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

Kris Boudt[1] Ellen C.S. Paulus[2] **Dale W.R. Rosenthal**[3]

NYU-Stern Volatility Institute

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[1]VU Amsterdam, VU Brussel
[2]London Business School
[3]University of Illinois at Chicago, daler@uic.edu

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: 48 bp.
- TED spread $\leq$ 48bp $\Longrightarrow$ stabilizing funding cycle:
  - Bid-ask spreads $\uparrow$ 10% $\Longrightarrow$ funding illiquidity $\downarrow$ 25%–36%.
  - First empirical verification of stabilizing cycle.
- TED spread $>$ 48bp $\Longrightarrow$ destabilizing funding cycle:
  - Bid-ask spreads $\uparrow$ 10% $\Longrightarrow$ funding illiquidity $\uparrow$ 16%–26%?
- 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 (2013)
    - Does not account for endogeneity, two regimes.

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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 $\downarrow$
  - $\Longrightarrow$ **Destabilizing Funding Cycle**
- Destabilizing funding $\Longrightarrow$ flight-to-quality.

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Theory of Market, Funding Liquidity: Stabilizing

Theory for stabilizing market, funding liquidity interactions:

- 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**
- Agrees with most ideas on self-healing nature of markets.

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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

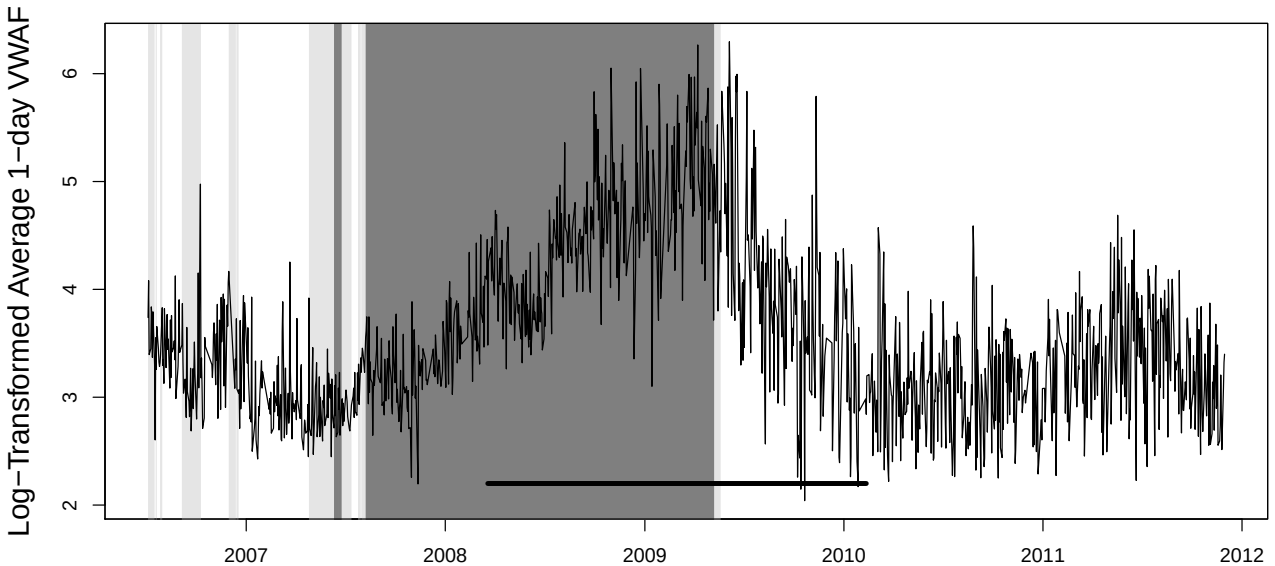

Figure: Log(Trade-Weighted Average Fee on S&P 500 Stock Loans). Light gray: ted_t >50bp; dark gray: ted_t >80bp; black bar: PDCF (03/2008–02/2010)

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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

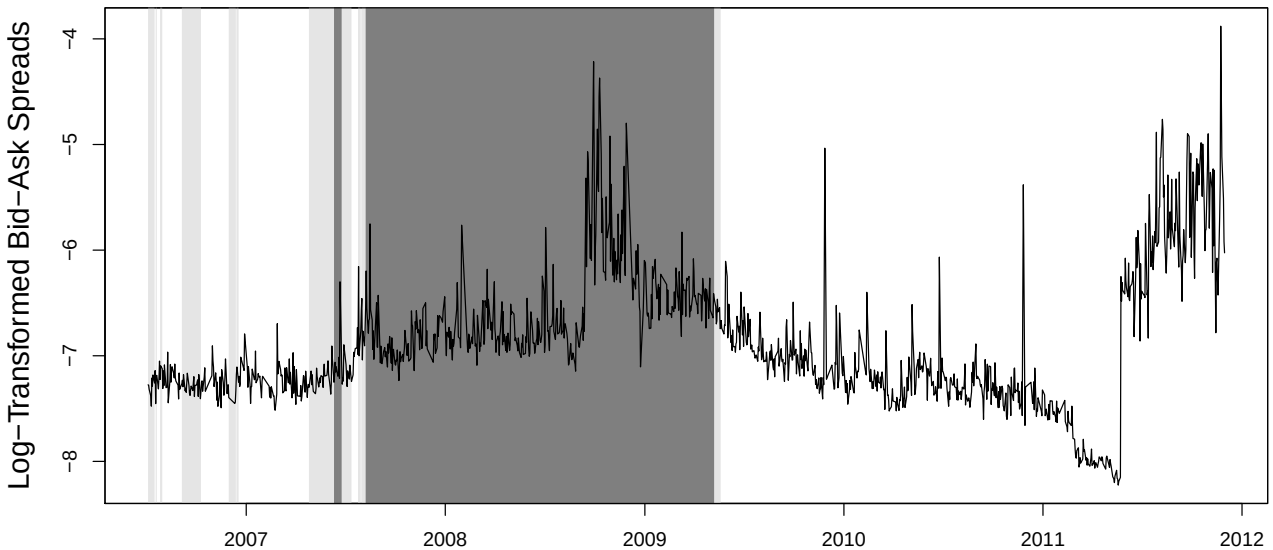

Figure: Log(Bid-Ask Spread for S&P 500 Stocks). Light gray: ted_t >50bp; dark gray: ted_t >80bp

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

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Volatility

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

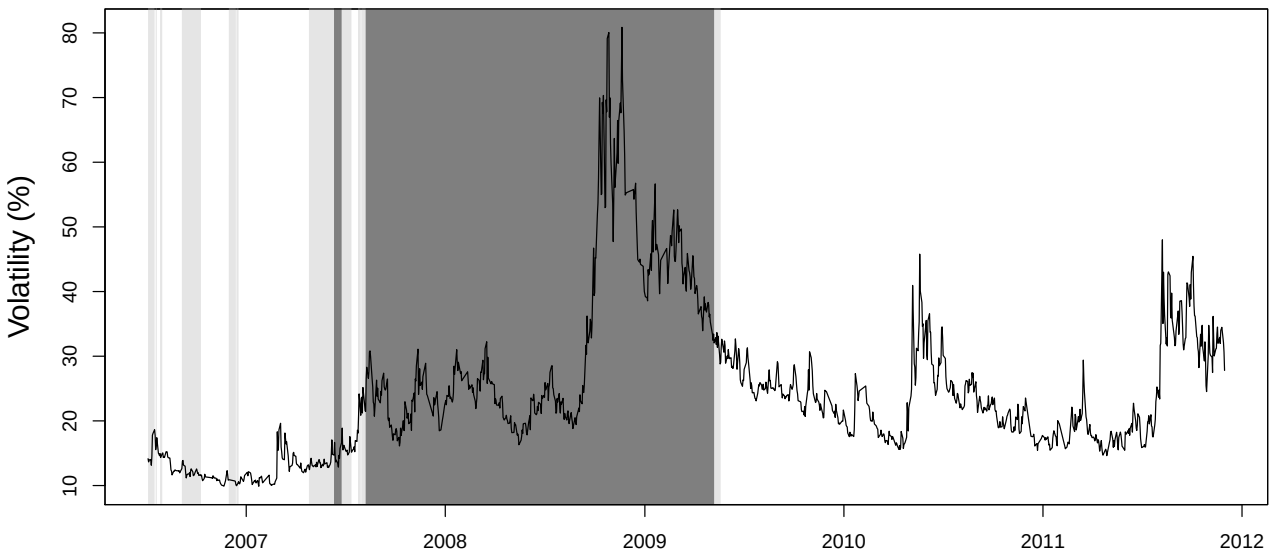

Figure: CBOE Implied Volatility Index. Light gray: ted_t >50bp; dark gray: ted_t >80bp

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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

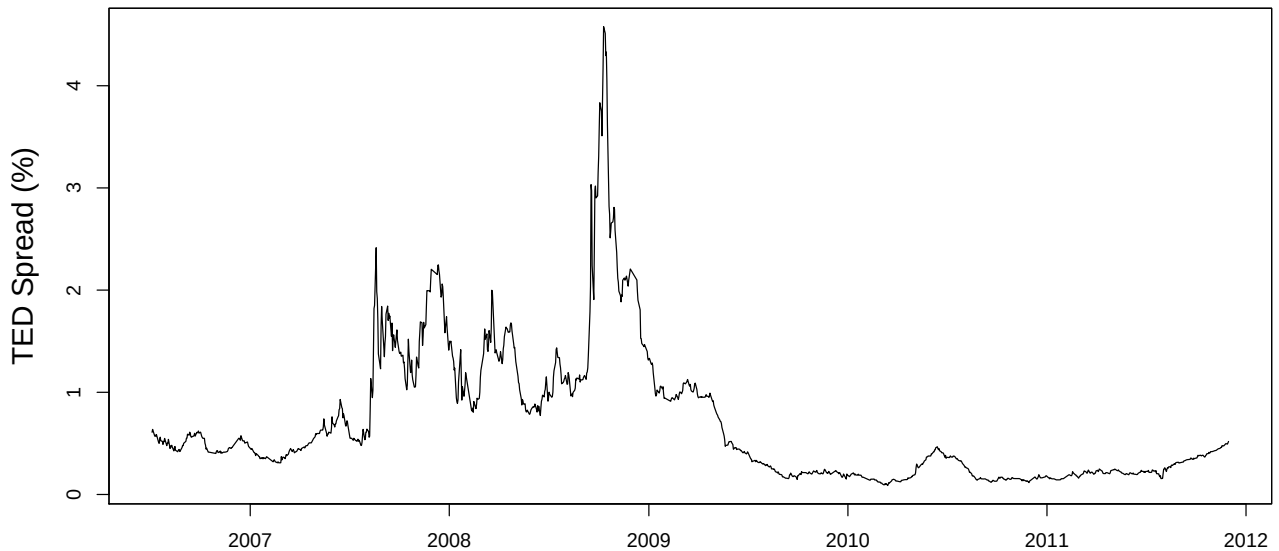

Figure: TED Spread. lower dashed line: ted_t >50bp; upper dashed line: ted_t >80bp

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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

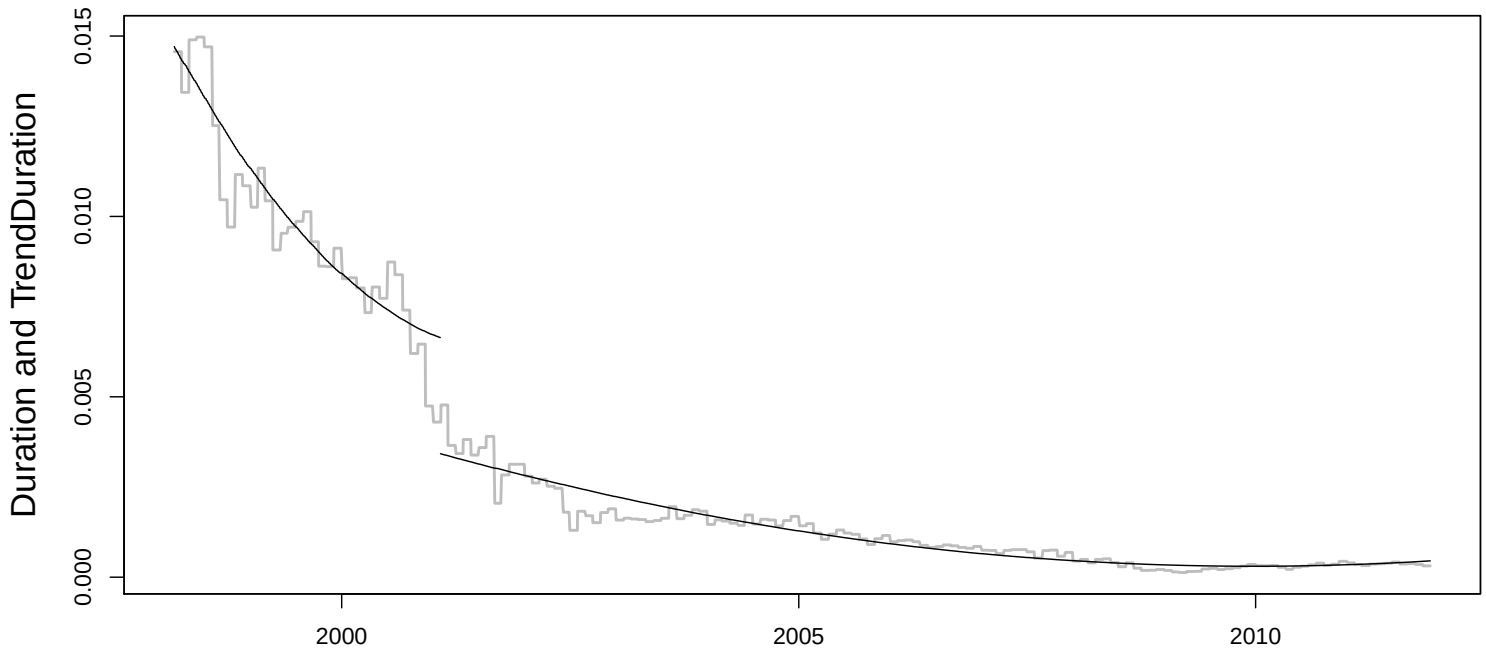

Figure: Inter-trade Duration Trend for US stocks (in years). Gray line: inter-trade duration; black line: trend pre-/post-NYSE decimalization in Jan 2001

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Instrument: AAA Liquidity

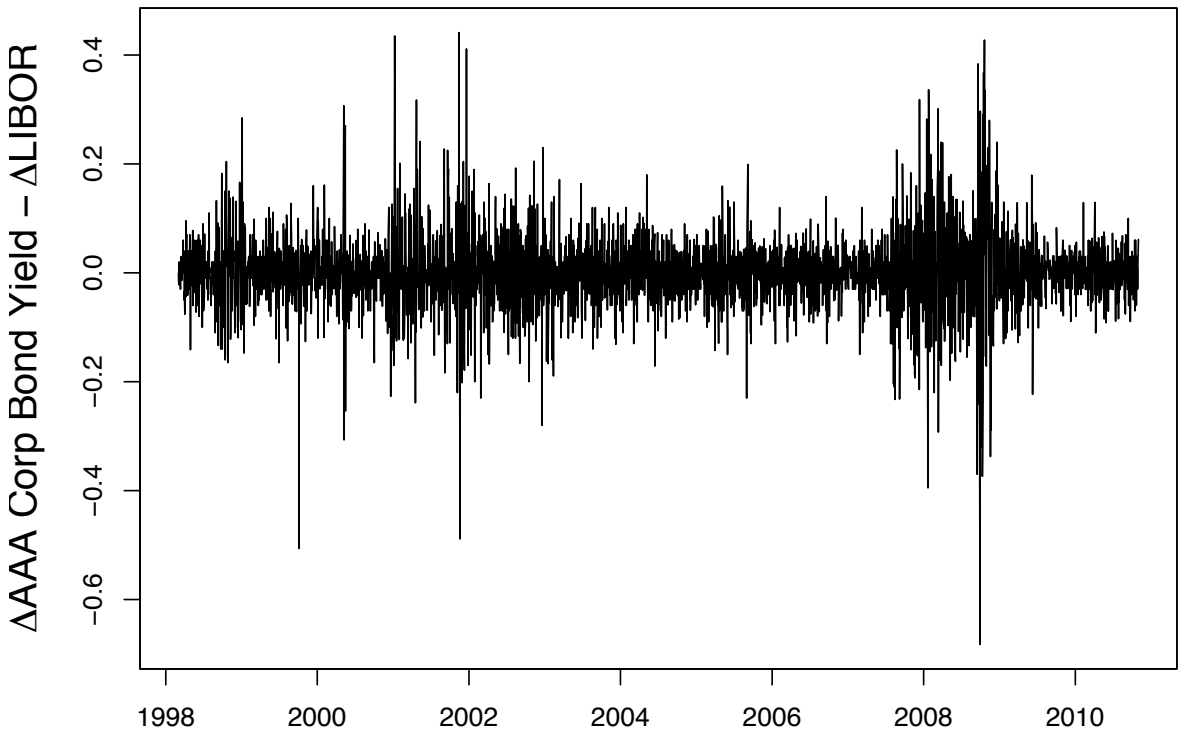

Figure: Difference b/w ΔYields(1Y AAA Corporates), ΔLIBOR: Mar 1998–Dec 2011

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Two-Regime Specification

- Allow for regime change if credit spread crosses threshold κ.
- 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: Funding Liquidity vs Market Liquidity

	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 κ			**0.43**	**0.48**
			[0.42, 0.44]	[0.44, 0.49]

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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: Adding an Autoregressive Term

	Linear Model		Two-Regime Model	
Covariates	OLS	IV	OLS	IV
(*intercept*)	**1.953**	*-0.111*	*1.574*	-19.440
	(0.193)	(0.061)	(0.581)	(14.204)
$mktilliq_t$	**0.129**	*-0.014*	0.024	-2.573
	(0.003)	(0.008)	(0.070)	(1.747)
$fundilliq_{t-1}$	**0.574**	**1.002**	**0.449**	*0.528*
	(0.001)	(0.001)	(0.037)	(0.071)
vol_t	**2.665**	0.021	2.585	8.887
	(0.313)	(0.026)	(0.574)	(5.221)
$volsq_t$	**-1.918**	-0.009	**-3.893**	-4.804
	(0.539)	(0.025)	(0.858)	(3.721)
ted_t	**0.010**	*0.005*	0.382	2.669
	(0.001)	(0.003)	(0.239)	(1.532)
$stress_t$			0.312	20.706
			(0.879)	(8.448)
$stressmktilliq_t$			0.107	*2.631*
			(0.108)	(1.086)
$stressfundilliq_{t-1}$			*0.107*	*0.010*
			(0.051)	(0.074)
$stressvol_t$			2.109	3.169
			(0.600)	(2.554)
$stressted_t$			*-0.523*	-2.809
			(0.243)	(1.171)
Threshold κ			**0.44**	**0.48**
			[0.21, 0.47]	[0.46, 0.49]

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Robustness Check: Autoregressive Term

- Relationship b/w funding, market liquidity again two regimes:
  1. Stable markets ($ted \leq 48$bp): 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% $\overset{?}{\implies}$ 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.

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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.

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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.
- Modeled spread over 3M US T-bills; may need to be changed.
- 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.
- Need more work to decide 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.
  - Improper estimation cannot detect these funding cycles.
- Stable markets ($ted \leq 48$bp):
  - Bid-ask spread $\uparrow$ 10% $\Longrightarrow$ funding illiquidity $\downarrow$ 25%–36%.
  - Stabilizing funding cycle arises. (First evidence!)
- Unstable markets ($ted > 48$bp):
  - Bid-ask spread $\uparrow$ 10% $\Longrightarrow$ funding illiquidity $\uparrow$ 16%–26%.
  - Destabilizing funding cycle arises.
- Funding liquidity based on volatility.
- Two regimes may exist in other funding measures.

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