

How Has Market Liquidity Changed After The Financial Crisis?

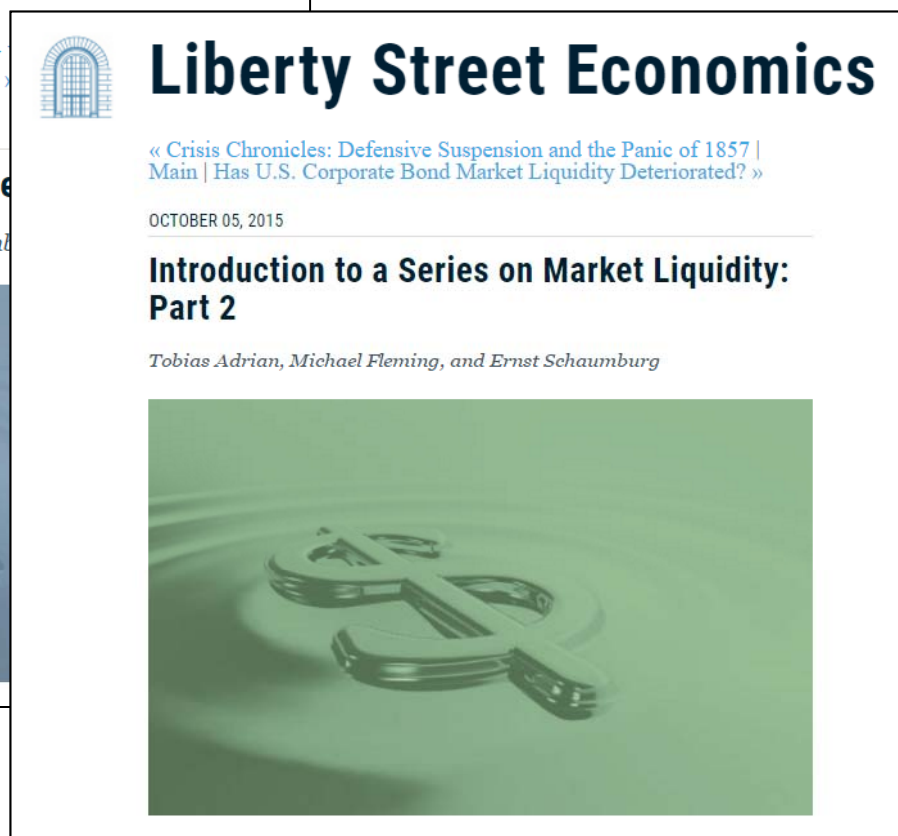
Andrew W. Lo, MIT

NY Fed Financial Advisory Roundtable

June 16, 2017

Growing Interest In Liquidity

- 3,725 papers on SSRN over the past 3 years



Liquidity Is Many Things

- Liquidity is a many splendored thing
- Liquidity is a regulatory thing
- Liquidity is a credit thing
- Liquidity is a hedge fund thing
- Liquidity is a systems thing
- Liquidity is a technological thing

Liquidity Is A Many-Splendored Thing

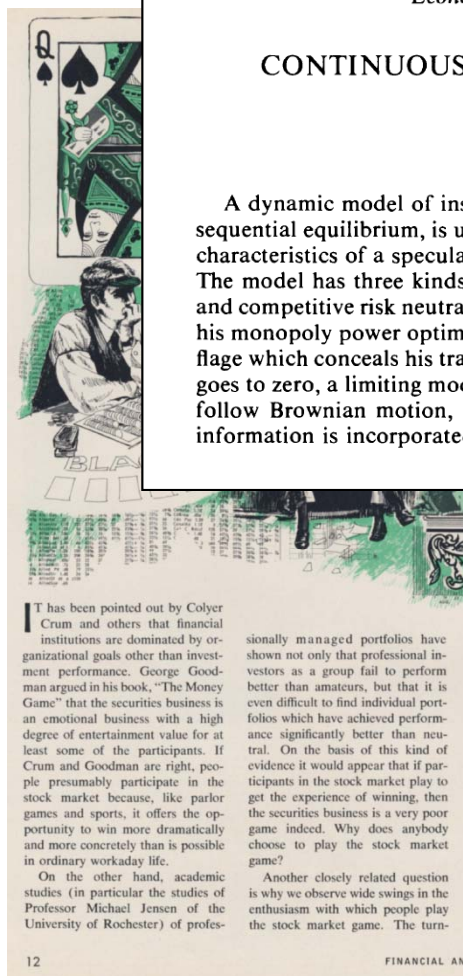
- What is a “liquid” asset?
- Three dimensions: price, time, size

liq·uid \ 'li-kwəd \ *adj.*

An asset is liquid if: (1) it can be traded without much cost or price impact; (2) it can be traded quickly; and (3) it can be traded in large size.

- And these features can change across time, space, and counterparty

Liquidity Is A Many-Splendored Thing



Econometrica, Vol. 53, No. 6 (November, 1985)

CONTINUOUS AUCTIONS AND INSIDER TRADING

A dynamic model of ins sequential equilibrium, is u characteristics of a specula The model has three kinds and competitive risk neutra his monopoly power optim flage which conceals his tra goes to zero, a limiting mod follow Brownian motion, t information is incorporated

Journal of Financial Economics 14 (1985) 71-100. North-Holland

BID, ASK AND MARKET WITH

Northwestern U

Received

The presence of traders with specialist is risk-neutral and information, and the expected number that is independent of the price level implies a divergence between approximately realizable re

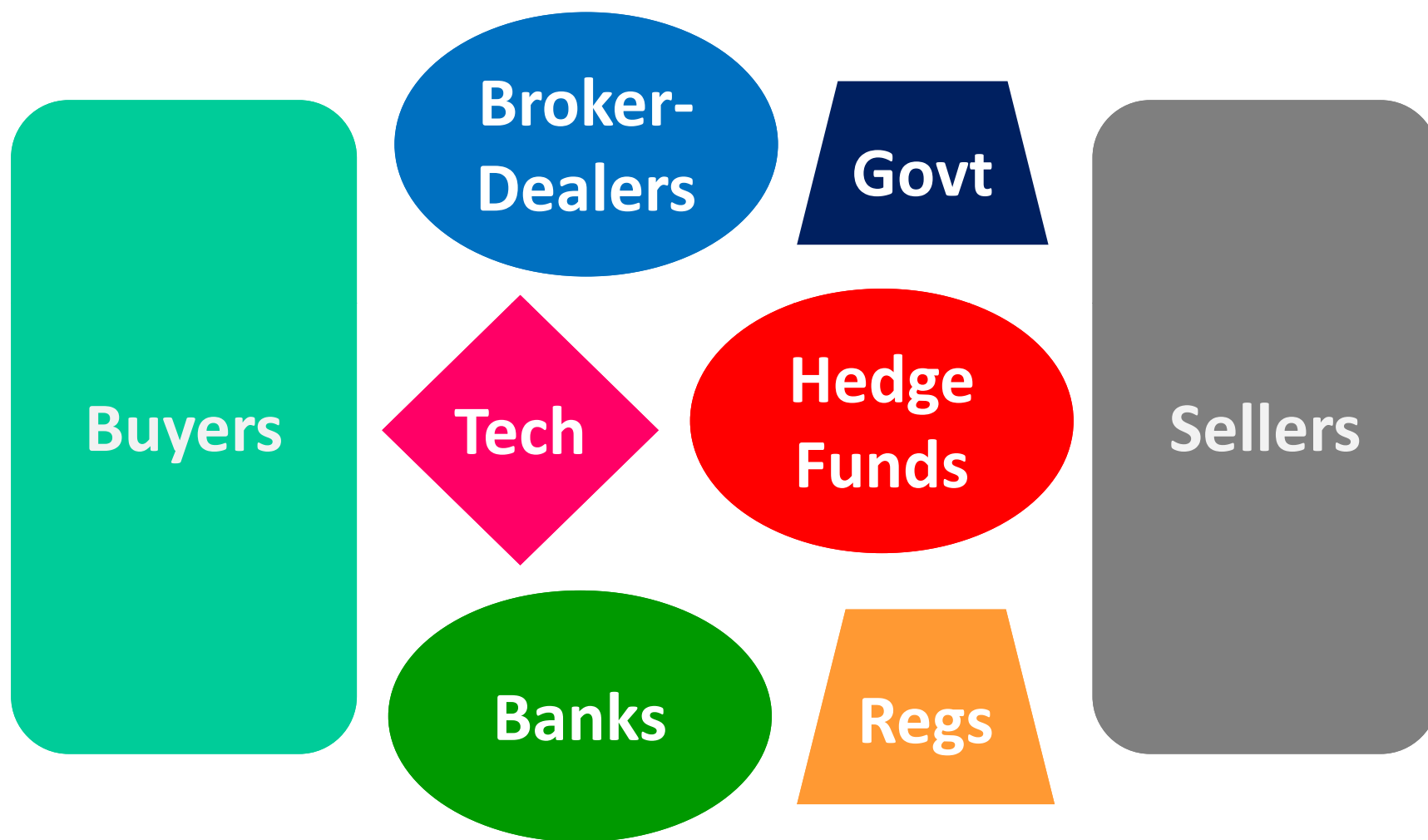
A Theory of Intraday Patterns: Volume and Price Variability

The Review of Financial Studies / Spring, 1988

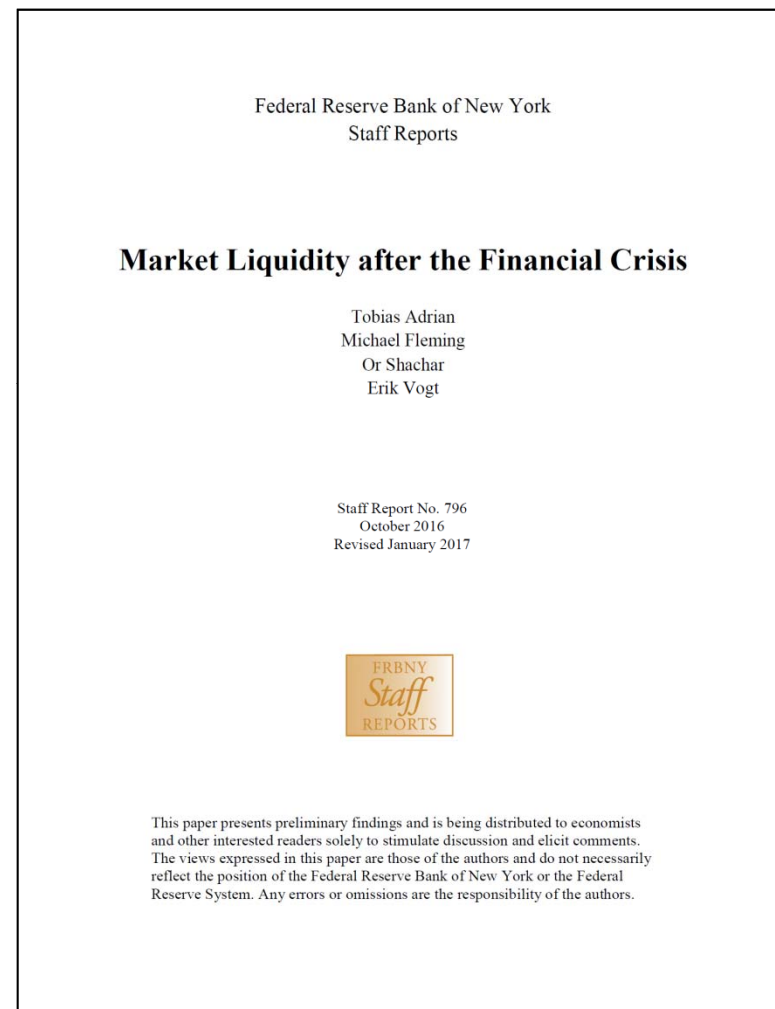
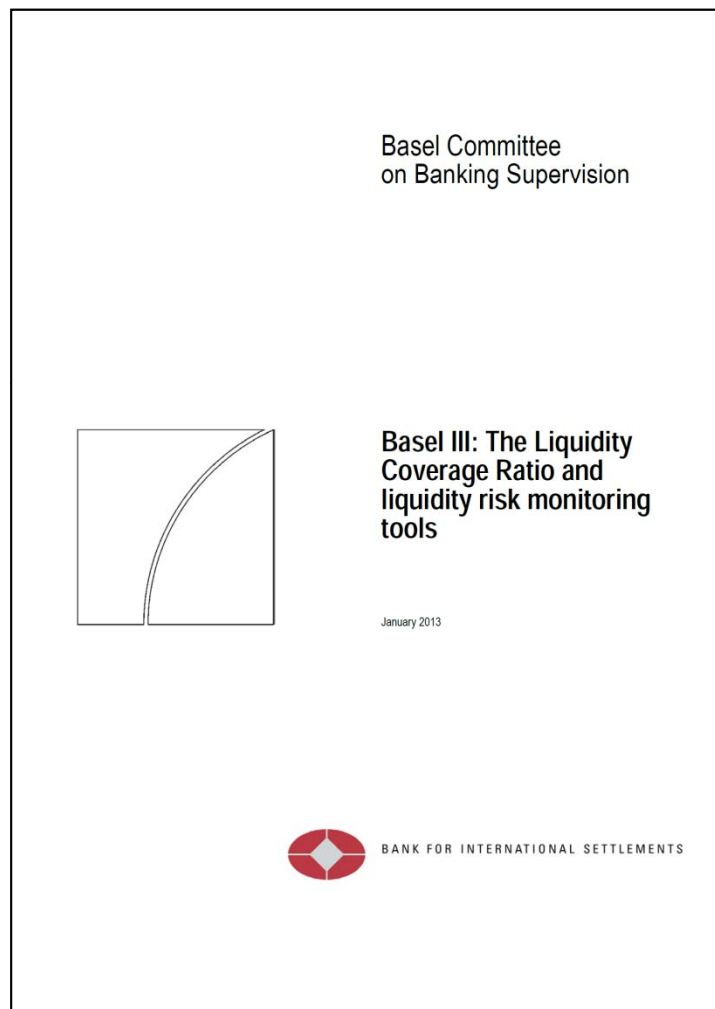
Anat R. Admati
Paul Pfleiderer
Stanford University

This article develops a theory in which concentrated-trading patterns arise endogenously as a result of the strategic behavior of liquidity traders and informed traders. Our results provide a partial explanation for some of the recent empirical findings concerning the patterns of volume and price variability in intraday transaction data.

Liquidity Is A Many-Splendored Thing



Liquidity Is A Regulatory Thing



Liquidity Is A Regulatory Thing

A key limitation of the depth measure is that it does not consider the spread between quoted prices, including the inside bid-ask spread, and as such does not directly capture the cost aspect of liquidity. Another important drawback of quoted depth is that market participants often do not reveal the full quantities they are willing to transact at a given price so that measured depth may underestimate true depth (see [Boni and Leach \(2004\)](#) and [Fleming and Nguyen \(2013\)](#)). Conversely, because of the speed with which orders can be withdrawn from the market, actual depth may instead be lower than what is posted in the limit order book.

One difficulty in interpreting trade size is that it underestimates market depth, because the quantity traded is often less than the quantity that could have been traded at a given price. The decline in trade size compared with the pre-crisis period, in particular, may reflect the increasing prevalence of high-frequency trading in the interdealer market, and not necessarily reduced liquidity.

Overall, we do not find strong evidence of a deterioration in Treasury market liquidity in the post-crisis era. The appreciable declines in quoted depth in mid-2013 and late 2014 may be the strongest evidence of worsening liquidity. However, the price impact coefficients suggest a more modest deterioration, and bid-ask spreads, which directly measure the cost of trading, remained narrow by recent historical standards as of mid-2016. Trade sizes declined considerably from levels observed before the crisis, but may reflect the growth of automated trading and associated changes in order submission strategies, and are not necessarily indicative of worse liquidity.

Liquidity Is A Regulatory Thing

Is There a Liquidity Problem Post-Crisis?

Remarks by

“...a small reduction in liquidity from regulatory changes—even if present, which is not obvious—may be a reasonable price to pay for greater safety.”

– Stanley Fischer

November 15, 2016

An Emerging Narrative

Stability-Li Post-Cris

Symptoms of changing liquidity

- Traditional liquidity measures such as price impact and bid-ask spread look fine.
- Turnover and trade sizes are generally down.
- Single-name CDS and matched-book repo markets are withering.
- The 10-year Treasury note “yield crash” of October 15, 2014 is a symptom of changes in the mix of intermediaries, including HFT.

Graduate School
Brooklin

An Emerging Narrative

DO WE HAVE A LIQUIDITY PROBLEM POST CRISIS?

Debbie Toennies - Head of Regulatory Affairs -

November 2016

Changing market liquidity is due to a confluence of factors

Monetary Policy	<ul style="list-style-type: none"> ■ Diverging monetary policies ■ Interest rates are at historic lows or negative ■ Central banks world-wide (US, EU, Japan) stimulated growth through quantitative easing / HQLA holdings
Market Structure and New and Declining Participants	<ul style="list-style-type: none"> ■ Share of fixed income owned by mutual funds, ETFs and other products offering daily liquidity has grown ■ Increased role of central banks as market participants ■ More algorithmic and high-frequency trading; increasing participation of principal trading firms (PTFs) ■ Shift to electronic trading platforms ■ Mandatory clearing through CCPs ■ Reduction in dealers' inventory positions, loss of proprietary trading activities, highly leveraged buyers
Behavioral Change	<ul style="list-style-type: none"> ■ <u>Sell-side</u>: Changes in risk management (VaR, Stress Testing, increased granularity), reduced risk appetite accumulation of HQLA, and decreased repo activity among dealers ■ <u>Buy-side</u>: Central banks holding more Treasuries, growth of government MMFs, more homogenous investor strategies
Regulatory Change	<ul style="list-style-type: none"> ■ Rapid price disclosure requirements (TRACE/MIFID) have reduced appetite by for large trades ■ Regulations have increased the cost of holding and financing inventory positions, especially for high-quality, assets and liquidity requirements are driving accumulation of HQLA on balance sheets

- New regulations are one of many drivers of changing market liquidity and may be exacerbating the impacts of other factors – policymakers are actively examining these issues
- Lower market liquidity could increase the cost to borrowers, corporations, and individuals, as well as reduce returns to investors

DO WE HAVE A LIQUIDITY PROBLEM POST CRISIS?
1
JPMORGAN CHASE & CO.

An Emerging Narrative

VIEWPOINT

ADDRESS

JULY 2015

Post-Crisis, the to regulatory re financial system reform have co Issuers have be record amounts market. In this their needs hav down across as liquidity risk pre and whether the combination of temporary) brin

As we observe several differen relative lack of leading into the participants nee cases intention strategies to ac BlackRock has years by makin construction, at how the financial system ca

The purpose of this ViewPo the different concepts that h conflated, highlighting some

EXECUTIVE SUMMARY

- ▶ The term "liquidity" has s market liquidity, liquidity
- ▶ The fixed income market secular. All market partil
 - Market losses borne b ordinary course of a p
 - Rather than focus on r
- ▶ It's time to shift the dialo
 - Asset managers must
 - BlackRock supports a
 - (i) Market structure
 - (ii) Enhance fund "t structural features to address regulators' concerns about fund redemption risk.
- (iii) Evolution of new and existing products: Support the development and adoption of new and existing products that help market participants address challenges associated with changes in fixed income markets.

The opinions expressed are as of July 2015 and may change as subsequent conditions vary.

BIS Quarterly Review, March 2015

IS POST-CRISIS BOND LIQUIDITY LOWER?

Mike Anderson
René M. Stulz

Working Paper 23317
<http://www.nber.org/papers/w23317>

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Liquidity Is A Credit Thing

MUNICIPAL BOND LIQUIDITY BEFORE AND AFTER THE FINANCIAL CRISIS

The Fragility of Discretionary Liquidity Provision*
Lessons from the Collapse of the Auction Rate Securities Market

Abstract: I examine how liquidity became a central concern after the recent collapse of the auction rate securities market. The risk had a minimal effect on the market, but since that collapse, the market has become more volatile. These findings have implications for yield spreads, and for the efficiency of the public

We study the role of intermediaries during the auction rate securities market from auction rate securities quantitative event “makers” before the collapse. Discretionary provision greatly affected such discretionary provision in other financial markets. More than the unexpected

THE COMPLEXITY OF LIQUIDITY:
THE EXTRAORDINARY CASE OF SOVEREIGN BONDS

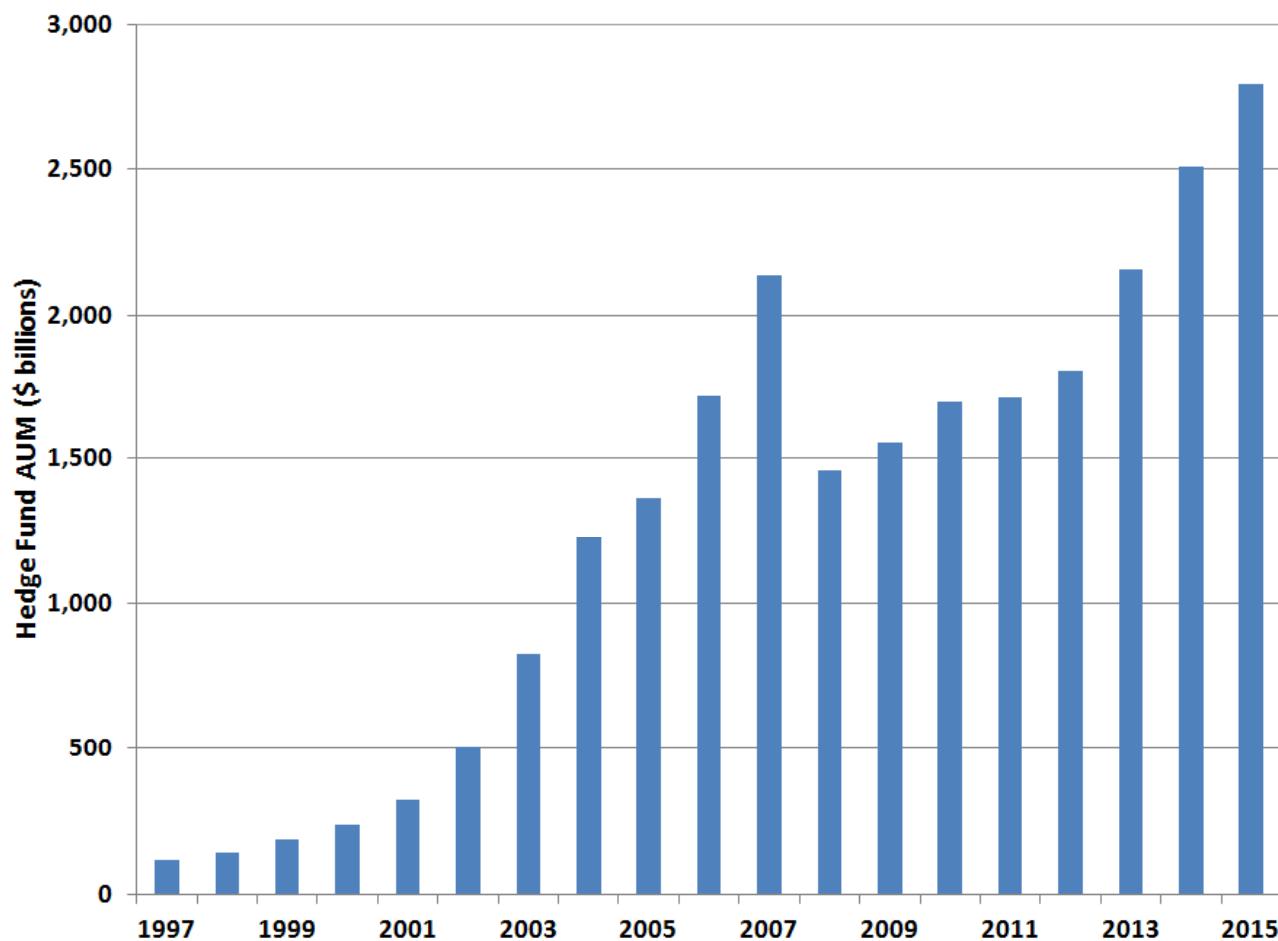
Jacob Boudoukh
Jordan Brooks
Matthew Richardson
Zhikai Xu

Working Paper 22576
<http://www.nber.org/papers/w22576>

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 2016

Liquidity Is A Hedge Fund Thing

Hedge Fund Assets Under Management



Source: BarclayHedge

Liquidity Is A Hedge Fund Thing

Category	# Fund-Months	Ann. Mean (%)	Ann. SD (%)	Sharpe Ratio	Sortino Ratio	Skew.	Kurt.	MaxDD (%)	Corr. to S&P 500 (%)	ρ_1 (%)	Box-Q(3) p-value (%)
January 1996 to December 2006											
Convertible Arbitrage	7,827	8.1	4.3	0.95	1.53	-1.25	8.63	-8.70	42.9	45.9	0.0
Dedicated Short Bias	1,384	-2.3	18.8	-0.31	-0.58	0.59	4.17	-42.29	-76.8	8.9	19.1
Emerging Markets	12,673	11.6	15.7	0.47	0.69	-1.61	10.51	-49.26	58.5	28.0	0.8
Equity Market Neutral	11,537	6.5	3.0	0.82	1.82	2.05	16.06	-2.21	3.0	-11.7	22.4
Event Driven	18,565	9.4	5.2	1.02	1.55	-2.02	13.89	-12.56	54.7	32.3	0.2
Fixed Income Arbitrage	7,749	6.8	3.7	0.75	0.95	-3.56	24.53	-13.69	-1.0	42.7	0.0
Global Macro	8,948	4.7	6.1	0.14	0.26	0.46	4.17	-14.24	21.7	2.5	41.6
Long/Short Equity Hedge	69,160	11.1	9.8	0.71	1.33	0.15	5.31	-18.52	68.8	18.7	16.7
Managed Futures	13,761	5.0	9.8	0.11	0.20	0.14	2.97	-16.34	-8.7	0.0	72.9
Multi-Strategy	8,100	8.5	5.2	0.85	1.43	-0.73	5.16	-6.67	49.1	0.1	65.1
Fund of Funds	55,507	6.6	6.4	0.41	0.68	-0.33	6.51	-12.97	53.3	22.2	5.0
All Single Manager Funds	163,702	8.7	6.5	0.72	1.28	-0.26	5.46	-10.95	65.2	19.2	13.1
January 2010 to December 2014											
Convertible Arbitrage	3,940	3.0	5.7	0.52	0.96	-0.07	2.67	-10.20	50.4	10.6	63.6
Dedicated Short Bias	571	-1.5	7.3	-0.21	-0.33	-0.40	2.94	-22.56	-59.1	10.2	66.5
Emerging Markets	22,401	0.4	8.5	0.04	0.06	-0.67	3.84	-16.10	78.6	7.9	41.9
Equity Market Neutral	8,930	3.9	2.4	1.59	2.97	-0.69	4.00	-3.35	81.6	22.4	25.1
Event Driven	11,465	5.0	4.9	1.01	1.78	-0.70	3.04	-7.66	77.1	20.1	20.2
Fixed Income Arbitrage	7,202	5.0	1.7	2.90	6.29	-0.94	4.23	-1.03	54.1	-10.0	68.3
Global Macro	16,824	3.7	2.5	1.46	3.29	0.12	3.54	-2.03	63.2	9.7	68.7
Long/Short Equity Hedge	66,758	4.7	6.2	0.73	1.27	-0.54	3.42	-10.67	89.0	11.1	64.2
Managed Futures	23,471	2.8	7.5	0.36	0.71	0.11	2.28	-14.48	25.4	-12.4	78.4
Multi-Strategy	57,505	5.2	2.5	2.06	4.06	-0.87	5.52	-3.20	80.9	16.3	23.2
Fund of Funds	139,161	1.7	3.5	0.46	0.78	-0.55	2.73	-7.42	79.3	11.6	59.1
All Single Manager Funds	233,194	4.2	4.2	1.00	1.84	-0.39	3.63	-6.36	85.3	11.7	46.8

Source: Getmansky, Lee, Lo (2015, Table 14)

Liquidity Is A Hedge Fund Thing

For Hedge Funds Post-Crisis:

- Less leverage, less volatility, lower riskfree rate, higher fixed costs (e.g., compliance)
- Higher volatility of volatility, skewness, kurtosis

⇒ **Lower Profits**

⇒ **Consolidation**

⇒ **Less Traditional Liquidity Provision**

⇒ **Greater HFT**

Liquidity Is A Systems Thing

Quantitative Equity Funds Hit Hard In August 2007

- Specifically, August 7–9, and massive reversal on August 10
- Some of the most consistently profitable funds lost too
- Seemed to affect only quants

Lack of Transparency Is Problematic!

- In Khandani and Lo (2007) we used a daily mean-reversion strategy to study these events:

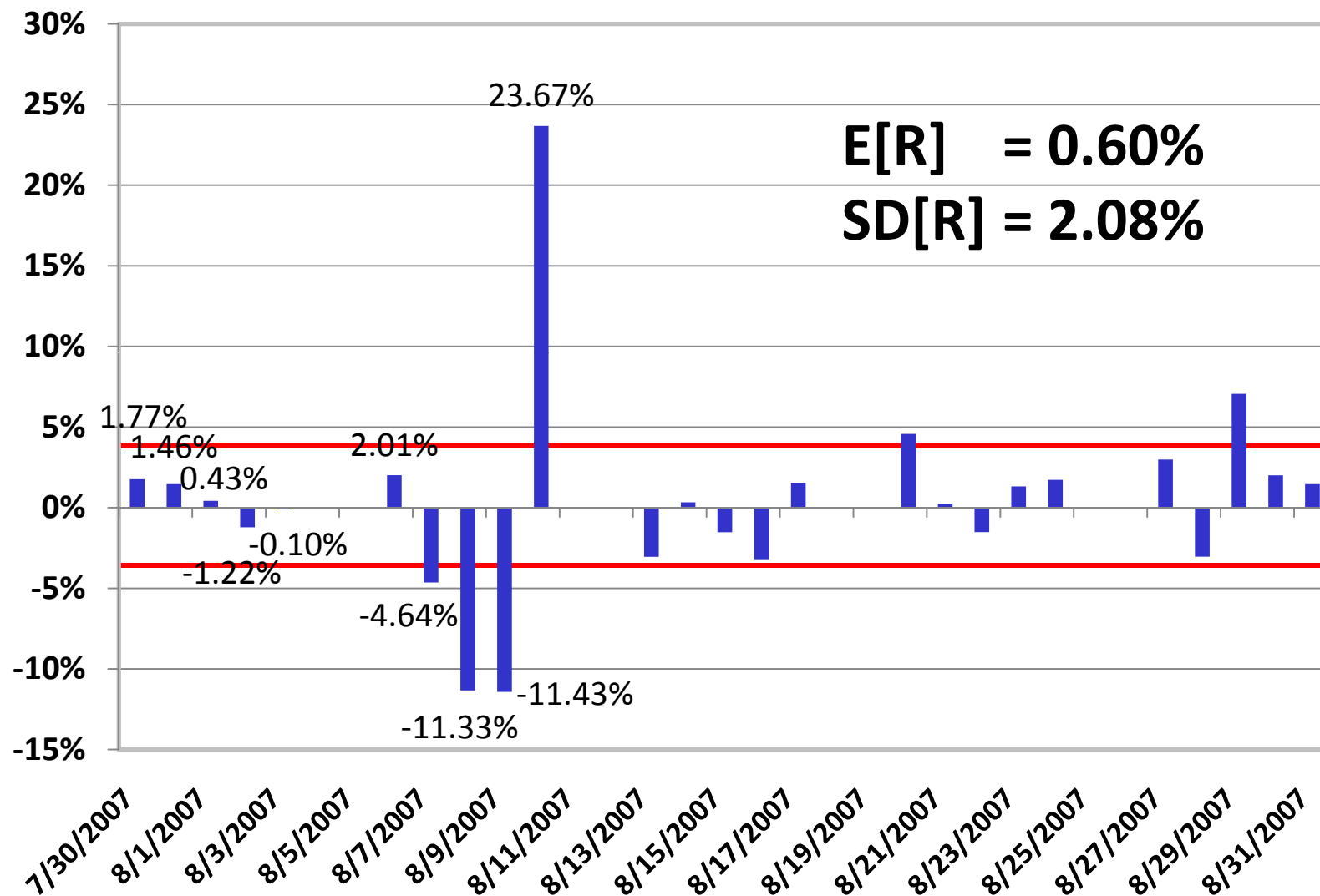
$$\omega_{it} = -\frac{1}{N}(R_{it-k} - R_{mt-k}), \quad R_{mt-k} \equiv \frac{1}{N} \sum_{i=1}^N R_{it-k}$$

$$I_t \equiv \frac{1}{2} \sum_{i=1}^N |\omega_{it}|, \quad R_{pt} \equiv \frac{\sum_{i=1}^N \omega_{it} R_{it}}{I_t}$$



Wall Street Journal
September 7, 2007

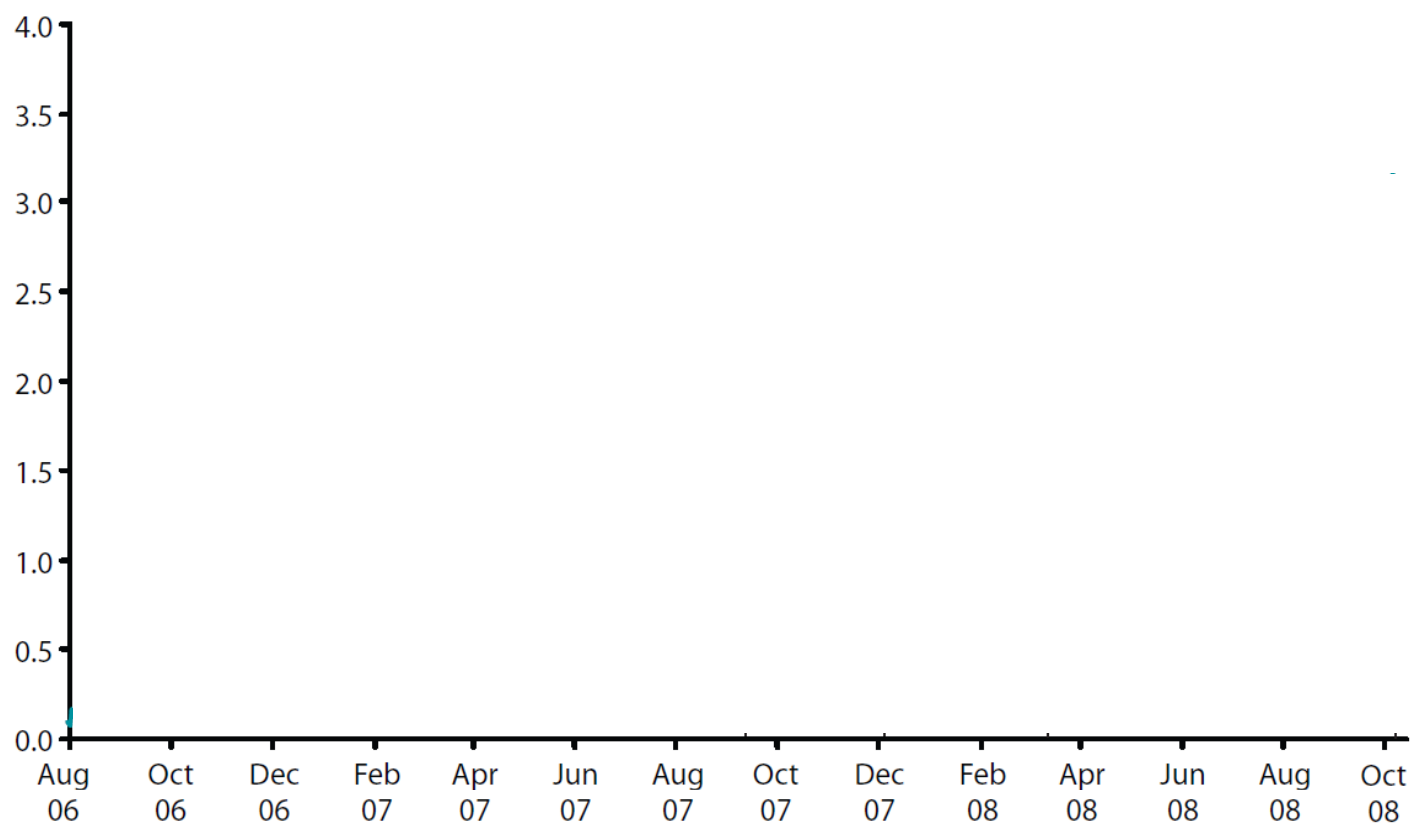
Liquidity Is A Systems Thing



Liquidity Is A Systems Thing

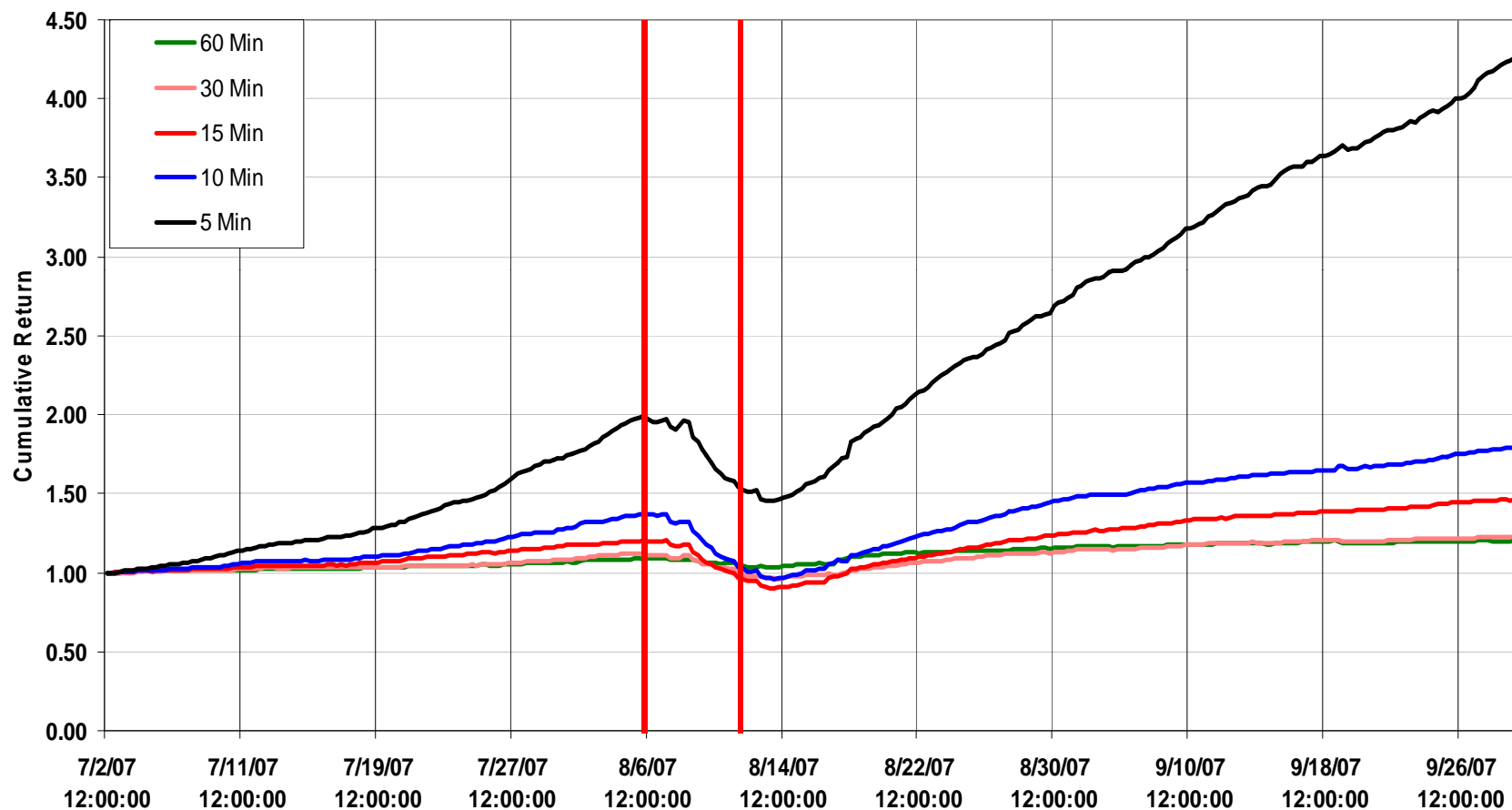
3-Month LIBOR/OIS Spread

August 2006 to October 2008



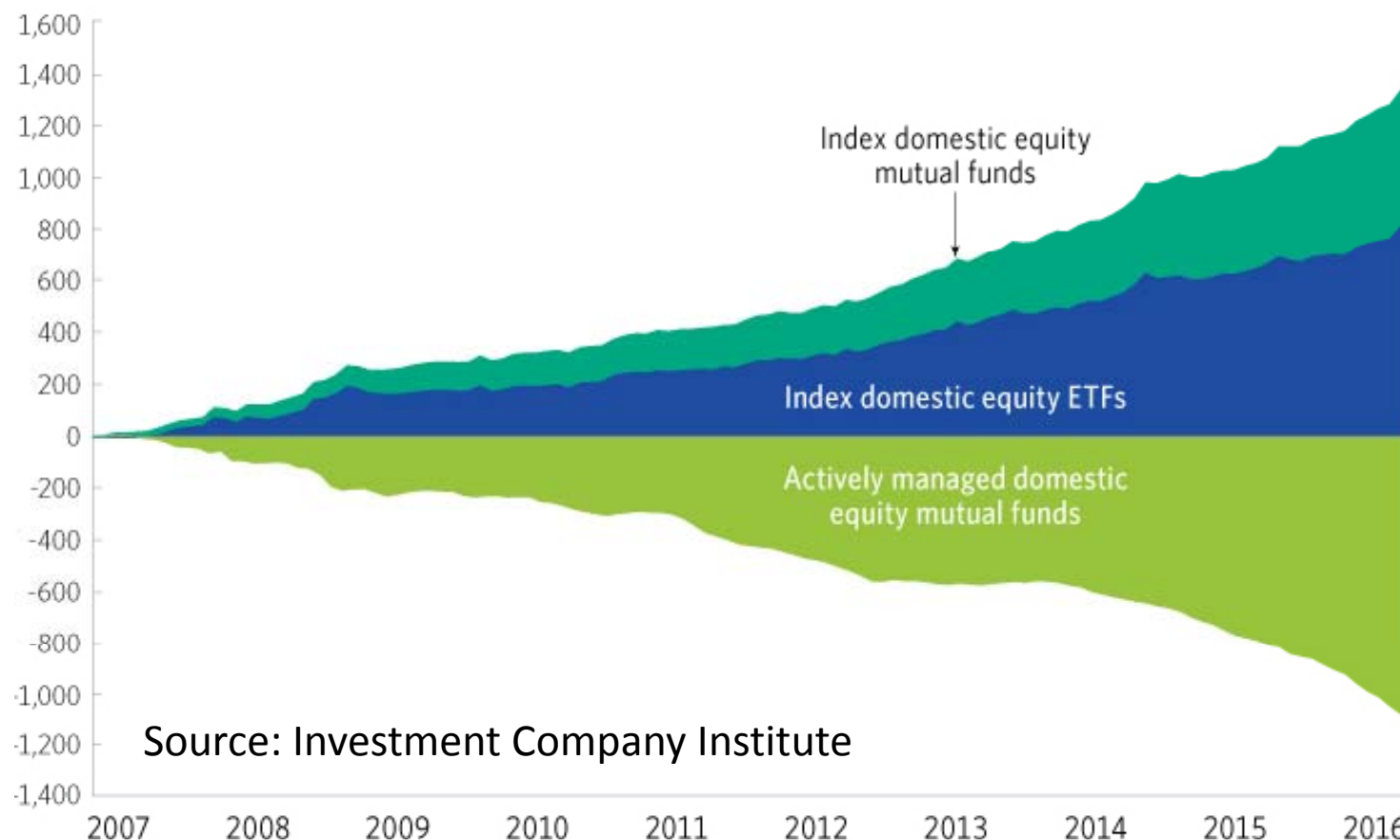
Liquidity Is A Systems Thing

Cumulative m -Min Returns of Intra-Daily Contrarian Profits for Deciles 10/1 of S&P 1500 Stocks July 2 to September 30, 2008



Liquidity Is A Systems Thing

Cumulative ETF and Mutual Fund Flows
 (\$billions, monthly, January 2007–December 2016)

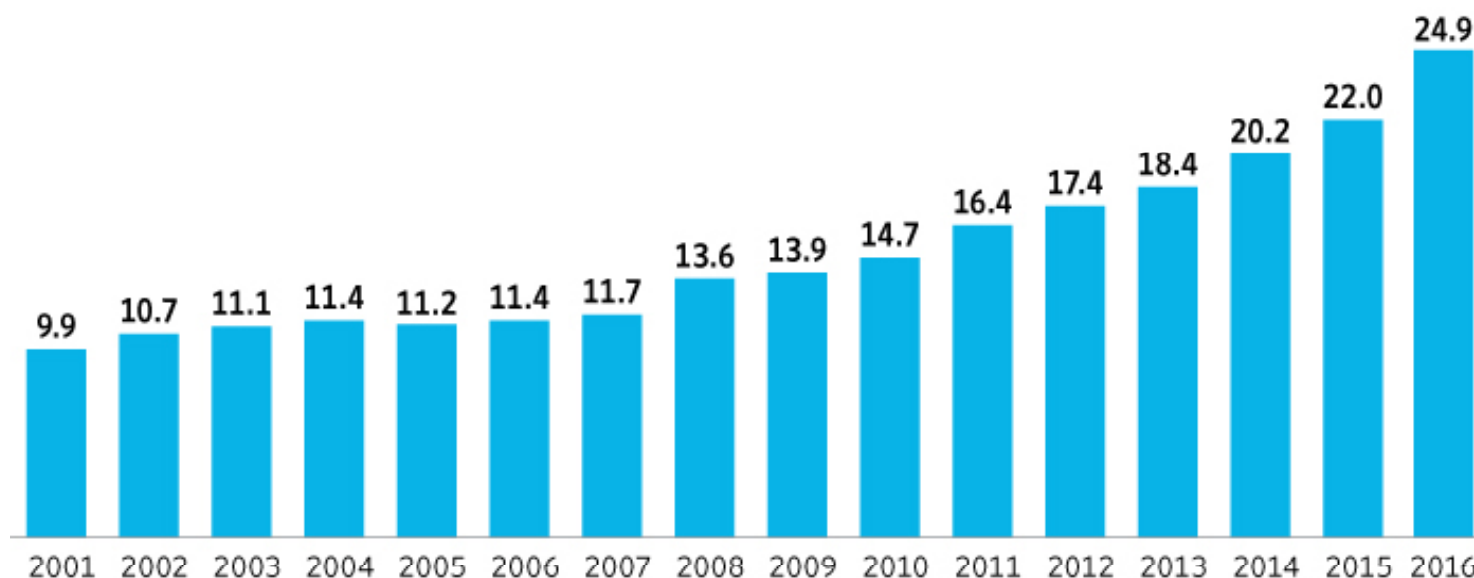


Source: Investment Company Institute

Source: ICI

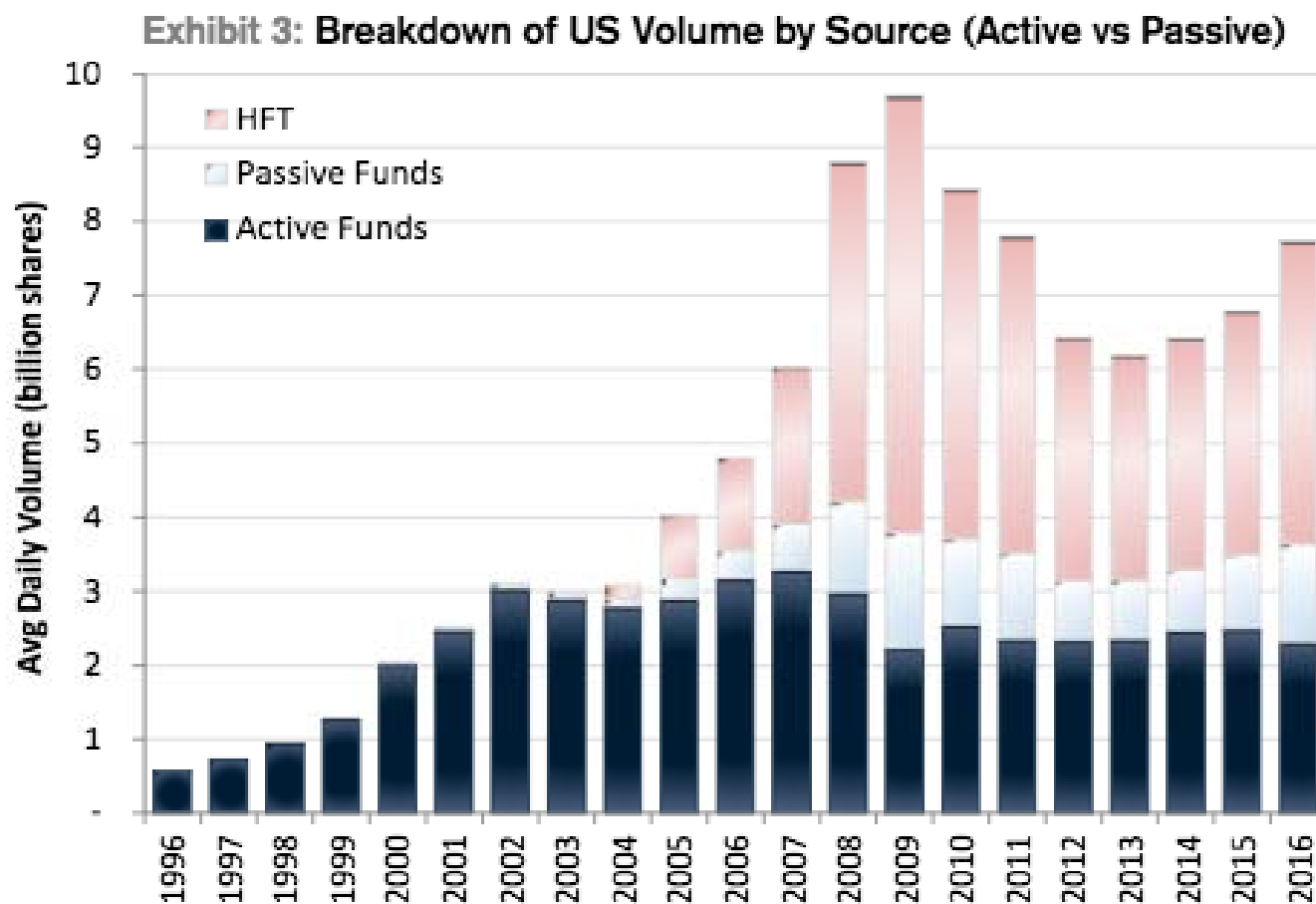
Liquidity Is A Systems Thing

Market Share of Equity Index Mutual Funds



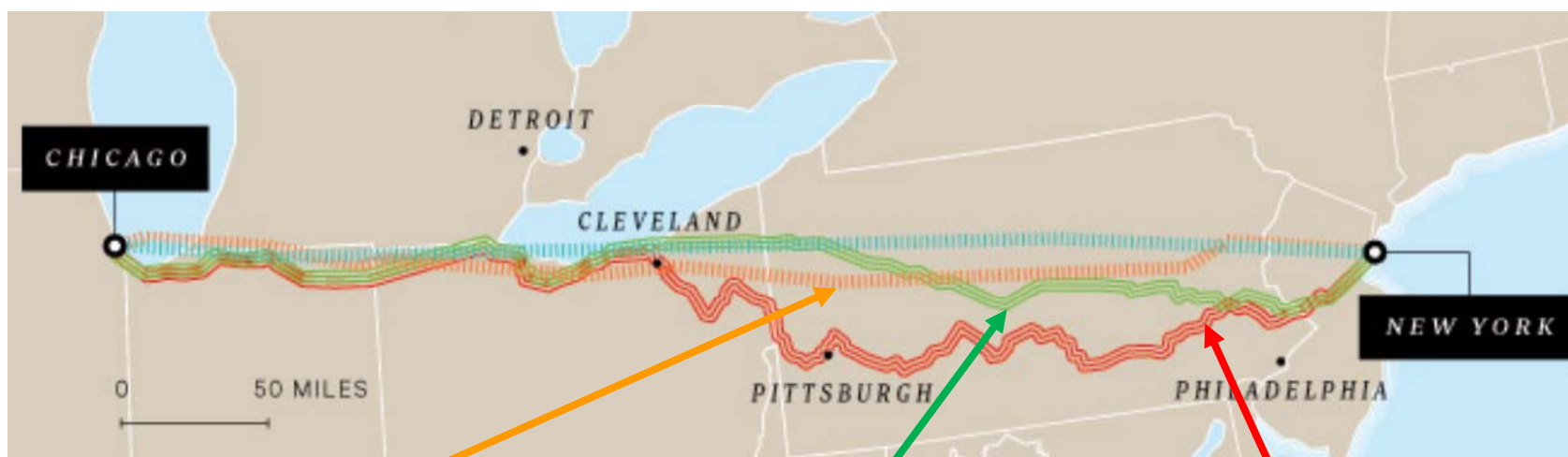
Source: Investment Company Institute

Liquidity Is A Technology Thing



Source: Credit Suisse

Liquidity Is A Technology Thing



McKay Bros. microwave network, 2012, 744 miles, 4.5ms

Spread Networks fiber-optic cable, 2010, 825 miles, 6.5ms

Legacy fiber-optic cable, mid-1980s, 1,000 miles, 8ms

Einstein (1905): 4ms

Source: Wired

Liquidity Is A Technology Thing

**Every cloud has a silver lining:
Fast trading, microwave connectivity and trading costs**

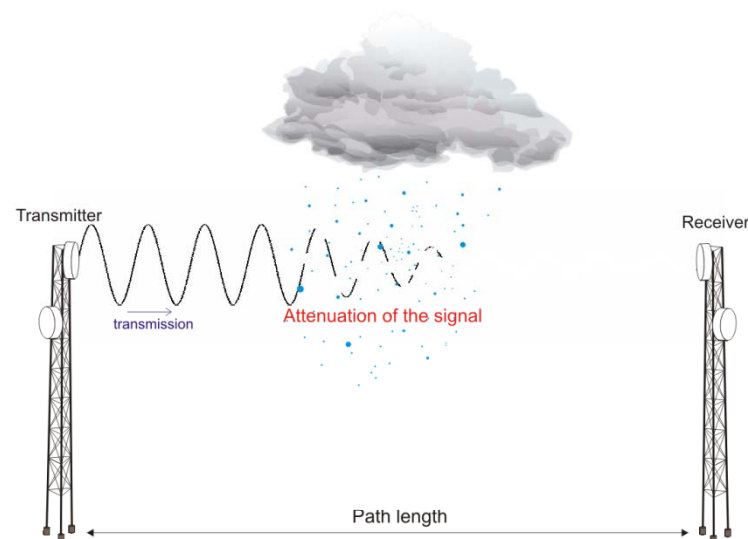
Andriy Shkilko*
Wilfrid Laurier University

Konstantin Sokolov
Wilfrid Laurier University

First version: March 2016
This version: April 2017

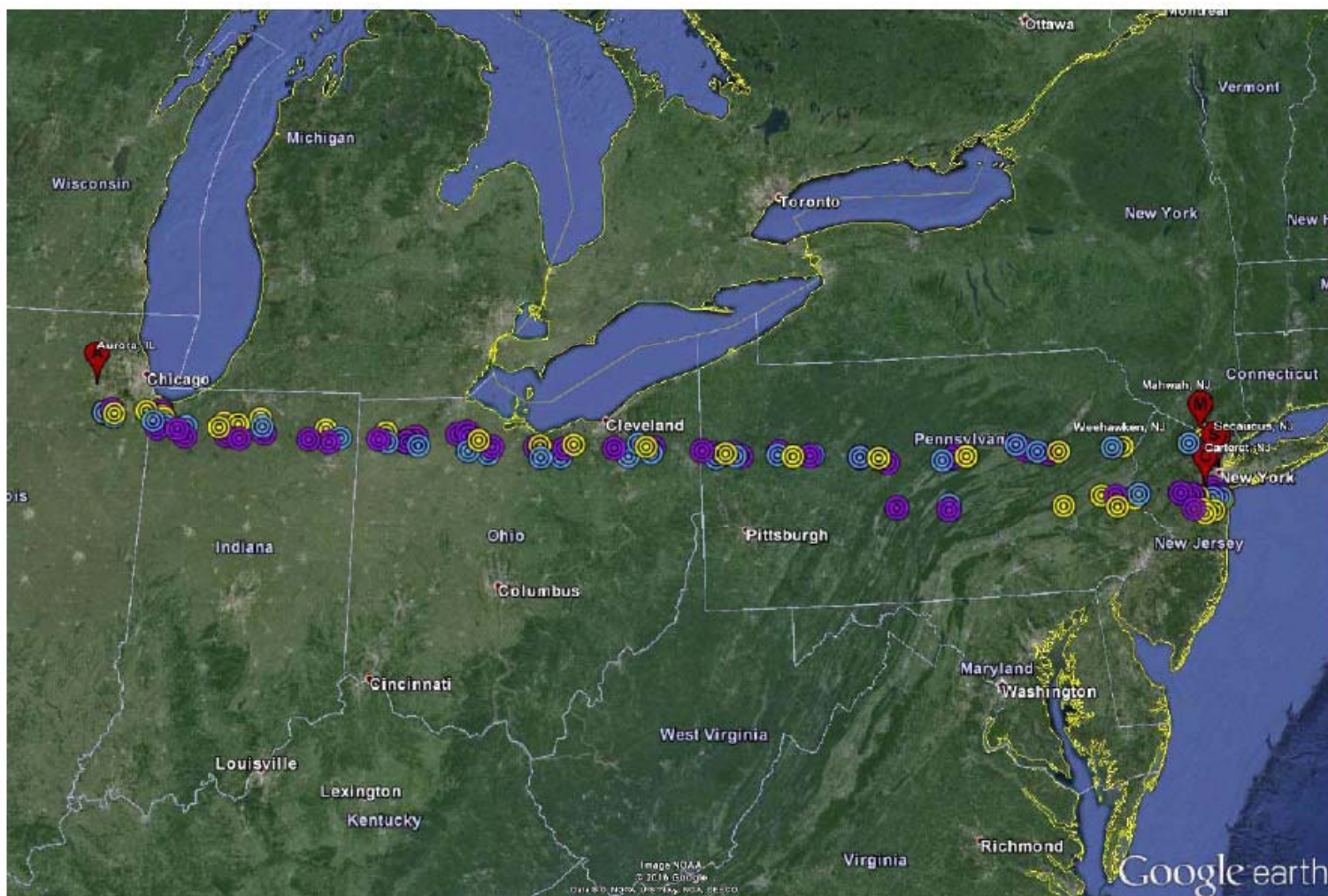
Abstract: Modern marketplace is characterized by speed differentials, whereby some traders are faster than others. How do these differentials affect liquidity? To answer this question, we study a series of exogenous weather-related episodes that temporarily remove speed advantages of the fastest traders by disrupting their microwave networks. During these episodes, adverse selection declines accompanied by lower trading costs, reduced volatility and an overall strengthening of liquidity supply. The results are confirmed in an event-study setting, whereby a new business model adopted by one of the technology providers reduces speed differentials among traders, resulting in liquidity improvements.

- Index futures (Chicago) vs. ETFs (NY) in 2011–2014
- Rain vs. shine



Source: Shkilko and Sokolov (2017)

Liquidity Is A Technology Thing



Source: Shkilko and Sokolov (2017)

16 June 2017

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Slide 26

Liquidity Is A Technology Thing



Source: Shkilko and Sokolov (2017)

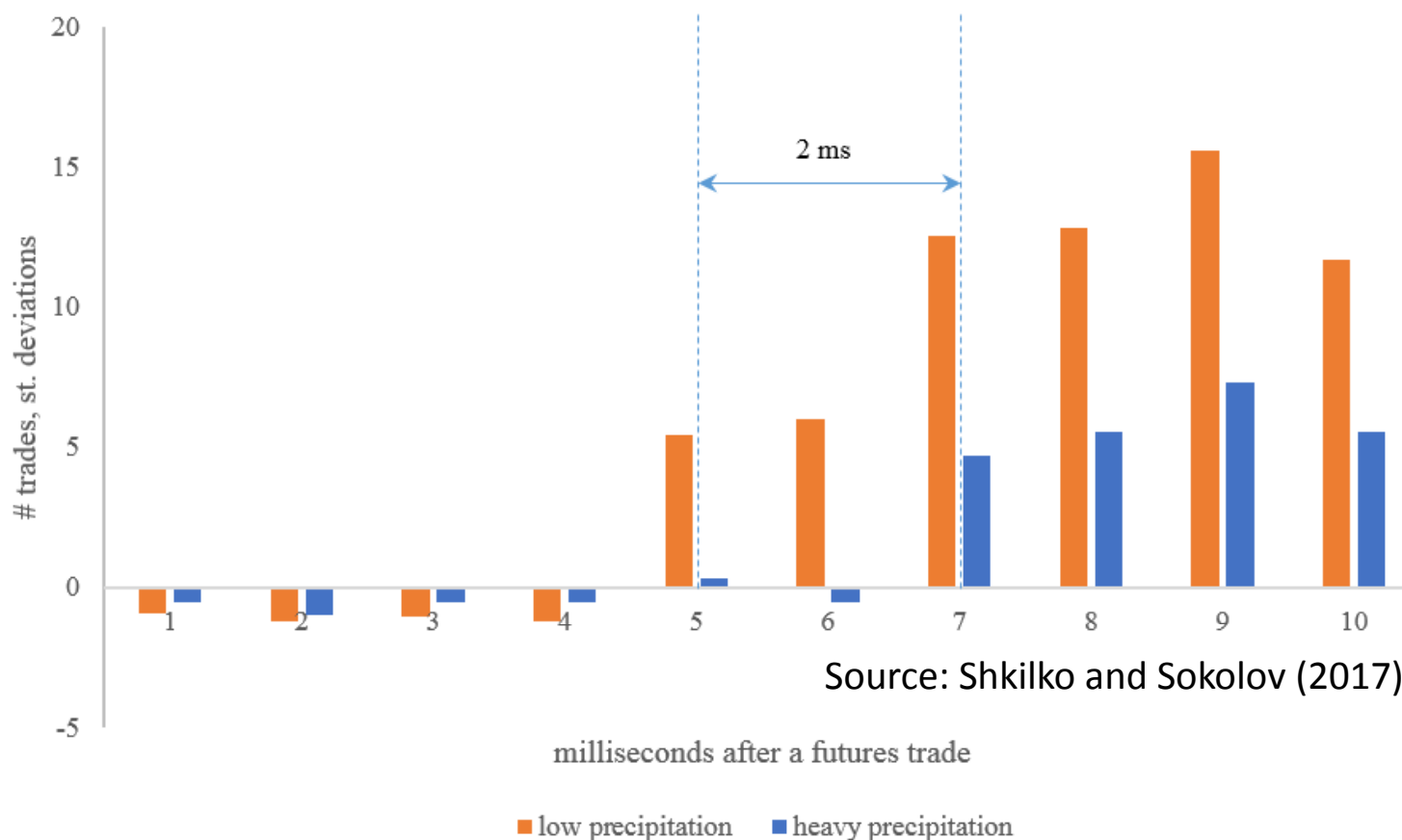
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Slide 27

Liquidity Is A Technology Thing

Impact of Precipitation on Number of ETF Trades Following Futures Trades in Four CME E-Mini Contracts in 2012



Liquidity Is A Technology Thing

Liquidity Improves During Precipitation

Source: Shkilko and Sokolov (2017)

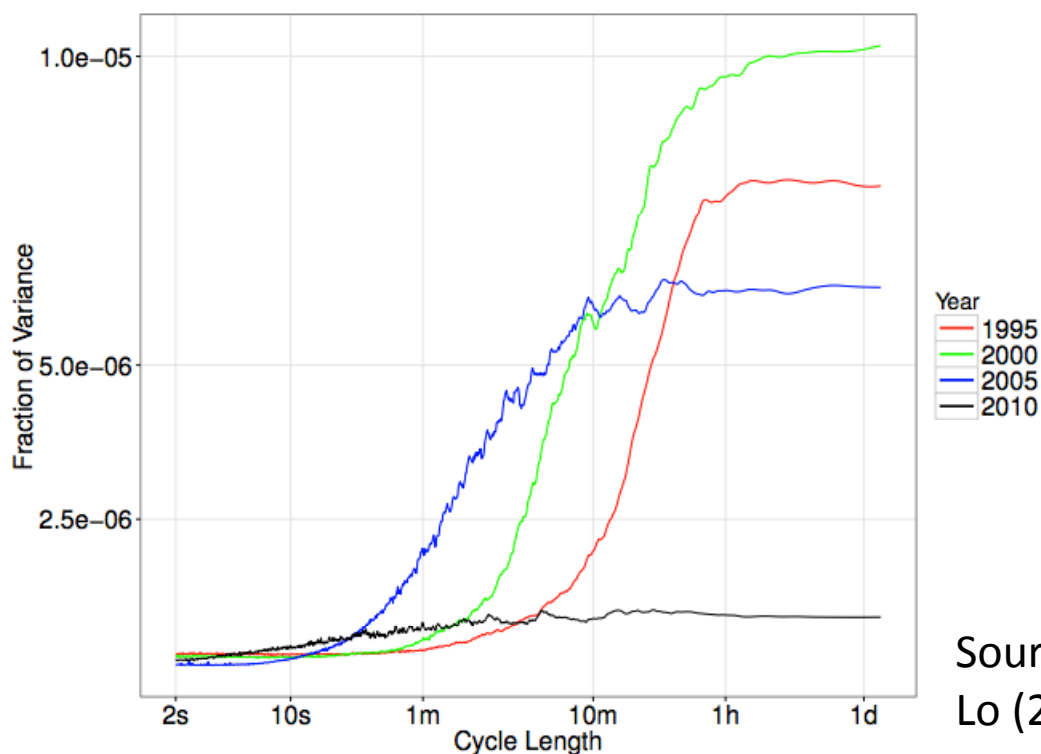
<i>PRECIP</i>	-0.10*** (.004)		
<i>PRECIP1</i>		-0.035*** (.012)	
<i>PRECIP2</i>			-0.047*** (.013)
<i>VIX</i>	.035*** (.009)	.035*** (.009)	.035*** (.009)

$$DEPVAR_{it} = \alpha_0 + \beta_1 PRECIP_t + \beta_2 VIX_t + \varepsilon_{it}$$

- Price impact declines by 7% during heavy precipitation
- This effect is most pronounced for assets with narrow spreads

Liquidity Is A Technology Thing

Variance Decomposition of Large Stocks by Trading Frequency



Source: Chaudhuri and Lo (2017)

Figure 3-3: Smoothed frequency decomposition of variance in annual per-second returns of the equal-weighted large-cap portfolio (containing S&P 500 constituents) across the years 1995-2010.

Conclusion

- Increased volumes, number of trades, decreased spreads
- But smaller depths, greater price impact for larger trades
- Lower volatility, lower leverage
- Greater volatility of volatility, skewness, kurtosis
- Greater sensitivity to changes in market conditions from algorithmic traders
- Policy implications: consider entire ecosystem

Thank You!