short story? The Waddell and SEC/CFTC stories just don't match up.

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SEPTEMBER 27, 2010, 3:18 PM ET

Data Wonks Debut Dizzying Diagram of Flash Crash

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By Tom Lauricella

Nanex

From the folks who brought you "quote stuffing" comes a more detailed look at the May 6th Flash Crash.

Among the biggest mysteries of the Flash Crash has been what turned a big – but not extreme – sell-off in the Dow Jones Industrial Average into a 1,000 point free-fall.

Nanex LLC, now known for having coined the term "quote stuffing" – the split-second, dumping of computerized buy or sell orders, which are then instantly canceled – has taken a deeper dive into the crucial fractions-of-a-second moments when the market came unglued.

After slicing the order-flow down to 25 milliseconds, Nanex's Eric Hunsader says he sees the footprints of the destabilizing practice of quote stuffing. The theory regarding quote stuffing is that it clogs up the quote feeds and allows high frequency traders to profit from any fleeting difference between quotes on separate exchange feeds.

Back on June 18, Nanex, then a virtually unknown stock data feed company, posted a report postulating that a massive barrage of stock quotes may have played a role in destabilizing the market on May 6. But it wasn't clear exactly how it transpired that day.

In the meantime, Mr. Hunsader is out with his latest dissection of the afternoon's trading. The result is a dizzying, but revealing chart about what happened between 2:42 and 2:53 pm.

It kind of looks more like a map of El Dorado but bear with us, because there's some juicy nuggetsd in them thar hills.

At 2:42 the Dow Jones Industrial Average was already down a hefty 400 points and sinking fast, having lost about 100 points in six minutes. But from there, the stock market went into a free fall.

According to Nanex's analysis, at 2:42, 43 seconds and 600 milliseconds, something unusual
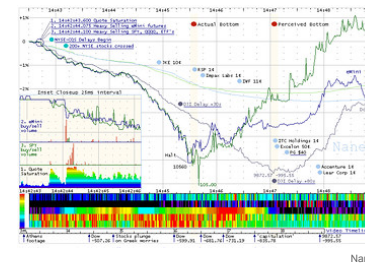

Nanex: Final Conclusion (Oct 14, 2010)

1) The Waddell & Reed trades were not the cause, nor the trigger. The algorithm was very well behaved; it was careful not to impact the market by selling at the bid, for example. And when prices moved down sharply, it would stop completely

• 6,438 trades, (75,000 contracts)
147,577 trades (844,513 contracts)
between 14:32 and 14:52.
Waddell & Reed trades in context with the other trades during that time do not appear to be significant.

• W&R trades also do not occur near the ignition point (14:42:44.075)

• W&R trades are practically absent during the torrential sell-off that began at 14:44:20.

• The bulk of the W&R trades occurred after the market bottomed and was rocketing higher -- a point in time that the SEC report tells us the market was out of liquidity.

• The algorithm does take price into consideration.

May 6, 2010 Sell Algo
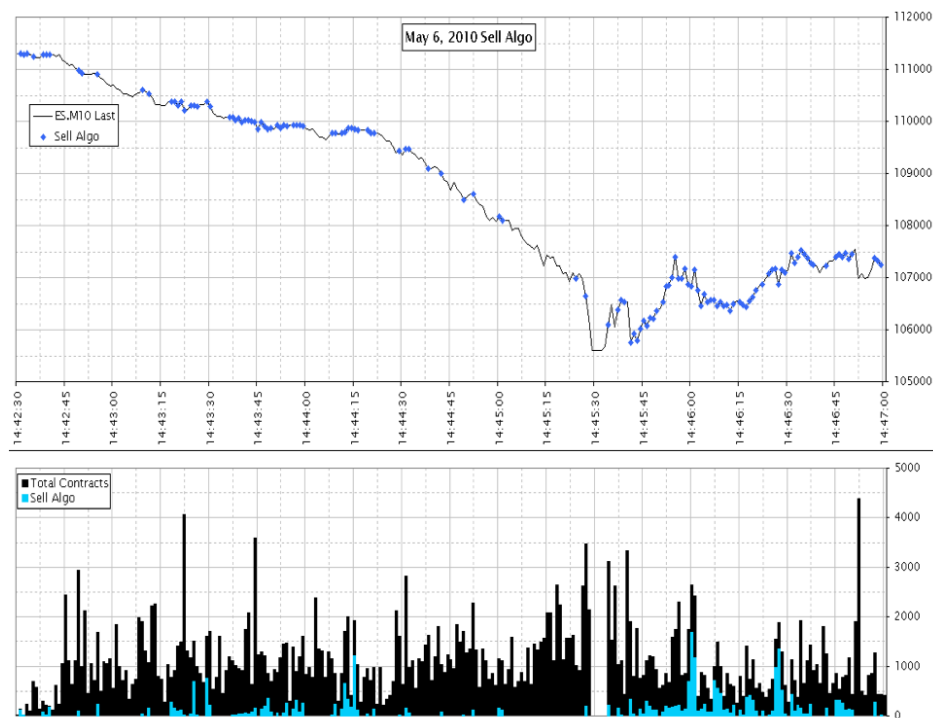
"Something is very wrong here"

2) The buyer of those contracts, however, was not so careful when it came to selling what they had accumulated. Rather than making sure the sale would not impact the market, they did quite the opposite: they slammed the market with 2,000 or more contracts as fast as they could. The sale was so furious, it would often clear out the entire 10 levels of depth before the offer price could adjust downward. As time passed, the aggressiveness only increased, with these violent selling events occurring more often, until finally the e-Mini circuit breaker kicked in and paused trading for 5 seconds, ending the market slide.

20 millisecond cascade

3) Because of arbitration, when the e-Mini changes price with high volume, many ETFs are repriced (quotes updated, trades executed).
4) The component stocks of ETFs are also repriced, along with many indexes.
5) And finally, all the option chains for the ETFs, their components and indexes are also repriced.

- The entire system simply cannot absorb the impact of a sudden move in the e-Mini on high volume. A sale (or purchase) of 2,000+ contracts which rips through one-side of the depth of book in 50-100 milliseconds, will immediately overload many systems
- The first large e-Mini sale slammed the market at approximately 14:42:44.075, which caused an explosion of quotes and trades in ETFs, equities, indexes and options -- all occurring about 20 milliseconds later (about the time it takes information to travel from Chicago to New York).
- This surge in activity almost immediately saturated or slowed down every system that processes this information; some more than others.
- Two more sell events began just 4 seconds later (14:42:48:250 and 14:42:50:475), which was not enough time for many systems to recover from the shock of the first event.
- This was the beginning of the freak sell-off which became known as the flash crash.
- In summary, the buyers of the Waddell & Reed e-Mini contracts, transformed a passive, low impact event, into a series of large, intense bursts of market impacting events which overloaded the system.
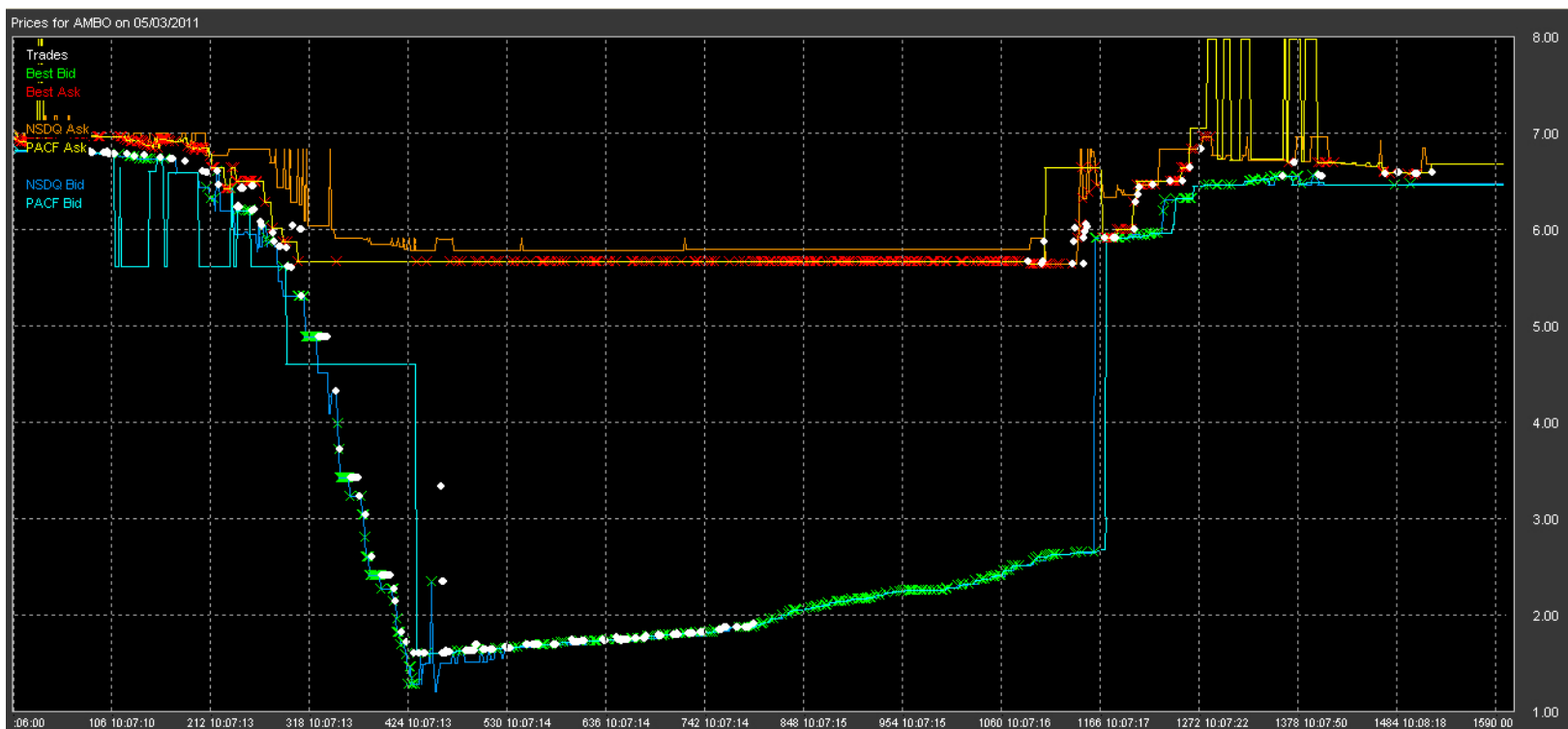
Is it over?

Nanex

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Strange Days 05/03/2011

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On 05/03/2011 shares of AMBO fell from $6.74 to $1.59 within a single second:

AMBO - AMBOW EDUCATION HOLDINGS

Prices for AMBO on 05/03/2011

In the following chart, bids circled in red were canceled to fast for the market order:

In Europe

...and IBEX futures

http://www.zerohedge.com/article/
europe-opens-mini-flash-crash

Commodity markets

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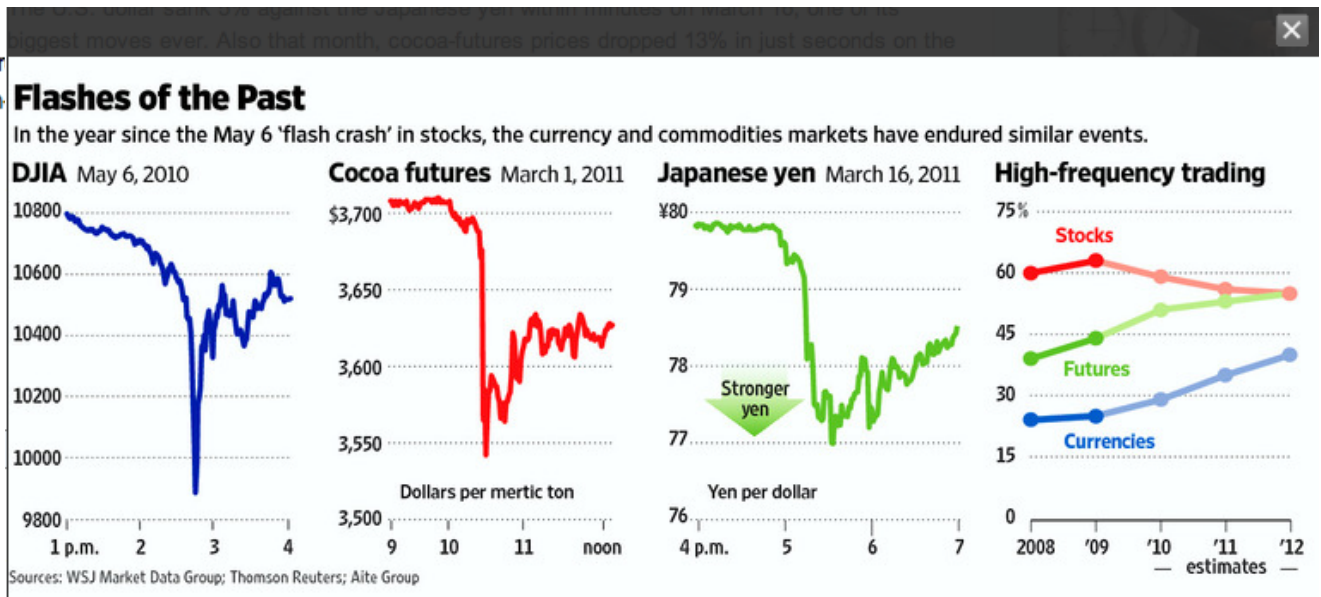Email   Print   Save This   Like 3   + More   Text

By CAROLYN CUI And TOM LAURICELLA

A boom in computerized, high-speed trading in commodities and currencies has coincided with a series of "flash crashes" in those markets, even though the stock market hasn't seen a repeat of the harrowing plunge of a year ago.

The U.S. dollar sank 5% against the Japanese yen within minutes on March 16, one of its biggest moves ever. Also that month, cocoa-futures prices dropped 13% in just seconds on the IntercontinentalExchange Inc. before rebounding almost as quickly. In February, the sugar market took a dive of 6% in just one second.

Like the stock market "flash crash," which occurr the unintended consequences of an influx of high markets that aren't equipped to deal with them.

Flashes of the Past

In the year since the May 6 'flash crash' in stocks, the currency and commodities markets have endured similar events.

DJIA May 6, 2010

Cocoa futures March 1, 2011
Dollars per metric ton

Japanese yen March 16, 2011
Yen per dollar
Stronger yen

High-frequency trading
Stocks
Futures
Currencies
— estimates —

Sources: WSJ Market Data Group; Thomson Reuters; Aite Group

An isolated event?

- All listed equities for 2006-2011 searching for potential "mini crashes" in individual stocks.
  - **To qualify as a down(up)-draft candidate, the stock had to tick down (up) at least 10 times before ticking up (down)-- all within 1.5 seconds and the price change had to exceed 0.8%.**

	Down Drafts			Up Drafts		
Year	Count	Download All	Examples	Count	Download All	Examples
2011	69+	Download		70+	Download	
2010	1041	Download	View	777	Download	View
2009	1,462	Download	View	1,253	Download	View
2008	4,065	Download	View	4,354	Download	View
2007	2,576	Download	View	2,456	Download	View
2006	254	Download	View	208	Download	View

Systemic instability

Price Change >= 0.8%
Ticks in a row >= 10
Time <= 1.5 seconds

— Down Drafts
— Up Drafts
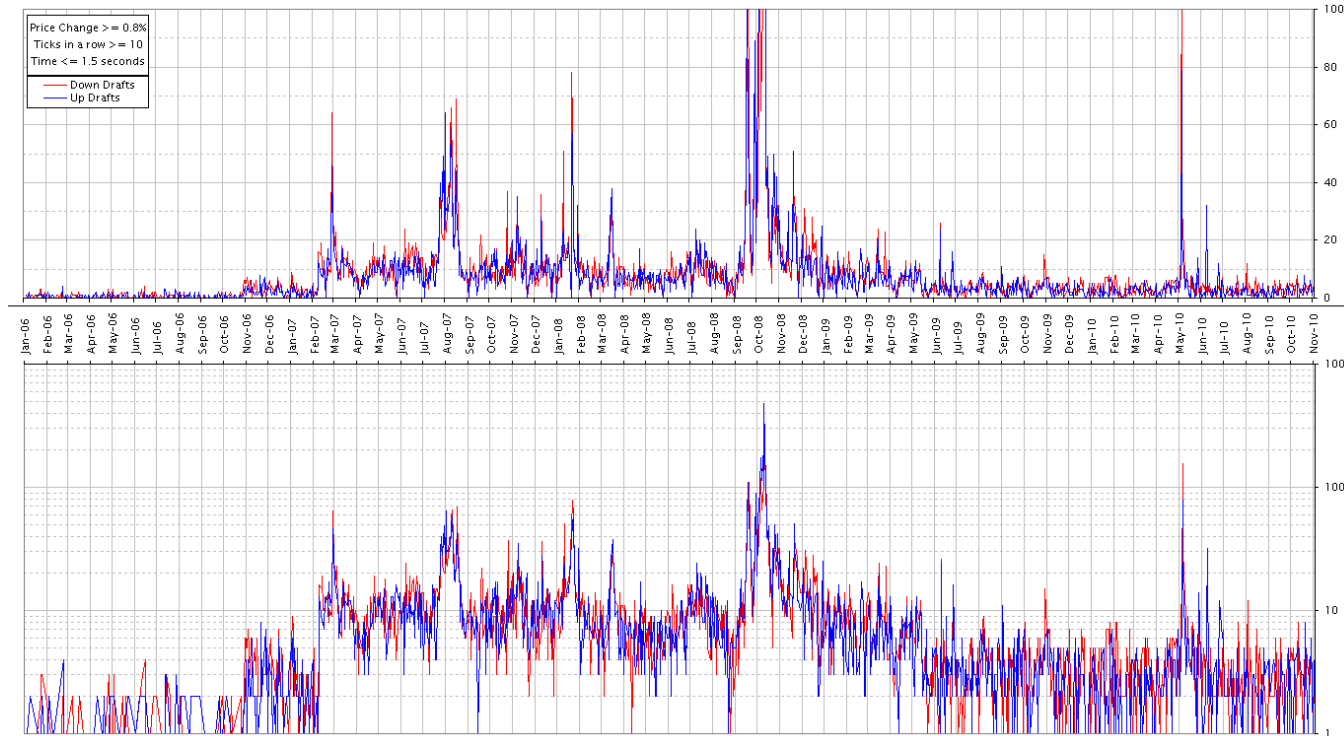
Regulation NMS was implemented in 2007

Consider the NYSE Hybrid Market rollout:

- Hybrid Phase III - COMPLETED rollout January 24, 2007

- Hybrid Phase IV - COMPLETED rollout February 27, 2007

Note that prior to Feb 2007, the NYSE had never been a reporting exchange in any incident.