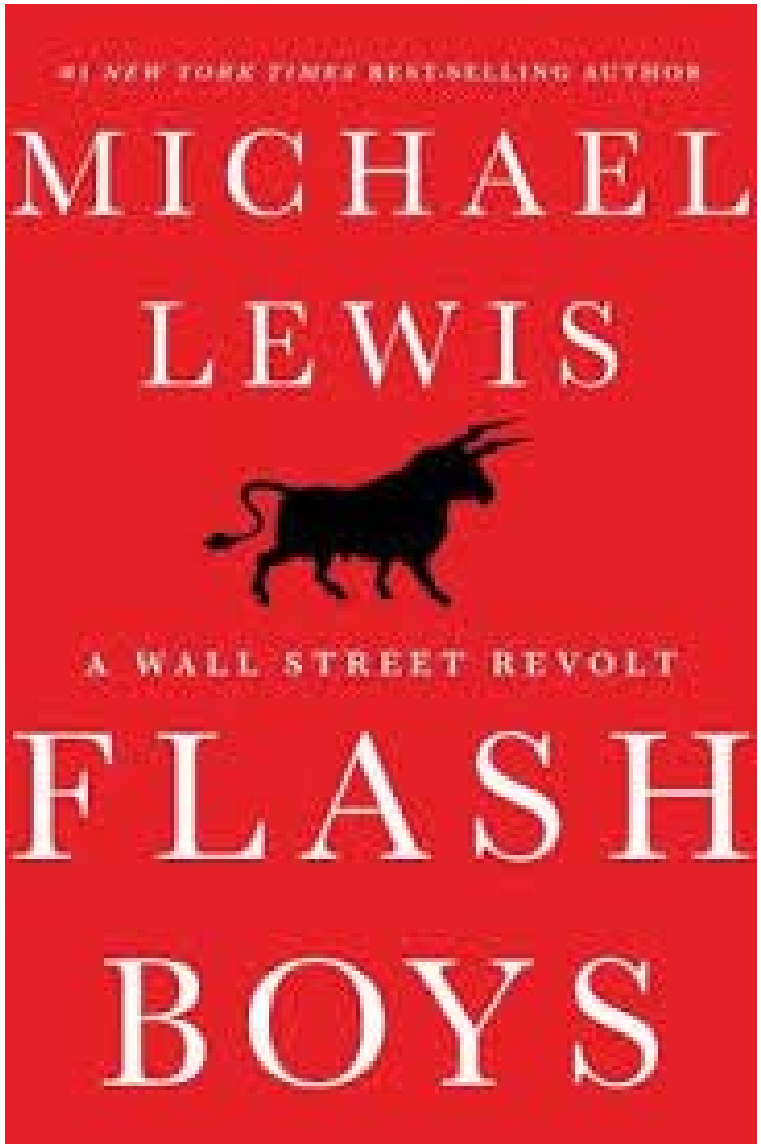
High-frequency trading and changes in futures price behavior

Charles M. Jones
Robert W. Lear Professor of Finance and Economics
Columbia Business School
April 2018

Has HFT broken our financial markets?

It's a popular view…



Trading certainly looks different today

20th century

21st century

Automation has driven out costs.
Is it increasing liquidity and helping firms hedge risks?

Keeping the computers in Aurora busy

Daily Message Statistics for 03/22/2018		
Channel	Description	Daily Message Count
310	CME Globex Equity Futures	10,404,772
311	CME Globex Equity Options	103,334,714
312	CME Globex Interest Rate Futures	66,357,328
313	CME Globex Interest Rate Options	15,539,368
314	CME Globex FX Futures	19,044,261
315	CME Globex FX Options	52,099,253
316	CME Globex Commodity Futures	2,681,668
317	CME Globex Commodity Options	8,956,795
318	CME Globex Equity Futures - excludes E-mini S&P 500	44,824,329
319	CME Globex Equity Options - excludes E-mini S&P 500	27,214,197
320	CME Globex FX Futures II	34,198,617
321	CME Globex FX Options II	35,179,420
382	NYMEX Globex Crude & Crude Refined Futures	91,995,015
383	NYMEX Globex Crude & Crude Refined Options	66,765,520
10003	Aggregate ITC	1,476,551
10004	Aggregate FIXBINARY	764,242,348
10005	Aggregate STREAMLINEFB	32,503,531

This is a fairly typical day: tens of thousands of messages per second!

High-frequency traders (HFTs)

- **Proprietary trading** at a rapid rate
- Focus on **low latency**
- Typically **short (intraday) holding periods**

Three broad categories of trading strategies:

- **Market-making** (formally or informally)
- High-frequency **relative-value trading**
  - Calendar spreads
  - Related commodities (crude oil vs. gasoline)
  - Commodities vs. affected firms (corn vs. Kellogg shares)
- **Directional trading** on public signals
  - Order flow
  - News releases

HFT vs. Algorithmic trading (AT)

- HFT is a subset of algorithmic trading.
- Hedgers and other large traders often use algorithms to "slice and dice" large orders into smaller pieces.

The economics behind HFT

Potential benefits

- **Increased competition** in market-making
- **Cost reduction** via technology

Some potential costs

- Complexity costs
- HFT speed could disadvantage slower traders
- Faster-take-all could lead to an unproductive arms race
- Greater complexity makes it easier for bad actors to hide

In equity markets…

- On average, HFT has been good for liquidity and market quality
- My read of the studies: liquidity improvements are due to increased competition in liquidity provision
- More speed per se does not seem to improve markets
- Averages can conceal important left-tail events

Enough on equities, let's look at some ag prices…


Nearby corn futures price
Cents Per Bushel
900
800
700
600
500
400
300
200
100
0
Apr-07
Apr-08
Apr-09
Apr-10
Apr-11
Apr-12
Apr-13
Apr-14
Apr-15
Apr-16
Apr-17

What to note…

- Price spikes in 2008 and about five years ago
- Prices more than doubled and then returned to "standard" production cost levels.
- Prices have been fairly quiescent for the past three years or so.

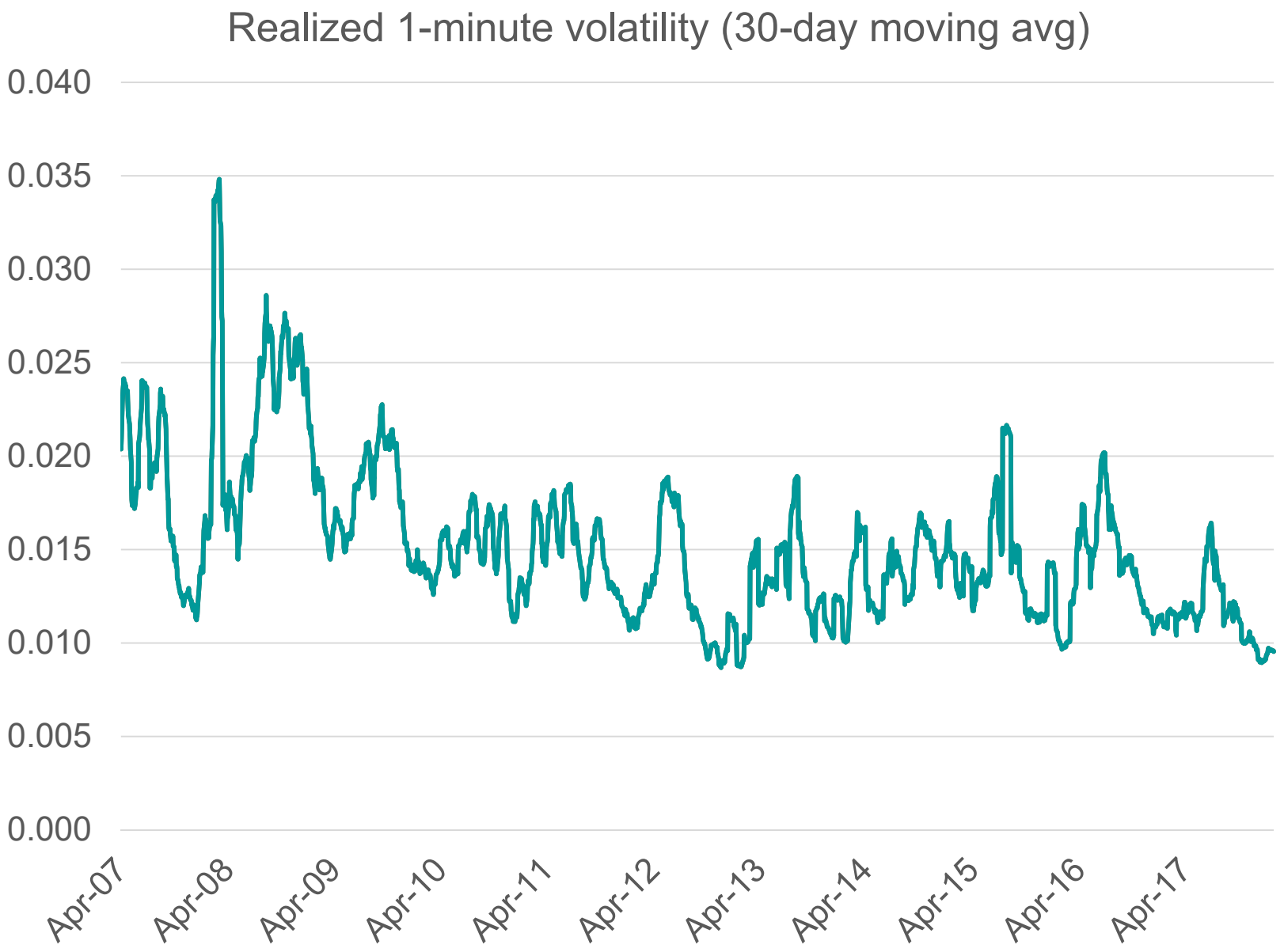
There's still volatility at finer scales

- A standard intraday calculation is **realized volatility**:
- Let p_t be the last sale price each minute, then the 1-minute return is

$$r_t = \ln(p_t / p_{t-1})$$

- And realized 1-minute volatility over a within-day period of length T is given by

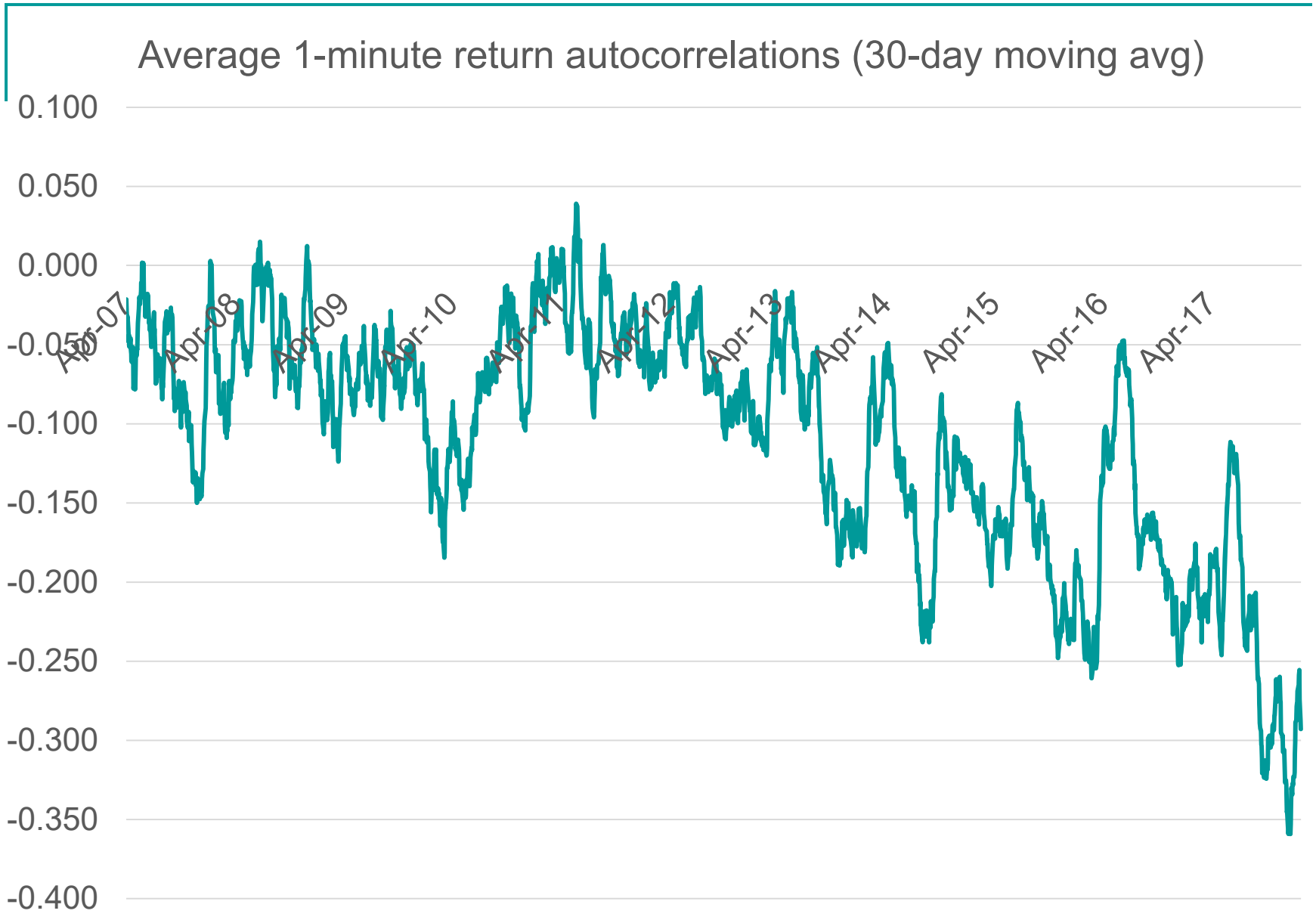
$$s_\tau = \sqrt{\frac{1}{T}\sum_{\tau-T}^{\tau} r_t^2}$$



Expressed as a daily return standard deviation, uses RTH transaction prices

1-minute return autocorrelations

- $\rho = \text{Corr}(r_t, r_{t-1})$
- Benchmark is a random walk in futures prices with $\rho = 0$.
- Bid-ask bounce and temporary moves in prices would lead to $\rho < 0$.



First-order autocorrelations based on RTH transaction prices

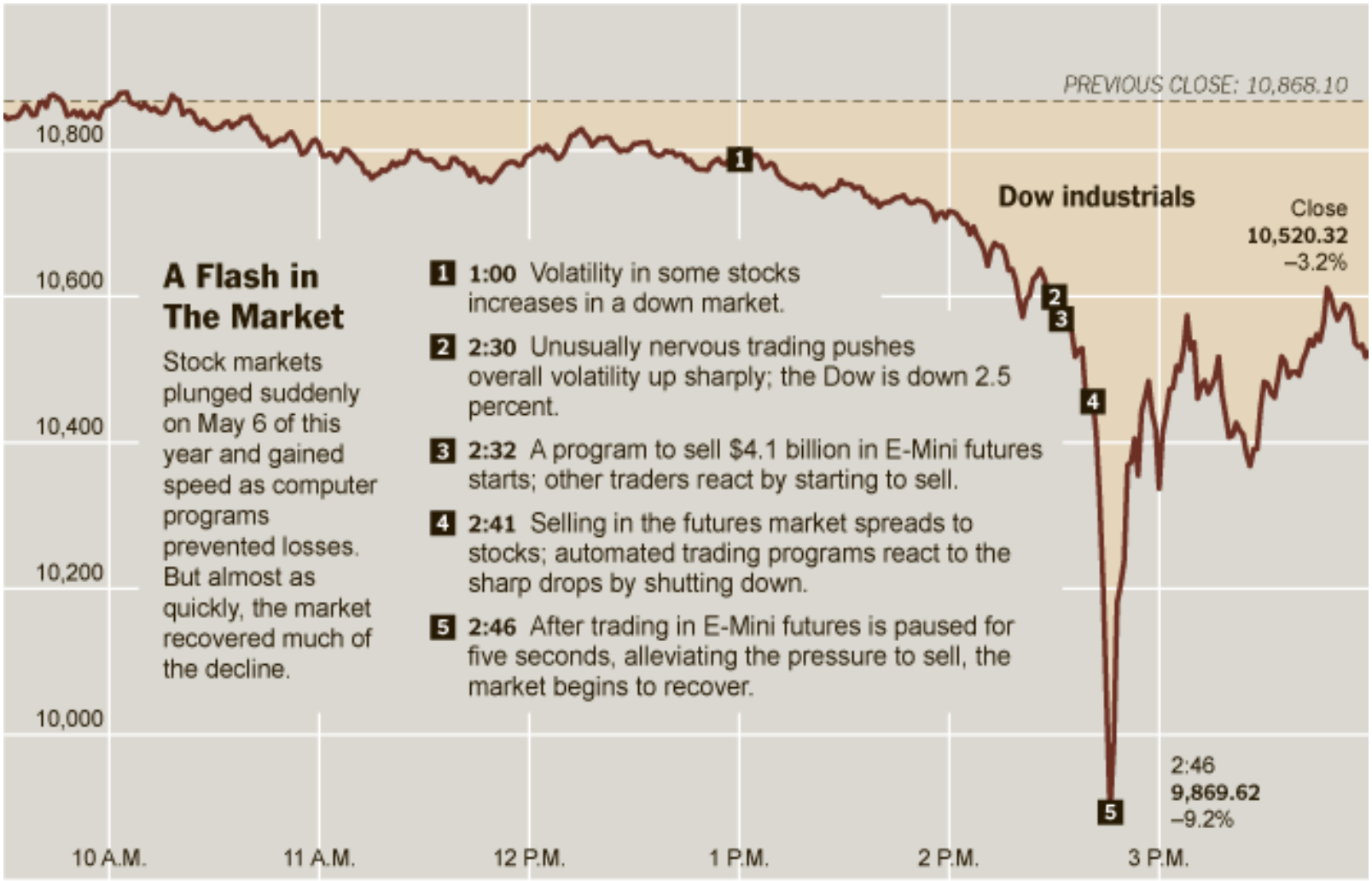
Summary of data

- Evidence for soybeans is similar
- No evidence of more overall volatility, but temporary volatility is higher now
- In recent data, almost 30% of the one-minute price change is reversed in the next minute
- Most likely explanation in this case: the minimum tick is too big, at least for right now
- But let's keep in mind another possible alternative:
  - Algorithms could be pushing prices too far
  - Price moves are followed by quick reversals

Is it due to the computers?

- Be careful: trends are not causality!
- In other markets, causality is often established by studying specific market structure changes that either increase or decrease HFT.
  - Hendershott-Jones-Menkveld (2010 JF) "Does algorithmic trading improve liquidity?"
- Another approach with proprietary or regulatory data: identify whether specific trader categories can account for the results
  - Flash crash paper by Kirilenko et al. (2017)

Flash crashes and big price reversals indicate poor market quality



Price reversals in corn

Big price moves Of at least 0.5%			
Year	Number of big 1-minute price moves	1-minute return autocorrelation following big moves	Fraction of big moves that are at least half reversed 1 min. later
2007	156	0.02	17%
2008	551	-0.08	23%
2009	269	-0.03	19%
2010	104	-0.02	15%
2011	113	-0.15	23%
2012	45	-0.07	18%
2013	64	-0.01	24%
2014	73	0.11	19%
2015	65	-0.15	37%
2016	53	-0.06	22%
2017	34	-0.19	38%

Last three years are statistically distinct from the prior period.

Overall conclusions

- No evidence that our futures markets are broken or rigged.
- All the evidence from other markets suggests that technological innovation and competition have contributed to this improvement.
- Probably no marginal benefit to speed per se.
- Maybe some evidence of occasional mini-flash reversals
- Policy recommendations:
  - Short trading pauses, kill switches to limit flash crashes
  - Robust audit trails and enforcement of existing rules.
  - Regulatory prodding to make trading infrastructure more reliable.