Does market liquidity explain the idiosyncratic volatility puzzle in the Chinese stock market?

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Disclosure

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Introduction

- Does idiosyncratic volatility predict stock return in US market?
  - Inconsistent evidences depending on how tests are constructed
    - No significant relation: Fama and MacBeth (1973) , Bali and Cakici (2008).
    - Positive relation: Malkiel and Xu (2006), Chichernea, Ferguson and Kassa (2015),
    - **Negative relation :** Ang et al. (2006), Chen et al. (2012)
      - Practitioners tend to believe this more than others
  - What are responsible for the negative premium if exists at all?
    - Irrational preference for risk + Institution benchmark constraint(Baker, Bradley and Wurgler 2011)
    - Arbitrage Asymmetry (Stambaugh, Yu and Yuan 2015)
- Is the negative relation extendable to global?
  - Ang et al. (2006) and Cotter et al (2015) confirm in 23 other developed markets
  - Nartea et al. (2011) find no evidence of an idiosyncratic volatility puzzle in ASEAN
  - Bley and Saad (2012) confirm in Saudi Arabia and Qatar but none in Kuwait/Abu Dhabi.
  - Nartea et al. (2013) confirm in Chinese stock market
- **Today's topic**:
  - investigate this puzzle in Chinese stock market and how it is related to liquidity.

Outline

- Idiosyncratic volatility puzzle and Liquidity
- Background on Chinese stock market
- Idiosyncratic volatility puzzle in Chinese market
- Methodology
  - Estimation of idiosyncratic volatility
  - Choice of liquidity measure
  - Portfolio testing methodology
- Empirical results and discussions

Idiosyncratic volatility puzzle and Liquidity

- What are responsible for idiosyncratic volatility (IV) puzzle?
  - Small firms: Bali and Cakici (2008), Fu (2009)
  - Return reversals and liquidity: Huang et al. (2010), Han and Lesmond (2011)

- Is the liquidity premium explained by IV?
  - IV dominates liquidity in explaining x-sectional returns: Spiegel and Wang (2005)
  - The effect of liquidity costs may be confounded with that of risk: Constantinides (1986)

- Is the IV premium explained by liquidity?
  - YES: Huang et al. (2010); Fu (2009)
  - NO: Ang et al (2006, 2009)

Background on Chinese stock market

- Chinese stock market:
  - Is largest emerging market and is only second to the U.S. stock markets
  - Can be traded on different exchanges:
    - A/B: listed and trade on Shanghai and Shenzhen exchanges
      - MktCap: 2.9bn USD, Total ADV: 31bn USD
    - H/N/L/S: listed and trade on Hong Kong, New York, London, and Singapore
      - MktCap: 2.7bn USD, Total ADV: 5bn USD
  - Access for foreign investors
    - Stock Connect Program, QFII, RQFII etc
- Market Characteristic
  - Scarcity of publicly available information (Tian, Wan, and Guo, 2002)
  - High return synchronicity relative (Chen, Chen, and Kao, 2010)
  - Short sales are not allowed
  - Highly volatile

Idiosyncratic volatility puzzle in Chinese market

- Insignificant relation between IV and future returns:
  - Deng and Zheng (2011) argues that idiosyncratic volatility premium is an illusion of estimation noise
  - Liu (2013) indicates idiosyncratic volatility premium disappear after controlling common risk factors
- Negative relation between IV and future returns:
  - Chen, Tu and Lin (2009) finds a significant negative relationship between idiosyncratic volatility and the cross-section of expected returns
  - Nartea et al. (2013) provide evidence of a negative idiosyncratic volatility effect on stock returns in China,
- Our findings:
  - Equal-weighted portfolio exhibits positive volatility premium while value-weighted portfolio exhibits negative premium
  - The inconsistent relation can be explained by liquidity.

Estimation of idiosyncratic volatility

- Definition of idiosyncratic volatility
  - It is model dependent
  - Most common definition is the residual volatility in Fama and French three-factor model

$$r_{it} = \alpha_i + \beta_i^{mkt}(RM - RF)_t + \beta_i^{smb} SMB_t + \beta_i^{hml} HML_t + \varepsilon_{it}$$

- Two types of idiosyncratic volatility measure
  - Stock-level based measure (Ang, Hodrick, Xing, and Zhang 2006):
    - Sensitive to microstructure noise from individual stocks
      - Han and Lesmond (2011) show bid-ask noise yields an inflated estimate of IV theoretically
  - Portfolio-level based measure (Malkiel and Xu 2006) :
    - We prefer to use this measure due to our concern on liquidity/volalitilty interaction effects
      - **Step 1**: Idiosyncratic volatility for portfolios constructed June of each year is estimated
      - **Step 2**: Assign each portfolio's idiosyncratic volatility to stocks within the portfolio
    - Portfolios (5x5) are formed based on size and beta sorts (IV1)
      - To ensure robustness, we also looked based on based on size and book-to-mark (IV2)

Estimation of idiosyncratic volatility

- Summary statistics for 25 size-beta equally-weighted portfolios over the period of July, 2005 to June, 2016

Size group	Beta group: returns(%)[beta]<size (10^10)>					
	Lowest	2	3	4	Highest	Mean
Small	2.67	2.88	3.16	2.98	3.08	2.95
	[0.6985]	[0.8988]	[0.9935]	[1.0775]	[1.2635]	[0.9864]
	<0.1670>	<0.1604>	<0.1664>	<0.1699>	<0.1710>	<0.1669>
2	2.33	2.56	2.32	2.25	2.32	2.35
	[0.7481]	[0.9195]	[1.0107]	[1.1061]	[1.2886]	[1.0146]
	<0.2642>	<0.2600>	<0.2638>	<0.2578>	<0.2600>	<0.2611>
3	1.83	1.97	2.19	1.98	1.69	1.93
	[0.7269]	[0.9225]	[1.0328]	[1.1337]	[1.3051]	[1.0242]
	<0.4070>	<0.3837>	<0.3838>	<0.3820>	<0.3817>	<0.3876>
4	1.38	1.66	1.51	1.67	1.49	1.54
	[0.6762]	[0.9032]	[1.0299]	[1.1463]	[1.3596]	[1.0230]
	<0.6882>	<0.6731>	<0.6424>	<0.6087>	<0.6393>	<0.6503>
Big	0.69	1.22	1.18	0.98	0.87	0.99
	[0.5896]	[0.8778]	[1.0276]	[1.1797]	[1.4382]	[1.0226]
	<5.5571>	<3.8360>	<3.9680>	<3.7246>	<2.7053>	<3.9582>
Mean	1.78	2.06	2.07	1.97	1.89	1.95
	[0.6879]	[0.9044]	[1.0189]	[1.1287]	[1.3310]	[1.0142]
	<1.4167>	<1.0627>	<1.0849>	<1.0286>	<0.8315>	<1.0849>

Notes: The table reports the average (over time) of the equally-weighted of the variables for each portfolio. Within each cell, the top number is the average of the monthly equally-weighted portfolio returns in percent. The middle number is the average of the portfolio pre-ranking CAPM-betas. The bottom number is the average of the monthly market value of the portfolio in billions of RMB.

Estimation of idiosyncratic volatility

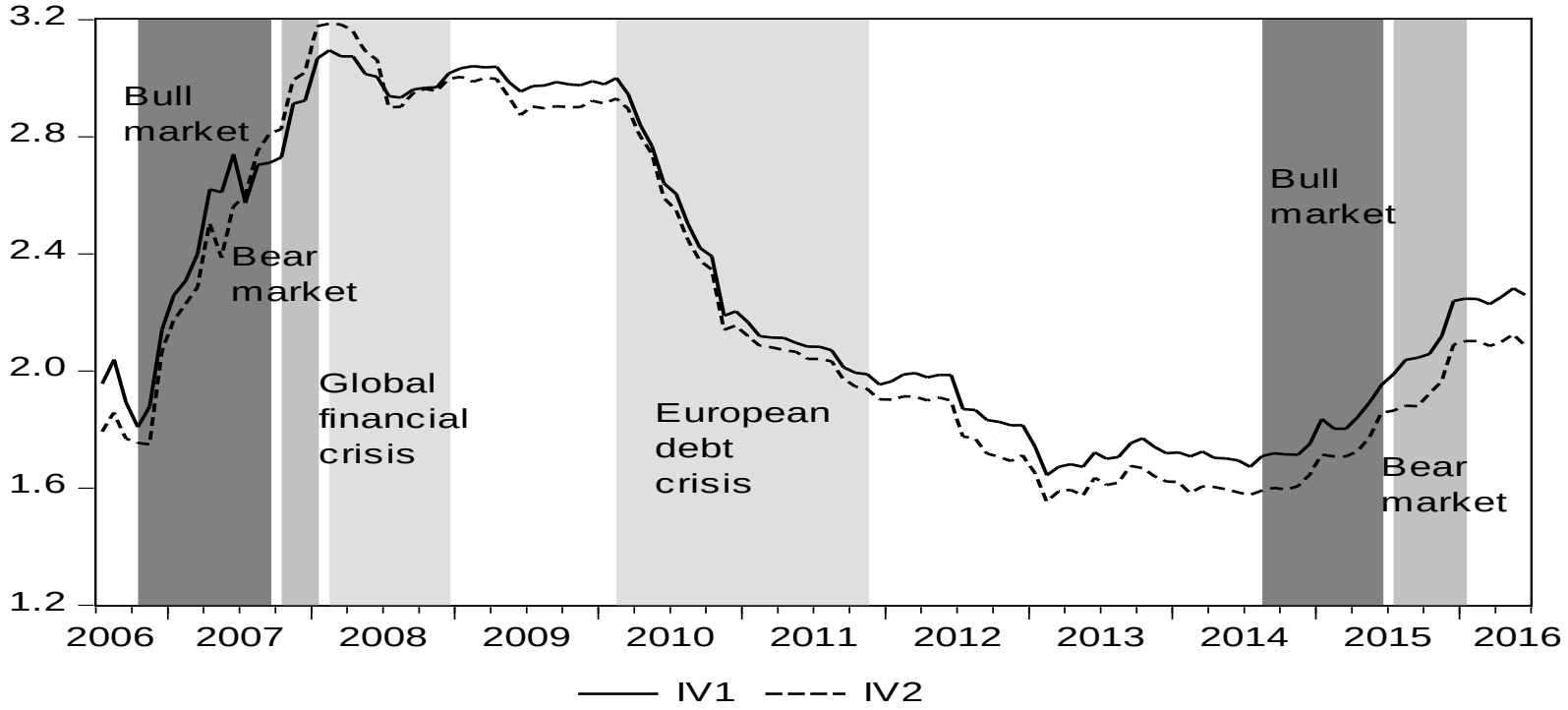
- Summary statistics for 25 size-book-to-market equally-weighted portfolios over the period of July, 2005 to June, 2016

Size group	Book to market group: returns(%)[beta]<size (10^10)>					
	Lowest	2	3	4	Highest	Mean
Small	2.66	2.74	3.10	3.09	3.19	2.95
	[0.9759]	[0.9764]	[0.9768]	[1.0021]	[1.0005]	[0.9864]
	<0.1522>	<0.1657>	<0.1690>	<0.1722>	<0.1756>	<0.1669>
2	2.02	2.27	2.30	2.67	2.52	2.35
	[0.939]	[1.0114]	[1.0110]	[1.0203]	[1.0364]	[1.0146]
	<0.2574>	<0.2608>	<0.2605>	<0.2571>	<0.2670>	<0.2612>
3	1.62	1.94	2.01	2.12	1.98	1.93
	[1.0028]	[0.9856]	[1.0216]	[1.0478]	[1.0634]	[1.0242]
	<0.3913>	<0.3965>	<0.3899>	<0.3856>	<0.3749>	<0.3876>
4	1.15	1.23	1.66	1.94	1.90	1.58
	[0.9506]	[0.9838]	[1.0323]	[1.0684]	[1.0830]	[1.0236]
	<0.6824>	<0.6518>	<0.6571>	<0.6283>	<0.6318>	<0.6503>
Big	0.28	0.59	1.06	1.42	1.56	0.98
	[0.8763]	[1.0125]	[1.0632]	[1.0754]	[1.0821]	[1.0219]
	<2.8525>	<2.3420>	<3.0899>	<4.8520>	<6.7203>	<3.9713>
Mean	1.55	1.75	2.02	2.25	2.23	1.96
	[0.9599]	[0.9939]	[1.0210]	[1.0428]	[1.0531]	[1.0141]
	<0.8672>	<0.7634>	<9.1328>	<1.2590>	<1.6345>	<1.0875>

Notes: The table reports the average (over time) of the equally-weighted of the variables for each portfolio. Within each cell, the top number is the average of the monthly equally-weighted portfolio returns in percent. The middle number is the average of the portfolio pre-ranking CAPM-betas. The bottom number is the average of the monthly market value of the portfolio in billions of RMB.

Estimation of idiosyncratic volatility

- Cross-sectional average of monthly IV1 and IV2 for Chinese A stocks



Notes: The table reports the average (over time) of the equally-weighted of the variables for each portfolio. Within each cell, the top number is the average of the monthly equally-weighted portfolio returns in percent. The middle number is the average of the portfolio pre-ranking CAPM-betas. The bottom number is the average of the monthly market value of the portfolio in billions of RMB.

Choice of liquidity measure

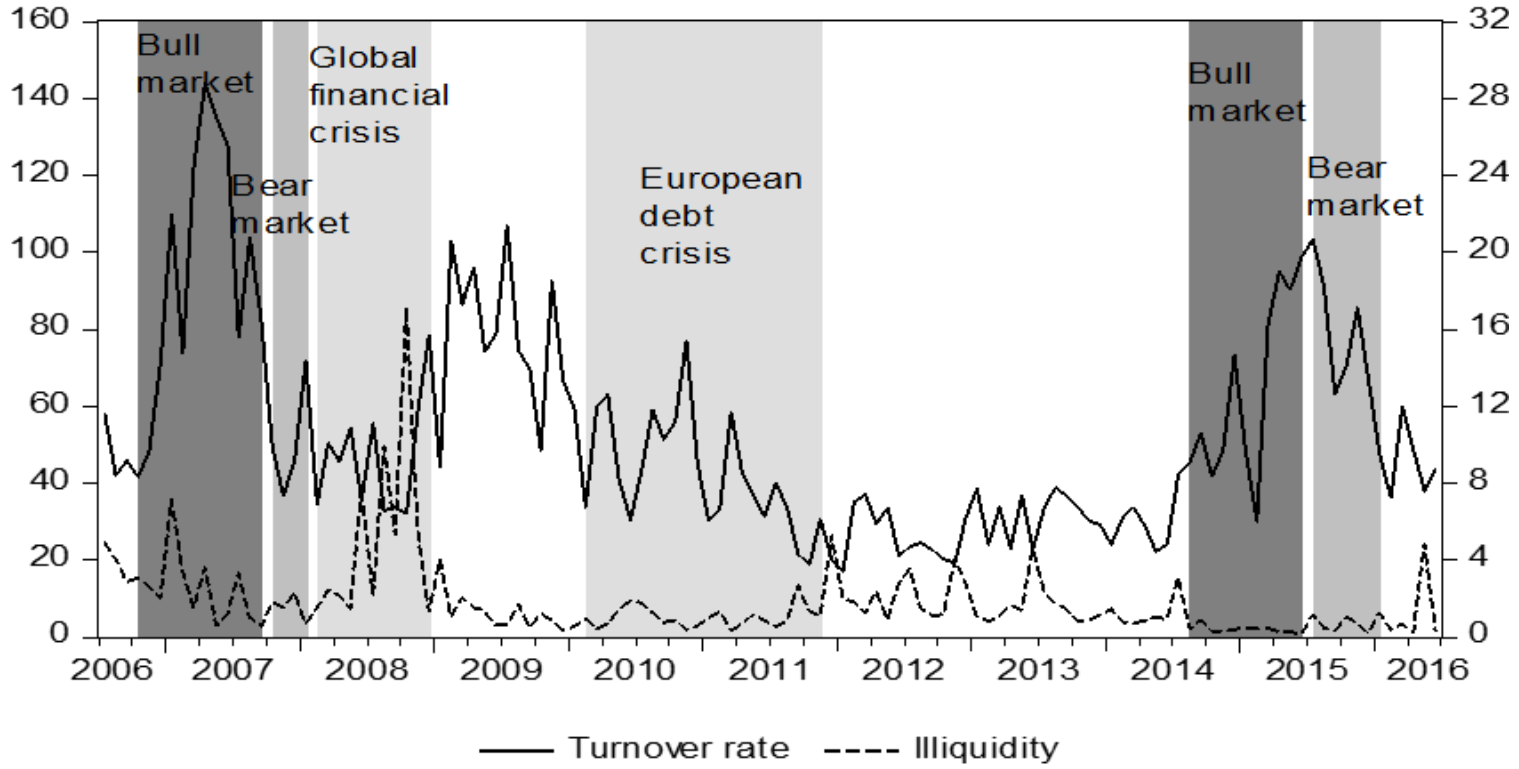
- Two types of liquidity measures
  - Direct liquidity measure based on Bid-ask spread and trading costs
    - Amihud and Mendelson 1986; Brennan and Subrahmanyam 1996
    - They are not easily available in Chinese market
  - Indirect liquidity measure based on trading volume and turnover
    - Rouwenhorst 1999; Levine and Schmukler 2006; Narayan and Zheng 2011
    - They are often used alternative measures in Chinese market.
- We considered two liquidity measures
  - Turnover rate: Datar, Naik, and Radcliffe(1998) provide theoretical footing that liquidity is correlated with trading frequency
  - Illiquidity measure: Amihud(2002) tries to capture the percentage change in price that is impacted by a trading volume of one dollar of a particular asset.

$$ILLIQ_{i,m} = \frac{1}{Day_{i,m}} \sum_{t=1}^{Day_{i,m}} \frac{\left|(P_{i,m,d} - P_{i,m,d-1}) / P_{i,m,d-1}\right|}{TV_{i,m,d}} \times 10^{10}$$

$Day_{i,m}$ is the number of trading days of stock i for month m; $\left|(P_{i,m,d} - P_{i,m,d-1}) / P_{i,m,d-1}\right|$ is the absolute value of the daily return for stock i, and $TV_{i,m,d}$ is the dollar trading volume for stock i.

Choice of liquidity measure

- Cross-sectional average of Liquidity and Turnover rate



Note: Liquidity is higher and increasing in the uptrend period of stock markets, such as the two bull market from the second half of 2006 to the first half of 2007 and from the second half of 2014 to June 2015, respectively, while lower and decreasing in the bear market and in times of financial crisis, such as the Global Financial Crisis of 2008, the European debt crisis of 2011 and the Chinese stock market crash of May 2015.

Portfolio Testing Methodology

- Quintile portfolios sorted by IV1 and IV2
  - Sort stocks based idiosyncratic volatility at month-end
  - Two types of portfolios are constructed: Equal-Weighted and Value-Weighted
- Time-series test
  - Explain whether liquidity levels can explain quintile portfolio return spread (High-Low)
  - Add the prior month's illiquidity level to the three-factor and four-factor model

$$(High-Low)_t = \alpha_0 + \alpha_1(RM-RF)_t + \alpha_2 SMB_t + \alpha_3 HML_t + \alpha_4 LIQ_{t-1} + \varepsilon_t$$

$$(High-Low)_t = \alpha_0 + \alpha_1(RM-RF)_t + \alpha_2 SMB_t + \alpha_3 HML_t + \alpha_4 MOM_t + \alpha_5 LIQ_{t-1} + \varepsilon_t$$

- Double sorts by IV and liquidity
  - 25 equally-weighted and value-weighted portfolios by sorting stocks based on their illiquidity level first and then within each illiquidity group ranking stocks based on IV
  - At each illiquidity level, form a portfolio that long the highest IV and short the lowest

Empirical results and discussions

- Beta: coefficient of the market risk premium in the CAPM model
- Alpha1: alpha estimated based on the CAPM model
- Alpha2: alpha estimated based on Fama-French three-factor model
- Alpha3: alpha estimated based on Four-factor model (FF three factors + 3-month momentum)
- Alpha4: alpha estimated based on Four-factor model (FF three factors + 6-month momentum)

Panel A: Performance of equally-weighted portfolios sorted on IV1

Rank	IV1	Illiq	Turn	Return(%)	Beta	Alpha1	Alpha2	Alpha3	Alpah4
low	1.64	2.25	52.34	2.04	1.02***	0.20	-0.94***	0.11	0.14
					(26.67)	(0.49)	(-5.27)	(0.61)	(0.18)
2	2.01	1.96	53.36	1.80	1.05***	-0.03	-0.90***	0.59	0.47
					(34.54)	(-0.11)	(-5.06)	(0.99)	(0.64)
3	2.28	1.71	54.53	1.77	1.04***	-0.07	-1.24***	1.50**	1.82**
					(26.04)	(-0.16)	(-6.36)	(2.42)	(2.38)
4	2.51	1.55	53.47	1.76	1.05***	-0.07	-1.11***	1.34*	1.83**
					(27.52)	(-0.17)	(-4.68)	(1.71)	(1.92)
High	2.92	1.43	50.03	1.51	1.05***	-0.32	-1.29***	1.17*	1.34
					(30.80)	(-0.89)	(-6.09)	(1.69)	(1.57)
High-Low	1.28	-0.82	-2.30	-0.53	0.04*	-0.51**	-0.35*	1.06	1.21
					(1.90)	(-2.57)	(-1.66)	(1.47)	(1.37)

Panel B: Performance of value-weighted portfolios sorted on IV1

Rank	IV1	Illiq	Turn	Return(%)	Beta	Alpha1	Alpha2	Alpha3	Alpah4
low	1.67	0.61	30.34	1.74	0.98***	-0.12	0.07	-1.08*	-1.59**
					(55.23)	(-0.65)	(0.35)	(-1.67)	(-2.03)
2	1.99	0.71	37.21	1.78	1.03***	-0.06	-0.02	0.08	-0.26
					(50.57)	(-0.27)	(-0.08)	(0.10)	(-0.26)
3	2.28	0.92	44.07	2.22	0.97***	0.38	-0.16	0.41	1.63
					(29.88)	(1.14)	(-0.50)	(0.38)	(1.27)
4	2.51	1.06	48.19	2.25	1.03***	0.38	-0.19	1.23	2.33*
					(30.54)	(1.07)	(-0.60)	(1.10)	(1.73)
High	2.92	1.12	42.49	2.37	1.05***	0.23	-0.27	1.20	1.40
					(40.89)	(0.87)	(-0.99)	(1.31)	(1.26)
High-Low	1.25	0.51	12.15	0.63	0.07*	0.35	-0.33	2.28*	2.98*
					(1.82)	(0.91)	(-0.87)	(1.76)	(1.90)

Empirical results and discussions

Test illiquidity as the explanation for the equally-weighted arbitrage portfolio based on IV1.

Variable	1	2	3	4	5	6
Intercept	-0.35*	1.06	1.21	0.03	1.20*	1.40
	(-1.66)	(1.47)	(1.37)	(1.63)	(1.68)	(1.63)
RM-RF	0.03*	0.03*	0.04*	-0.09**	0.03*	0.03*
	(1.85)	(1.86)	(1.94)	(-2.49)	(1.68)	(1.74)
SMB	-0.10***	-0.09**	-0.09***	0.05	-0.08**	-0.08**
	(-2.75)	(-2.58)	(-2.65)	(1.12)	(-2.35)	(-2.41)
HML	0.06	0.07	0.06		0.07	0.06
	(1.15)	(1.43)	(1.27)		(1.40)	(1.24)
MOM1		-9.79**			-9.75**	
		(-2.04)			(-2.07)	
MOM2			-15.46*			-15.96*
			(-1.83)			(2.85)
ILLIQ				0.28***	0.29***	0.29***
				(2.76)	(2.82)	(2.85)

Notes: The table reports the results of the following time-series regression.

$$(High - Low)_t = \alpha_0 + \alpha_1(RM - RF)_t + \alpha_2 SMB_t + \alpha_3 HML_t + \alpha_4 LIQ_{t-1} + \varepsilon_t$$

$$(High - Low)_t = \alpha_0 + \alpha_1(RM - RF)_t + \alpha_2 SMB_t + \alpha_3 HML_t + \alpha_4 MOM_t + \alpha_5 LIQ_{t-1} + \varepsilon_t$$

where $(High - Low)_t$ is the month t return of the equally-weighted portfolio which is long the portfolio with the highest IV1 and short the portfolio with the lowest IV1, LIQ_t is measured by $ILLIQ_t$. *,** and *** means significant at 10%, 5% and 1% respectively.

Empirical results and discussions

Test illiquidity as the explanation for the value-weighted arbitrage portfolio based on IV1.

Variable	1	2	3	4	5	6
Intercept	-0.33	2.28*	2.98*	-0.03	2.54**	3.39**
	(-0.87)	(1.76)	(1.90)	(-0.08)	(2.03)	(2.25)
RM-RF	0.06*	006*	0.07*	0.05	0.05	0.06*
	(1.84)	(1.87)	(1.95)	(1.59)	(1.64)	(1.72)
SMB	0.35***	0.36***	0.36***	0.37***	0.38***	0.38***
	(5.44)	(5.69)	(5.65)	(5.99)	(6.23)	(6.23)
HML	-0.04	-0.02	-0.03	-0.04	-0.20	-0.03
	(-0.47)	(-0.17)	(-0.33)	(-0.53)	(-0.25)	(-0.4)
MOM1		-18.10**			-17.83**	
		(-2.11)			(-2.16)	
MOM2			-32.83**			-33.78**
			(-2.71)			(-2.34)
ILLIQ				0.61**	0.62***	0.62***
				(3.34)	(3.42)	(3.48)

Notes: The table reports the results of the following time-series regression.

$$(High-Low)_t = \alpha_0 + \alpha_1(RM-RF)_t + \alpha_2 SMB_t + \alpha_3 HML_t + \alpha_4 LIQ_{t\text{-}1} + \varepsilon_t$$

$$(High-Low)_t = \alpha_0 + \alpha_1(RM-RF)_t + \alpha_2 SMB_t + \alpha_3 HML_t + \alpha_4 MOM_t + \alpha_5 LIQ_{t\text{-}1} + \varepsilon_t$$

where $(High-Low)_t$ is the month t return of the value -weighted portfolio which is long the portfolio with the highest IV1 and short the portfolio with the lowest IV1. LIQ_t is measured by $ILLIQ_t$. *,** and *** means significant at 10%, 5% and 1% respectively.

Empirical results and discussions

Performance of the portfolios double-sorted on illiquidity and IV1

Panel A: Performance of the equally-weighted portfolios double-sorted on illiquidity and IV1

	Low-IV	2	3	4	High-IV	High-Low	Beta and Alpha for High-Low				
							Beta	Alpha 1	Alpha2	Alpha3	Alpha4
Low-illiq	0.59	0.52	0.76	0.43	0.42	-0.17	-0.11***	-2.51***	-2.54***	-3.60***	-4.48***
							(-4.67)	(-11.04)	(-10.73)	(-4.42)	(-4.98)
2	1.21	1.43	1.18	0.93	1.07	-0.14	-0.12***	-2.48***	-2.64***	-2.69***	-3.15***
							(-4.92)	(-9.94)	(-10.01)	(-2.94)	(-2.85)
3	1.66	1.74	1.64	1.82	1.51	-0.15	-0.00	-2.44***	-2.60***	-2.07**	-2.04*
							(-0.06)	(-9.64)	(-9.91)	(-2.29)	(-1.85)
4	2.04	2.12	2.24	2.46	1.88	-0.16	0.21***	-2.35***	-2.23***	-1.96*	-2.68*
							(6.84)	(-7.34)	(-6.28)	(-1.68)	(-1.80)
High-illiq	3.47	3.79	3.03	3.47	3.00	-0.47	0.26***	-2.63***	-2.71***	-3.61**	-4.65**
							(6.64)	(-6.46)	(-5.13)	(-2.33)	(-2.48)

Panel B: Performance of the value-weighted portfolios double-sorted on illiquidity and IV1

	Low-IV	2	3	4	High-IV	High-Low	Beta and Alpha for High-Low				
							Beta	Alpha 1	Alpha2	Alpha3	Alpha4
Low-illiq	0.78	0.96	1.34	0.82	0.76	-0.02	-0.17***	-2.38***	-2.70***	-1.26	-2.41
							(-3.63)	(-4.78)	(-4.94)	(-0.67)	(-1.04)
2	2.01	2.25	2.25	1.33	1.58	-0.49	-0.25***	-2.89***	-3.32***	-0.90	-0.80
							(-6.62)	(-6.98)	(-7.69)	(-0.61)	(0.44)
3	2.99	2.73	2.55	2.80	2.27	-0.72	-0.18***	-3.09***	-3.35***	-1.14	-1.04
							(-3.57)	(-5.73)	(-5.70)	(-0.57)	(-0.42)
4	2.33	2.97	2.99	3.55	2.85	0.51	0.05	-1.75***	-1.63**	-0.61	-1.94
							(0.93)	(-2.99)	(-2.54)	(-0.28)	(-0.72)
High-illiq	5.10	5.93	3.85	4.38	3.75	-1.35	-0.26***	-3.52***	-3.53***	-2.51	-1.49
							(3.22)	(-4.24)	(-3.80)	(-0.78)	(-0.38)

Summary

- Idiosyncratic volatility premium for single sorted portfolio
  - Equal-weighted portfolio sorted by IV shows that negative premium
  - Value-weighted portfolio sorted by IV shows that positive premium

- Time series tests suggest that
  - IV premium in both equally-weighted and value-weighted returns can be explained by previous month's liquidity level
  - Size and momentum also helps explain
  - IV premium is significantly positive after controlling for liquidity, size and momentum

- Double-sorting tests suggest that
  - Equally-weighted and value-weighted arbitrage strategies present negative premium at a given liquidity level
  - negative premium is most pronounced at the highest illiquidity level