Market Liquidity, Funding Liquidity, and TED Spread: A Two-Regime Model

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Liquidity is a key idea in markets:

- **Market liquidity**: ease of trading an asset without moving price.
- **Funding liquidity**: ease of obtaining funds (usu. w/collateral).

These different liquidities are endogenous:

- Funding for intermediaries, investors affects market liquidity.
- Market liquidity improves value of funding collateral.

Theory: two equilibria (spirals) for market, funding liquidity.

- Peacetime: one liquidity decreases $\implies$ other increases
- Crises: one liquidity decreases $\implies$ other decreases

Theory and evidence for bad equilibrium in recent crisis.

Few empirical studies of interaction b/w these liquidities.
How Market Liquidity Affects Funding Liquidity

- Question: how does market liquidity affect funding liquidity?
- Find a proxy for equity-collateralized funding liquidity; and,
- Use that to study funding, market liquidity in equity markets.
- Lets us test important features of the theorized relation:
  - Two regimes (stabilizing vs destabilizing)
  - Feedback b/w funding liquidity vs market liquidity, volatility
Data $\implies$ two regimes in funding, market liquidity dynamics.

May separate regimes using a TED spread threshold: 48 bp.

TED spread $\leq$ 48bp $\implies$ stabilizing funding cycle:
- Bid-ask spreads $\uparrow$ 10% $\implies$ funding illiquidity $\downarrow$ 25%–36%.
- First empirical verification of stabilizing cycle.

TED spread $> 48$bp $\implies$ destabilizing funding cycle:
- Bid-ask spreads $\uparrow$ 10% $\implies$ funding illiquidity $\uparrow$ 16%–26%?

Handling endogeneity: crucial to analyzing funding cycles.
Related Literature

- **Theory:** Funding Liquidity $\iff$ Market Liquidity
  - Sophisticated investors/arbitrageurs supply market liquidity.
    - Must finance positions, usu. by collateralized lending.
    - Pay loan fees/margins, budget constrained in crises.
    - So expect to see two regimes of liquidity provision.
  - Brunnermeier and Pedersen (2009)

- **Empirical Studies**
  - Funding Liquidity $\implies$ Market Liquidity
    - Mitchel, Pedersen and Pulvino (2009)
    - Comerton-Forde et al. (2010)
  - Funding Liquidity $\iff$ Market Liquidity
    - Drehmann and Nikolaou (2013)
    - Does not account for endogeneity, two regimes.
Theory of Market, Funding Liquidity: Destabilizing

Theory for destabilizing market, funding liquidity interactions:

- Cost of collateralized borrowing: increases w/asset volatility.
- Drop in market liquidity may increase borrowing costs
  - Financiers don’t know fundamental value of assets, and
  - Worry about lower liquidity of collateral, increase loan fees.
  - Budget constraint binds, unwinding positions moves prices
  - Prices further from fundamentals, market liquidity ↓
  - → Destabilizing Funding Cycle
- Destabilizing funding → flight-to-quality.
Theory for stabilizing market, funding liquidity interactions:

- Drop in market liquidity may decrease borrowing costs
  - Financiers believe prices will return to fundamental value,
  - \(\implies\) arb positions more profitable, decrease loan fees
  - Budget constraint relaxes, positions grow moving prices
  - Prices move closer to fundamentals, market liquidity \(\uparrow\)
  - \(\implies\) **Stabilizing Funding Cycle**

- Agrees with most ideas on self-healing nature of markets.
Funding Liquidity: Equity-Collateralized Loans

- Best measure of collateralized funding: repo rates.
- Unfortunately, we could not find good repo rates source.
- However, believe stock loan data is a good proxy:
  - Traders borrow stock (usu for shorting) via stock loans.
  - Fees increase when more demand to borrow.
  - Lender also holds back *haircut* of deposited cash.
  - Haircut, fees rise when stock more likely to decline.
  - Thus haircut, fees proxy for perceived collateral quality.
- Loan fee data available; haircut data not (but correlated).
Stock Loan Fees

- Consider demand for borrowing stock (usually: to short)
  - Curve shift out/in $\implies$ more/less capital betting on price fall
  - Isolated outward shifts of stock loan demand curves
  - $\implies$ Significant negative abnormal next-month returns
  - $\implies$ Stock loans reveal private information about stock
- Demand curve shifts in/out: stock is worse/better collateral.
- Use daily S&P 500 stock loan data, 200607–201105:
  - Volume-Weighted Average stock loan Fee (VWAF)
  - Total Balance Quantities (TBQ) = qty of stock on loan
  - # loan transactions: stock $i$, day $t$ ($Trades_{it}$)

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4 We thank Data Explorers for these data.
Funding Illiquidity: Average Stock Loan Fees

• Isolate shifts in stock loan (shorting) demand curve:

\[ \mathbb{1}_{DS, it} = \begin{cases} 
1 & \Delta \text{VWAF}_{i,t} > 0 \cap \Delta \text{TBQ}_{i,t} > 0; \\
1 & \Delta \text{VWAF}_{i,t} < 0 \cap \Delta \text{TBQ}_{i,t} < 0; \\
0 & \text{else.} 
\end{cases} \]  

(1)

• Measure of funding illiquidity, \( \text{fundilliq}_t \):

\[ \text{fundilliq}_t = \log \left( \frac{\sum_{i=1}^{N} \text{Trades}_{it} \times \text{VWAF}_{it} \times \mathbb{1}_{DS, it}}{\sum_{i=1}^{N} \text{Trades}_{it} \times \mathbb{1}_{DS, it}} \right). \]  

(2)
Figure: Log(Trade-Weighted Average Fee on S&P 500 Stock Loans). Light gray: $ted_t > 50\text{bp}$; dark gray: $ted_t > 80\text{bp}$; black bar: PDCF (03/2008–02/2010)
Market Illiquidity: Bid-Ask Spreads

- Market illiquidity: Mean % bid-ask spreads of S&P 500 stocks
- N.B. From CBOE calculation, changed in late-May 2011.\(^5\)
- Take logarithm to reduce influence of skewness

\(^5\)This change limits our ability to extend the study.

Figure: Log(Bid-Ask Spread for S&P 500 Stocks). Light gray: \(ted_t >50\text{bp}\); dark gray: \(ted_t >80\text{bp}\)
Volatility

- Market volatility proxy: CBOE Implied Volatility Index (VIX)

**Figure:** CBOE Implied Volatility Index. Light gray: \( ted_t > 50 \text{bp} \); dark gray: \( ted_t > 80 \text{bp} \)
TED Spread

- TED Spread: Treasury vs EuroDollar Deposits
- Spread between LIBOR and 3M US T-bill rates
- Used to separate stabilizing, destabilizing funding regimes

**Figure:** TED Spread. lower dashed line: $ted_t > 50$bp; upper dashed line: $ted_t > 80$bp
**Instruments**

1. Inter-trade duration trend: driven by exogenous tech shocks
   - Trade activity $\implies$ mkt liquidity (George and Longstaff, 1993)

2. AAA liquidity: $aaaliq = \Delta y_{AAA} - \Delta LIBOR$
   - Bond liquidity $\implies$ stock liquidity: Chordia, Sarkar, Subrahmanyam (2005)
   - Change in AAA yields due to bond (il)liquidity
   - Exogenous to credit risk which affects stock loan fees

3. Lagged volatility: ‘internal’ instrument for stock volatility
cf Bloom et al. (2007)
Instrument: Inter-trade Duration Trend

Figure: Inter-trade Duration Trend for US stocks (in years). Gray line: inter-trade duration; black line: trend pre-/post-NYSE decimalization in Jan 2001
Instrument: AAA Liquidity

Figure: Difference b/w $\Delta$Yields(1Y AAA Corporates), $\Delta$LIBOR: Mar 1998–Dec 2011
Two-Regime Specification

- Allow for regime change if credit spread crosses threshold $\kappa$.
- Define market stress indicator, specify linear threshold model:

$$stress_t(\kappa) = \begin{cases} 
1 & \text{if } ted_t > \kappa \\
0 & \text{else}
\end{cases}$$ (3)

$$fundilliq_t = \beta_0 + \beta_1 mktilliq_t + \beta_2 vol_t + \beta_3 volsq_t + \beta_4 ted_t + \beta_5 stressmktilliq_t + \beta_6 stressvol_t + \beta_7 stressted_t + \varepsilon_t$$ (4)

where $stress$ variables have interaction with $stress_t(\kappa)$.

- For threshold $\hat{\kappa}$, estimate other coefficients by 2SLS.
First-Stage Regressions

- First-stage regressions for linear, two-regime IV.
- **durtrend**: less trading = less liquid, less volatile markets.
  - Agrees with George and Longstaff (1993).
  - Except **ted > 48bp**: less trading *increases* mkt liquidity.
  - Perhaps reduces panic trading?
- **aaaliq**: bond illiquidity ↑ ⇒ equity illiquidity ↓.
  - Agrees w/Chordia, Sarkar, Subrahmanyam (2005).
  - However, less effect when **ted > 48bp**.
- *F*-tests indicate relevance of instruments at 99% level
## Second-Stage: Funding Liquidity vs Market Liquidity

<table>
<thead>
<tr>
<th>Covariates</th>
<th>Linear Model</th>
<th>Two-Regime Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OLS</td>
<td>IV</td>
</tr>
<tr>
<td>(intercept)</td>
<td>4.732</td>
<td>8.399</td>
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<td></td>
<td>(0.516)</td>
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<tr>
<td>volt</td>
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<td></td>
<td>(0.894)</td>
<td>(1.206)</td>
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<tr>
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<tr>
<td></td>
<td>(0.042)</td>
<td>(0.134)</td>
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<td>stresst</td>
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<tr>
<td></td>
<td>(0.977)</td>
<td>(13.222)</td>
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<tr>
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<td>5.210</td>
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<tr>
<td></td>
<td>(0.124)</td>
<td>(1.685)</td>
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<tr>
<td>stressvolt</td>
<td>4.824</td>
<td>-6.267</td>
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<tr>
<td></td>
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<td>(4.853)</td>
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<td>stresstedt</td>
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<tr>
<td></td>
<td>(0.296)</td>
<td>(1.617)</td>
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<tr>
<td>Threshold $\kappa$</td>
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<td>0.48</td>
</tr>
<tr>
<td></td>
<td>[0.42, 0.44]</td>
<td>[0.44, 0.49]</td>
</tr>
</tbody>
</table>
Relationship b/w funding, market liquidity has two regimes:

1. Stable markets ($ted \leq 48$bp): significant at 90% level.
   - Bid-ask spreads $\uparrow 10\% \implies$ funding illiquidity $\downarrow 36\%$.
   - $\implies$ stabilizing funding cycle.

2. Unstable markets ($ted > 48$bp): not significant
   - Bid-ask spreads $\uparrow 10\% \implies$ funding illiquidity $\uparrow 16\%$.
   - Weak evidence of destabilizing funding cycle.

Volatility $\uparrow \implies$ funding illiquidity $\uparrow$. (stronger in peacetime)

Results are likely stronger: IV 2SLS inflates std errors.

Naive approaches miss liquidity, volatility significance.
  - Signs off, magnitudes much smaller.
Robustness: Adding an Autoregressive Term

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<tr>
<td></td>
<td>OLS</td>
<td>IV</td>
</tr>
<tr>
<td>(intercept)</td>
<td>1.953</td>
<td>-0.111</td>
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<td></td>
<td>(0.193)</td>
<td>(0.061)</td>
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<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
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<td>(0.025)</td>
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<td>0.005</td>
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<tr>
<td></td>
<td>(0.001)</td>
<td>(0.003)</td>
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<tr>
<td>Threshold $\kappa$</td>
<td>0.44</td>
<td>0.48</td>
</tr>
</tbody>
</table>
Robustness Check: Autoregressive Term

- Relationship b/w funding, market liquidity again two regimes:
  1. Stable markets ($ted \leq 48bp$): not significant but right sign.
     - Bid-ask spreads $\uparrow$ 10\% $\implies$ funding illiquidity $\downarrow$ 25\%.
     - weak evidence of stabilizing funding cycle.
  2. Unstable markets ($ted > 48bp$): significant at 90\% level.
     - Bid-ask spreads $\uparrow$ 10\% $\implies$ funding illiquidity $\uparrow$ 26\%.
     - $\implies$ destabilizing funding cycle.

- Volatility $\uparrow$ $\implies$ funding illiquidity $\uparrow$. (stronger in crisis?)
- Threshold again 48 bp.
- Naive approaches miss liquidity, volatility significance.
  - Signs off and/or magnitudes much smaller.
Robustness Check: Stock Loan Data

- Look at full/filtered size-weighted stock loan data.
- Look at shifts in demand curve or all shifts.
- Weight average fees by loan sizes, not by # loans.
- These changes expose us to more noise, outliers.
- Find significant threshold of 47 bp (vs 48 bp) in both cases.
- However, coefficients not significant in either case.
Robustness Check: Another Funding Measure

- Second check: another funding measure (Broker Call Rate).
- Charged by commercial banks to broker-dealers.
  - Rate is charged on short-term margin loans
  - Problem #1: rate is rarely-changing spread over Fed Funds.
  - Problem #2: No information on volume transacted.
- Modeled spread over 3M US T-bills; may need to be changed.
- Find two regimes, TED spread threshold of 77 bp:
  - $ted < 77bp$: market illiquidity $\uparrow$ 10% $\implies$ $fundilliq \downarrow$ 3%
    $\implies$ stabilizing funding cycle
  - $ted \geq 77bp$: stabilizing cycle is weakened.
    $\implies$ no destabilizing relationship
- Sensible: don’t expect policy-makers to destabilize market.
- Need more work to decide if measure is useful/informative.
Conclusion

- Introduce stock-loan proxy for equity-collateralized funding.
- Use a two-regime 2SLS estimation to reveal:
  - Relationship b/w funding, market liquidity has two regimes.
  - May separate regimes using a TED-spread threshold.
  - Improper estimation cannot detect these funding cycles.
- Stable markets \((ted \leq 48bp)\):
  - Bid-ask spread \(\uparrow 10\%) \implies\) funding illiquidity \(\downarrow 25\%–36\%\).
  - Stabilizing funding cycle arises. (First evidence!)
- Unstable markets \((ted > 48bp)\):
  - Bid-ask spread \(\uparrow 10\%) \implies\) funding illiquidity \(\uparrow 16\%–26\%\).
  - Destabilizing funding cycle arises.
- Funding liquidity based on volatility.
- Two regimes may exist in other funding measures.