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

**liquid** 
\(\text{ˈli-kwəd}\) 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

CONTINUOUS AUCTIONS AND INSIDER TRADING

A theory of intraday patterns: Volume and price variability

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 Conversely, because of the speed with which orders can be withdrawn from the market, actual depth may instead be lower than what is posted in the limit order book.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

“...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
An Emerging Narrative

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.
An Emerging Narrative

Changing market liquidity is due to a confluence of factors:

**Monetary Policy**
- Diverging monetary policies
- Interest rates are at historic lows or negative
- Central banks worldwide (US, EU, Japan) stimulated growth through quantitative easing / HGLA holdings

**Market Structure and New and Declining Participants**
- 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**
- Sell-side: Changes in risk management (VaR, Stress Testing, increased granularity), reduced risk appetite accumulation of HGLA, and decreased repo activity among dealers
- Buy-side: Central banks holding more Treasuries, growth of government MMFs, more homogenous investor strategies

**Regulatory Change**
- Rapid price disclosure requirements (TRACE/MFID) have reduced appetite 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 HGLA 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
An Emerging Narrative
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

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

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

<table>
<thead>
<tr>
<th>Category</th>
<th># Fund-Months</th>
<th>Ann. Mean (%)</th>
<th>Ann. SD (%)</th>
<th>Sharpe Ratio</th>
<th>Sortino Ratio</th>
<th>Skew.</th>
<th>Kurt.</th>
<th>MaxDD (%)</th>
<th>Corr. to S&amp;P 500 (%)</th>
<th>ρ&lt;sub&gt;4&lt;/sub&gt; (%)</th>
<th>Box-Q(3) p-value (%)</th>
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<tbody>
<tr>
<td>Convertible Arbitrage</td>
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<td><strong>19.2</strong></td>
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### January 2010 to December 2014

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<tr>
<th>Category</th>
<th># Fund-Months</th>
<th>Ann. Mean (%)</th>
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<th>ρ&lt;sub&gt;4&lt;/sub&gt; (%)</th>
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<td>79.3</td>
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<td>59.1</td>
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<tr>
<td><strong>All Single Manager Funds</strong></td>
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<td><strong>4.2</strong></td>
<td><strong>4.2</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.84</strong></td>
<td><strong>-0.39</strong></td>
<td><strong>3.63</strong></td>
<td><strong>-6.36</strong></td>
<td><strong>85.3</strong></td>
<td><strong>11.7</strong></td>
<td><strong>46.8</strong></td>
</tr>
</tbody>
</table>
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:

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

\[
I_t \equiv \frac{1}{2} \sum_{i=1}^{N} |\omega_{it}|, \quad R_{pt} \equiv \frac{\sum_{i=1}^{N} \omega_{it} R_{it}}{I_t}
\]
Liquidity Is A Systems Thing

E[R] = 0.60%
SD[R] = 2.08%
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

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Liquidity Is A Systems Thing

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

Source: Investment Company Institute

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Liquidity Is A Systems Thing

Market Share of Equity Index Mutual Funds

Source: Investment Company Institute
Liquidity Is A Technology Thing

Exhibit 3: Breakdown of US Volume by Source (Active vs Passive)

Source: Credit Suisse
Liquidity Is A Technology Thing

Einstein (1905): 4ms

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

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.

Source: Shkilko and Sokolov (2017)

- 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)
Liquidity Is A Technology Thing

Source: Shkilko and Sokolov (2017)
Liquidity Is A Technology Thing

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

Source: Shkilko and Sokolov (2017)
**Liquidity Is A Technology Thing**

### Liquidity Improves During Precipitation

<table>
<thead>
<tr>
<th></th>
<th>Precipitation</th>
<th>Price impact declines by 7% during heavy precipitation</th>
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</thead>
<tbody>
<tr>
<td><strong>Dependent variable:</strong></td>
<td><strong>Precipitation</strong></td>
<td><strong>Price impact declines by 7% during heavy precipitation</strong></td>
</tr>
</tbody>
</table>
| **Precipitation** | -.010*** (.004) | - 
| **Precipitation1** | - .035*** (.012) | - 
| **Precipitation2** | - .047*** (.013) | - 
| **VIX** | .035*** (.009) | - 

Source: Shkilko and Sokolov (2017)

\[
\text{DEPVAR}_{it} = \alpha_0 + \beta_1 \text{PRECIP}_t + \beta_2 \text{VIX}_t + \varepsilon_{it}
\]

- 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!