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

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Structural Changes in Money Markets: Implications for Monetary Policy
European Central Bank

30 September 2013

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# Liquidity

- *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 $\Longrightarrow$ other increases
  - Crises: one liquidity decreases $\Longrightarrow$ other decreases
- Theory and evidence for bad equilibrium in recent crisis.
- Few empirical studies of interaction b/w these liquidities.

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# 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

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# Results Preview

- Data $\Longrightarrow$ two regimes in funding, market liquidity dynamics.
- May separate regimes using a TED spread threshold.
- TED spread $\leq$ 48bp $\Longrightarrow$ stabilizing funding cycle:
  - Bid-ask spreads $\uparrow$ 10% $\Longrightarrow$ funding illiquidity $\downarrow$ 36%.
- TED spread $>$ 48bp $\overset{?}{\Longrightarrow}$ destabilizing funding cycle:
  - Bid-ask spreads $\uparrow$ 10% $\overset{?}{\Longrightarrow}$ funding illiquidity $\uparrow$ 16%?
  - Coefficient sign implies so, but magnitude insignificant.
- Handling endogeneity: crucial to analyzing funding cycles.

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# Related Literature

- Theory: Funding Liquidity $\Longleftrightarrow$ 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.
  - Gromb and Vayanos (2002, 2010)
  - Brunnermeier and Pedersen (2009)
- Empirical Studies
  - Funding Liquidity $\Longrightarrow$ Market Liquidity
    - Mitchel, Pedersen and Pulvino (2009);
    - Comerton-Forde et al. (2010)
  - Funding Liquidity $\Longleftarrow$ Market Liquidity
    - Drehmann and Nikolaou (2010)
    - Does not account for endogeneity, two regimes.

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# Theory of Market, Funding Liquidity Interaction

Theory for market and 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 $\downarrow$
  - $\Longrightarrow$ **Destabilizing Funding Cycle**
- Drop in market liquidity may decrease borrowing costs
  - Financiers believe prices will return to fundamental value,
  - $\Longrightarrow$ arb positions more profitable, decrease loan fees
  - Budget constraint relaxes, positions grow moving prices
  - Prices move closer to fundamentals, market liquidity $\uparrow$
  - $\Longrightarrow$ **Stabilizing Funding Cycle**
- Destabilizing funding $\Longrightarrow$ flight-to-quality.

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# 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).

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# Stock Loan Fees

- Consider demand for borrowing stock (usually: to short)
  - Curve shift out/in $\Longrightarrow$ more/less capital betting on price fall
- Cohen, Diether, and Malloy (2007) studied stock loan fees.
  - Isolated outward shifts of stock loan demand curves
  - $\Longrightarrow$ Significant negative abnormal next-month returns
  - $\Longrightarrow$ 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[4]:
  - Volume-Weighted Average stock loan Fee (VWAF)
  - Total Balance Quantities (TBQ) = qty of stock on loan
  - # loan transactions: stock $i$, day $t$ ($Trades_{it}$)

[4]We thank Data Explorers for these data.

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# Funding Illiquidity: Average Stock Loan Fees

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

$$\mathbb{1}_{DS,it} = \begin{cases} 1 & \Delta VWAF_{i,t} > 0 \cap \Delta TBQ_{i,t} > 0; \\ 1 & \Delta VWAF_{i,t} < 0 \cap \Delta TBQ_{i,t} < 0; \\ 0 & \text{else.} \end{cases} \quad (1)$$

- Measure of funding illiquidity, $fundilliq_t$:

$$fundilliq_t = \log\left(\frac{\sum_{i=1}^{N} Trades_{it} \times VWAF_{it} \times \mathbb{1}_{DS,it}}{\sum_{i=1}^{N} Trades_{it} \times \mathbb{1}_{DS,it}}\right). \quad (2)$$

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# Funding Illiquidity: Plot

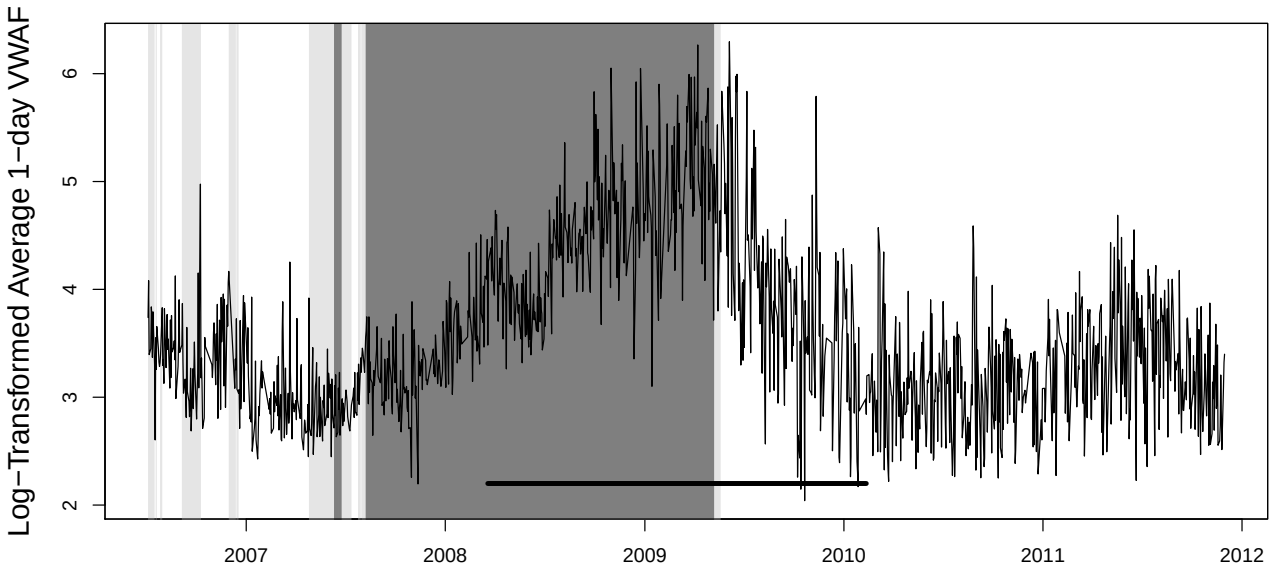


Figure: Log(Trade-Weighted Average Fee on S&P 500 Stock Loans). Light gray: $ted_t$ >50bp; dark gray: $ted_t$ >80bp; black bar: PDCF (03/2008–02/2010)

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# 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

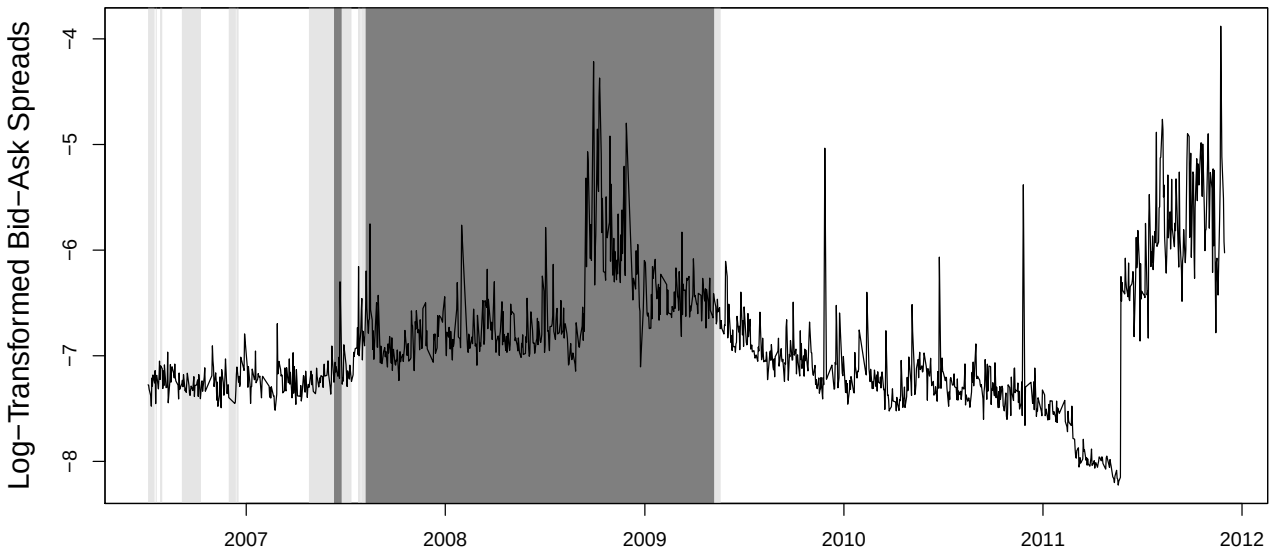


Figure: Log(Bid-Ask Spread for S&P 500 Stocks). Light gray: $ted_t$ >50bp; dark gray: $ted_t$ >80bp

[5] This change limits our ability to extend the study.

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# Volatility

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

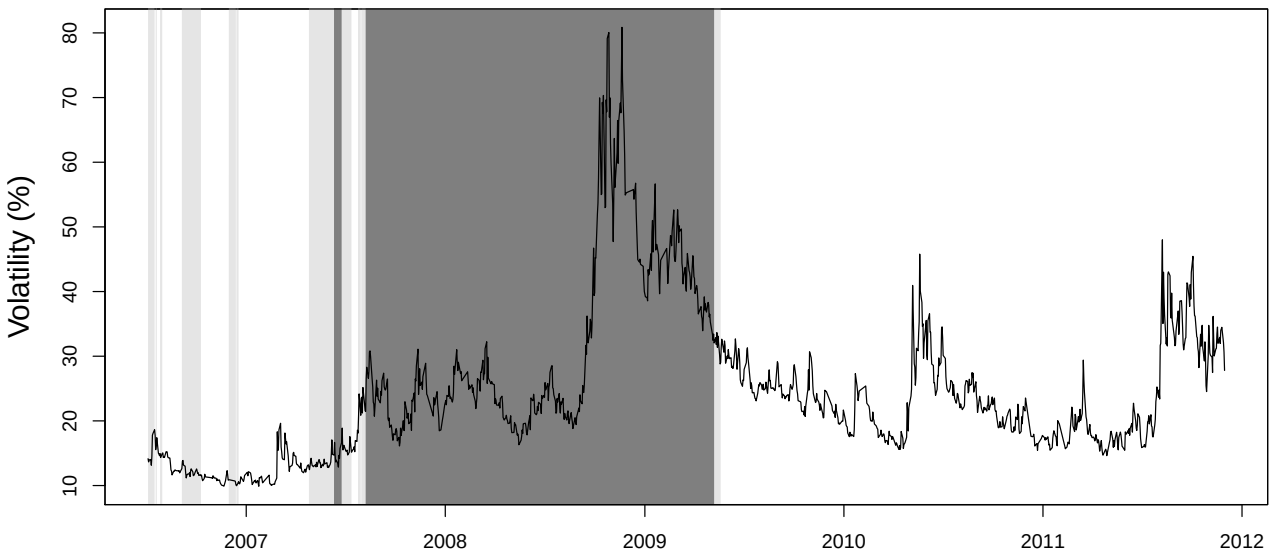


Figure: CBOE Implied Volatility Index. Light gray: $ted_t$ >50bp; dark gray: $ted_t$ >80bp

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# TED Spread

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

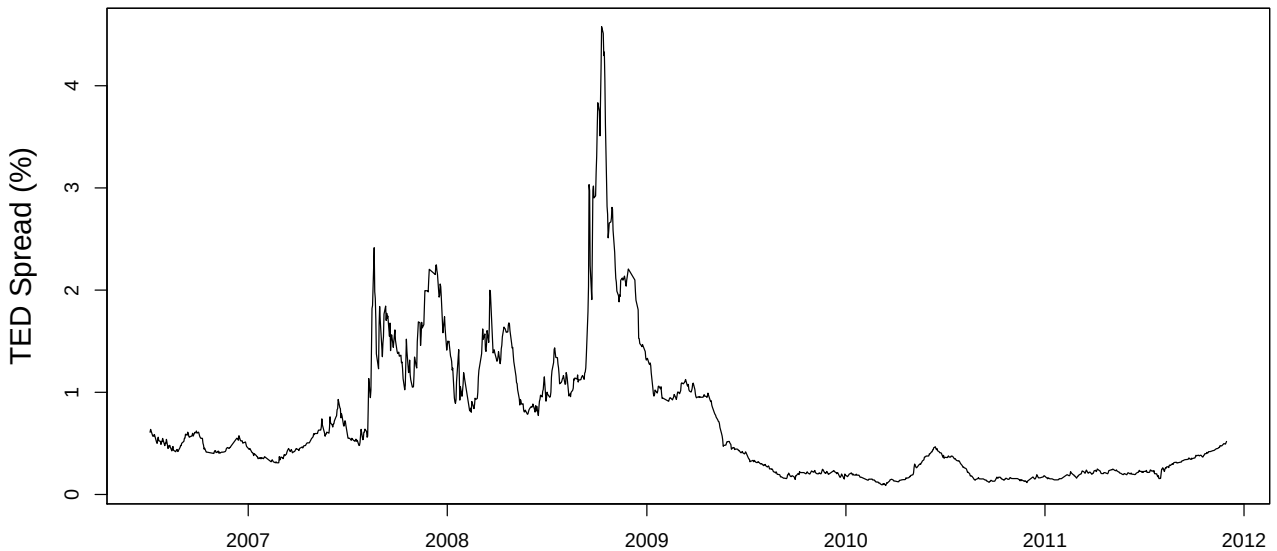


Figure: TED Spread. lower dashed line: $ted_t$ >50bp; upper dashed line: $ted_t$ >80bp

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# Instruments

1. Inter-trade duration trend: driven by exogenous tech shocks
   - Trade activity $\Longrightarrow$ mkt liquidity (George and Longstaff, 1993)
2. AAA liquidity: $aaaliq = \Delta y_{AAA} - \Delta LIBOR$
   - Bond liquidity $\Longrightarrow$ 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)

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# Instrument: Inter-trade Duration Trend

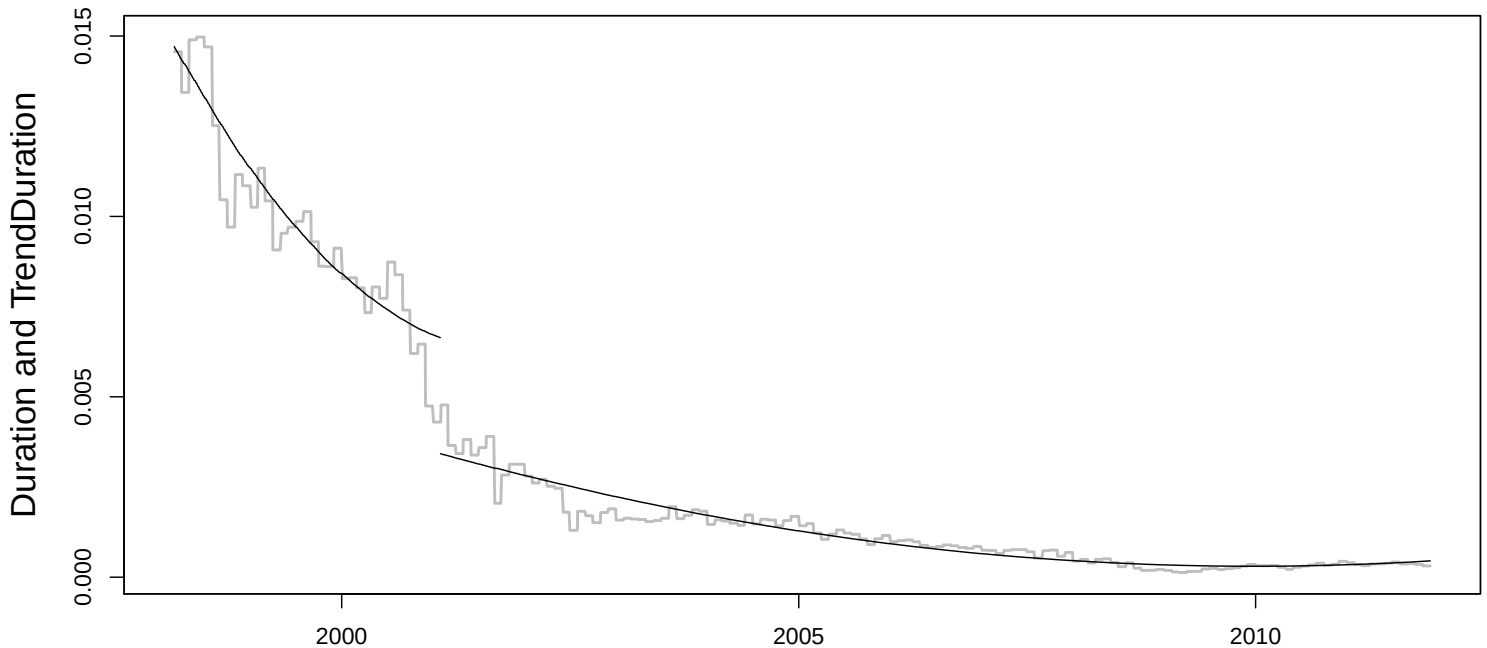


Figure: Inter-trade Duration Trend for US stocks (in years). Gray line: inter-trade duration; black line: trend pre-/post-NYSE decimalization in Jan 2001

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# Instrument: AAA Liquidity

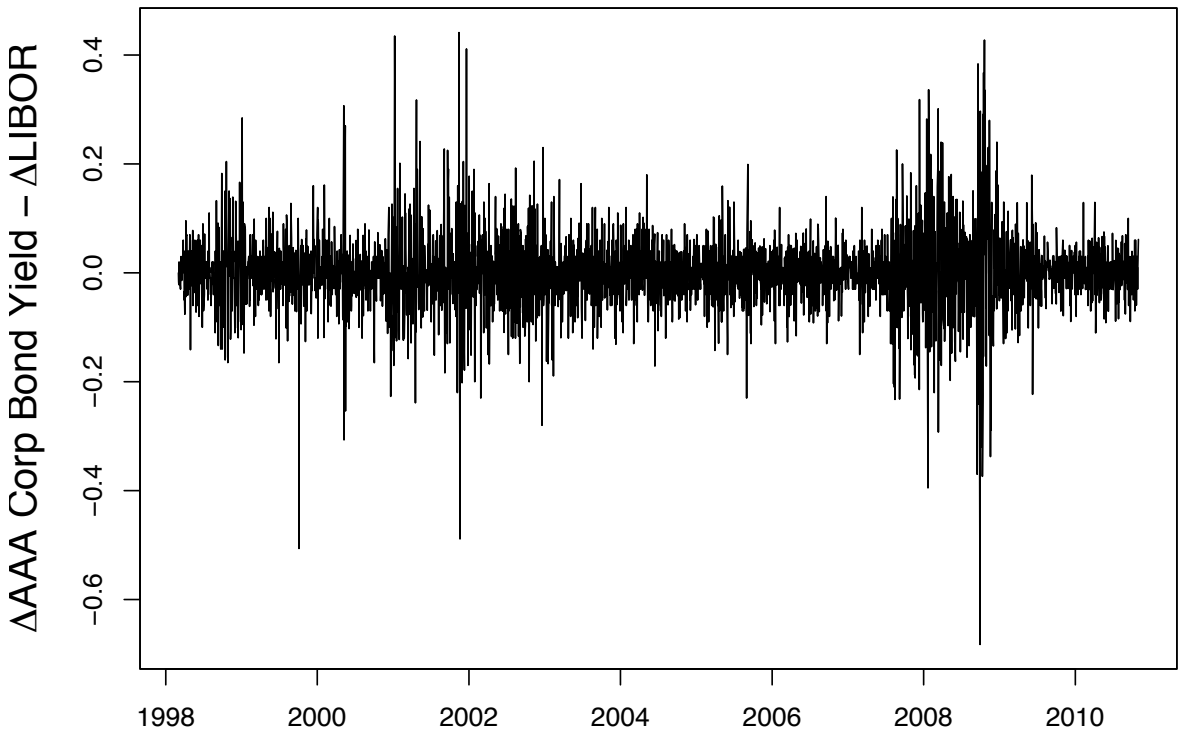


Figure: Difference b/w ΔYields(1Y AAA Corporates), ΔLIBOR: Mar 1998–Dec 2011

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# Two-Regime Specification

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

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

$$\begin{aligned} fundilliq_t = {} & \beta_0 + \beta_1 mktilliq_t + \beta_2 vol_t + \beta_3 volsq_t \\ & + \beta_4 ted_t + \beta_5 stressmktilliq_t + \beta_6 stressvol_t \\ & + \beta_7 stressted_t + \varepsilon_t \end{aligned} \tag{4}$$

  where *stress* variables have interaction with $stress_t(\kappa)$.
- Estimation via Hansen (2000), Caner and Hansen (2004).
- For threshold $\hat{\kappa}$, estimate other coefficients by 2SLS.

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# 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 $\uparrow \implies$ equity illiquidity $\downarrow$.
  - Agrees w/Chordia, Sarkar, Subrahmanyam (2005).
  - However, less effect when *ted* $>$ 48bp.
- $F$-tests indicate relevance of instruments at 99% level

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# Second-Stage Regressions

| | Linear Model | | Two-Regime Model | |
|---|---|---|---|---|
| Covariates | OLS | IV | OLS | IV |
| (*intercept*) | **4.732** | **8.399** | **2.594** | -26.327 |
| | (0.516) | (2.746) | (0.665) | (18.332) |
| $mktilliq_t$ | **0.323** | **0.790** | 0.014 | *-3.612* |
| | (0.065) | (0.348) | (0.082) | (2.283) |
| $vol_t$ | **6.263** | **4.953** | **5.192** | *13.093* |
| | (0.655) | (1.290) | (0.652) | (7.240) |
| $volsq_t$ | **-4.550** | **-3.627** | **-8.303** | -6.818 |
| | (0.894) | (1.206) | (0.924) | (6.712) |
| $ted_t$ | 0.012 | -0.174 | **0.717** | 3.965 |
| | (0.042) | (0.134) | (0.292) | (1.962) |
| $stress_t$ | | | **2.466** | *40.553* |
| | | | (0.977) | (13.222) |
| $stressmktilliq_t$ | | | **0.382** | *5.210* |
| | | | (0.124) | (1.685) |
| $stressvol_t$ | | | **4.824** | -6.267 |
| | | | (0.649) | (4.853) |
| $stressted_t$ | | | **-1.055** | -4.599 |
| | | | (0.296) | (1.617) |
| Threshold $\kappa$ | | | **0.43** | **0.48** |
| | | | [0.42, 0.44] | [0.44, 0.49] |

Table: Funding Illiquidity vs Market Illiquidity, Volatility, etc. (07/2006–12/2011).

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# Second-Stage Regression Results: Commentary

- 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 ($ted > 48bp$): not significant
     - Bid-ask spreads $\uparrow$ 10% $\overset{?}{\implies}$ 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.

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# Robustness Check: Stock Loan Data

- A couple of robustness checks: are results fragile?
- First check: Look at all, weighted stock loan data 1.
  - Do not just look at shifts in the demand curve; and,
  - 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).
- Signs correct for *mktilliq* effect but not significant.

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# 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.
- Consider this rate vs 3M US T-bills.
- Find two regimes, TED spread threshold of 77 bp:
  - $ted < 77$bp: market illiquidity $\uparrow$ 10% $\implies$ *fundilliq* $\downarrow$ 3% $\implies$ stabilizing funding cycle
  - $ted \geq 77$bp: stabilizing cycle is weakened. $\implies$ no destabilizing relationship
- Sensible: don't expect policy-makers to destabilize market.
- Homework: Tell me if measure is useful/informative.

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# 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
- Stable markets ($ted \leq 48$bp):
  - Funding liquidity based on volatility; and,
  - Bid-ask spread $\uparrow$ 10% $\implies$ funding illiquidity $\downarrow$ 36%.
  - Stabilizing funding cycle arises.
- Unstable markets ($ted > 48$bp):
  - Bid-ask spread $\uparrow$ 10% $\overset{?}{\implies}$ funding illiquidity $\uparrow$ 16%.
  - Destabilizing funding cycle arises?
- Naive estimation cannot detect these funding, volatility cycles.
- Two regimes may exist in other funding measures.

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