In Search of Liquidity Risk in Bank Stock Returns

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Motivation

- Liquidity transformation is inherent to banks' business model
  - Making long-term/illiquid loans against short-term/liquid liabilities
  - Providing on-demand liquidity
- This exposes them to financial fragility and potential distress as highlighted by the recent financial crisis
  - Strong reliance on wholesale short term funding pre-crisis
  - Run on repo markets + credit line drawdowns
- Call for new regulation to address this liquidity risk
  - Liquidity Coverage Ratio (LCR), Net Stable Funding Ratio (NSFR)

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- "Little is known about how one should regulate bank liquidity" – *Allen-Gale (2017)*
- We argue that we know even less about how market participants perceive liquidity risk embedded in banks

This Paper

- Takes an empirical asset-pricing approach to explore the market's assessment of liquidity risk

- **Research question**
  - How does liquidity mismatch on banks balance sheets affect their (risk-adjusted) stock returns?
  - Is liquidity mismatch a source of risk driving returns in the financial sector?

- **Relevance**
  - Document novel and robust facts about bank stock returns
    - Liquidity mismatch vs. risk premia
  - Policy implications
    - Effect of liquidity regulation (i.e., reducing liquidity mismatch) impact banks' cost of capital?

Preview of Results

- Banks with highest liquidity mismatch command lower (risk-adjusted) returns
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- Banks with highest liquidity mismatch command lower (risk-adjusted) returns
  - Long-short portfolio delivers alpha of 6 percent annually
- Results are overall robust to:
  - Asset pricing specifications: FF3, FF5, bond risk factors, market liquidity factor, financial size factor
  - Weighting scheme
  - Bank characteristics: e.g., size, profitability, bank risk proxies (leverage, asset quality, tail risk)
  - Measures of liquidity mismatch – *in progress*

Preview of Results

- Rule in/out some potential explanations
  - Endogenous sorting? – **Unlikely**
  - Mispricing due to the under-estimation/mis-measurement of liquidity risk pre-crisis – **Yes**

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- Potential policy implications
  - Liquidity mismatch may not fully account for liquidity risk
  - Newly implemented regulation may potentially have counter-productive effects: this may increase the cost of equity for banks, all else equal, but without necessarily tackling the real source of liquidity risk and financial fragility

Related Literature

Cross-Section of Bank Stock Returns

- Financial stocks have been traditionally overlooked in the empirical asset pricing literature with a few recent exceptions including:
  - Gandhi-Lustig (2015): size
  - Adrian et.al. (2016): financial-specific factors
  - Baker-Wurgler (2014), Bouwman et.al. (2017): beta, capital

▸ Theory ▸ Empirical Evidence

Banking Data

- **Y-9C reports** (quarterly, 1991 - Q1 to 2016 - Q4)
  - Consolidated financial statements at the bank holding company level
  - Includes balance sheet, income statement, detailed supporting schedules, off balance-sheet items
  - Reporting requirements: >150 $m (up to Mar 2006), >500 $m (up to Mar 2015), >1 $bn (now)
- Call reports (quarterly, 1991 - Q1 to 2016 - Q4)
  - Consolidated Reports of Condition and Income
  - Provide more granular information, at the bank level
  - Reporting requirement for every national bank, state member bank, insured state nonmember bank, and savings association
- **CRSP stock returns** (monthly) / COMPUSTAT
  - The Federal Reserve maintains a table linking CRSP's PERMNOs to Y-9C's RSSD9001

Banking Data

- Focus on commercial banks
  - 3-digit header SIC code: 602, 671
- Standard filters:
  - Consumer loans > 50 %
  - Non-standard BHC's

    e.g., Metlife, Goldman Sachs, Morgan Stanley, American Express, Discover
  - Penny stocks
- $\sim$ 300 banks per year
  - Average bank: 25 $bn in total assets, 3 $bn market capitalization

Measuring Liquidity

Many definitions

- **Traditional measures**: *Short-term wholesale funding*, *Maturity gap*
  - *Incomplete?*
- **Regulatory measures**: *LCR*, *NSFR*
  - Liquidity Coverage Ratio: requires holding sufficient liquid assets to withstand severe funding outflows over the next 30 days
  - Net Stable Funding Ratio: ratio of LT stable funding over LT assets
  - *Too complex?*
- **"Academic" measures**:
  - *Berger-Bouwman (2009)*: fixed weights
  - *Bai et.al. (2018) Liquidity Mismatch Index*: time-varying weights depending on market and funding liquidity, short sample period, relies on confidential information

- We develop a simple measure of liquidity mismatch: **Liquidity Gap (LG) ratio**

Measuring Liquidity

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$$LG = \frac{\text{Volatile Liabilities} - \text{Liquid Assets}}{\text{Total Liabilities}}$$

- Captures a bank's ability to immediately service severe outflows from the liabilities that are more prone to withdrawals
- Simplified version of the LCR based on Berger-Bouwman (2009) asset/liability categories

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- Volatile Liabilities $>$ Liquid Assets $\rightarrow$ LG $>$0, high liquidity mismatch
- Volatile Liabilities $<$ Liquid Assets $\rightarrow$ LG $<$0, low liquidity mismatch

Measuring Liquidity Risk

- Liquid Assets
  - Cash and balances due from other institutions
  - All securities and trading assets
  - Federal funds sold and securities purchased under agreements to resell

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  - Rank the different types of liabilities

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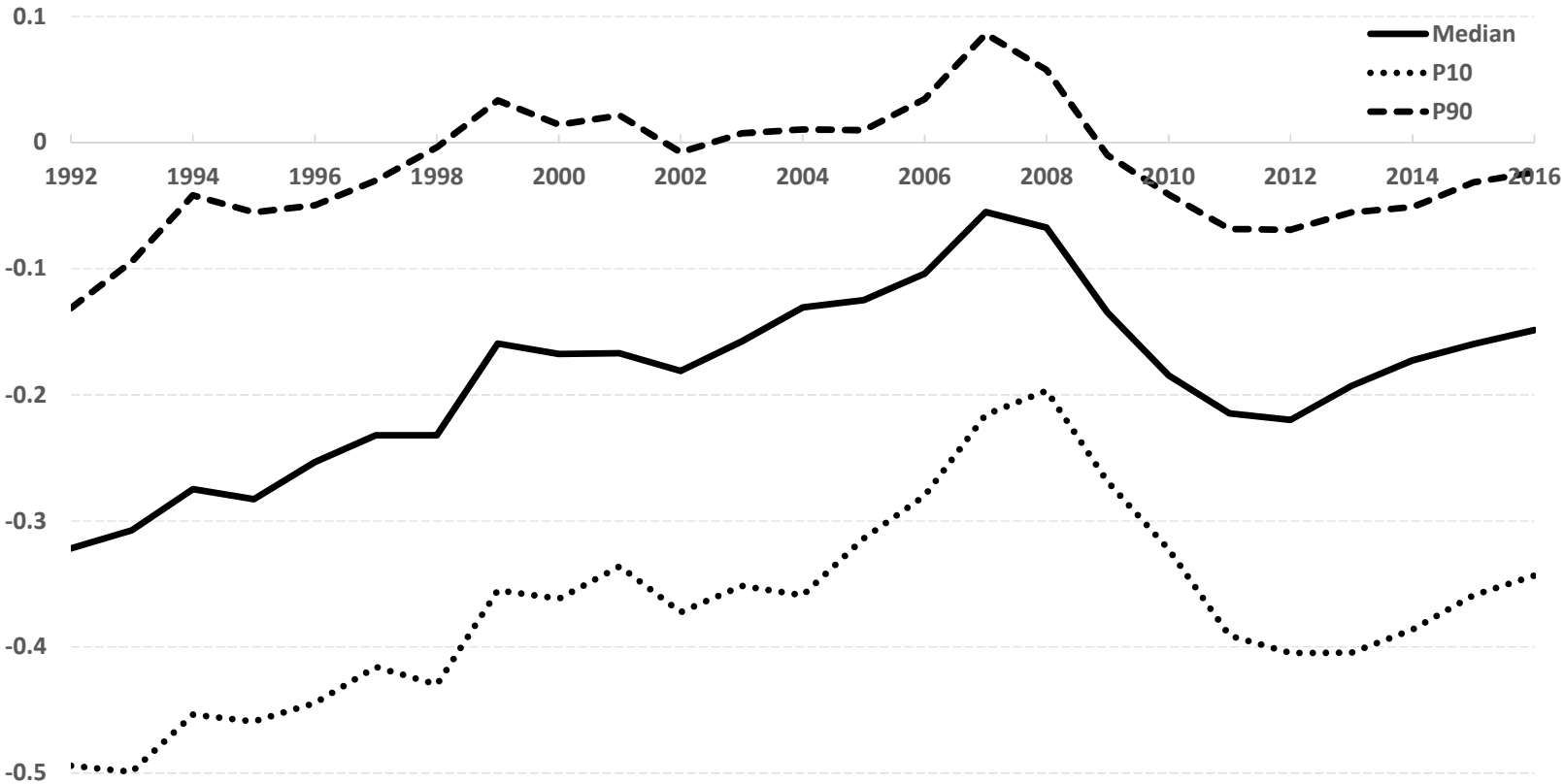
  - Rank the different types of liabilities
- The top 4 liabilities are stable across the whole sample period
- Computing volatility of outflows only generates the same result

Volatile Liabilities

Item	Std Dev	Mean	VW Share
Trading Liabilities	0.616	0.126	0.044
Other Borrowed Money	0.556	0.101	0.119
Deposits, Foreign	0.537	0.100	0.111
Federal Funds Purchased and Repos	0.516	0.074	0.084
Volatile Liabilities	0.439	0.106	0.327
Other Liabilities	0.414	0.083	0.054
Subordinated Notes and Debentures	0.256	0.052	0.024
Non-interest Bearing Deposits, Domestic	0.204	0.095	0.125
Equity	0.150	0.080	0.103
Interest Bearing Deposits, Domestic	0.127	0.071	0.369
Non-volatile Liabilities and Equity	0.112	0.076	0.673

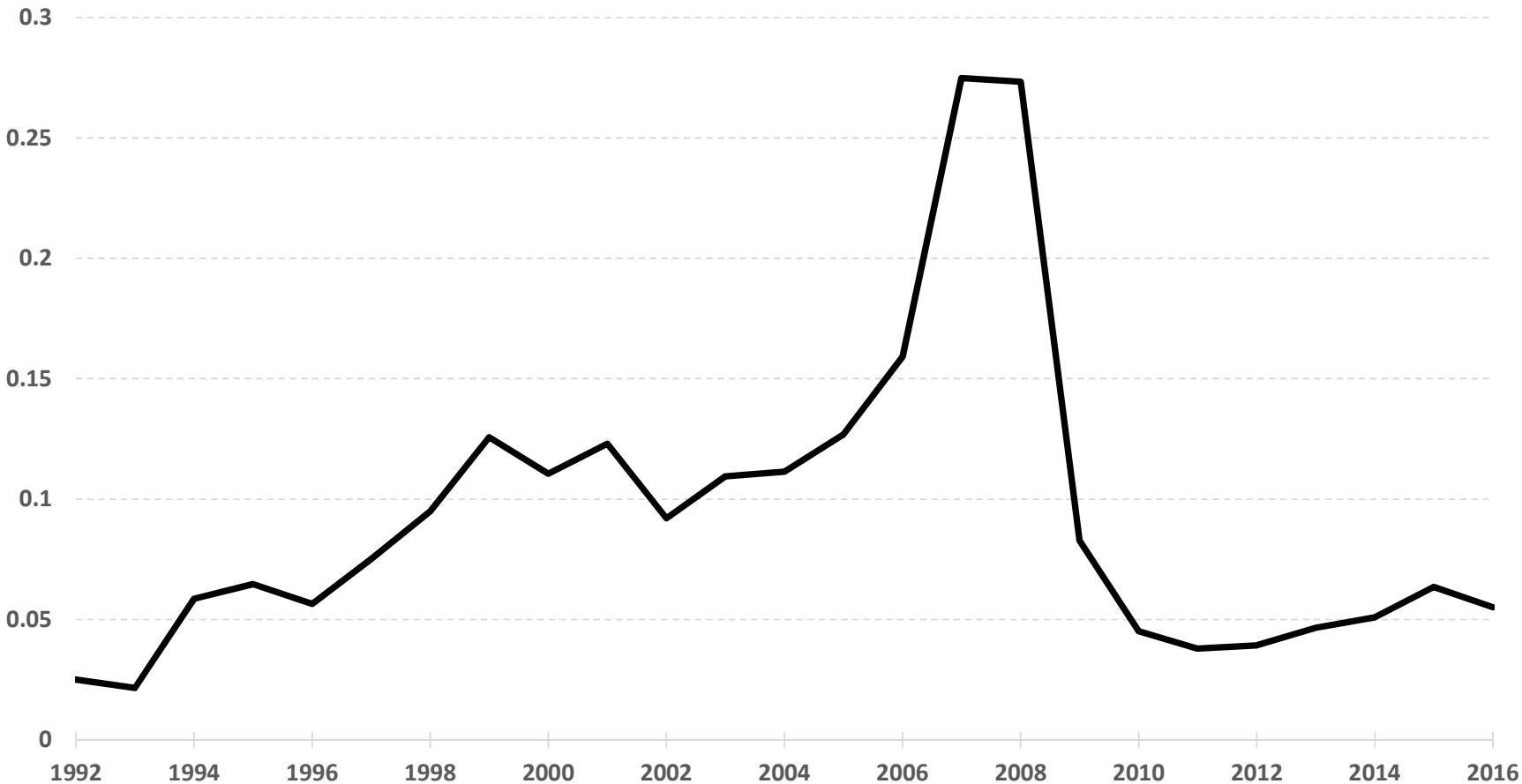
Liquidity Gap

Distribution over Time



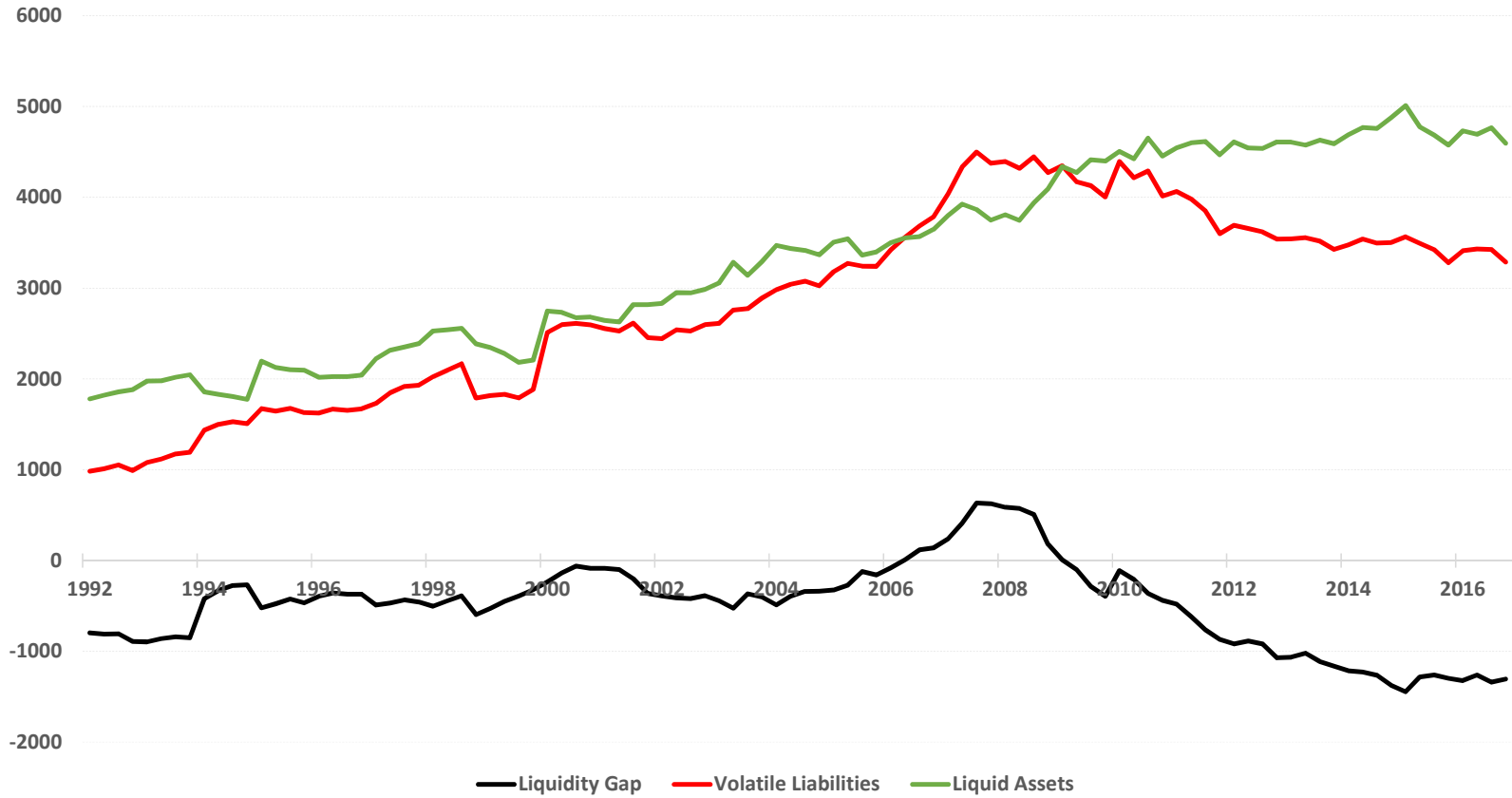
Liquidity Gap

% of Banks with Positive Liquidity Gap



Liquidity Gap Properties

Aggregate Liquidity Gap ($bn)



▸ Composition

Extending the Sample with COMPUSTAT

- LG is computed based on Y9-C data from 1991-2016
- We project LG using COMPUSTAT data and extend the sample back to 1974
  - 7 accounting variables including short-term, long-term debt, equity, cash can explain over 90% of LG variation

▸ Regression Tables

Portfolio Sorts & Factor Regressions

- Baseline sample
  - Period: 1974 - 2016
  - $\sim$ 155,000 BHC-month return observations
  - 1,092 unique BHC's, with $\sim$ 300 per year
- We follow Fama and French (1993)
  - Sort stocks and form portfolios from January - December of year t using LG in December of year $t-1$
  - Rebalance annually
  - Analyze monthly excess returns for liquidity-gap-sorted portfolios
- We run linear factor regressions $r^e_{p,t+1} = \alpha_p + \beta_p' f_{t+1} + \epsilon_{p,t+1}$
  - $r^e_{p,t+1}$: monthly excess returns
  - f_{t+1}: risk factors
  - β_p: loadings on the factors

Portfolio Sorts & Factor Regressions

Model specifications

- Raw excess returns
- CAPM
- Fama-French 3-factor model
- Baseline 8-factor model

$$f_t = [market \quad smb \quad hml \quad rmw \quad cma \quad ltg \quad crd \quad ps]$$

  - Fama-French 5 factors
  - Bond risk factors: long-term interest rate risk (ltg), credit risk (crd)
  - Pastor-Stambaugh liquidity factor (ps)

Alphas

VW - Sample Period: 1974 - 2016

	Low	(2)	(3)	(4)	High	Low-High
			Panel A. Alphas			
Excess Returns	0.096***	0.089***	0.086***	0.081**	0.063	**0.033**
	(3.29)	(2.99)	(2.61)	(2.46)	(1.60)	**(1.61)**
CAPM alpha	0.037*	0.033	0.021	0.013	-0.017	**0.055*** **
	(1.86)	(1.46)	(0.95)	(0.50)	(-0.67)	**(2.84)**
3-factor alpha	0.004	-0.004	-0.024	-0.028	-0.069***	**0.073*** **
	(0.25)	(-0.21)	(-1.33)	(-1.22)	(-3.54)	**(3.73)**
8-factor alpha	0.017	-0.001	-0.009	-0.018	-0.043**	**0.060*** **
	(0.91)	(-0.04)	(-0.42)	(-0.77)	(-2.17)	**(2.93)**
N	516	516	516	516	516	516

t statistics in parentheses

* p<0.10, ** p<0.05, *** p<0.01

- Results also hold for equal-weighted and decile portfolios

▸ Factor Loadings

Controlling for Bank Characteristics

- Can bank characteristics correlated with LG explain these results?

Portfolio	Lo	2	3	4	Hi	Mean	Std Dev
Liquidity Gap	-0.37	-0.25	-0.19	-0.13	-0.02	-0.19	0.16
Assets, Bil. $	4.16	8.15	14.04	23.11	73.51	24.60	149.98
Return on Assets, %	3.44	3.00	2.60	2.60	2.40	2.80	7.60
Equity/Assets, %	9.72	9.63	9.38	9.27	9.00	9.40	2.41
Charge-offs/TA, %	0.33	0.47	0.55	0.58	0.68	0.52	0.96

Controlling for Bank Characteristics

Double Sorts

- Size effect – *Gandhi-Lustig (2015)*
- Profitability – *ROA*
- Risk Substitution
  - Leverage – *equity/assets* – *Bouwman et.al.(2017)*
  - Asset quality – *charge-offs*
  - Risk management – *tail risk*

Controlling for Bank Characteristics

Size Effect?

- Gandhi-Lustig (2015) show that large banks earn a significantly low return relative to smaller banks even though they are highly levered and connect it to a TBTF subsidy
- We test the robustness of our results to size effects
  - Augment our baseline model with a financial-specific size factor
  - Double sort
  - Control for size in cross-sectional regressions

Controlling for Bank Characteristics

Size Effect?

	(1)	(2)	(3)	(4)	(5)	(6)
Alpha	**0.028**	**0.008**	**0.008**	**0.007**	**-0.018**	**0.045****
	(1.44)	**(0.40)**	**(0.41)**	**(0.33)**	**(-0.90)**	**(2.28)**
β^{M}	0.701***	0.728***	0.716***	0.702***	0.868***	-0.167***
	(15.87)	(14.06)	(13.98)	(10.15)	(14.19)	(-3.01)
β^{smb}	0.311***	0.383***	0.355***	0.308***	0.274***	0.038
	(4.64)	(6.21)	(6.05)	(3.58)	(3.70)	(0.52)
β^{hml}	0.516***	0.661***	0.801***	0.733***	1.022***	-0.506***
	(5.62)	(9.21)	(11.37)	(7.55)	(10.79)	(-3.97)
β^{rmw}	-0.000	0.002***	0.001*	0.004***	0.001	-0.001
	(-0.06)	(3.33)	(1.65)	(3.57)	(1.41)	(-1.44)
β^{cma}	-0.001	-0.002**	-0.002**	-0.001	-0.004**	0.003
	(-0.56)	(-1.99)	(-2.11)	(-1.04)	(-2.39)	(1.51)
β^{ltg}	-0.040	0.103	-0.005	0.079	0.129	-0.170
	(-0.35)	(1.00)	(-0.06)	(0.65)	(1.10)	(-1.06)
β^{crd}	0.035	-0.049	0.144	0.036	0.016	0.018
	(0.21)	(-0.30)	(0.90)	(0.19)	(0.09)	(0.09)
β^{ps}	-0.036	-0.104**	-0.149***	-0.191***	-0.169***	0.132**
	(-0.92)	(-2.30)	(-2.70)	(-3.19)	(-2.72)	(1.99)
$\beta^{smb^{fin}}$	**-0.262*** **	**-0.212*** **	**-0.403*** **	**-0.614*** **	**-0.611*** **	**0.348*** **
	(-4.28)	**(-3.77)**	**(-7.64)**	**(-7.74)**	**(-9.78)**	**(4.76)**

* p<0.10, ** p<0.05, *** p<0.01

Controlling for Bank Characteristics

Size Effect?

Portfolio	Low	(2)	(3)	(4)	High	Low-High
			Panel A. Size (total assets)			
Small	0.025	0.001	-0.001	-0.009	-0.015	0.040**
	(1.19)	(0.03)	(-0.04)	(-0.43)	(-0.64)	(2.55)
Medium	0.011	-0.014	0.006	-0.019	-0.036*	0.047***
	(0.61)	(-0.68)	(0.31)	(-0.92)	(-1.72)	(2.92)
Big	0.004	-0.021	-0.021	-0.051**	-0.038*	0.042*
	(0.20)	(-0.92)	(-0.87)	(-2.38)	(-1.76)	(1.85)
N	516	516	516	516	516	516

* p<0.10, ** p<0.05, *** p<0.01

Controlling for Bank Characteristics

Profitability Effect?

Portfolio	Low	(2)	(3)	(4)	High	Low-High
			Profitability (return-on-assets)			
Low	0.046*	-0.016	-0.053*	0.003	-0.024	0.071**
	(1.84)	(-0.65)	(-1.77)	(0.13)	(-0.74)	(1.98)
Medium	0.010	-0.001	0.003	-0.018	-0.066***	0.076***
	(0.50)	(-0.07)	(0.11)	(-0.72)	(-2.80)	(3.10)
High	0.014	-0.011	-0.012	-0.018	-0.029	0.043*
	(0.72)	(-0.46)	(-0.64)	(-0.79)	(-1.36)	(1.78)

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Controlling for Bank Characteristics

Risk Substitution Effect?

Portfolio	Low	(2)	(3)	(4)	High	Low-High
Panel A. Leverage (total asset/common equity)						
Low	0.008	-0.010	-0.037*	-0.018	-0.024	0.032
	(0.38)	(-0.50)	(-1.72)	(-1.00)	(-1.10)	(1.31)
Medium	0.022	0.013	-0.010	-0.022	0.007	0.015
	(0.97)	(0.56)	(-0.40)	(-0.93)	(0.33)	(0.66)
High	0.016	-0.009	-0.014	-0.054**	-0.043	**0.059***
	(0.71)	(-0.37)	(-0.49)	(-2.05)	(-1.61)	(1.76)
Panel B. Charge-offs (net charge-offs over total assets)						
Low	0.026	-0.014	-0.002	-0.034	-0.035	0.061**
	(1.08)	(-0.56)	(-0.09)	(-1.29)	(-1.56)	(2.38)
Medium	0.014	-0.006	-0.012	-0.059**	-0.072***	0.085***
	(0.69)	(-0.28)	(-0.57)	(-2.48)	(-2.74)	(2.71)
High	0.023	-0.008	0.009	-0.010	0.000	0.023
	(1.09)	(-0.36)	(0.40)	(-0.45)	(0.00)	(0.95)
N	516	516	516	516	516	516

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▸ Other Risks ▸ Other Controls

Fama-Macbeth Regressions (1992 - 2016)

	(1)	(2)	(3)	(4)	(5)
Liquidity Gap	**-0.094***	**-0.067***	**-0.063**	**-0.076***	**-0.068****
	(-1.89)	**(-1.75)**	**(-1.61)**	**(-1.95)**	**(-2.06)**
β^{M}		0.015	0.016	0.013	0.019
		(0.32)	(0.34)	(0.29)	(0.44)
β^{smb}		0.032	0.032	0.033	0.041*
		(1.46)	(1.36)	(1.45)	(1.88)
β^{hml}		-0.009	-0.009	-0.009	-0.001
		(-0.31)	(-0.29)	(-0.32)	(-0.04)
Size			0.0478	0.0382	-0.0125
			(0.51)	(0.42)	(-0.15)
Equity/Assets				-0.684**	-0.953
				(-2.49)	(-1.03)
Net Charge-offs					-3.604**
					(-2.48)
Non-interest Income Share					0.000
					(1.22)
Tail Risk					-1.274***
					(-2.61)
ROA					-0.006
					(-0.62)
Z-score					0.015***
					(2.67)
B/M					0.240
					(0.32)
Constant	0.115***	0.102***	0.101***	0.162***	-0.081
	(2.75)	(3.33)	(3.22)	(3.73)	(-0.11)
R^2	1.14	13.61	14.40	15.41	21.30
Number of observations	70722	70722	69242	69242	64143
Number of periods	288	288	288	288	288

More Robustness Tests

Results are also robust to:

- Alternative variants of liquidity gap
  - With/without off-balance sheet items
  - Expanded definition for volatile liabilities
- NSFR proxy

▸ Tables

What Drives the Liquidity Risk Anomaly?

a. Liquidity Gap Components

	Low	(2)	(3)	(4)	High	Low-High
Panel A. Alphas - Liquidity Gap						
3-factor alpha	0.040*	0.006	-0.008	-0.011	-0.073***	**0.113*** **
	(1.78)	(0.27)	(-0.32)	(-0.43)	(-2.95)	**(4.26)**
8-factor alpha	0.047**	0.026	0.029	0.038	-0.015	**0.062** **
	(1.98)	(1.04)	(0.98)	(1.25)	(-0.60)	**(2.53)**
Panel B. Alphas - Volatile Liabilities / Total Liabilities						
3-factor alpha	0.023	0.018	0.003	-0.038	-0.050**	**0.073*** **
	(1.02)	(0.68)	(0.12)	(-1.52)	(-2.38)	**(3.74)**
8-factor alpha	0.035	0.031	0.021	-0.005	0.011	0.024
	(1.54)	(1.07)	(0.85)	(-0.19)	(0.41)	(1.04)
Panel C. Alphas - Liquid Assets / Total Liabilities (reverse order)						
3-factor alpha	-0.058**	-0.022	-0.029	0.000	-0.064*	0.005
	(-2.37)	(-0.66)	(-1.11)	(-0.01)	(-1.93)	(0.16)
8-factor alpha	0.022	-0.021	0.005	0.036	-0.035	0.057
	(-0.69)	(-0.55)	(0.18)	(-1.07)	(-1.17)	(1.38)
N	300	300	300	300	300	300

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

What Drives the Liquidity Risk Anomaly?

b. Endogenous Sorting?

- Lower risk premia for banks that – a priori – appear to be more exposed to liquidity risk is counterintuitive
- This is reminiscent of the distress risk puzzle for non-financials
  - *Campbell-Hilscher-Szilagyi (2008)*

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- This is reminiscent of the distress risk puzzle for non-financials
  - *Campbell-Hilscher-Szilagyi (2008)*
- Endogenous sorting argument?
  - See Kashyap et.al. (2002), Gatev-Strahan (2009), Gatev et.al. (2009), Cornett et.al. (2011) on synergies between deposit taking and liquidity provision
  - Banks that appear safer from a liquidity mismatch perspective are in fact responding endogenously to a higher exposure to some systematic liquidity risk
  - Conversely, banks that take on more liquidity mismatch can have better access to liquidity in period of stress
    - Outside liquidity: equity issuance is less costly
    - Inside liquidity: higher interconnectedness/information, have faster access to trading markets, incur a lower fire sale discount
    - Better access to the lender of last resort

What Drives the Liquidity Risk Anomaly?

b. Endogenous Sorting?

- If this argument is true, we should see higher liquidity gap banks outperforming in crisis times

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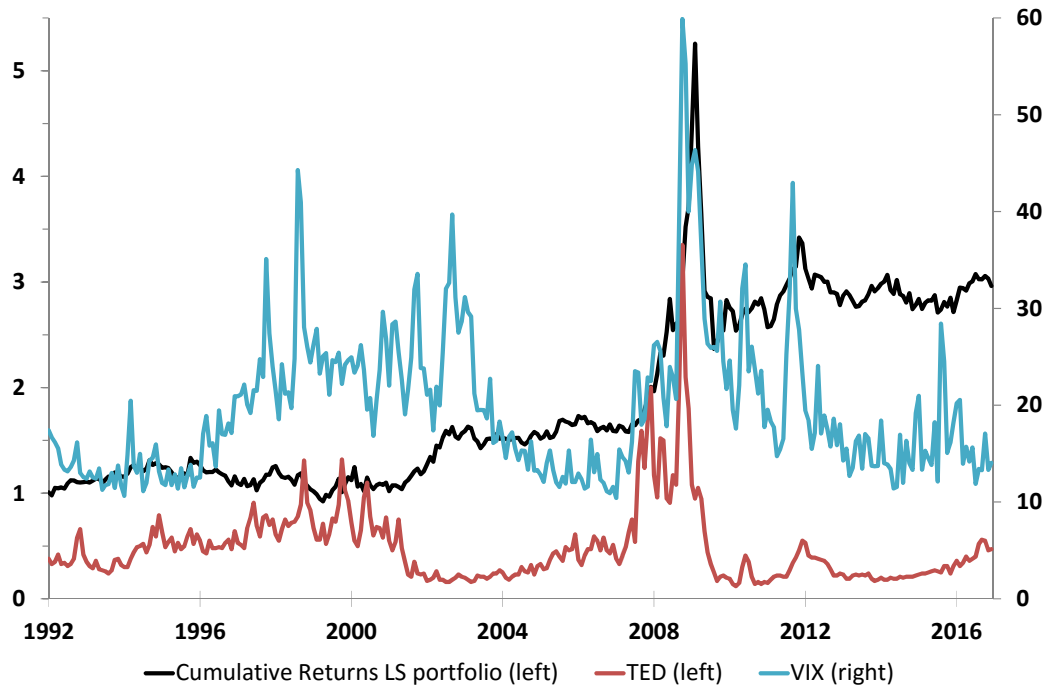
b. Endogenous Sorting?

- If this argument is true, we should see higher liquidity gap banks outperforming in crisis times
  - We find the opposite!



- Corr(α_{LS}, VIX) $= 0.21^{***}$
- Corr(α_{LS}, TED spread) $= 0.19^{***}$

What Drives the Liquidity Risk Anomaly?

c. Mispricing? - Pre vs. Post Crisis

	Low	(2)	(3)	(4)	High	Low-High
			Panel A. Alphas - 1974 - 1991			
Excess Returns	0.090*	0.072	0.070	0.027	0.025	0.064**
	(1.89)	(1.42)	(1.33)	(0.48)	(0.39)	(2.19)
CAPM alpha	0.038	0.018	0.008	-0.041	-0.051	0.089***
	(1.38)	(0.60)	(0.28)	(-1.27)	(-1.45)	(3.52)
3-factor alpha	0.009	-0.017	-0.032	-0.060*	-0.091***	0.101***
	(0.36)	(-0.63)	(-1.16)	(-1.89)	(-2.92)	(3.82)
8-factor alpha	0.010	-0.020	-0.009	-0.046	-0.076**	0.086***
	(0.35)	(-1.09)	(-0.33)	(-1.13)	(-2.25)	(2.70)
N	216	216	216	216	216	216
			Panel B. Alphas - 1992 - 2007			
Excess Returns	0.145***	0.121***	0.085*	0.123***	0.092**	0.053*
	(4.00)	(3.04)	(1.96)	(3.31)	(2.11)	(1.83)
CAPM alpha	0.108***	0.083**	0.042	0.078**	0.026	0.082***
	(2.95)	(2.11)	(1.03)	(2.12)	(0.68)	(2.87)
3-factor alpha	0.056*	0.017	-0.023	0.021	-0.036	0.093***
	(1.84)	(0.69)	(-0.76)	(0.71)	(-1.27)	(3.43)
8-factor alpha	0.039	0.011	-0.018	0.017	-0.029	0.068***
	(1.45)	(0.45)	(-0.65)	(0.60)	(-1.07)	(2.76)
N	192	192	192	192	192	192

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

What Drives the Liquidity Risk Anomaly?

Mispricing? - Pre vs. Post Crisis

	Low	(2)	(3)	(4)	High	Low-High
			Panel C. Alphas - 2008 - 2009			
Excess Returns	-0.003	-0.042	0.053	-0.179	-0.255	0.252
	(-0.02)	(-0.20)	(0.23)	(-0.64)	(-0.58)	(0.73)
CAPM alpha	0.054	0.041	0.137	-0.090	-0.102	0.156
	(0.43)	(0.35)	(1.16)	(-0.49)	(-0.54)	(0.89)
3-factor alpha	0.016	0.055	0.139	-0.133	-0.062	0.078
	(0.19)	(0.69)	(1.16)	(-1.53)	(-0.35)	(0.37)
8-factor alpha	-0.021	-0.028	0.263*	-0.167	0.021	-0.041
	(-0.15)	(-0.29)	(1.78)	(-0.97)	(0.16)	(-0.27)
N	24	24	24	24	24	24
			Panel D. Alphas - 2010 - 2016			
Excess Returns	0.130**	0.139*	0.154*	0.156**	0.119	0.012
	(2.15)	(1.91)	(1.93)	(2.15)	(1.49)	(0.35)
CAPM alpha	-0.017	-0.026	-0.004	-0.016	-0.057	0.039
	(-0.43)	(-0.47)	(-0.08)	(-0.32)	(-1.02)	(1.25)
3-factor alpha	0.001	-0.015	0.010	-0.006	-0.047	0.048
	(0.03)	(-0.34)	(0.23)	(-0.17)	(-1.18)	(1.57)
8-factor alpha	0.047	0.051	0.085**	0.067*	0.017	0.029
	(1.58)	(1.18)	(2.17)	(1.78)	(0.48)	(1.03)
N	84	84	84	84	84	84

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

What Drives the Liquidity Risk Anomaly?

c. Mispricing? - Pre vs. Post Crisis

- Sort by the complexity index, assigned by the Federal Reserve
  - Subjective measure $\{0, 1\}$
  - Reflects material credit-extending activity, high-risk non-bank financial activities, complex management practices
- More complex banks tend to exhibit larger differences
- Consistent with bank opacity, mis-measurement of liquidity mismatch/mispricing of liquidity risk

Portfolio	Low	(2)	(3)	(4)	High	Low-High
			Complexity			
Not Complex	0.068***	0.069**	0.042	0.065***	0.028	0.040**
	(3.40)	(2.57)	(1.54)	(2.60)	(1.00)	(2.32)
Complex	0.043	0.052*	0.017	0.019	-0.021	0.064**
	(1.50)	(1.82)	(0.53)	(0.64)	(-0.78)	(2.20)
N	288	288	288	288	288	288

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Liquidity Risk in Other Contexts

- Should we expect similar patterns in other contexts?

Liquidity Risk in Other Contexts

- Should we expect similar patterns in other contexts?
  - Hedge funds?
    Barth-Monin (2018) – Liquidity risk is priced and accounts for large portion of risk-adjusted returns
  - Non-financial institutions?
    Ortiz-Molina-Phillips (2014) – Asset illiquidity increases cost of capital;
    Gopalan-Song-Yerramili (2014) – High rollover risk lead to lower credit quality

Conclusion

- We take an empirical asset-pricing approach to explore the market's assessment of liquidity risk
  - How does liquidity mismatch on banks balance sheets affect their (risk-adjusted) stock returns?
- We show that banks with higher liquidity gap have lower expected returns
  - Long-short portfolio delivers statistically significant risk-adjusted alpha of 6 percent annually
- Results are robust to several asset pricing specifications, controlling for key bank characteristics such as size, profitability, and risk proxies, etc..
- Potential explanations are most likely related to market's under-estimation and potential mis-measurement of liquidity risk, particularly for more complex banks pre-crisis

Motivation

- **Liquidity Coverage Ratio**
  - Requires banks to hold sufficient liquid assets on their balance sheets to withstand severe funding outflows over the next 30 days
- **Net Stability Funding Ratio**
  - Ratio of long-term stable funding over long-term assets

Motivation

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- "Little is known about how one should regulate bank liquidity" – *Allen-Gale (2017)*

Motivation

- **Liquidity Coverage Ratio**
  - Requires banks to hold sufficient liquid assets on their balance sheets to withstand severe funding outflows over the next 30 days
- **Net Stability Funding Ratio**
  - Ratio of long-term stable funding over long-term assets

- "Little is known about how one should regulate bank liquidity" – *Allen-Gale (2017)*
- We argue that we know even less about how market participants perceive liquidity risk embedded in banks

Related Literature

Theory

- The link between banks' role as liquidity creators and financial fragility is at the core of banking theory
  - Bank runs
    Diamond-Dybvig (1983), Goldstein-Pauzner (2005)
  - Funding is excessively short-term
    Huang-Ratnovski (2011), Brunnermeier-Oehmke (2013), He-Milbradt (2016)

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  - Funding is excessively short-term
    Huang-Ratnovski (2011), Brunnermeier-Oehmke (2013), He-Milbradt (2016)

- The effect of liquidity mismatch on banks is ambiguous
  - Short-term debt as a disciplining device
    Calomiris-Khan (1991), Diamond-Rajan (2001)

▸ Literature

Related Literature

Empirical Evidence

- Gatev-Strahan (2009), Gatev et.al. (2009), Cornett et.al. (2011): synergies between deposit taking and liquidity provision
  - See *Kashyap et.al. (2002)*
  - Banks with higher exposure to credit line drawdowns (i.e., subject to illiquidity on asset side), typically receive high deposit inflows in crisis periods
    $\rightarrow$ Banks with high exposure to liquidity demand shocks are not necessarily the most fragile ones
- Acharya-Mora (2015), on the other hand, argue that this liquidity hedging mechanism was not at play during the financial crisis, until the government stepped in

▸ Literature

COMPUSTAT Extension

$$LG_{i,t} = \sum_{j=1}^{N} \beta_j x_{j,i,t} \quad \text{if year } > 2000$$

- $LG_{i,t}$ is the liquidity risk for each bank i at time t, $x_{j,i,t}$ is the j^{th} explanatory variable where $j = 1...N$
- Conduct in-sample regression performance by comparing actual and predicted values for 1991-2000
- Assumption is that BHC's management of liquidity is the same before and after 1991

Back

COMPUSTAT Extension

	(1) mismatch	(2) mismatch
CEQTA	0.0723	0.0981
	(2.99)	(3.92)
CHTA	-0.596	-0.370
	(-19.21)	(-11.99)
DLCTA	1.332	1.252
	(118.46)	(104.33)
DLTTTA	1.160	1.070
	(102.66)	(82.06)
IVAOTA	-0.744	-0.518
	(-71.37)	(-42.29)
RECTTA	0.314	0.551
	(32.27)	(47.73)
SALETA	0.195	0.0260
	(5.04)	(0.68)
Constant	-0.367	-0.559
	(-38.71)	(-54.58)
N	5478	5478
R^2	0.909	0.876

t statistics in parentheses

CEQ= Common Ordinary Equity - Total; CH= Cash; DLC= Debt in Current Liabilities - Total; DLTT= Long Term Debt - Total; IVAO =Investment and Advances - Other; RECT=Receivables - Total; SALE= Sales Turnover (Net).

Back

COMPUSTAT Extension

	(1) Actual	(2) Actual
Predicted, OLS	1.018*** (129.29)	
Predicted, with FE		1.055*** (121.88)
Constant	-0.00505** (-2.27)	0.00508** (2.10)
N	2730	2730
R^2	0.860	0.845

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Other Double Sorts

Portfolio	Low	(2)	(3)	(4)	High	Low-High
			Tail risk			
Low	0.040*	-0.007	0.009	-0.014	-0.020	0.058***
	(1.93)	(-0.35)	(0.47)	(-0.58)	(-0.97)	(3.66)
Medium	-0.009	-0.009	-0.017	-0.036	-0.038	0.045**
	(-0.45)	(-0.40)	(-0.81)	(-1.40)	(-1.45)	(2.54)
High	0.003	-0.025	0.017	-0.039	-0.067**	0.068***
	(0.10)	(-0.95)	(0.55)	(-1.20)	(-2.56)	(2.95)
			Default risk (z-score)			
Low	0.009	0.041	0.021	-0.005	0.018	0.043
	(0.27)	(1.25)	(0.61)	(-0.11)	(0.44)	(1.41)
Medium	0.029	0.044	0.043	-0.022	-0.021	0.039**
	(1.07)	(1.34)	(1.16)	(-0.63)	(-0.59)	(1.99)
High	0.042	0.013	0.024	0.035	0.025	0.037*
	(1.59)	(0.53)	(0.75)	(1.09)	(0.78)	(1.82)
			Non-interest income share			
Low	0.027	-0.008	0.028	-0.005	0.024	0.036*
	(0.88)	(-0.22)	(0.81)	(-0.16)	(0.55)	(1.71)
Medium	0.032	0.002	0.020	-0.014	-0.005	0.041*
	(1.17)	(0.07)	(0.66)	(-0.40)	(-0.13)	(1.88)
High	0.037	0.026	0.026	0.050	0.014	0.035*
	(1.24)	(0.91)	(0.99)	(1.17)	(0.54)	(1.85)

* p<0.10, ** p<0.05, *** p<0.01

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More Robustness

Low	(2)	(3)	(4)	High	Low-High
Panel A. Use Measure with Off Balance Sheet Items					
0.025	0.013	-0.005	-0.008	-0.025	0.050
(1.36)	(0.64)	(-0.20)	(-0.31)	(-1.08)	(3.11)
Panel B. Expanded Volatile Liabilities					
0.016	0.021	0.005	0.000	-0.031	0.047
(0.83)	(1.03)	(0.24)	(0.01)	(-1.46)	(2.94)
Panel C. Sample period excluding financial crisis (1974-2007)					
0.032	0.017	0.000	0.017	-0.022	0.054
(1.55)	(0.79)	(0.00)	(0.73)	(-0.91)	(3.05)
Panel D. Using ex-dividend returns					
-0.012	-0.034	-0.039	-0.034	-0.084	0.073
(-0.63)	(-1.78)	(-1.92)	(-1.64)	(-3.81)	(4.17)

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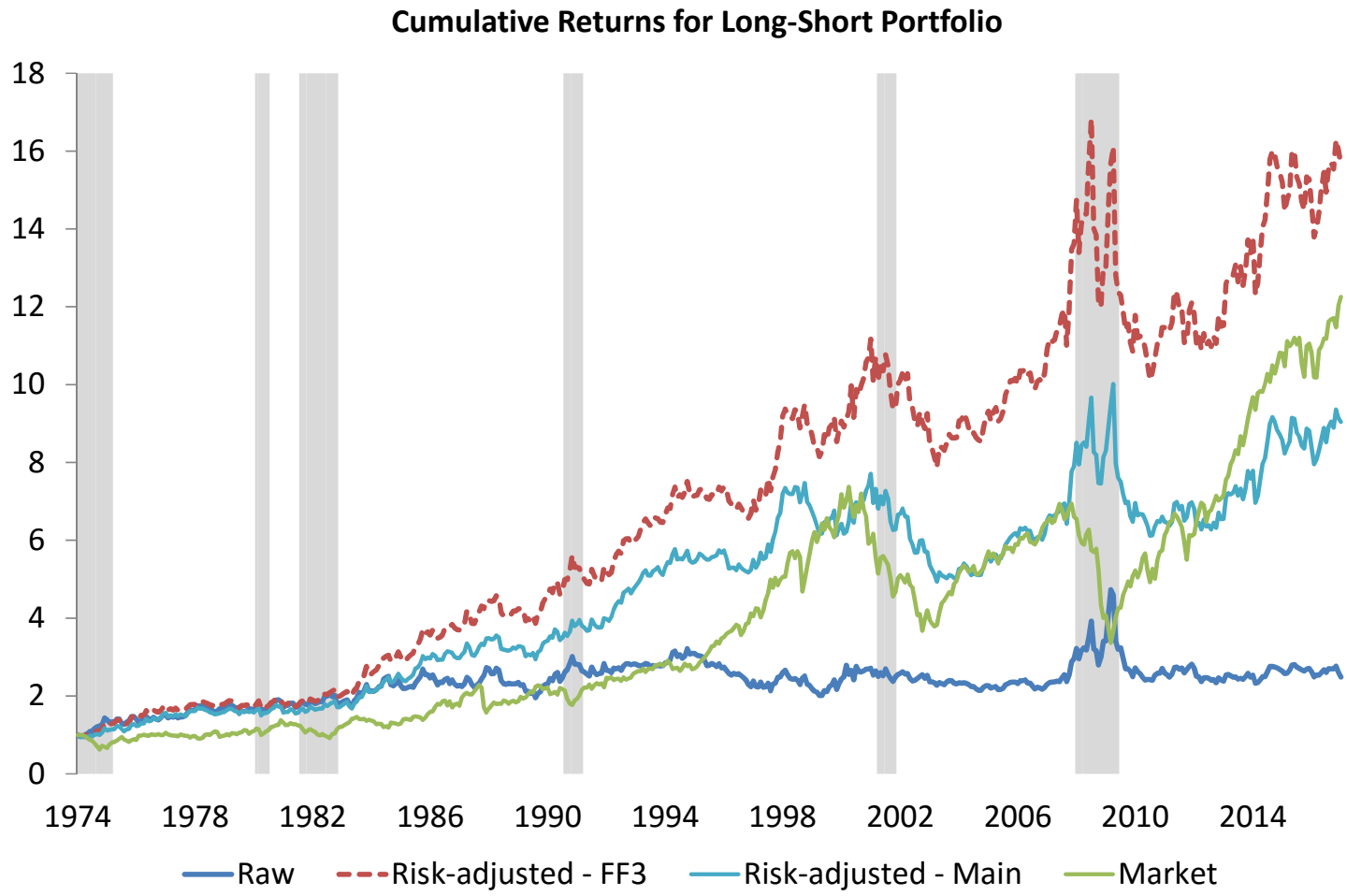
Cumulative Returns - LS portfolio

Sample Period: 1974-2016



Factor Loadings

Sample Period: 1974 - 2016

	Low	(2)	(3)	(4)	High	Low-High
	Panel D. 5-Factor Fama-French + ltg + crd + ps (regression coefficients)					
β^{M}	0.880***	0.873***	0.992***	1.122***	1.286***	-0.406***
	(18.88)	(24.26)	(24.52)	(17.06)	(20.25)	(-7.06)
β^{smb}	0.164**	0.264***	0.129**	-0.036	-0.069	0.233***
	(2.53)	(4.94)	(2.25)	(-0.36)	(-0.87)	(3.12)
β^{hml}	0.619***	0.744***	0.958***	0.974***	1.261***	-0.642***
	(7.29)	(9.61)	(9.99)	(7.84)	(9.05)	(-4.21)
β^{rmw}	-0.001	0.002***	0.000	0.002**	-0.000	-0.001
	(-0.85)	(2.66)	(0.43)	(2.39)	(-0.02)	(-0.64)
β^{cma}	-0.002	-0.003***	-0.004***	-0.004**	-0.006***	0.004**
	(-1.26)	(-2.60)	(-2.71)	(-2.19)	(-3.42)	(2.23)
β^{ltg}	0.011	0.145	0.075	0.200	0.250*	-0.238
	(0.09)	(1.31)	(0.79)	(1.31)	(1.75)	(-1.50)
β^{crd}	-0.070	-0.134	-0.017	-0.210	-0.228	0.158
	(-0.41)	(-0.76)	(-0.09)	(-0.88)	(-0.95)	(0.69)
β^{ps}	-0.054	-0.118**	-0.177***	-0.233***	-0.210**	0.156**
	(-1.23)	(-2.29)	(-2.61)	(-2.78)	(-2.49)	(2.00)

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Factor Loadings

Sample Period: 1974-2016

	Low	(2)	(3)	(4)	High	Low-High
	Panel D. 5-Factor Fama-French + ltg + crd + ps (regression coefficients)					
β^{M}	**0.880*** (18.88)**	**0.873*** (24.26)**	**0.992*** (24.52)**	**1.122*** (17.06)**	**1.286*** (20.25)**	**-0.406*** (-7.06)**
β^{smb}	0.164** (2.53)	0.264*** (4.94)	0.129** (2.25)	-0.036 (-0.36)	-0.069 (-0.87)	0.233*** (3.12)
β^{hml}	0.619*** (7.29)	0.744*** (9.61)	0.958*** (9.99)	0.974*** (7.84)	1.261*** (9.05)	-0.642*** (-4.21)
β^{rmw}	-0.001 (-0.85)	0.002*** (2.66)	0.000 (0.43)	0.002** (2.39)	-0.000 (-0.02)	-0.001 (-0.64)
β^{cma}	-0.002 (-1.26)	-0.003*** (-2.60)	-0.004*** (-2.71)	-0.004** (-2.19)	-0.006*** (-3.42)	0.004** (2.23)
β^{ltg}	0.011 (0.09)	0.145 (1.31)	0.075 (0.79)	0.200 (1.31)	0.250* (1.75)	-0.238 (-1.50)
β^{crd}	-0.070 (-0.41)	-0.134 (-0.76)	-0.017 (-0.09)	-0.210 (-0.88)	-0.228 (-0.95)	0.158 (0.69)
β^{ps}	-0.054 (-1.23)	-0.118** (-2.29)	-0.177*** (-2.61)	-0.233*** (-2.78)	-0.210** (-2.49)	0.156** (2.00)

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Factor Loadings

Sample Period: 1974-2016

	Low	(2)	(3)	(4)	High	Low-High
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β^{smb}	0.164**	0.264***	0.129**	-0.036	-0.069	0.233***
	(2.53)	(4.94)	(2.25)	(-0.36)	(-0.87)	(3.12)
β^{hml}	0.619***	0.744***	0.958***	0.974***	1.261***	-0.642***
	(7.29)	(9.61)	(9.99)	(7.84)	(9.05)	(-4.21)
β^{rmw}	-0.001	0.002***	0.000	0.002**	-0.000	-0.001
	(-0.85)	(2.66)	(0.43)	(2.39)	(-0.02)	(-0.64)
β^{cma}	-0.002	-0.003***	-0.004***	-0.004**	-0.006***	0.004**
	(-1.26)	(-2.60)	(-2.71)	(-2.19)	(-3.42)	(2.23)
β^{ltg}	**0.011**	**0.145**	**0.075**	**0.200**	**0.250***	**-0.238**
	(0.09)	**(1.31)**	**(0.79)**	**(1.31)**	**(1.75)**	**(-1.50)**
β^{crd}	-0.070	-0.134	-0.017	-0.210	-0.228	0.158
	(-0.41)	(-0.76)	(-0.09)	(-0.88)	(-0.95)	(0.69)
β^{ps}	-0.054	-0.118**	-0.177***	-0.233***	-0.210**	0.156**
	(-1.23)	(-2.29)	(-2.61)	(-2.78)	(-2.49)	(2.00)

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

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Controlling for Bank Characteristics

Risk Substitution Effect?

Portfolio	Low	(2)	(3)	(4)	High	Low-High
Panel A. Leverage (total asset/common equity)						
Low	0.008	-0.010	-0.037*	-0.018	-0.024	0.032
	(0.38)	(-0.50)	(-1.72)	(-1.00)	(-1.10)	(1.31)
Medium	0.022	0.013	-0.010	-0.022	0.007	0.015
	(0.97)	(0.56)	(-0.40)	(-0.93)	(0.33)	(0.66)
High	0.016	-0.009	-0.014	-0.054**	-0.043	0.059*
	(0.71)	(-0.37)	(-0.49)	(-2.05)	(-1.61)	(1.76)
Panel B. Tail risk						
Low	0.040*	-0.007	0.009	-0.014	-0.020	0.060**
	(1.93)	(-0.35)	(0.47)	(-0.58)	(-0.97)	(2.55)
Medium	-0.009	-0.009	-0.017	-0.036	-0.038	0.028
	(-0.45)	(-0.40)	(-0.81)	(-1.40)	(-1.45)	(0.94)
High	0.003	-0.025	0.017	-0.039	-0.067**	0.069**
	(0.10)	(-0.95)	(0.55)	(-1.20)	(-2.56)	(2.14)
Panel C. Charge-offs (net charge-offs over total assets)						
Low	0.026	-0.014	-0.002	-0.034	-0.035	0.061**
	(1.08)	(-0.56)	(-0.09)	(-1.29)	(-1.56)	(2.38)
Medium	0.014	-0.006	-0.012	-0.059**	-0.072***	0.085***
	(0.69)	(-0.28)	(-0.57)	(-2.48)	(-2.74)	(2.71)
High	0.023	-0.008	0.009	-0.010	0.000	0.023
	(1.09)	(-0.36)	(0.40)	(-0.45)	(0.00)	(0.95)
N	516	516	516	516	516	516

* p<0.10, ** p<0.05, *** p<0.01

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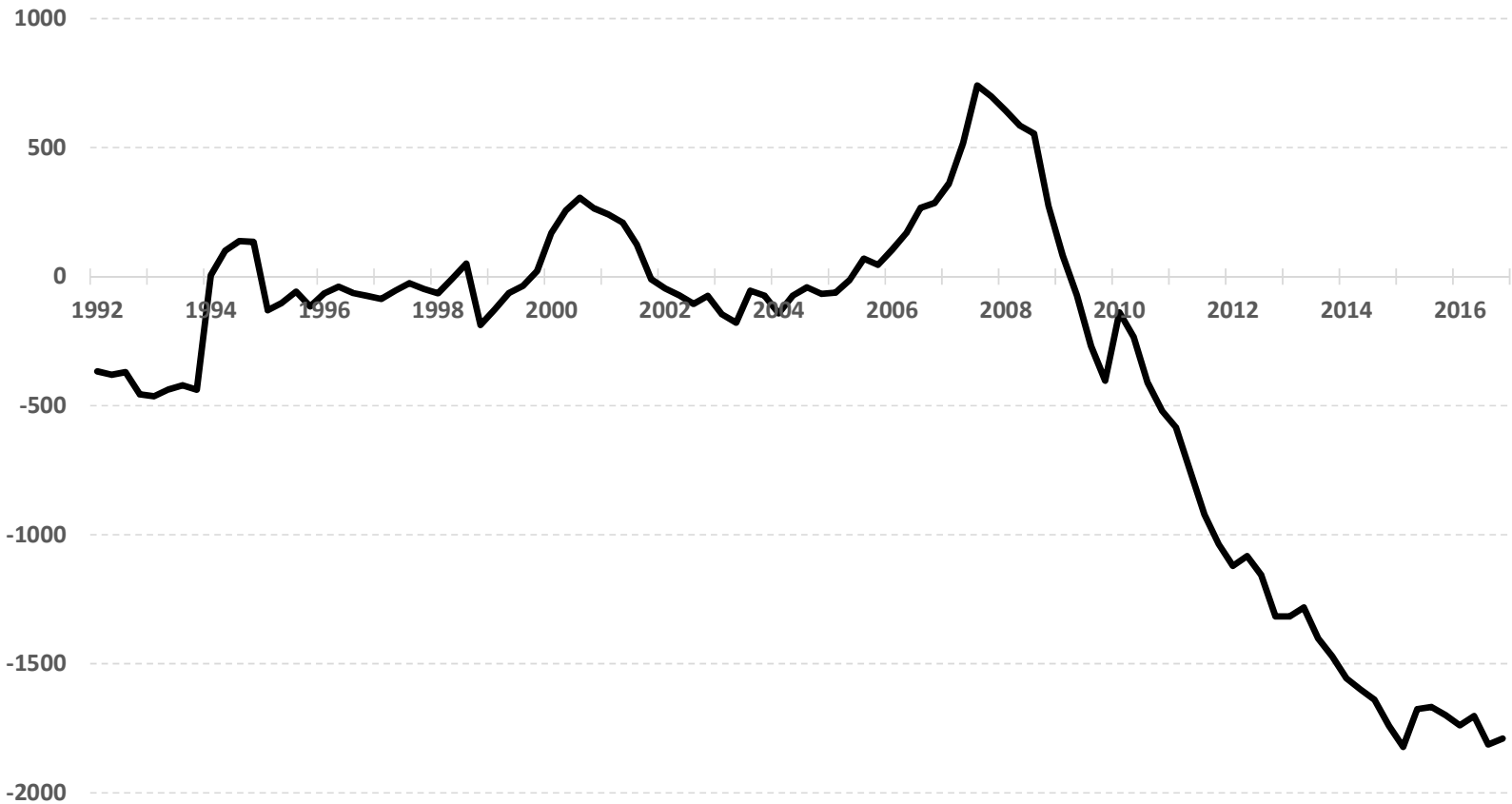
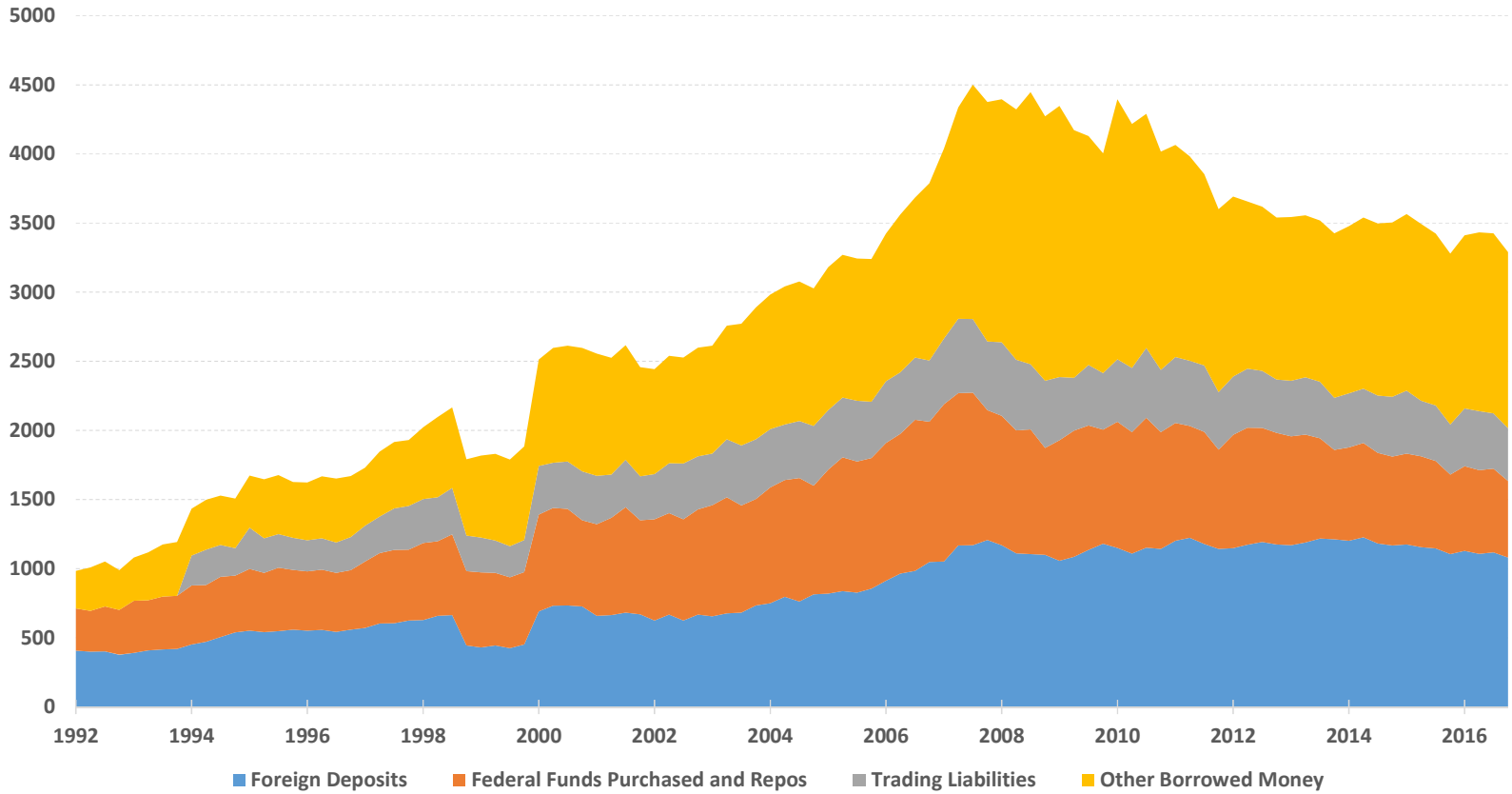
Liquidity Gap

Aggregate Liquidity Gap ($bn)



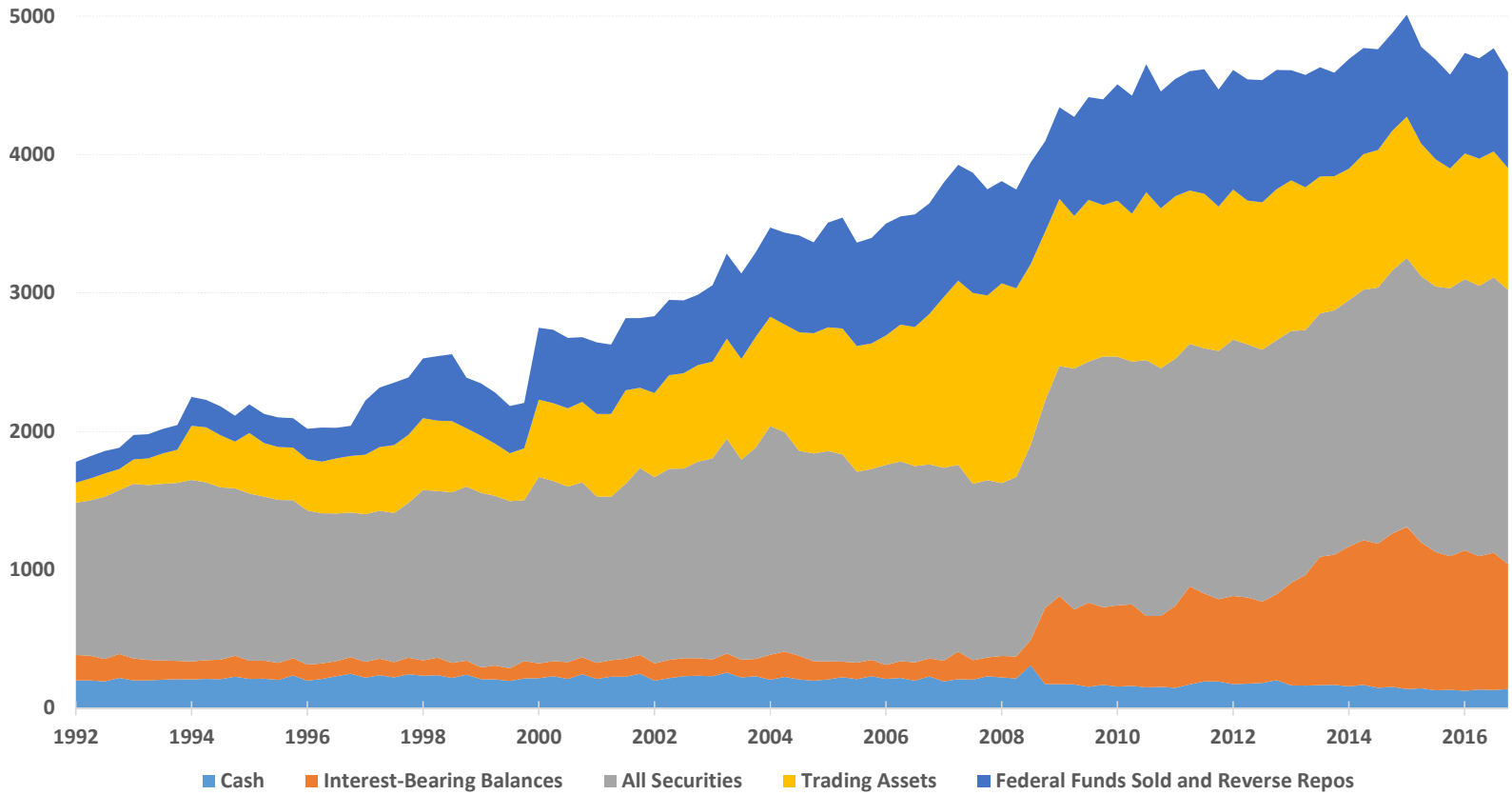
Liquidity Gap Properties

Aggregate Volatile Liabilities ($bn)



Liquidity Gap Properties

Aggregate Liquid Assets($bn)



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