Asset Class Liquidity Risk

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I. Introduction

In the wake of the financial crisis of 2008-2009, the financial industry has displayed an increasing interest in liquidity-related research. At this point, the notion of an increased expected return compensation for holding illiquid assets is a widely accepted concept (see, e.g., Amihud and Mendelson (1986) and Brennan and Subrahmanyam (1996)). I refer to this asset characteristic as an asset's liquidity level, which is different than its liquidity risk. While the liquidity level of an asset, *i.e.* the ability to trade large quantities of its shares quickly with minimal price impact, is often measured as an average over time, the liquidity risk of an asset is based on the time variation of it's price. Specifically the liquidity risk (beta) of an asset is measured by the covariation of its returns with unexpected changes in aggregate liquidity (see, e.g., Pástor and Stambaugh (2003), Acharya and Pedersen (2005), and Sadka (2006)). The financial economics literature has documented that liquidity risk commands a premium in the cross-section of US stocks (Pástor and Stambaugh (2003)), over and beyond an asset's liquidity level (e.g., Korajczyk and Sadka (2008)), that it can explain some asset-pricing anomalies (Sadka (2006), Asness, Moskowitz, and Pedersen (2013)), that it is priced among global equities (Lee (2011)), that it can explain a significant part of mutual-fund and hedge-fund performance (Dong, Feng, and Sadka (2013) and Sadka (2010, 2012)), that it is priced in the cross-section of corporate bonds (Lin, Wang, and Wu (2011) and Acharya, Amihud, and Bharath (2013)), and that it serves as a better predictor of performance during crisis periods (see Lou and Sadka (2011)).

The purpose of this article is to study the importance of liquidity risk in the cross-section of popular indices across a variety of asset classes globally. Despite the relatively small sample, 106 indices over 1994-2012, which precludes obtaining statistical significance in some tests, the results lend further support for the robustness of liquidity risk pricing. While there is a significant within-asset-class variation, on average, the hedge-fund asset class is the most exposed to liquidity risk, and fixed income – the least. Roughly 20% of all sample indices display a significant exposure to liquidity risk across the various asset classes and the liquidity-risk premium is estimated at about 2% annually.

Since the study uses only popular indices, most of which are either investable or can be easily tradable with low-tracking-error instruments and therefore are relatively liquid, the return premium is unlikely due to differences in asset liquidity level. The results are also robust to various controls and methodological choices. Overall, the results enhance the understanding of liquidity risk across various asset classes globally.

This study has several practical implications. First, the paper presents a method for evaluating the liquidity risk of an asset, relying solely on the time series of its monthly returns. The method can be easily applied to a variety of asset classes. Second, the results suggest that long-run investors able to sustain underperformance during liquidity crises, may consider increasing the liquidity-risk exposures of their portfolios in order to earn the liquidity-risk premium.

The remainder of this paper is organized as follows. Section II describes the samples and the measures used. Section III studies the liquidity risk pricing using full-sample betas, while Section IV, uses rolling betas. Section V discusses some practical applications, and Section VI concludes.

II. Data and Measures

Monthly returns of 106 indices for the period 1994-2012 are collected as follows: 22 global equity indices, 35 industry sector indices, 21 fixed income indices, and 28 hedge fund indices. Due to popularity and availability,

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I would like to thank an anonymous referee, Marie Brière (the editor), and Tray Spilker for useful comments and suggestions. Tray Spilker also assisted in data collection. Any errors are my own.

both global and sector equity indices are included in this study, which also increases the power of the cross-sectional tests. Note that the commonly used S&P500 index (SPX) is not included in the sample because it is highly correlated with the market index which is used below as a control variable while calculating index liquidity betas. The fixed income indices include Barclays aggregate indices as well as iShares ETFs. Equity market indices and other popular global equity indices are provided by DowJones and MSCI. Hedge fund indices comprise of the HFRI indices, and sector ETFs are S&P and iShares. Most of the indices used in this study are investable, and if not, can typically be mimicked by suitable, low-tracking-error ETFs. The returns are based on US dollars. Table 1 contains summary statistics of the sample indices. All indices have at least five years of data.

The primary liquidity measure used for this study is the permanent component of trade-to-trade price impact constructed in Sadka (2006), which is extracted from the Trades and Quotes (TAQ) tick-by-tick data. Because price impact measures illiquidity, not liquidity, a negative sign is added to the time series of price impact, so that a positive shock can be interpreted as an improvement to market liquidity. The measure is estimated monthly at the individual-stock level, then averaged to compose a market measure of liquidity each month. The liquidity risk factor is estimated as the residuals from fitting an AR(3) model to market-wide liquidity.

Figure 1 plots the liquidity factor over the sample period.[1] As discussed in Sadka (2010), consistent with the notion of liquidity dryouts, most notable are the negative shocks to liquidity that occur in September 1998 and September 2008, corresponding to the Russian bond default and the fall of LTCM in 1998 and the financial crisis and the Lehman Brothers bankruptcy in September 2008. Also apparent is the negative liquidity shock during the Quant crisis in August 2007. It seems this shock marks the beginning of a volatile period in market liquidity, which peaked with the negative shock of September 2008. Marking the decimalization of the NYSE, January 2001 displays a negative liquidity shock, consistent with the drop in quoted depth that was associated with the reduction in tick size.

Before moving on, it is important to stress the low correlation of liquidity with other commonly used factors. I consider here three other variables: MKT–RF of Fama and French (1993), changes in VIX, and changes in the TED spread.[2] The latter two variables are included in the attempt to distinguish the liquidity factor, which is based on market liquidity, from other variables that might capture funding liquidity shocks (e.g., Brunnermeier and Pedersen (2009)).

Table 2 presents the pairwise time-series correlation of these factors and the liquidity factor. The factor most correlated with liquidity (in absolute value) is changes in VIX. The correlation is – 0.20, which suggests that periods of increased volatility are associated with a drop in market liquidity. Interestingly, the market return does not exhibit a particularly high correlation with liquidity (0.11). For example, the market return during September 1998 and August 2007 is 5.92% and 0.74%, respectively. In other words, there is nothing special about the market return during these months that would indicate they exhibit severe liquidity shocks. The correlation of liquidity and changes in TED is – 0.02. These results motivate the inclusion of liquidity as an additional source of risk. However, given the statistically significant correlation of liquidity and changes in VIX, in what follows, I calculate liquidity beta while controlling for the changes in VIX in the regressions. Nevertheless, the results are robust to the exclusion of such control.

III. Liquidity Risk in the Cross-section: Full Sample

Estimation of liquidity exposure

To begin the analysis, I start by calculating full-sample liquidity betas. The liquidity beta of a given index is calculated through a regression of its monthly returns (in excess of the risk-free rate) on the equity market portfolio (in excess of the risk-free rate), the liquidity factor, and the changes in VIX. Both the market portfolio and the risk-free rate are obtained from Ken French's website.

The results are summarized in Table 3. This table reports summary statistics of the liquidity betas, for the entire sample, as well as separately for the four asset classes in consideration. The average liquidity beta for the entire sample is 0.25, ranging from – 0.94 (S&P 500 Technology Hardware & Equipment Industrial Group Index) to 2.25 (HFRI Emerging Markets: Russia/Eastern Europe Index). Roughly 21% of the indices exhibit a statistically significant liquidity exposure (at the 5% level), weakening concerns of liquidity exposures occurring as a matter of chance. Of the liquidity betas, 25% are negative. Hedge funds seem to be the asset class with the strongest liquidity exposure, with an average liquidity beta of 0.43; 54% of hedge funds exhibit significant liquidity exposure while 7% carry negative exposures.

The results of the analysis thus far highlight the significant exposure of global indices to liquidity risk. In what follows, I study whether this risk is associated with a return premium.

Liquidity Risk Premium

This subsection studies whether there exists some positive relation between liquidity beta and average returns. Table 4 calculates full-sample univariate cross-sectional regressions of average returns on liquidity beta, using the entire sample of indices and separately for the different asset classes.

The results indicate a 1.57% return premium (t-statistic of 2.23) using the entire sample. Liquidity risk does not seem to be priced in the cross-section of global equity, but is marginally significant in the cross-section of industry sectors. This might be due to differences in the variation in liquidity within each of these asset classes. Both universes of fixed income and hedge funds exhibit significant liquidity risk premia. While Sadka (2010) and Lin, Wang, and Wu (2011) mostly study individual funds and bonds,

respectively, the results here suggest that the premia is also displayed in the cross-section of asset classes.

These results should be interpreted with caution. The significance of the premia coefficients is gauged through single cross-sectional regressions of average index returns on full-sample betas, ignoring potential cross-sectional correlations that could affect standard errors (but not the point estimates). In addition, the number of indices increases by about 50% from the beginning to the end of the sample period, therefore average returns of different indices are essentially compared over different periods. To alleviate some of these concerns, I apply an additional out-of-sample test below.

■ IV. Liquidity Risk in the Cross-section: Dynamic Portfolios

The tests in the previous section rely on in-sample estimation, using full-sample calculated liquidity betas and average returns. This section provides out-of-sample tests, using rolling liquidity betas and future returns.

Average returns

Each month, indices are sorted into 15 portfolios based on their twelve-month rolling liquidity betas. The liquidity beta of an index is calculated via a regression of the index return (in excess of the risk-free rate) on the market portfolio and the liquidity factor using the most recent 12 monthly observations (with at least nine observations). The portfolios are held for one month and are rebalanced every month. On average, each portfolio consists of 5.6 indices.

Figure 2 plots the average returns of the portfolios as a function of their average liquidity beta. The average return (liquidity beta) of a portfolio is calculated as the time-series average of the monthly average return (liquidity beta) of its constituent indices (equally weighted). The highest liquidity-beta portfolio earns an average of 9.5% per year, with a Sharpe ratio of 0.45. For comparison, the Sharpe ratio of the market portfolio is similar (0.42), but with an average return of 6.7% per year. The figure shows a significant positive relation between average returns and liquidity beta (the t-statistic of the graph slope is 3.93). The return spread between the highest and lowest liquidity beta portfolios is 5.04% annually; the four-factor alpha (calculated through a model that controls for the Fama-French three factors and momentum) is 3.56% annually. However, the t-statistic of the return spread is 1.20 – the low statistical significance is perhaps not surprising given the lack of power due to the small sample size. Nonetheless, these results lend further support for the pricing of liquidity risk globally.

Time varying exposures

One concern with the out-of-sample tests presented above is that the sorting process of indices into portfolios might be consistently selecting particular asset classes. To further study this point, Table 5 presents the liquidity beta of the top and bottom deciles of liquidity-beta sorted portfolios. The table presents the liquidity betas of the portfolios at the end of the second and fourth quarters each year, while separating into each of the four asset classes. A missing value for an asset class in a given period indicates that none of the indices that belong to that asset class are included in the portfolio that period.

The results indicate two main findings. First, the 12-month rolling liquidity betas seem to exhibit a significant variation, both cross-sectionally and over time. For example, at the end of June 2000, the highest liquidity beta is shown by some hedge funds (12.04), while the lowest liquidity beta was displayed by some global equity (– 13.06). Second, the asset class affiliation in the top and bottom decile portfolios does not seem to be predominantly governed by a single asset class. Nevertheless, generally speaking, it seems that hedge funds do not have a frequent presence in the bottom decile, while fixed income indices do not have a frequent presence in the top decile. Otherwise, all asset classes seems to have a relatively similar representation in the top and bottom liquidity beta decile portfolios.

■ V. Practical Applications

The results above highlight two key findings: (1) a substantial number of indices are exposed to aggregate liquidity risk, and (2) high-exposure funds tend to earn a risk premium. These findings emphasize the risk-return trade-off pertaining to liquidity. In what follows, I discuss some potential applications.

Risk Management

From a risk management standpoint, the paper provides a useful tool for evaluating an assets exposure to liquidity risk. The liquidity beta requires only historical monthly returns to gauge an assets liquidity risk, without the need to compute its liquidity level. The results indicate that some assets significantly underperform during liquidity crises, and therefore reducing investment in these assets can reduce exposure to such risk. Liquidity risk seems to exhibit a significant time variation, requiring the review of risk exposures over time and a resultant dynamic risk management strategy. Investors with relatively short investment horizons, such as hedge funds and funds-of-funds, may find it useful to hedge liquidity risk by acquiring low-liquidity-beta assets and/or reducing holdings of high-liquidity-beta assets.

Asset Allocation

The results show that the high-minus-low liquidity risk return spread is about 5% annually on average over the entire sample period. For long-run investors, such as pension funds and endowments, that could sustain underperformance during short (yet significant) liquidity crises, it would seem sensible to increase exposure to liquidity risk with the intention to earn this liquidity-risk premium. In other words, the liquidity-beta premium may be considered alpha for long horizon investors (see also Kamara, Korajczyk, Lou, and Sadka (2013)). While some prior works have shown implications to investing

in individual securities or funds based on liquidity beta, this paper shows that such considerations are also relevant at the higher level decisions of investment allocation across different asset classes.

VI. Conclusion

This paper provides empirical evidence for the importance of considering market-wide liquidity as a risk factor in the cross-section of 106 indices that span various asset classes. A substantial number of indices significantly load on liquidity risk, and high-liquidity-loading indices tend to earn high future returns during 1994-2012. These results suggest that liquidity risk is also priced among global indices, even though such indices are considered quite liquid. Investors with relatively short investment horizons may find it useful to hedge liquidity risk by acquiring low-liquidity-beta assets, while long-run investors may consider increasing exposure to liquidity risk to earn the associated risk premium. ■

1 The liquidity factor is periodically updated on my website: https://www2.bc.edu/~sadka/.

2 I thank Ken French for providing risk factors on his website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Appendix

Table 1. Sample Indices

This table reports summary statistics of the sample indices. The sample includes 106 indices across the asset classes of global equity, industry sectors, fixed income, and hedge funds, with at least five years of data over the period 1994-2012.

#	Asset class	Index name	Begin	End	Number	Average return	Standard Dev.
			month	month	of months	(%, annualized)	(%, annualized)
1	Global Equity	NASDAQ Composite Index	199401	201212	228	10,89	24,42
2		NASDAQ 100 Stock Index	199401	201212	228	14,28	27,09
3		RUSSELL 1000 Index	199401	201212	228	9,04	15,64
4		Russell 2000 Index	199401	201212	228	9,57	19,99
5		RUSSELL 3000 Index	199401	201212	228	8,98	15,74
6		MSCI World Index	199401	201212	228	7,68	15,58
7		MSCI Europe Index	199502	201212	215	9,61	18,50
8		Deutsche Borse AG German Stock Index DAX	199401	201212	228	10,24	24,24
9		FTSE 100 Index	199401	201212	228	8,48	16,33
10		CAC 40 Index	199401	201212	228	8,67	21,59
11		Milan Stock Exchange MIB Telematico Index	199401	200905	185	9,83	23,18
12		IBEX 35 Index	199401	201212	228	11,60	24,62
13		OMX Stockholm Index	199401	201212	228	13,85	25,06
14		Swiss Exchange Swiss Performance Index	199401	201212	228	10,44	17,01
15		MSCI AC Asia Ex. Japan Index	199401	201212	228	6,87	24,95
16		Hong Kong Hang Seng Index	199401	201212	228	10,02	26,15
17		Tokyo Stock Exchange Tokyo Price Index TOPIX	199401	201212	228	1,70	18,95
18		Taiwan Stock Exchange Weighted Index	199401	201212	228	7,25	28,76
19		Stock Exchange of Thailand SET Index	199401	201212	228	7,73	35,11
20		Luxembourg Stock Exchange LuxX Return Index	199902	201212	167	9,08	27,25
21		DOW JONES INDUS. AVG	199401	201212	228	10,07	15,17
22		iShares MSCI Emerging Markets ETF (NYSE Arca)	200309	201212	112	16,40	25,45

Appendix (continued)

Table 1. Sample Indices (continued)

23	Industry Sector	ISHARES DIV MONTHLY INCOME	200601	201212	84	9,89	22,46
24		ISHARES GLOBAL CONSUMER DISC	200610	201212	75	6,45	21,23
25		ISHARES GLOBAL CONSUMER STAP	200610	201212	75	9,11	13,77
26		ISHARES GLOBAL ENERGY ETF	200112	201212	133	12,26	21,53
27		ISHARES GLOBAL FINANCIALS ET	200112	201212	133	4,21	24,74
28		ISHARES GLOBAL HEALTHCARE ET	200112	201212	133	4,56	13,20
29		ISHARES GLOBAL INDUSTRIALS E	200610	201212	75	5,57	22,89
30		ISHARES GLOBAL MATERIALS ETF	200610	201212	75	9,25	28,42
31		ISHARES GLOBAL TECH ETF	200112	201212	133	4,80	22,52
32		ISHARES GLOBAL TECH ETF	200503	201212	94	6,74	20,24
33		ISHARES GLOBAL TELECOM ETF	200112	201212	133	5,63	18,11
34		ISHARES GLOBAL UTILITIES ETF	200610	201212	75	1,46	15,90
35		ISHARES NORTH AMERICAN NATUR	200111	201212	134	11,79	23,50
36		ISHARES NORTH AMERICAN NATUR	200406	201212	103	13,01	24,93
37		ISHARES NORTH AMERICAN TECH	200104	201212	141	5,97	25,54
38		ISHARES OIL SANDS INDEX FUND	200611	201212	74	5,92	38,70
39		ISHARES PHLX SEMICONDUCTOR E	200108	201212	137	2,92	32,92
40		ISHARES S&P/TSX CAPPED MATER	200601	201212	84	16,27	34,01
41		ISHARES U.S. BASIC MATERIALS	200007	201212	150	10,49	24,84
42		ISHARES U.S. CONSUMER SERVIC	200007	201212	150	5,34	17,75
43		ISHARES U.S. ENERGY ETF	200007	201212	150	11,14	21,97
44		ISHARES U.S. HEALTHCARE ETF	200007	201212	150	4,04	13,25
45		ISHARES U.S. INDUSTRIALS ETF	200008	201212	149	5,44	20,30
46		ISHARES US CONSUMER GOODS ET	200009	201212	148	7,63	12,31
47		ISHARES US FINANCIALS ETF	200006	201212	151	2,86	21,48
48		ISHARES US TELECOMMUNICATION	200006	201212	151	-1,55	23,16
49		ISHARES US UTILITIES ETF	200007	201212	150	6,67	15,53
50		ISHARES USTECHNOLOGY ETF	200006	201212	151	0,79	28,83
51		S&P 500 Consumer Durables & Apparel Indu Grp Idx GICS Lvl 2	199401	201212	228	7,84	20,30
52		S&P 500 Consumer Services Indu Grp Idx GICS Lvl 2	199401	201212	228	11,62	18,05
53		S&P 500 Diversified Financials Industry Group Index GICS Level 2	199401	201212	228	11,19	25,89
54		S&P 500 Food Beverage & Tobacco Industry Group Index GICS Lvl 2	199401	201212	228	11,77	14,14
55		S&P 500 Household & Personal Products Indu Grp Idx GICS Lvl 2	199401	201212	228	11,63	16,42
56		S&P 500 Retailing Industry Group Index GICS Level 2	199401	201212	228	12,53	21,34
57		S&P 500 Technology Hardware & Equipment Indu Grp Idx GICS Lvl 2	199401	201212	228	14,50	29,55

Appendix (continued)

Table 1. Sample Indices (continued)

#	Asset Class	Index name	Begin	End	Number	Average return	Standard Dev.
			month	month	of months	(%, annualized)	(%, annualized)
58	Fixed Income	144A Ex Aggregate	199801	201212	180	6,19	6,09
59		144A: Global Aggregate Eligible	200010	201212	147	6,61	6,47
60		Asian Pacific Aggregate	200006	201212	151	4,22	9,21
61		Asian-Pac Agg: Global Aggregate Eligible	200009	201212	148	4,41	9,25
62		Eurodollar (Excluding U.S. Aggregate)	199501	201212	216	6,49	3,88
63		Eurodollar: Global Aggregate Eligible	200010	201212	147	5,69	2,98
64		Euro-Yen Ex Asian-Pacific	200008	201212	149	3,56	9,70
65		Euro-Yen: Global Aggregate Eligible	200009	201212	148	3,47	9,73
66		Global (Excluding US/Pan-European)	199812	201212	169	5,04	9,52
67		Global Aggregate	199401	201212	228	6,07	5,55
68		Global: Canada	199401	201212	228	8,30	8,97
69		Other Currencies: Global Aggregate Eligible	200501	201212	96	6,36	15,89
70		Pan-Euro: Global Aggregate Eligible	200009	201212	148	8,98	10,99
71		Pan-European Aggregate	199902	201212	167	6,33	10,85
72		U.S. Aggregate	199401	201212	228	6,07	3,68
73		U.S. Aggregate: Global Aggregate Eligible	200010	201212	147	6,00	3,62
74		ISHARES 1-3 YEAR TREASURY BONDS	200208	201212	125	2,66	1,51
75		ISHARES 3-7 YEAR TREASURY BONDS	200702	201212	71	6,17	4,15
76		ISHARES 7-10 YEAR TREASURY BONDS	200208	201212	125	6,40	6,96
77		ISHARES IBOXX HIGH YIELD CORE	200705	201212	68	7,29	15,35
78		ISHARES NATIONAL AMT-FREE MUNICIPAL BOND ETF	200710	201212	63	5,47	6,16
79	Hedge Fund	HFRI ED: Distressed/Restructuring Index	199401	201212	228	9,32	6,27
80		HFRI ED: Merger Arbitrage Index	199401	201212	228	7,77	3,62
81		HFRI EH: Equity Market Neutral Index	199401	201212	228	5,50	3,22
82		HFRI EH: Quantitative Directional Index	199401	201212	228	10,13	12,72
83		HFRI EH: Sector - Energy/Basic Materials Index	199501	201212	216	16,08	18,34
84		HFRI EH: Sector - Technology/ Healthcare Index	199401	201212	228	13,09	16,72
85		HFRI EH: Short Bias Index	199401	201212	228	0,28	18,58
86		HFRI Emerging Markets (Total) Index	199401	201212	228	9,24	14,05

Appendix (continued)

Table 1. Sample Indices (continued)

87	HFRI Emerging Markets: Asia ex-Japan Index	199401	201212	228	6,53	13,01
88	HFRI Emerging Markets: Global Index	199401	201212	228	8,64	13,04
89	HFRI Emerging Markets: Latin America Index	199401	201212	228	9,81	16,46
90	HFRI Emerging Markets: Russia/ Eastern Europe Index	199405	201212	224	17,88	27,11
91	HFRI Equity Hedge (Total) Index	199401	201212	228	10,08	9,36
92	HFRI Event-Driven (Total) Index	199401	201212	228	10,02	6,84
93	HFRI FOF: Conservative Index	199401	201212	228	5,03	4,11
94	HFRI FOF: Diversified Index	199401	201212	228	5,00	6,13
95	HFRI FOF: Market Defensive Index	199401	201212	228	6,51	5,58
96	HFRI FOF: Strategic Index	199401	201212	228	5,91	8,59
97	HFRI Fund of Funds Composite Index	199401	201212	228	5,30	5,98
98	HFRI Fund Weighted Composite Index	199401	201212	228	8,73	7,13
99	HFRI Macro (Total) Index	199401	201212	228	7,96	6,59
100	HFRI Macro: Systematic Diversified Index	199401	201212	228	9,56	7,70
101	HFRI Relative Value (Total) Index	199401	201212	228	8,26	4,30
102	HFRI RV: Fixed Income-Asset Backed Index	199401	201212	228	9,21	4,16
103	HFRI RV: Fixed Income-Convertible Arbitrage Index	199401	201212	228	7,79	7,18
104	HFRI RV: Fixed Income-Corporate Index	199401	201212	228	6,36	5,71
105	HFRI RV: Multi-Strategy Index	199401	201212	228	6,63	4,38
106	HFRI RV: Yield Alternatives Index	199401	201212	228	8,02	7,40

Table 2. Correlation Matrix

This table reports the correlation between the market portfolio (Fama and French (1993)), the liquidity factor (Sadka (2006)), changes in VIX, and changes in the TED spread over the period 1994–2012.

	MKT	LIQ	ΔVIX
LIQ	0,11		
	(0,088)		
ΔVIX	– 0,71	– 0,20	
	(0,000)	(0,003)	
ΔTED	– 0,02	– 0,02	0,12
	(0,744)	(0,779)	(0,081)
P-values are reported in parentheses.			

Appendix (continued)

Table 3. Summary of Liquidity Exposures

The table reports summary statistics of the liquidity betas of the sample indices. The liquidity beta of an index is calculated via a regression of the index return (in excess of the risk-free rate) on the market portfolio (Fama and French (1993)), the liquidity factor (Sadka (2006)), and changes in VIX. Statistics are reported for the entire sample, as well as separately for each asset class. The sample includes 106 indices across the asset classes of global equity, industry sectors, fixed income, and hedge funds, for the period 1994–2012.

	Number of indices	Average liquidity beta	Standard deviation	Min	Median	Max	Fraction significant at 5%	Franction negative
All	106	0,25	0,46	– 0,94	0,21	2,25	0,21	0,25
Global Equity	22	0,33	0,55	– 0,73	0,31	1,39	0,18	0,23
Industry Sector	35	0,13	0,45	– 0,94	0,18	1,29	0,03	0,31
Fixed Income	21	0,12	0,26	– 0,21	0,07	0,63	0,10	0,38
Hedge Fund	28	0,43	0,46	– 0,50	0,40	2,25	0,54	0,07

Table 4. Liquidity Premium in the Cross-Section

The table reports annualized liquidity-risk premium estimates. The estimates are obtained by regressing index average returns on the full-sample liquidity betas, calculated as in Table 3, over the cross-section of all sample indices, as well as spearately over indices in each asset class. Square brackets report simple t-statistics.

All	1,57%
	[2,23]
Global Equity	– 0,85%
	[0,69]
Industry Sector	1,94%
	[1,29]
Fixed Income	3,23%
	[2,74]
Hedge Fund	3,05%
	[2,29]

Appendix (continued)

Table 5. Time varying exposures of extreme portfolios

Each month, indices are sorted into 10 portfolios based on their 12-month rolling liquidity betas. The liquidity beta of an index is calculated via a regression of the index return (in excess of the risk-free rate) on the market portfolio (Fama and French (1993)) and the liquidity factor (Sadka (2006)) using the most recent 12 monthly observations (with at least 9 observations). For indices that form the top and bottom portfolios, the table reports the average liquidity beta of indices per asset class as of the end of the second and fourth quarter each year. A missing value in the table for an asset class in a given year indicates that none of the indices that belong to that asset class are included in the portfolio. The sample includes 106 indices across the asset classes of global equity, industry sectors, fixed income, and hedge funds, for the period 1994-2012.

Year	Quarter end	Low-liquidity-beta portfolio				High-liquidity-beta portfolio			
		Global Equity	Industry Sector	Fixed Income	Hedge Fund	Global Equity	Industry Sector	Fixed Income	Hedge Fund
1994	4	– 6,73	.	.	– 4,06	3,86	.	.	8,26
1995	2	– 5,72	.	.	.	3,76	5,35	3,49	6,34
1995	4	– 9,70	.	.	.	4,51	6,14	2,70	.
1996	2	– 7,30	.	.	– 7,95	7,47	10,17	.	10,33
1996	4	– 4,88	.	.	– 3,78	6,30	10,98	.	9,34
1997	2	– 2,88	– 2,78	.	– 2,90	6,06	.	.	5,07
1997	4	– 2,68	– 3,34	.	– 4,77	11,51	.	.	.
1998	2	.	– 4,84	.	– 9,19	11,12	.	.	.
1998	4	– 6,02	– 2,19	.	.	7,47	7,17	.	6,80
1999	2	– 4,73	.	– 2,75	.	5,28	6,27	.	8,82
1999	4	– 10,86	– 7,72	.	– 9,54	10,78	3,88	.	9,53
2000	2	– 11,91	.	.	– 13,06	12,04	8,02	9,10	8,47
2000	4	– 8,46	– 7,98	.	– 5,30	6,34	3,07	.	3,89
2001	2	– 6,52	– 6,09	.	.	2,32	2,60	.	2,30
2001	4	– 5,05	– 5,39	.	.	2,39	3,98	.	.
2002	2	– 3,92	– 4,96	– 2,31	.	8,31	7,49	.	6,84
2002	4	– 2,57	– 6,03	.	.	7,41	7,27	.	8,44
2003	2	– 3,26	– 6,41	.	.	7,08	6,90	.	.
2003	4	– 2,45	– 4,51	.	.	12,16	.	.	6,70
2004	2	– 4,92	– 6,14	.	.	10,92	8,66	.	.
2004	4	– 6,07	– 5,20	– 5,63	.	4,49	5,39	.	4,24
2005	2	– 3,05	– 3,23	– 3,53	.	4,21	6,32	.	3,59
2005	4	– 2,20	– 2,05	.	.	6,42	8,62	.	6,20
2006	2	.	– 2,88	– 1,90	.	3,29	2,20	.	2,21
2006	4	– 8,00	– 8,76	– 5,93	.	1,89	3,21	.	.
2007	2	– 9,52	– 6,85	– 6,35	.	4,52	3,62	.	.
2007	4	.	– 1,34	– 1,26	.	2,87	3,05	.	.
2008	2	– 1,64	– 1,17	.	– 0,90	0,69	0,90	1,10	.
2008	4	– 0,59	– 1,12	.	.	2,57	3,66	2,01	2,05
2009	2	.	– 1,00	– 0,51	.	2,02	2,24	1,79	.
2009	4	– 1,40	– 2,23	– 1,25	– 1,32	0,98	1,24	0,96	.
2010	2	– 0,79	– 1,88	– 1,47	.	2,54	2,59	.	.
2010	4	– 7,47	– 4,85	– 5,37	.	3,54	6,18	.	.
2011	2	– 7,60	– 5,74	– 4,44	.	3,83	5,58	.	3,95
2011	4	– 2,72	– 1,83	– 1,73	.	2,28	3,25	.	1,59
2012	2	– 3,50	– 2,61	– 2,30	.	.	2,44	.	.
2012	4	– 2,33	– 2,39	.	.	3,09	2,45	1,30	1,64

Appendix (continued)

Figure 1. Liquidity factor

The figure plots the monthly liquidity factor of Sadka (2006) for the period 1994-2012.

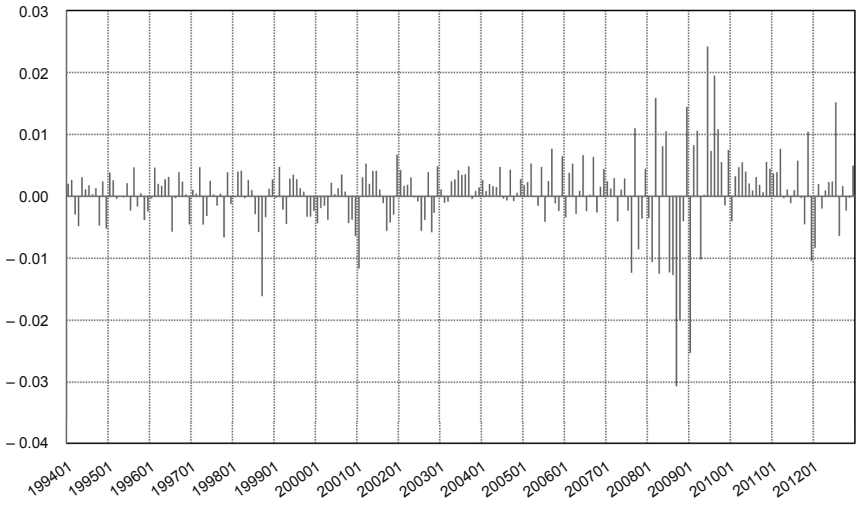
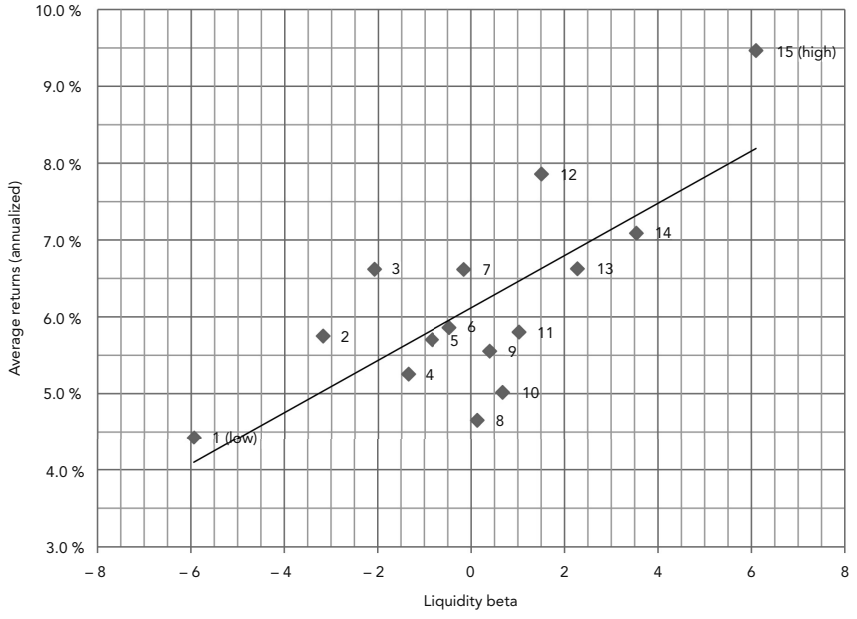


Figure 2. Average returns of portfolios as a function of liquidity beta

Each month, indices are sorted into 15 portfolios based on their 12-month rolling liquidity betas. The liquidity beta of an index is calculated via a regression of the index return (in excess of the risk-free rate) on the market portfolio (Fama and French (1993)) and the liquidity factor (Sadka (2006)) using the most recent 12 monthly observations (with at least nine observations). The figure plots the average returns (in excess of the risk-free rate) of the 15 portfolios against the time-series averages of portfolio liquidity beta. The sample includes 106 indices across the asset classes of global equity, industry sectors, fixed income, and hedge funds, for the period 1994-2012.



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