Limited Market Access and Funding Liquidity

Zhuo Chen Andrea Lu

Kellogg School of Management, Northwestern University

Oct 26, 2013
FDIC/JFSR Fall Banking Conference

Motivation - A Market-based Funding Liquidity Measure

- Funding liquidity
  - The easiness for investors to finance their positions.
  - Negative funding liquidity shock results in difficulty in raising capital in a short time.
  - As a result, investors cannot move capital quickly enough to exploit investment opportunities.
  - Funding liquidity shock can affect asset prices and even real economy.
- Measures of funding liquidity
  - Empirically it is challenging to measure funding liquidity shock.
  - Existing funding liquidity measures. List
  - Let market speak: extract funding liquidity shock from stock market returns.
  - BAB factor (Frazzini and Pedersen (2013)): a possible market-based measure for shadow cost of borrowing constraint.

Motivation

BAB factor's correlations with existing funding liquidity measures

	Asset Growth	Bond Liquidity	CDS	Credit Spread	Financial Leverage	HF Leverage	IB ExReturn
BAB (M)	6.9	**13.4**	9.3	3.6	-5.5	-16.8	-18.2
BAB (Q)	**28.4**	**23.0**	20.0	17.4	15.9	-24.1	-0.4

	Broker Leverage	LIBOR	Loan	Swap spread	TED spread	Term spread	VIX
BAB (M)	-0.1	-10.2	6.3	**26.0**	11.0	10.9	-1.6
BAB (Q)	**25.3**	-6.5	**30.9**	27.7	17.0	7.6	9.2

	FPC14	FPC10	FPC7
BAB (M)	-2.8	**11.7**	0.5
BAB (Q)	14.1	11.5	13.3

Main Results

Market-based funding liquidity measure

- BAB premium depends on both funding tightness and assets' sensitivity to funding tightness.
- BAB portfolio yields higher return if it is constructed over stocks with high margin requirements.
- A "diff-in-diff" method smoothes out the time-varying margin effect and maintains the time-varying funding liquidity shock.

Our funding liquidity measure is ...

- Highly correlated with existing funding liquidity proxies.
- "Flight-to-liquidity" effect and liquidity spirals.

Implications on hedge fund performance

- Hedge fund performance comoves with funding liquidity shock.
- Funding liquidity risk is manageable by some hedge funds.
- Return spread is 0.89% per month between funds with funding management ability and funds without funding management ability.

Related Literature

Funding liquidity and asset prices

- Leverage aversion: Black (1972), Frazzini and Pedersen (2013); margin CAPM: Ashcraft, Garleanu, and Pedersen (2010); financial intermediary leverage: He and Krishnamurthy (2012), Adrian, Etula, and Muir (2013); limits of arbitrage: Shleifer and Vishny (1997), Pulvino (1998), Brunnermeier and Pedersen (2011).

Hedge fund

- Liquidity and hedge fund returns: Sadka (2010), Teo (2011), Hu, Pan, and Wang (2013); hedge fund skill: Aragon (2007), Teo (2009), Cao et al. (2013); hedge fund performance evaluation: Getmansky, Lo, and Makarov (2004), Jagannathan, Malakhov, and Novikov (2010).

Risk-return relationship

- Leverage constraint: Black (1972); divergence of opinion with short-sale constraint: Miller (1977), Hong and Sraer (2012); limited market participation: Merton (1987); mutual fund manager's benchmarking: Brennan (1993).

BAB Portfolio Conditional on Margin Requirement

Margin rules

- Regulation T of Federal Reserve Board.
- Stock exchanges set maintenance margin requirements.
- Brokers may set higher initial and maintenance margin requirements.

Margin proxies

- Five margin proxies: size, idiosyncratic volatility, Amihud illiquidity, institutional ownership, and analyst coverage.

Portfolio formation

- Sort stocks into 5 margin groups, construct BAB portfolio within each group.

BAB Portfolio Conditional on Margin Requirement

Margin sorted groups						
	1 (Low)	2	3	4	5 (High)	Diff
Panel A: Size [1965M1-2012M10]						
Exret	0.34	0.41	0.59	0.76	1.22	**0.88**
	(2.11)	(2.28)	(3.33)	(4.55)	(6.64)	**(4.86)**
Alpha	0.18	0.10	0.28	0.36	0.77	**0.59**
	(1.14)	(0.64)	(1.72)	(2.27)	(2.93)	**(2.14)**
Panel B: Idio. vol [1965M1 - 2012M10]						
Exret	0.23	0.62	0.50	0.83	1.44	**1.21**
	(1.73)	(4.87)	(3.99)	(5.98)	(8.13)	**(6.08)**
Alpha	0.24	0.44	0.22	0.50	0.92	**0.68**
	(1.57)	(2.87)	(1.59)	(3.21)	(4.45)	**(3.02)**
Panel C: Market liquidity [1965M1 - 2012M10]						
Exret	0.27	0.40	0.41	0.46	0.88	**0.62**
	(2.03)	(2.84)	(2.91)	(3.24)	(5.73)	**(4.17)**
Alpha	0.10	0.16	0.10	0.10	0.48	**0.37**
	(0.79)	(1.21)	(0.70)	(0.68)	(2.34)	**(1.86)**

BAB Portfolio Conditional on Margin Requirement

Margin sorted groups						
	1 (Low)	2	3	4	5 (High)	Diff
Panel D: Institutional Ownership [1980M4 - 2012M3]						
Exret	0.40	0.56	0.53	0.85	1.37	**0.97**
	(1.99)	(2.64)	(2.31)	(3.63)	(5.16)	**(4.12)**
Alpha	0.11	0.18	0.23	0.54	0.80	**0.69**
	(0.60)	(0.96)	(1.07)	(2.47)	(2.48)	**(2.09)**
Panel E: Analyst Coverage [1976M7-2011M12]*						
Exret	0.29	0.56	0.51	0.89	1.27	**0.99**
	(1.22)	(2.49)	(2.32)	(3.37)	(4.79)	**(3.88)**
Alpha	0.04	0.17	0.10	0.39	0.77	**0.74**
	(0.21)	(0.95)	(0.46)	(1.37)	(2.26)	**(2.16)**
* 5 - no coverage; 4 - one analyst coverage						

Measuring Funding Liquidity Shock

Return difference between a BAB portfolio constructed over high margin stocks and a BAB portfolio constructed over low margin stocks

- A "diff-in-diff" approach.
- Advantage: smooth out margin effect; mitigate other noises.
- The first principal component of 5 "diff-in-diff" sequences to extract the common underlying driving force, i.e., funding liquidity shock.
- Validation: common factor structure; correlations with existing funding liquidity proxies; stock market reaction.

▸ Funding liquidity proxies

Measuring Funding Liquidity Shock

Correlations with existing funding liquidity proxies

	Asset Growth	Bond Liquidity	CDS	Credit Spread	Financial Leverage	HF Leverage	IB ExReturn
FLS	**12.9**	**12.9**	**41.1**	**22.9**	**23.1**	**45.8**	**26.4**
BAB	6.9	**13.4**	9.3	3.6	-5.5	-16.8	-18.2

	Broker Leverage	LIBOR	Loan	Swap spread	TED spread	Term spread	VIX
FLS	-2.5	-9.8	**17.9**	**18.5**	**16.1**	-7.4	**25.0**
BAB	-0.1	-10.2	6.3	**26.0**	11.0	10.9	-1.6

	FPC14	FPC10	FPC7
FLS	**35.5**	**30.5**	**26.8**
BAB	-2.8	**11.7**	0.5

▶ Time-series

Measuring Funding Liquidity Shock

Flight-to-liquidity

- 25 Fama-French portfolios' exposures to the funding liquidity shock.

		Book-to-market					
		Low				High	HML
Size	Small	2.88	7.86	7.91	7.89	11.92	9.04
		(0.56)	(1.96)	(2.54)	(2.57)	(3.62)	(2.83)
		3.38	6.29	5.63	6.05	6.76	3.38
		(1.11)	(2.61)	(2.56)	(2.92)	(2.59)	(1.38)
		3.79	4.44	5.27	4.56	1.91	-1.87
		(1.43)	(2.61)	(2.64)	(2.13)	(0.81)	(-0.61)
		1.88	3.52	4.14	2.68	2.95	1.07
		(0.96)	(2.65)	(2.37)	(1.48)	(1.33)	(0.31)
	Large	-1.67	-2.76	-3.37	-1.68	-0.57	1.10
		(-1.56)	(-1.99)	(-2.51)	(-0.79)	(-0.26)	(0.39)
	SMB	4.55	10.62	11.27	9.57	12.49	
		(0.84)	(2.26)	(2.90)	(2.17)	(2.85)	

Hedge Fund Decile Portfolios

Funding liquidity beta sorted portfolios using individual hedge fund returns (CISDM hedge fund dataset, Jan 1996 - April 2009)

$$R_t^i = \alpha^i + \beta_{FLS}^i FLS_t + \beta_{Mkt}^i Mkt_t + \epsilon_t^i$$

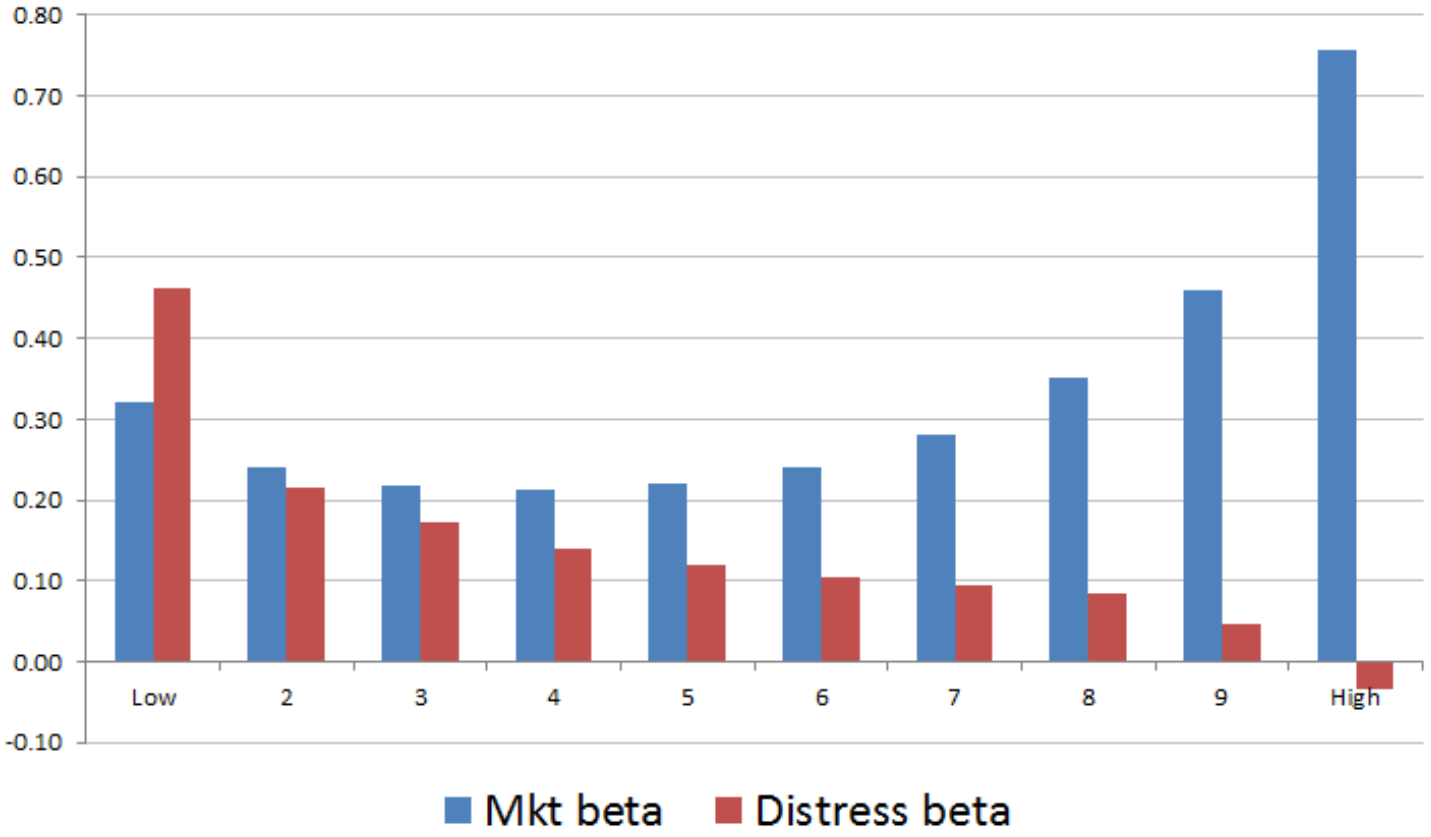
Hedge fund decile portfolio performance

	Low	2	3	4	5	6	7	8	9	High	LMH
Exret	0.94	0.68	0.47	0.38	0.37	0.36	0.37	0.39	0.32	0.05	**0.89**
	(3.76)	(3.88)	(3.29)	(3.14)	(2.94)	(2.87)	(2.66)	(2.3)	(1.53)	(0.15)	**(3.31)**
Alpha	0.75	0.53	0.36	0.32	0.30	0.30	0.30	0.31	0.19	-0.14	**0.89**
	(4.03)	(3.48)	(3.26)	(3.89)	(3.34)	(3.22)	(3.02)	(2.65)	(1.56)	(-0.59)	**(3.02)**
Vol	10.96	7.66	6.29	5.29	5.51	5.51	6.11	7.39	9.03	14.86	**11.79**
SR	1.03	1.06	0.90	0.86	0.80	0.79	0.73	0.63	0.42	0.04	**0.91**

Lock-up Capital?

Hedge fund portfolio exposures on stock market and distressed securities

$$R_t^i = \alpha^i + \beta_{distress}^i Distress_t + \beta_{Mkt}^i Mkt_t + \epsilon_t^i$$



Serial Correlation of Hedge Fund Returns?

Funding liquidity beta sorted portfolios with serial correlation adjustment

Panel A: Removal of the 1^{st} and 2^{nd} order autocorrelations

	Low	2	3	4	5	6	7	8	9	High	LMH
Exret	0.81	0.76	0.56	0.39	0.32	0.32	0.37	0.38	0.20	-0.02	**0.83**
	(2.71)	(3.63)	(3.09)	(2.98)	(2.11)	(2.24)	(1.87)	(1.65)	(1.06)	(-0.01)	**(2.55)**
Alpha	0.49	0.57	0.40	0.28	0.22	0.24	0.27	0.26	0.07	-0.25	**0.75**
	(2.92)	(3.99)	(2.81)	(3.25)	(2.21)	(2.4)	(2)	(1.53)	(0.72)	(-0.64)	**(2.25)**
Vol	13.07	8.42	7.71	6.63	6.51	6.69	7.67	8.81	11.07	19.25	**14.00**
SR	0.74	0.99	0.85	0.82	0.58	0.61	0.51	0.45	0.29	0.00	**0.70**

Serial Correlation of Hedge Fund Returns?

Funding liquidity beta sorted portfolios with serial correlation adjustment

Panel A: Removal of the 1^{st} and 2^{nd} order autocorrelations

	Low	2	3	4	5	6	7	8	9	High	LMH
Exret	0.81	0.76	0.56	0.39	0.32	0.32	0.37	0.38	0.20	-0.02	**0.83**
	(2.71)	(3.63)	(3.09)	(2.98)	(2.11)	(2.24)	(1.87)	(1.65)	(1.06)	(-0.01)	**(2.55)**
Alpha	0.49	0.57	0.40	0.28	0.22	0.24	0.27	0.26	0.07	-0.25	**0.75**
	(2.92)	(3.99)	(2.81)	(3.25)	(2.21)	(2.4)	(2)	(1.53)	(0.72)	(-0.64)	**(2.25)**
Vol	13.07	8.42	7.71	6.63	6.51	6.69	7.67	8.81	11.07	19.25	**14.00**
SR	0.74	0.99	0.85	0.82	0.58	0.61	0.51	0.45	0.29	0.00	**0.70**

Panel B: Inverse of AC1 coefficients weighted portfolio

	Low	2	3	4	5	6	7	8	9	High	LMH
Exret	1.13	0.65	0.52	0.39	0.39	0.45	0.35	0.30	0.32	-0.04	**1.17**
	(3.77)	(3.1)	(3.47)	(2.81)	(3.04)	(3.36)	(2.24)	(1.52)	(1.38)	(-0.11)	**(3.22)**
Alpha	0.96	0.47	0.36	0.34	0.32	0.40	0.29	0.20	0.17	-0.28	**1.23**
	(3.53)	(2.4)	(3.08)	(3.66)	(3.48)	(3.67)	(2.81)	(1.26)	(1.09)	(-0.88)	**(2.75)**
Vol	13.11	9.23	6.57	6.10	5.65	5.85	6.79	8.54	10.33	17.24	**15.95**
SR	1.03	0.85	0.95	0.77	0.83	0.92	0.61	0.42	0.38	-0.03	**0.88**

Panel C: Inverse of absolute value of AC1 coefficients weighted portfolio

	Low	2	3	4	5	6	7	8	9	High	LMH
Exret	0.97	0.71	0.52	0.46	0.42	0.42	0.41	0.40	0.20	-0.11	**1.07**
	(3.23)	(3.23)	(3.39)	(3.34)	(2.99)	(3.19)	(2.62)	(2.29)	(0.92)	(-0.28)	**(3.12)**
Alpha	0.80	0.53	0.39	0.41	0.36	0.38	0.38	0.29	0.05	-0.33	**1.13**
	(3.27)	(2.49)	(3.03)	(3.61)	(3.34)	(3.84)	(2.98)	(2.51)	(0.33)	(-1.23)	**(2.93)**
Vol	13.11	9.56	6.71	5.99	6.13	5.81	6.92	7.65	9.81	16.32	**15.03**
SR	0.88	0.89	0.93	0.92	0.82	0.87	0.72	0.63	0.25	-0.08	**0.86**

Is it about skill?

Normal v.s. stressful times

Panel A: Normal times

	Low	2	3	4	5	6	7	8	9	High	LMH
Exret	1.16	0.86	0.69	0.57	0.58	0.58	0.59	0.66	0.63	0.51	**0.65**
	(4.33)	(4.42)	(4.70)	(5.07)	(4.76)	(4.98)	(4.56)	(4.27)	(3.32)	(1.58)	**(2.50)**
Alpha	0.70	0.52	0.43	0.37	0.35	0.36	0.35	0.37	0.24	-0.11	**0.81**
	(3.32)	(2.92)	(3.31)	(4.17)	(3.49)	(3.62)	(3.44)	(3.10)	(1.98)	(-0.48)	**(2.40)**
Vol	10.76	7.82	5.87	4.52	4.87	4.64	5.21	6.20	7.55	12.89	**10.50**
SR	1.30	1.32	1.41	1.52	1.42	1.49	1.37	1.28	0.99	0.47	**0.75**

Panel B: NBER recessions

	Low	2	3	4	5	6	7	8	9	High	LMH
Exret	-0.21	-0.27	-0.64	-0.61	-0.70	-0.75	-0.77	-1.02	-1.28	-2.31	**2.10**
	(-0.33)	(-0.81)	(-1.6)	(-1.45)	(-1.76)	(-1.69)	(-1.60)	(-1.69)	(-1.70)	(-1.95)	**(2.24)**
Alpha	0.12	0.20	-0.02	0.07	-0.06	0.01	0.07	-0.07	0.01	-0.44	**0.56**
	(0.35)	(1.58)	(-0.16)	(0.53)	(-0.49)	(0.04)	(0.4)	(-0.36)	(0.03)	(-0.75)	**(1.03)**
Vol	11.32	5.87	7.07	7.41	7.06	7.78	8.56	10.64	13.30	20.90	**16.61**
SR	-0.22	-0.55	-1.09	-0.98	-1.19	-1.15	-1.08	-1.15	-1.16	-1.33	**1.52**

Robustness Tests

Funding liquidity beta sorted portfolios - excess returns

Low	2	3	4	5	6	7	8	9	High	LMH
Panel A: Value-weighted portfolios										
0.72	0.60	0.35	0.37	0.34	0.32	0.31	0.35	0.32	-0.24	**0.97**
(2.57)	(3.64)	(2.45)	(2.81)	(2.69)	(2.78)	(2.23)	(2.13)	(1.7)	(-0.71)	**(2.70)**
Panel B: Forward-looking funding liquidity shock correction										
0.95	0.68	0.49	0.40	0.34	0.35	0.36	0.38	0.37	0.04	**0.91**
(3.72)	(3.96)	(3.4)	(3.11)	(2.88)	(2.85)	(2.56)	(2.18)	(1.86)	(0.11)	**(3.53)**
Panel C: Delisting										
-0.53	-0.61	-0.88	-0.68	-0.68	-0.65	-0.74	-0.86	-1.05	-1.53	**1.00**
(-1.73)	(-2.49)	(-4.03)	(-3.36)	(-3.35)	(-3.15)	(-3.36)	(-3.24)	(-3.71)	(-3.71)	**(2.93)**
Panel D: Control for ΔVIX										
1.02	0.66	0.54	0.37	0.34	0.40	0.34	0.41	0.38	0.27	**0.75**
(3.86)	(3.74)	(4.1)	(3.19)	(2.73)	(3.28)	(2.5)	(2.46)	(1.86)	(0.76)	**(2.73)**
Panel E: Exclude recent crisis 1996M1-2006M12										
1.17	0.87	0.67	0.57	0.56	0.56	0.56	0.62	0.57	0.35	**0.83**
(4.02)	(4.33)	(4.51)	(5.01)	(4.65)	(4.88)	(4.4)	(4.07)	(3.06)	(1.07)	**(3.19)**
Panel F: Only AUM denominated in USD funds										
1.03	0.67	0.53	0.41	0.38	0.40	0.33	0.38	0.39	0.23	**0.80**
(3.81)	(3.76)	(3.61)	(3.5)	(3.18)	(3.07)	(2.31)	(2.37)	(1.89)	(0.67)	**(2.78)**
Panel G: Exclude FOF										
1.06	0.74	0.61	0.48	0.40	0.47	0.37	0.45	0.23	0.05	**1.00**
(3.79)	(3.89)	(4.11)	(3.57)	(3.19)	(3.59)	(2.35)	(2.32)	(0.93)	(0.14)	**(3.20)**

▶ Model

Model Setup

n+1 assets in the market

- n risky assets with positive supply, one-period return $R_{k,t+1}$.
- One internal asset with zero net supply, one-period deterministic return R.

Model Setup

n+1 assets in the market

- n risky assets with positive supply, one-period return $R_{k,t+1}$.
- One internal asset with zero net supply, one-period deterministic return R.

Investors' utility function

- $U_t^i = E_t[R_{t+1}^i W_t^i] - \frac{\gamma^i}{2W_t^i} VAR_t[R_{t+1}^i W_t^i]$.
- $R_{t+1}^i = \Sigma_{k=1}^{n+1} \omega_{k,t}^i R_{k,n+1}$.
- Investors choose $\omega_{k,t}^i$ to maximize U_t^i.

Model Setup

n+1 assets in the market

- n risky assets with positive supply, one-period return $R_{k,t+1}$.
- One internal asset with zero net supply, one-period deterministic return R.

Investors' utility function

- $U_t^i = E_t[R_{t+1}^i W_t^i] - \frac{\gamma^i}{2W_t^i} VAR_t[R_{t+1}^i W_t^i]$.
- $R_{t+1}^i = \Sigma_{k=1}^{n+1} \omega_{k,t}^i R_{k,n+1}$.
- Investors choose $\omega_{k,t}^i$ to maximize U_t^i.

Borrowing constraint - margin and leverage condition

$$\Sigma_{k=1}^{n} m_{k,t} I_{k,t} \omega_{k,t}^i \leq \frac{1}{M_t}, \text{ where } I_{k,t} = \begin{cases} 1, & \text{if } \omega_{k,t}^i \geq 0 \\ -1, & \text{if } \omega_{k,t}^i < 0 \end{cases}$$

- $m_{k,t}$ is margin requirement; M_t is market leverage condition.

Model Setup

n+1 assets in the market

- n risky assets with positive supply, one-period return $R_{k,t+1}$.
- One internal asset with zero net supply, one-period deterministic return R.

Investors' utility function

- $U_t^i = E_t[R_{t+1}^i W_t^i] - \frac{\gamma^i}{2W_t^i} VAR_t[R_{t+1}^i W_t^i]$.
- $R_{t+1}^i = \Sigma_{k=1}^{n+1} \omega_{k,t}^i R_{k,n+1}$.
- Investors choose $\omega_{k,t}^i$ to maximize U_t^i.

Borrowing constraint - effective margin

$$\Sigma_{k=1}^{n} \hat{m}_{k,t} I_{k,t} \omega_{k,t}^i \leq 1, \text{ where } I_{k,t} = \begin{cases} 1, & \text{if } \omega_{k,t}^i \geq 0 \\ -1, & \text{if } \omega_{k,t}^i < 0 \end{cases}$$

- $\hat{m}_{k,t} = m_{k,t} M_t$ is effective margin requirement.

Model Setup

Two types of investors

- Risk-averse type A investors.

$$\max_{\{\omega_t^A\}} \quad U_t^A = \omega_t^{A\prime} E_t R_{t+1}^n - \frac{\gamma^A}{2} \omega_t^{A\prime} \Omega \omega_t^A$$

- Risk-taking type B investors, $\tilde{m}_{k,t} = \hat{m}_{k,t} I_{k,t}$.

$$\max_{\{\omega_t^B\}} \quad U_t^B = \omega_t^{B\prime} E_t R_{t+1}^n - \frac{\gamma^B}{2} \omega_t^{B\prime} \Omega \omega_t^B$$

$$s.t. \ \ \Sigma_{k=1}^n \tilde{m}_{k,t} \omega_{k,t}^B \leq 1$$

Model Solution

Two lemmas

- Lemma 1: Type A and Type B investors' optimal portfolio choice.

$$\begin{aligned} \omega_t^A &= \frac{1}{\gamma^A}\Omega^{-1}E_t R_{t+1}^n \\ \omega_t^B &= \frac{1}{\gamma^B}\Omega^{-1}(E_t R_{t+1}^n - \eta_t \tilde{m}_t) \end{aligned}$$

- Lemma 2: Asset's risk premium in the presence of borrowing constraint.

$$E_t R_{k,t+1} - R = \beta_k(E_t R_{m,t+1} - R) + \psi_t(\hat{m}_{k,t} - \beta_k \hat{m}_{M,t})$$

Model Solution

Three assumptions

- Assumption 1: For a given level of margin requirement $m_{BAB,t}$, there are stocks with heterogeneous market risk exposures β_k. The distributions of β_k across different margin levels are the same.
- Assumption 2: The security-specific margin requirement has a functional form $\hat{m}_{k,t} = a_{k,t} - \frac{b_k}{\psi_t}$.
- Assumption 3: Time-varying characteristic parameter $a_{k,t}$ follows some distribution that has a constant dispersion over time.

Model Solution

Three assumptions

- Assumption 1: For a given level of margin requirement $m_{BAB,t}$, there are stocks with heterogeneous market risk exposures β_k. The distributions of β_k across different margin levels are the same..
- Assumption 2: The security-specific margin requirement has a functional form $\hat{m}_{k,t} = a_{k,t} - \frac{b_k}{\psi_t}$.
- Assumption 3: Time-varying characteristic parameter $a_{k,t}$ follows some distribution that has a constant dispersion over time.

Two propositions

- Proposition 1: The BAB premium depends on both shadow cost of borrowing constraint ψ_t and assets' margin requirement $m_{BAB,t}$.

$$R_{t+1}^{BAB} = \psi_t m_{BAB,t}\left(\frac{\beta_H - \beta_L}{\beta_H \beta_L}\right)$$

- Proposition 2: The return difference of a BAB portfolio constructed over high margin stocks and a BAB portfolio constructed over low margin stocks captures time-varying funding condition ψ_t.

$$BAB^{high} - BAB^{low} = \frac{\beta_H - \beta_L}{\beta_H \beta_L}\psi_t$$

In this paper...

- We implement a "diff-in-diff" approach to extract market wide funding liquidity shock.
- Our FLS measure is highly correlated with other funding liquidity proxies.
- Hedge fund returns depend on market wide funding condition.
- Hedge funds that can manage funding liquidity shock earn higher returns.
- A simple model explains the importance of isolating the funding liquidity shock from asset specific margin requirement.

Empirical Tests Appendices

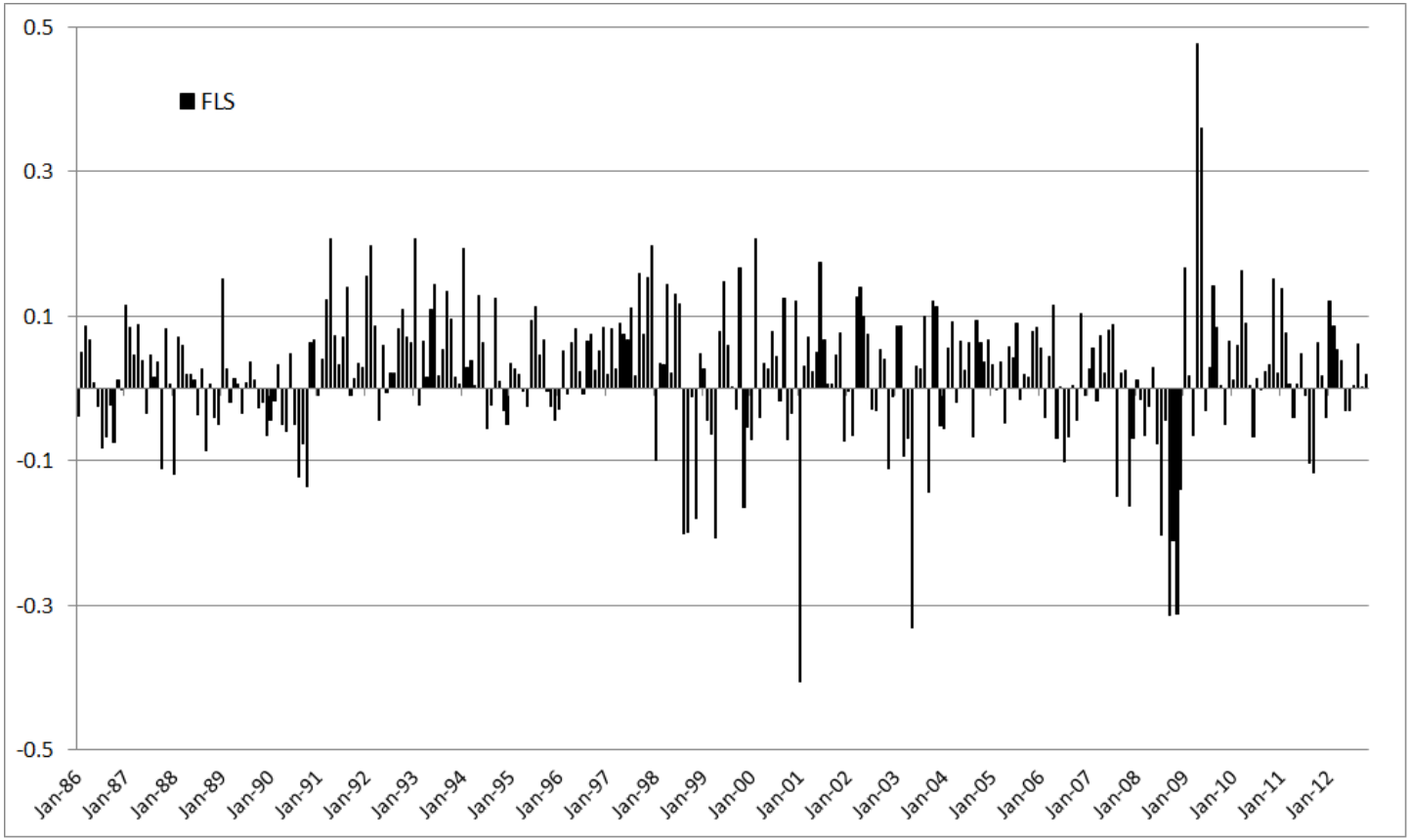
Other funding liquidity measures commonly used in literature

- Brokers and dealers' asset growth rate (Adrian and Shin (2010)), 1986Q1-2012Q3.
- Bond liquidity premium as the difference of on-the-run and off-the-run Treasury bond yields (Fontaine and Garcia (2013)), 1986M1-2012M3.
- Major investment banks' senior 10-year debt CDS spread (Ang, Gorovyy, and van Inwegen (2011)), 2004M1-2013M3.
- Credit spread between AAA bond yield and BAA bond yield (Adrian, Etula, and Muir (2012)), 1986M1-2013M4.
- Financial sector leverage (Ang, Gorovyy, and van Inwegen (2011)), 1986M1-2012M12.
- Hedge fund leverage (Ang, Gorovyy, and van Inwegen (2011)), 2004M12-2009M9.
- Major investment banks excess return (Ang, Gorovyy, and van Inwegen (2011)), 1986M1-2012M10.
- Brokers and dealers leverage factor (Adrian, Etula, and Muir (2013)), 1986Q1-2012Q4.
- Three-month LIBOR rate (Ang, Gorovyy, and van Inwegen (2011)), 1986M1-2013M4.
- Percentage of loan officers tightening credit standards for commercial and industrial loans (Lee (2013)), 1990Q2-2013Q1.
- The spread between interest rate swap and T-bill (Asness, Moskowitz, and Pedersen (2013)), 2000M7-2013M4.
- Treasury-Eurodollar (TED) spread (Gupta and Subrahmanyam (2000)), 1986M1-2013M4.
- Term spread between 10-year Treasury bond and 3-month T-bill (Ang, Gorovyy, and van Inwegen (2011)), 1986M1-2013M4.
- VIX on SP500 (Ang, Gorovyy, and van Inwegen (2011)), 1986M1-2013M4.

Back-motivation Back-identification

Empirical Tests Appendices

Time series of extracted funding liquidity shock - monthly



Back