Internet Appendix for
"Liquidity transformation and financial fragility: Evidence from funds of hedge funds"

In this appendix, we report the results that are excluded from the published paper for the sake of brevity. These include the results that are reported in the paper as untabulated results or briefly discussed without any tabulation.

A. Sample representativeness

To demonstrate that our sample of registered FoFs are representative of non-registered FoFs that report to the commercial databases ("database FoFs"), we conduct a comparative analysis of the two key variables in our study (flow-performance sensitivity and returns) for these two groups of FoFs. Panel A of Table IA1 shows no significant difference in the flow-performance sensitivity between registered FoFs and database FoFs. This is true for both the full sample period (2004-2011) and the crisis period (2007-2009). Further, Panel B shows no significant difference between the average quarterly returns for the two groups. This evidence is consistent with the finding of Aiken, Clifford, and Ellis (2013), who show that the performance of registered FoFs is representative of the performance of the broader FoF universe.

B. Correlations among the different measures of liquidity restrictions

Since only about one-third of the hedge funds in our sample report to commercial databases, we rarely have complete information about all three illiquidity variables for all hedge funds held in a FoF's portfolio. Therefore, it is challenging to reliably compute FoF illiquidity gaps based on all three illiquidity variables. To gauge the robustness of our findings, we compute the pairwise correlations of the different illiquidity measures: redemption restriction (defined in the paper), lockup period, redemption notice period, and a measure that combines the three different measures using hedge funds in the commercial databases. All three variables are measured in days. The results reported in Table IA2 show that all the pairwise correlations are significantly positive, ranging from 0.3 to 0.9. These findings suggest that the redemption restriction captures a common element of a broader set of liquidity restrictions in both hedge funds and FoFs.

C. Illiquidity gap and incentive fee compensation

We investigate whether higher illiquidity gaps are positively related to the extent of FoF managers winning their bets in the form of higher dollar incentive fees. We do not directly observe the realized dollar incentive fees paid to the FoF managers, but we can indirectly infer their fees from their realized returns. Specifically, following Agarwal, Daniel, and Naik (2009), we compute the annual incentive compensation as:

$$\text{Dollar incentive fee}_{i,y} = AUM_{i,y-1} \times \text{Incentive Fee}_i \times \max\left\{\text{Return}_{i,y}, 0\right\}$$

where $AUM_{i,y-1}$ is the FoF *i*'s assets under management at the end of year *y*-1, $\text{Return}_{i,y}$ is the FoF *i*'s annual (before-fee) return during year *y*, and Incentive Fee_i is the FoF *i*'s contractual incentive fee. For example, a FoF with $100 million in AUM and a 10% incentive fee earns $500,000 in fees if the return is 5%, but no fees are earned for negative returns.

Table IA3 reports the results from regressing the logarithm of dollar incentive fees on lagged illiquidity gap. The coefficient on gap is positive and significant (coeff. = 1.407; *t*-stat = 3.36), indicating that higher illiquidity gaps are associated with higher incentive fees awarded to FoF managers. Specifically, a one standard deviation increase in illiquidity gap is associated with a 168% $\left(=\exp\{1.407\times 70\div 100\}-1\right)$ increase in incentive compensation. This shows that higher illiquidity gaps are positively related to the extent of FoF managers winning their bets in the form of higher dollar incentive fees.

D. Illiquidity gap and liquidity beta

We use two approaches to further study the relation between illiquidity gap and liquidity risk in FoF returns. First, we estimate FoF-by-FoF regressions of quarterly FoF returns on quarterly realizations of the Pástor and Stambaugh (2003) liquidity factor and the seven factors in Fung and Hsieh (2004) model. This yields an estimate of liquidity beta for each of the 43 FoFs that have at least 12 quarterly return observations. We then sort FoFs into two groups based on whether their average illiquidity gap is above or below the median illiquidity gap, and test the difference in FoF liquidity betas across the two groups. Panel A of Table IA4 shows that the liquidity betas for high-gap FoFs are significantly larger, on average, than those for low-gap FoFs (0.089 versus 0.044, *t*-stat = 2.24).

Second, we compute a time series of quarterly returns for a portfolio of FoFs with high illiquidity gaps, and for a portfolio of FoFs with low illiquidity gaps. At each quarter end, we sort FoFs into two groups based on whether their illiquidity gaps are above or below the median. For each group, we compute the equal-weighted return of FoF portfolios over the following quarter. We then regress the portfolio returns on the Pástor and Stambaugh (2003) liquidity factor and the seven factors in the Fung and Hsieh (2004) model. As shown in Panel B of Table IA4, the liquidity beta for the high-gap portfolio is positive and statistically significant (coeff. = 0.074; *t*-stat = 2.13). In contrast, the coefficient for the low-gap portfolio is positive but statistically insignificant (coeff. = 0.040; *t*-stat = 0.97). We find a similar result in Columns 3 and 4 for value-weighted (instead of equal-weighted) portfolio returns. In brief, these results reinforce the implications of our findings in Table 6 of the paper that larger illiquidity gaps are associated with greater liquidity risk in FoF returns.

E. Return premium associated with illiquidity gap

We estimate the incremental return associated with higher illiquidity gaps over an entire market cycle. Motivated by prior studies showing that hedge funds more exposed to liquidity risk earn higher returns (Sadka, 2010), we would expect higher returns among FoFs with higher illiquidity gaps, over an entire cycle. However, the 2007–09 financial crisis represents nearly 40% of our sample period (2004–2011). Therefore, the negative relation between FoF returns and illiquidity gaps during crisis periods ends up carrying a lot of weight when estimating the unconditional relation between a FoF's illiquidity gap and its returns. To extend our sample period before 2004 and after 2011, we examine the subset of the 79 registered FoFs that report their monthly returns to the four commercial hedge fund databases (EurekaHedge, HFR, Lipper TASS, and Morningstar). Using the commercially available data allows us to observe monthly returns of FoFs over a longer window, closer to an entire cycle of crisis and non-crisis periods. After matching the regulatory filings with the commercial data, we arrive at a subset of 35 FoFs that report returns over 1999–2016, a symmetric 5-year window extension both before and after the sample period of 2004 to 2011 in our study. We then sort the sample into quintiles based on FoFs' lagged illiquidity gaps.[1] We report the average returns for each quintile in Table IA5. FoFs that fall in the bottom quintile of illiquidity gap (i.e., lowest liquidity risk) earn average returns of 30 basis points per month. In contrast, returns average 46 basis points for FoFs with illiquidity gap in the top quintile (i.e., highest liquidity risk). The annualized difference of 1.92% is significant (*t*-statistic = 1.96) and suggests that the incremental return associated with higher illiquidity gaps is positive when estimated over an entire cycle.

F. Determinants of FoF illiquidity gaps

In section IV.A of the paper, we examine the determinants of FoF illiquidity gap. Here we include the instrumental variable (IV)–the passive change in illiquidity gap–as an additional explanatory variable of illiquidity gap. As shown in Table IA6, our results remain qualitatively similar.

G. Illiquidity gap and flow-performance sensitivity

In section VI.B.1 of the paper, we find that investor flows are more sensitive to the past performance of FoFs with greater illiquidity gaps during crisis periods but not during the non-crisis periods. Instead of splitting the sample into crisis and non-crisis periods, we also divide the sample based on below-median and above-median FoF past returns or negative and positive FoF past returns, respectively. As shown in Table IA7**,** we find qualitatively similar results using these alternative specifications.

[1] Since we can only compute FoF illiquidity gaps over 2004–2011, we carry forward the last available illiquidity gap as of 2011 for observations following the end of our holdings sample (i.e., post–2011), and backfill the earliest available illiquidity gap as of 2004 for observations that precede the start of our holdings sample (i.e., pre–2004).

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Table IA1. Sample representativeness

Panel A of this table compares the flow-performance sensitivity of the registered FoFs and the FoFs in the four commercial databases, i.e., "database funds" (EurekaHedge, HFR, Lipper TASS, and Morningstar). $Flow_{i,t}$ is the flows of FoF *i* during quarter *t*. $Return_{i,t-1}$ is the returns of FoF *i* during quarter *t-1*. Panel B reports the mean and standard deviation (SD) of quarterly returns for the registered FoFs and the database FoFs. *, **, ***, and **** denote statistical significance at 10, 5, 1, and 0.1 percent level, respectively.

Panel A. Flow-performance sensitivity for database FoFs and registered FoFs

	Flow $_{i,t}$					
	Full Sample (2004–2011)			Crisis Period (2007–2009)		
	(1) database FoFs	(2) registered FoFs	difference	(3) database FoFs	(4) registered FoFs	difference
Return $_{i,t-1}$	0.427****	0.408*	0.019	0.423****	0.428*	0.000
	(6.71)	(1.92)	*p*-value=0.91	(5.07)	(1.86)	*p*-value=0.98
Constant	0.029****	0.009		0.0198	–0.001	
	(4.59)	(1.00)		(1.66)	(–0.90)	
Observations	243427	1145		106264	539	
R-squared	0.013	0.007		0.018	0.020	

Panel B. Returns for database FoFs and registered FoFs

Sample	obs	Mean (%)	SD (%)
Database FoFs	389,780	1.04	7.99
Registered FoFs	1,220	0.97	4.02
Difference		–0.07	
		t-stat = 0.32	

Table IA2. Correlations among the different measures of liquidity restrictions

This table reports the correlation coefficients among the different measures of liquidity restrictions including the redemption restriction, redemption notice period, lockup period, and a combined measure that equals to the sum of the three measures. All variables are measured in days. *p*-values are reported in parentheses below the correlation coefficients. Panel A and Panel B report the correlation coefficients for hedge funds and funds of funds (FoFs), respectively.

Panel A. Hedge funds (N=19,954)

	Redemption restriction	Combined measure	Notice period	Lockup period
Redemption restriction	1			
Combined measure	0.627	1		
	(0.000)			
Notice period	0.384	0.538	1	
	(0.000)	(0.000)		
Lockup period	0.361	0.944	0.383	1
	(0.000)	(0.000)	(0.000)	

Panel B. FoFs (N=7,635)

	Redemption restriction	Combined measure	Notice period	Lockup period
Redemption restriction	1			
Combined measure	0.619	1		
	(0.000)			
Notice period	0.395	0.519	1	
	(0.000)	(0.000)		
Lockup period	0.352	0.932	0.325	1
	(0.000)	(0.000)	(0.000)	

Table IA3. Illiquidity gap and incentive fee compensation

This table reports the results of from the regression of the logarithm of incentive compensation on the illiquidity gap of a FoF. We include FoFs that have non-zero incentive fees. Following Agarwal, Daniel, and Naik (2009), we compute the annual incentive compensation as:

$$\text{Dollar incentive fee}_{i,y} = AUM_{i,y-1} \times \text{Incentive Fee}_i \times \max\left\{\text{Return}_{i,y}, 0\right\}$$

where $AUM_{i,y-1}$ is the FoF *i*'s assets under management at the end of year *y*-1, $\text{Return}_{i,y}$ is the FoF *i*'s annual (before-fee) return during year *y*, and Incentive Fee_i is the FoF *i*'s contractual incentive fee. *, **, ***, and **** denote statistical significance at 10, 5, 1, and 0.1 percent level, respectively.

	Log (Dollar incentive fee) $_{i,y}$
Gap $_{i,y-1}$	1.407**
	(3.36)
Constant	13.95***
	(5.36)
Year fixed effects	No
Observations	111
R-squared	0.021

Table IA4. Illiquidity gap and liquidity beta

Panel A reports the average liquidity betas for FoFs with high and low illiquidity gaps. We regress FoF quarterly returns on the quarterly realizations of Pástor and Stambaugh (2003) liquidity factor and the seven factors in Fung and Hsieh (2004) model to obtain an estimate of liquidity beta for each FoF. We then divide FoFs into two groups based on the average illiquidity gap of a FoF over the sample period being above or below the median illiquidity gap across all FoFs. We require a minimum of 12 return observations to estimate each regression. Panel B reports the results of regressing calendar-time quarterly portfolio returns of FoFs with high or low illiquidity gap on the seven factors in Fung and Hsieh (2004) model and Pástor and Stambaugh (2003) liquidity factor. At each quarter end, we divide FoFs into two groups based on the lagged illiquidity gap. We then form equal-weighted and value-weighted calendar-time portfolios for FoFs with high and low illiquidity gaps. *, **, ***, and **** denote statistical significance at 10, 5, 1, and 0.1 percent level, respectively.

Panel A. Cross-sectional comparison

Illiquidity Gap	Obs	Mean
Low	21	0.044
High	22	0.089
Difference		0.045**
		(2.24)

Panel B. Calendar-time portfolio approach

	Calendar-time portfolio returns			
	Equal-Weighted		Value-Weighted	
	Low	High	Low	High
	(1)	(2)	(3)	(4)
PS liquidity factor	0.040	0.074**	0.026	0.072*
	(0.97)	(2.13)	(0.63)	(1.77)
Fung-Hsieh seven factors	Yes	Yes	Yes	Yes
Observations	28	28	28	28
R-squared	0.756	0.823	0.794	0.792

Table IA5. Return premium associated with illiquidity gap

This table reports the pooled average of monthly returns over quarter q+1 of FoFs sorted into five groups based on their illiquidity gaps at the end of quarter q. We use monthly returns in the four commercial databases for the FoFs that are common to the sample of registered FoFs and FoFs in the commercial databases from 1999 to 2016, a symmetric 5-year window extension both before and after the sample period of 2004 to 2011 in our study. We carry forward the last available illiquidity gap as of 2011 for observations following the end of our holdings sample (i.e., post–2011), and backfill the earliest available illiquidity gap as of 2004 for observations that precede the start of our holdings sample (i.e., pre–2004). ** denotes significance at the 5% level.

Group	Mean illiquidity gap (days)	Mean return (%, monthly)
1	–134.19	0.30
2	–34.43	0.31
3	–8.04	0.27
4	16.90	0.36
5	73.16	0.46
Difference (5–1)		0.16**
		t-stat=1.96

Table IA6. Determinants of FoF illiquidity gaps

This table reports the results of regressing illiquidity gap of a FoF on the natural logarithms of FoF size and age, management fee, incentive fee, passive change in gap, and quarter fixed effects. Incentive fee dummy is equal to one if a FoF's incentive fee is greater than zero, and is zero if a FoF does not charge an incentive fee. Tech bubble dummy is an indicator variable that takes the value of one if a fund has experienced the technology bubble (1999–2001), and otherwise zero. The dependent variable is scaled by 100 days for expositional convenience of estimated slope coefficients. All time-varying independent variables are measured at the end of the prior quarter. All variables are defined in Table 1. Standard errors are clustered at the quarter level. *, **, ***, and **** denote statistical significance at 10, 5, 1, and 0.1 percent level, respectively.

	Gap $_{i,t}$			
	(1)	(2)	(3)	(4)
Passive Change In Gap $_{i,t-1}$	0.247****	0.227***	0.266****	0.251****
	(3.83)	(3.53)	(4.83)	(4.61)
Log Size $_{i,t-1}$	0.119****	0.124****	0.138****	0.158****
	(7.79)	(7.86)	(9.74)	(11.45)
Log Age $_{i,t-1}$	–0.501****	–0.492****	–0.266****	–0.292****
	(–13.34)	(–12.17)	(–6.57)	(–6.31)
Management Fee $_i$	–0.173****	–0.221***	–0.266****	–0.186***
	(–3.91)	(–3.64)	(–6.26)	(–3.33)
Incentive Fee $_i$	0.0268****		0.0257****	
	(4.39)		(4.81)	
Incentive Fee Dummy$_i$		0.194****		0.328****
		(5.08)		(7.48)
Tech Bubble Dummy$_i$			–0.534****	–0.590****
			(–14.30)	(–14.09)
Constant	–0.219	–0.293	–1.300****	–1.705****
	(–1.20)	(–1.47)	(–6.79)	(–8.82)
Observations	961	961	961	961
R-squared	0.165	0.159	0.241	0.249

Table IA7. Illiquidity gap and flow-performance sensitivity

This table reports the results of regressing the quarterly flows of a FoF on its returns, illiquidity gap, an interaction of returns and illiquidity gap. Control variables include FoF flows, the natural logarithms of FoF size and age, FoF management fee, FoF incentive fee, and quarterly fixed effects. All time-varying independent variables are measured at the end of the prior quarter. Illiquidity gap is scaled by 100 days for expositional convenience of estimated slope coefficients. Model 1 (2) includes the observations with below-median (above-median) FoF returns. Model 3 (4) includes observations with below-zero (above-zero) FoF returns.

	Flow $_{i,t}$			
	Below Median	Above Median	Below Zero	Above Zero
	(1)	(2)	(3)	(4)
Gap $_{i,t\text{-}1}$	0.00430	-0.000301	0.00349	0.00993
	(0.48)	(-0.02)	(0.18)	(0.75)
Gap $_{i,t\text{-}1}$ x Return $_{i,t\text{-}1}$	0.549***	0.0420	0.481**	-0.0560
	(3.17)	(0.16)	(2.30)	(-0.23)
Return $_{i,t\text{-}1}$	0.448***	0.221	0.790***	0.304
	(2.89)	(0.74)	(3.61)	(0.95)
Controls	Yes	Yes	Yes	Yes
Observations	445	460	238	667
R-squared	0.130	0.101	0.192	0.095