Online Appendix for
The Effect of Investment Constraints on Hedge Fund Investor Returns

8 September 2018

This Online Appendix includes the following supplementary analyses, which are not included in the main paper due to the reasons of space.

I. Data Appendix

A. Closed to New Investments Indicator

In the main paper, we discuss the findings in Panel C of Table 1, which reports summary statistics for variables related to the closed to new investments (C7) constraint. Due to differences in data availability between commercial databases, we apply different rules to construct indicators for whether a fund is closed to new investments. Hedge Fund Research (HFR), EurekaHedge, and Morningstar explicitly provide a closed-to-new-investment indicator variable. For Lipper TASS, we set the closed-to-new investments dummy to one if the fund has a non-missing closed-to-investment or reopen-to-investment date, and zero otherwise. In rare special cases, if the fund has a missing closed-to-investment date but a non-missing reopen-to-investment date, we set the closed-to-investment dummy to one if the reopen-to-investment date is greater than the fund inception date. BarclayHedge provides a fund status variable.

B. Registered Hedge Fund of Hedge Fund Holdings and Discretionary Liquidity Restrictions

We use the registered fund-of-fund (FoHF) holdings in the analysis presented in the main paper's Panel C of Table 1 and Panel C of Table 2. We follow the steps in Aiken, Ellis, and Clifford ((2013) and (2015a)) to construct our variables.

Following Aiken et al. (2015a), we define a hedge fund as using a discretionary liquidity restriction (DLR) when any fund-of-fund reports a position for the hedge fund that is 1) in a side pocket (either completely or partially), 2) subject to investor-level gates, 3) liquidating, 4) organized as a special purpose vehicle or special liquidating vehicle, or 5) explicitly said to be illiquid or having its liquidity restricted. We gather this data from the US Securities and Exchange Commission (SEC) forms N-Q and N-CSR(S) to capture each fund of fund's portfolio holdings. We hand match DLR data with our aggregate databases based on five commercial databases. One caveat is that not all funds in our database feature in fund of fund portfolios that report to the SEC. Therefore, the data only provides us with partial information about potential restrictions to redeem capital from funds in our sample.

In the main paper's Panel C of Table 2, we study the choice of diversification constraint. This choice is further confirmed by using data from registered fund of hedge funds' (FoHF) holdings. Following Aiken et al. (2013), we gather the underlying hedge fund holdings of our sample FoHFs from SEC forms N-Q, N-CSRS, and N-CRS. These registered FoFs are often run by the most prominent hedge fund management firms that are rarely available for researchers (Edelman, Fung, and Hsieh (2013)).

II. Robustness of Results

A. Robustness of Size–Performance Relationship

Figure A1 examines the size–performance relationship when we adjust for backfill bias. It shows that a micro fund's performance is elevated when we do not correct backfill bias at all.

In Section III of the main paper, we document a positive backward-looking size–performance relationship. One natural question is whether this result is driven by flows or returns. Are funds large now because they grew the asset base by generating large returns or

attracting large flows in the past? To answer this question, we construct backward-looking portfolios and sort hedge funds into nominal size groups based on the last available assets under management (AUM) observation. Second, we divide hedge funds into two groups based on the cross-sectional median of flow-based AUM observations. Untabulated results show that the positive size–performance relationship is present both for high and low inflow funds within each size interval. This implies that the result is not driven by flows or artificially by return-based AUM growth.

III. Rebalancing Frequency and Performance Persistence

To investigate the effect of the rebalancing frequency constraint (C1) on performance persistence, we rank funds quarterly, semiannually, or annually into quintile portfolios. We divide funds into quintiles based on the *t*-statistic of ranking-period Fung and Hsieh (2004) alpha (FH alpha) or relative alpha estimated from the prior 24-month data. Since the results that use the relative alphas to evaluate out-of-sample performance do not qualitatively change our main conclusions, we only report them in Table A1 and not in the main paper.

IV. Liquidity Constraints and Performance Persistence

Table 5 in the main paper shows that performance persistence measured using FH alphas decreases after we impose the lockup provision, redemption period constraints and especially the maximum acceptable notice period constraint.

Table A2 shows that the conclusions are unchanged when out-of-sample performance is evaluated using relative alphas instead of FH alphas.

V. Marginal Effects of Rebalancing Frequency and Liquidity Constraints

To assess whether the effect of imposing investment constraints related to rebalancing frequency or liquidity constraints (C1 and C2) on performance persistence is more important, in the main paper's Table 6, we compare differences in the top-quintile FH alphas between the constrained portfolios specified in main paper's Table 4 (rebalancing frequency) and Table 5 (liquidity constraints).

Table A3 shows that the conclusions are quantitatively unchanged when out-of-sample performance is evaluated using the relative alphas instead of FH alphas.

VI. Style Allocation Constraint

In the main paper's Section V, we assess how different constraints affect a hypothetical investor's performance. We distinguish several scenarios which differ depending on the size of the hypothetical investor's portfolio and which of the constraints are accounted for.

As an additional test in Table A4, we construct four style-specific portfolios that contain the top 30 funds, which are solely selected from a specific investment style. In Panels A to D, we see that the top 30 funds in the Directional Traders and Security Selection style deliver less consistent performance than those in the Multiprocess and Relative Value style. However, when we examine the marginal effects between the style-diversified and single-style portfolios in Panel E, we find that the performance differences are not statistically significant. Hence, the performance of portfolios that are diversified across styles is not statistically significantly different from that of portfolios that are focused on one of the styles.

VII. Liquidity Diversification

In the main paper, we have assumed that the hypothetical investor portfolios are rebalanced annually. As we see from the earlier results presented in the main paper's Section IV, this

assumption can be too restrictive[1]. Panel A of Table A5 shows that the magnitude of FH alphas is generally higher when portfolios are rebalanced quarterly and not annually (as in the baseline case reported earlier in Panel D of Table 8). Even when the three-month maximum acceptable notice period constraint is imposed, the FH alphas remain positive and statistically significant for all three investor portfolio sizes.

Quarterly rebalancing also results in some outperformance in relative terms. Panel B and C of Table A5 show that the top 30 funds are able to outperform both the bottom 30 funds and random 30 funds when the lockup and redemption restrictions are properly taken into account. However, after controlling for the maximum acceptable notice period, only the $100 million investor who predicts fund performance using relative alphas is able to beat both the bottom 30 funds and the 30 random funds.

Finally, as an additional robustness test, in Panel D we report the marginal effect of using quarterly instead of annual rebalancing. Although the FH alphas of the quarterly rebalanced portfolios are higher than the ones rebalanced annually in most cases, the performance differences are only statistically significant in two of the eighteen cases. Hence, the quarterly rebalanced top 30 funds do not consistently outperform the annually rebalanced top 30 funds.

We next turn to potential diversification benefits that could be obtained by diversifying across portfolios that are rebalanced at different horizons. Panel A, B and C of Table A6 report the results when the hypothetical investor allocates 25% of her portfolio to annually rebalance 75%, 50%, and 25% respectively, and quarterly rebalance 25%, 50%, and 75% respectively, of the top 30 fund portfolio.

[1] We thank an anonymous referee for this suggestion.

The most interesting pattern in FH alphas obtains when performance is predicted using relative alphas and the maximum acceptable notice period is controlled for. In this scenario, across all three portfolio size categories, the FH alphas are positive and statistically significant. This implies that investors who rank funds based on past relative performance can benefit by diversifying across different rebalancing periods.

VIII. Delays in Reporting and Emerging Managers

Investors may base their decisions on different information sets. In particular, some investors may have access to historical track records with a delay while others may not adjust for backfill bias if they invest in emerging or younger funds. To examine these issues we carry out two further robustness tests.

As Aragon and Nanda (2017) demonstrate, some hedge funds report their performance to commercial databases with delay. To account for this delay we re-run our analysis after imposing an additional lag. The effect of this delay on hypothetical investor performance is reported in Panel A of Table A7. Across specifications, the magnitude of FH alphas is similar to the baseline case reported in Panel D of Table 8 in the main paper[2]. This is confirmed by the marginal performance differences reported in Panel B of Table A7, which are not statistically significant except in a few cases with a long maximum acceptable notice period constraint.

Some investors do not require long track records, especially if their investment focus is on "emerging managers" that have been documented to deliver outperformance (Aggarwal and Jorion (2010)). Since adjusting for backfill bias may eliminate some emerging managers from the investment opportunity set, Panel C of Table A7 shows the performance of the hypothetical

[2] Note that because of additional lags the baseline that is used to estimate marginal effects differs from the results reported in Panel D of Table 8 in the main paper.

investor portfolio when we do not adjust for backfill bias by removing the first 12 return observations. We observe that the FH alphas are comparable to the alphas presented in the baseline case (Panel D of Table 8) when the bias is adjusted for. The marginal performance differences reported in Panel D show that adjusting for backfill bias does not qualitatively change our conclusions regarding the performance of the hypothetical investor portfolio.

IX. Sensitivity Analysis of C3 and C4 Constraints

Although we set out to test the effect of realistic investment constraints on hedge fund performance persistence, including diversification requirements (C3) and the percentage of AUM constraint (C4), our analysis presented in the main paper also raises normative questions. Investors and policy makers may, for example, ask what the optimal number of hedge funds in a portfolio is if the objective is to maximize out-of-sample performance. To test the sensitivity of the hypothetical investor performance persistence to these two constraints, we vary the number of hedge funds held in the portfolios from 10 to 100. We also separately allow for different percentage of AUM limits ranging from 2% to 30%. The choice of the ranges for both constraints is motivated by investors' actual holdings, as documented in Table 2 of the main paper.

Overall, the results documented in Figure A2 show that the hypothetical portfolio performance is decreasing with the number of hedge funds held in hypothetical investor portfolios. According to Panel A of Figure A2, there is an almost negative monotonic relationship between alphas and the number of funds held in the hypothetical portfolios. Given that we do not incorporate constraints for liquidity needs or the diversification constraint (C4), FH alphas are economically large and statistically significant for all three hypothetical investor portfolios. To measure the marginal importance of the diversification constraint (C3), we estimate the performance difference between our baseline 30 fund portfolio and other specifications. Panel B

of Figure A2 shows that the performance of portfolios having *less* than 30 funds is not statistically significantly higher than the performance of the baseline portfolio with 30 funds. In contrast, for the hypothetical $100 million investor, portfolios with *more* than 30 funds underperform the baseline top 30 portfolio. For the hypothetical $500 million investor, we find that the top 30 fund portfolio starts to outperform when the number of funds held in the portfolio exceeds 55. The effect of the diversification constraint is not significant for the $1 billion portfolio. Although there is a monotonically decreasing relationship between alphas and number of funds held, it is not statistically significant when we compare the baseline top 30 fund's performance with other specifications that vary the number of funds held.

Panel C of Figure A2 complements this analysis and shows that the performance of the hypothetical portfolios increases with the percentage of AUM constraint (C4). This can be explained by the fact that the larger percentage of AUM limit allows the inclusion of smaller funds to the hypothetical portfolios than smaller percentage of AUM limits would allow. Again, we observe that FH alphas are large and statistically significant across specifications, because we do not impose tight liquidity needs but rather focus on the percentage of AUM limit. The tighter percentage of AUM constraint has the most significant effect on the hypothetical $1 billion portfolio, but it only marginally reduces the performance of the $100 million investor portfolio. Panel D confirms the finding that the increase in the percentage of AUM constraint has the strongest effect on the performance of the $1 billion portfolio. The portfolio with the 10% of AUM constraint consistently underperforms the portfolios with larger percentage of AUM constraints; the differences in the FH alphas between the portfolio with 10% of AUM constraint and other portfolios with the percentage of AUM constraint varying between 16% and 34% are statistically significant at 5% level.

Figure A1: Size–Performance Relationship Adjusted for Backfill Bias.

We form size portfolios as in Table 2 of the main paper. This figure shows the annualized Fung and Hsieh (2004) alphas for each of the nominal size groups after returns are adjusted for backfill bias. We exclude 12, 24, or 31 months of fund-level returns in order to control for this bias.

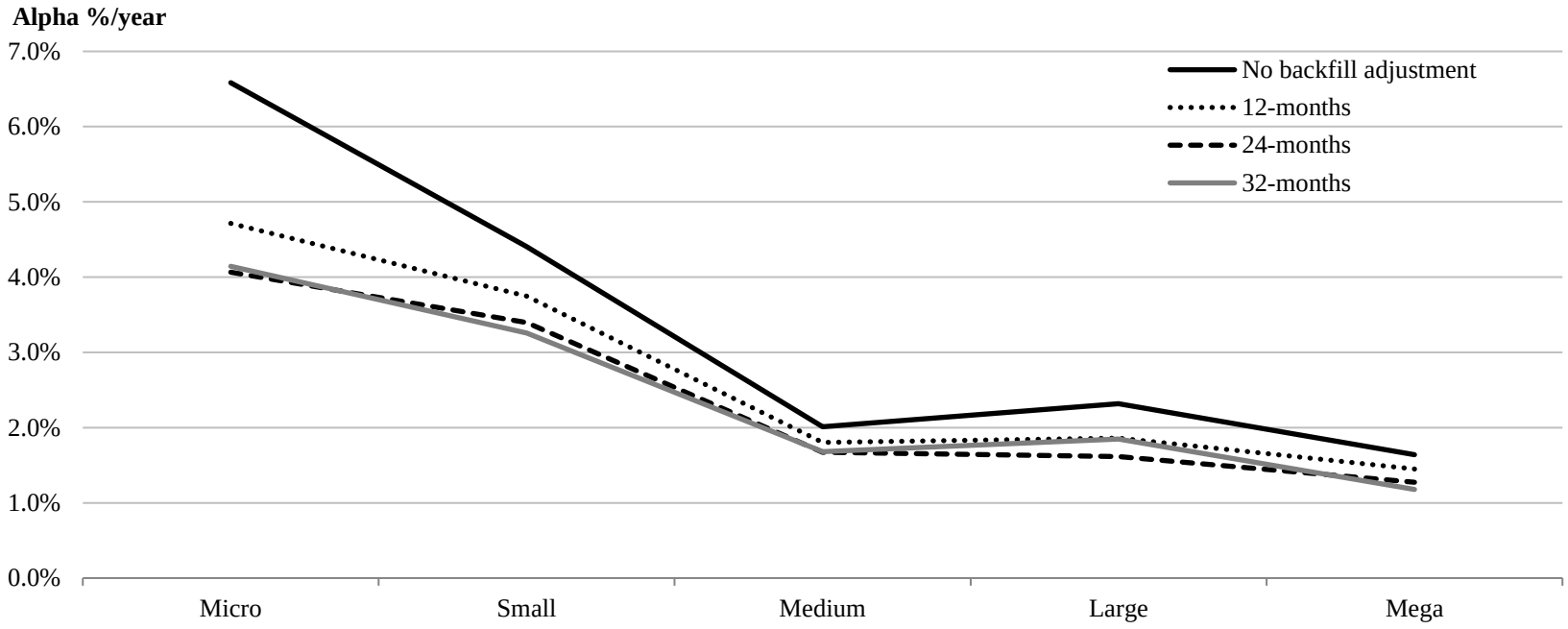
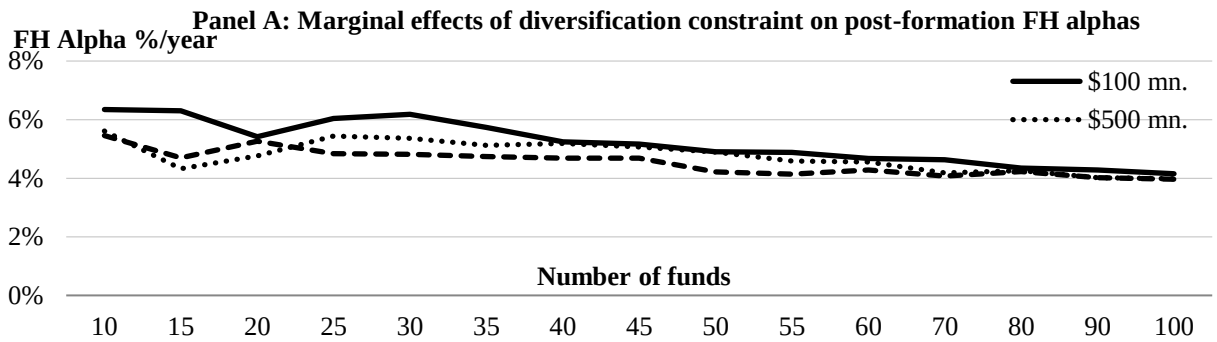
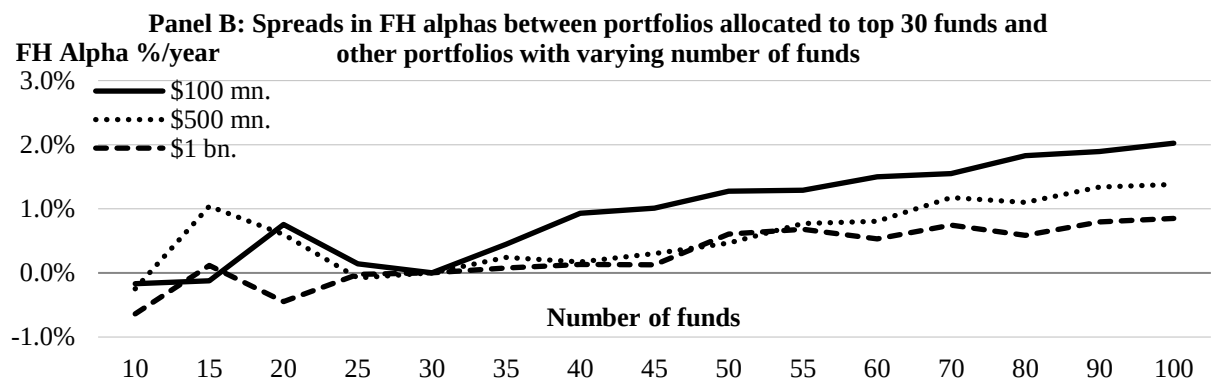


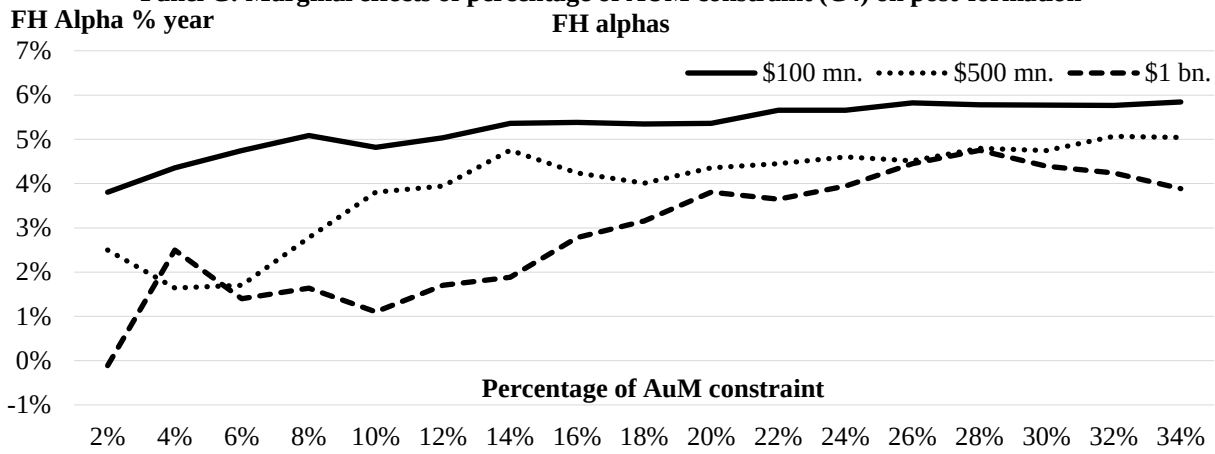
Figure A2: Marginal Effects of Diversification Requirements and Percentage of Assets Under Management Constraints on Investor Performance.

This figure shows the economic sensitivity of the hypothetical investor portfolio performance to variation in constraints C3 and C4. We impose the rebalancing frequency constraint (C1) for each portfolio and sort hedge funds into portfolios every December based on the *t*-statistic of the Fung and Hsieh (2004) (FH) alpha. We impose the liquidity constraint (C2) stating that the lockup and redemption periods must not exceed 12 months. In Panel A, we report the post-formation FH alphas for the portfolios when the diversification constraint (C3) varies between 10 and 100. Panel B measures the spread in the FH alphas between the top 30 fund portfolio and other portfolios with varying number of funds. In Panel C, we report the post-formation FH alphas for the portfolios, which are allocated to top 30 funds, and the percentage of assets under management (AUM) constraint (C4) varies between 2% and 34%. Panel D measures the spread in the FH alphas between the portfolio with the 10% AUM constraint and other portfolios with varying AUM constraint. The y-axis of the figures shows the annualized FH alphas.





Panel C: Marginal effects of percentage of AUM constraint (C4) on post-formation FH alphas



Panel D: Spreads in FH alphas between portfolio having 10% AUM constraint and other portfolios with varying constraint

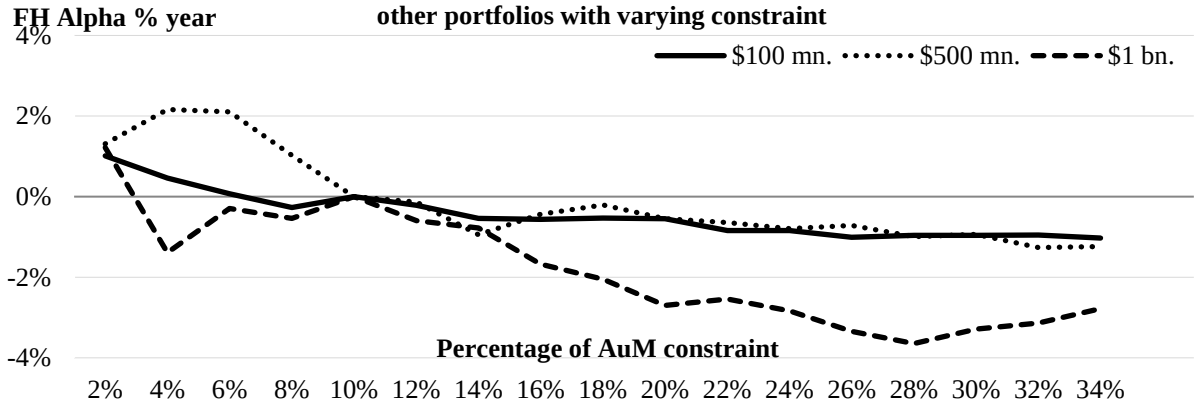


Table A1: Rebalancing Frequency and Performance Persistence Measured Using the Relative Alpha.

This table reports the impact of rebalancing frequency (C1) on performance persistence. We impose the constraint for rebalancing frequency (C1) and sort funds into quintiles quarterly, semiannually, or annually using the *t*-statistic of the Fung and Hsieh (2004) alpha (FH α) or relative alpha (Rela α) that are estimated from the 24 most recent return observations. To account for fund size in the formation of portfolios, for December 2012 we calculate the percentiles of funds belonging to the respective nominal fund size category. For each preceding month of portfolio formation, we use these percentile limits to sort funds into size category portfolios; we then calculate post-formation returns for each of the portfolios. To gauge performance persistence, we estimate the relative alpha spread between top and bottom portfolios, and conduct the Patton and Timmermann (2010) monotonicity test. Reported are the relative alpha and its *t*-statistic for each of the portfolios and the *p*-value of the Patton and Timmermann (2010) test for monotonicity. Panel A, B and C report the results for the quarterly, semiannually, and annually sorted portfolios respectively.

	All Funds		Micro and Small		Medium		Large and Mega	
Predict	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α
Evaluate	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α
A: Quarterly								
Top	4.81	6.12	5.18	6.71	5.04	5.04	3.50	5.02
4	3.15	3.80	3.79	4.37	2.85	2.85	2.37	1.83
3	2.53	2.76	2.82	3.39	1.81	1.81	1.30	2.27
2	1.31	1.03	1.54	1.09	0.97	0.97	−0.13	−0.74
Bottom	0.45	−1.54	0.67	−1.69	−0.58	−0.58	0.13	−1.18
Top-Bottom	4.37	7.66	4.51	8.40	5.63	5.63	3.36	6.21
t-statistic	3.13	7.21	2.75	7.10	4.26	4.26	2.62	5.97
Mon. *p*-value	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.16
B: Semiannual								
Top	4.48	5.40	4.91	6.13	4.55	4.55	3.59	4.03
4	3.38	3.65	3.95	3.95	3.24	3.24	1.37	1.76
3	2.43	2.28	3.18	3.00	1.24	1.24	1.57	1.85
2	1.43	1.74	0.90	1.62	1.46	1.46	0.19	0.20
Bottom	0.50	−0.87	1.01	−0.85	−0.55	−0.55	1.21	0.07
Top-Bottom	3.99	6.27	3.91	6.98	5.09	5.09	2.38	3.97
t-statistic	3.12	5.83	2.61	6.02	3.99	3.99	1.87	3.35
Mon. *p*-value	0.00	0.00	0.05	0.00	0.11	0.11	0.39	0.04
C: Annual								
Top	3.60	4.57	4.04	5.35	3.38	3.38	2.55	3.10
4	3.05	2.70	3.66	3.05	1.95	1.95	0.51	0.98
3	1.54	2.50	2.49	3.32	1.39	1.39	1.46	2.01
2	2.25	2.41	2.31	2.50	0.61	0.61	0.49	0.28
Bottom	1.90	0.01	2.36	0.49	1.13	1.13	2.08	0.67
Top-Bottom	1.70	4.56	1.67	4.86	2.25	2.25	0.47	2.42
t-statistic	1.26	4.12	1.09	3.94	1.80	1.80	0.36	1.86
Mon. *p*-value	0.69	0.03	0.07	0.14	0.32	0.32	0.65	0.50

Table A2: Liquidity Constraints and Performance Persistence Measured Using the Relative Alpha.

This table shows the effects of liquidity constraints (C2) on performance persistence. We impose the constraint for rebalancing frequency (C1) and sort hedge funds into quintiles quarterly, semiannually, or annually using the t-statistic of the Fung and Hsieh (2004) alpha (FH α) or relative alpha (Rela α) estimated from the 24 most recent return observations. If liquidity constraints for the lockup or redemption periods are imposed we exclude hedge funds having lockup or redemption periods longer than the holding period. If the constraint for the maximum acceptable notice period is imposed we set it equalling to one (1m), three (3m) or six months (6m). The maximum acceptable notice period is assumed to determine the lag in the investor's available information set, which can be used to rank funds. If the maximum acceptable notice period is one month, the lag in the investor's available information set is one month; then, for instance, annually sorted portfolios are formed at the end of November (instead of December). We apply a similar logic to constraints associated with other notice and holding period. We then calculate equal-weighted returns and estimate post-formation relative alphas for each portfolio. Panel A, B and C report the results for the quarterly, semiannually, and annually sorted portfolios respectively. Reported are the same performance measures as in Table A2.

			Imposed liquidity constraints (C2)															
	All funds		Only lockups		Only lockup, redemptions		Only notice period						Lockup, redemption, and notice periods					
							Notice ≤ 1m		Notice ≤ 3m		Notice ≤ 6m		Notice ≤ 1m		Notice ≤ 3m		Notice ≤ 6m	
Predict	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α
Evaluate	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α
Panel A: Quarterly																		
Top	4.81	6.12	2.53	4.16	2.60	4.08	1.59	3.23	2.19	3.40			1.25	2.96	2.05	3.24		
4	3.15	3.80	0.99	1.52	0.81	1.59	0.58	1.28	−0.19	0.39			0.46	1.35	−0.18	0.29		
3	2.53	2.76	−0.31	0.17	−0.51	0.21	−0.59	−0.72	−0.67	−0.54			−0.44	−0.63	−1.01	−0.35		
2	1.31	1.03	−1.36	−1.66	−1.25	−1.82	−1.39	−1.32	−0.86	−0.71			−1.42	−1.58	−0.70	−0.88		
Bottom	0.45	−1.54	−1.91	−4.38	−1.62	−4.17	−1.52	−3.93	−1.10	−3.31			−1.21	−3.64	−0.74	−3.04		
Top–Bottom	4.37	7.66	4.44	8.54	4.22	8.25	3.11	7.16	3.29	6.70			2.45	6.60	2.79	6.27		
t-statistic	3.13	7.21	2.99	8.08	2.81	8.06	2.04	5.79	2.83	7.09			1.58	5.57	2.23	6.42		
Mon. *p*-value	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.01	0.01	0.02			0.10	0.00	0.14	0.00		

	Imposed liquidity constraints (C2)																	
	All funds		Only lockups		Only lockups, redemptions		Only notice period						Lockup, redemption, and notice periods					
							Notice ≤ 1m		Notice ≤ 3m		Notice ≤ 6m		Notice ≤ 1m		Notice ≤ 3m		Notice ≤ 6m	
Predict	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α
Evaluate	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α
Panel B: Semiannual																		
Top	4.48	5.40	2.54	3.65	2.55	3.62	0.78	2.57	1.79	3.00	0.84	2.44	0.66	2.60	1.76	2.89	0.75	2.28
4	3.38	3.65	0.94	1.17	0.89	1.19	−0.13	1.02	−0.87	0.36	−0.42	−0.37	−0.45	1.04	−0.70	0.16	−0.96	−0.69
3	2.43	2.28	−0.21	−0.15	−0.39	−0.29	0.28	−0.76	−0.41	−0.73	−1.32	−0.18	0.45	−1.04	−0.47	−0.64	−1.21	0.16
2	1.43	1.74	−1.16	−1.25	−1.19	−1.16	−0.74	−0.77	−0.40	−0.51	0.17	−0.63	−0.65	−0.80	−0.67	−0.62	0.37	−0.83
Bottom	0.50	−0.87	−2.14	−3.52	−1.86	−3.44	−1.26	−3.29	−0.61	−2.87	0.32	−1.94	−1.23	−3.19	−0.74	−2.82	0.24	−2.04
Top–Bottom	3.99	6.27	4.67	7.17	4.41	7.07	2.04	5.87	2.40	5.87	0.52	4.38	1.89	5.79	2.50	5.71	0.51	4.32
t-statistic	3.12	5.83	3.58	6.56	3.27	6.51	1.39	4.45	1.89	5.90	0.41	4.47	1.25	4.44	1.81	5.69	0.36	4.11
Mon. *p*-value	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.06	0.25	0.16	0.90	0.16	0.46	0.14	0.13	0.06	0.86	0.56
Panel C: Annual																		
Top	3.60	4.57	1.68	2.98	1.69	2.99	0.48	2.43	1.60	2.25	0.27	1.39	0.50	2.49	1.55	2.23	0.21	1.37
4	3.05	2.70	0.46	0.34	0.46	0.34	−0.72	0.49	−1.23	0.27	−0.71	−0.27	−0.72	0.58	−1.21	0.22	−0.66	−0.27
3	1.54	2.50	−1.35	−0.30	−1.39	−0.36	−0.30	−0.54	−0.70	−0.47	−1.00	0.24	−0.32	−0.70	−0.69	−0.40	−1.06	0.27
2	2.25	2.41	−0.33	−0.35	−0.32	−0.34	0.11	−0.89	−0.33	−1.17	0.55	−0.88	0.17	−0.87	−0.39	−1.17	0.48	−0.96
Bottom	1.90	0.01	−0.79	−3.19	−0.80	−3.20	−0.50	−2.75	0.01	−1.87	0.40	−1.35	−0.59	−2.78	−0.10	−2.04	0.35	−1.47
Top–Bottom	1.70	4.56	2.47	6.17	2.48	6.18	0.98	5.17	1.59	4.12	−0.13	2.74	1.09	5.28	1.65	4.27	−0.13	2.84
t-statistic	1.26	4.12	1.84	5.63	1.85	5.64	0.68	4.01	1.00	4.11	−0.08	2.54	0.75	4.11	1.04	4.35	−0.09	2.64
Mon. *p*-value	0.69	0.03	0.72	0.06	0.75	0.09	0.29	0.00	0.41	0.00	0.87	0.38	0.33	0.01	0.37	0.00	0.88	0.37

Table A3: Marginal Effects of Rebalancing Frequency and Liquidity Constraints on Performance Persistence Measured Using the Relative Alpha.

This table shows the economic impact of liquidity restrictions (C2) on the relative alphas of the top-quintiles of the Fung and Hsieh (2004) alpha (FH α) or relative alpha (Rela α) *t*-statistic-sorted portfolios. We compare the relative alphas of the portfolios subject only to the rebalancing frequency constraint (C1) to relative alphas of the portfolios which simultaneously impose both the constraints for rebalancing frequency (C1) and liquidity restrictions (C2). We form the portfolios subject to constraints C1 and C2 as in Table 5 of the main paper. If the portfolio with the constraints C1 and C2 imposes the constraint for the maximum acceptable notice period, the same lag in the investor's available information set is imposed on the portfolio which only imposes the constraint C1. In Panel A, we report the relative alpha for each of the portfolios. To gauge the economic impact of the liquidity restrictions on the relative alphas of the top-quintile portfolios, we estimate the spread in the relative alphas between the portfolio with the constraint C1 and the portfolio which imposes both the constraints C1 and C2 simultaneously. In Panel B we measure the economic impact of the constraint C1 on the relative alphas of the top-quintile portfolios and estimate the spread in the relative alphas between the (B1) quarterly and annually sorted portfolios; (B2) quarterly and semiannually sorted portfolios; and (B3) semiannually and annually sorted portfolios.

Panel A: Marginal effects of liquidity constraints (C2) on persistence in relative alphas

	Only lockups		Only lockups, redemptions		Only notice period						Lockup, redemption, and notice periods					
					Notice ≤ 1m		Notice ≤ 3m		Notice ≤ 6m		Notice ≤ 1m		Notice ≤ 3m		Notice ≤ 6m	
Predict	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α
Evaluate	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α	Rela α
A1: Quarterly																
Rebalancing frequency	3.02	4.61	3.02	4.61	2.50	3.82	2.18	3.43			2.50	3.82	2.18	3.43		
Liquidity restrictions	2.53	4.16	2.60	4.08	1.59	3.23	2.19	3.40			1.25	2.96	2.05	3.24		
Rebalancing–Liquidity	0.49	0.45	0.42	0.53	0.90	0.59	0.00	0.04			1.25	0.86	0.14	0.20		
t-statistic	2.29	2.39	2.39	2.77	1.78	1.25	−0.48	1.74			2.92	2.14	1.22	1.58		
A2: Semiannual																
Rebalancing frequency	2.68	3.85	2.68	3.85	1.66	3.30	1.88	3.06	0.83	2.42	1.66	3.30	1.88	3.06	0.83	2.42
Liquidity restrictions	2.54	3.65	2.55	3.62	0.78	2.57	1.79	3.00	0.84	2.44	0.66	2.60	1.76	2.89	0.75	2.28
Rebalancing–Liquidity	0.14	0.20	0.13	0.23	0.89	0.73	0.09	0.06	−0.01	−0.02	1.00	0.70	0.12	0.16	0.08	0.14
t-statistic	0.82	1.98	1.42	1.99	2.31	2.18	1.31	1.25	−0.63	−0.89	2.04	2.01	−0.10	0.74	0.00	0.13
A3: Annual																
Rebalancing frequency	1.74	3.04	1.74	3.04	1.18	2.98	1.67	2.29	0.26	1.37	1.18	2.98	1.67	2.29	0.26	1.37
Liquidity restrictions	1.68	2.98	1.69	2.99	0.48	2.43	1.60	2.25	0.27	1.39	0.50	2.49	1.55	2.23	0.21	1.37
Rebalancing–Liquidity	0.06	0.06	0.05	0.05	0.70	0.56	0.07	0.04	0.00	−0.02	0.67	0.49	0.12	0.06	0.05	0.00
t-statistic	−0.50	−0.71	−0.65	−0.83	0.87	1.43	1.16	1.01	−0.18	−1.21	0.55	1.16	0.09	−1.08	−0.01	−1.43

Panel B: Marginal effects of the rebalancing frequency (C1) on performance persistence in relative alphas

	Only lockups		Only lockups, redemptions		Only notice period						Lockup, redemption, and notice periods					
					Notice ≤ 1m		Notice ≤ 3m		Notice ≤ 6m		Notice ≤ 1m		Notice ≤ 3m		Notice ≤ 6m	
Predict	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α
B1: Quarterly – annual																
Rebalancing frequency																
Evaluate: Rela α	1.21	1.56	1.21	1.56	1.21	1.01	0.58	1.14			1.21	1.01	0.58	1.14		
t-statistic	3.18	4.70	3.18	4.70	2.91	3.63	1.28	3.59			2.91	3.63	1.28	3.59		
Liquidity restrictions																
Evaluate: Rela α	0.82	0.70	0.89	0.70	1.01	0.61	0.67	0.41			0.60	0.61	0.57	0.41		
t-statistic	1.84	3.38	1.99	3.38	2.12	3.18	1.43	2.53			1.21	3.18	1.04	2.53		
B2: Quarterly – semiannual																
Rebalancing frequency																
Evaluate: Rela α	0.34	0.70	0.34	0.70	0.69	0.61	0.31	0.41			0.69	0.61	0.31	0.41		
t-statistic	1.32	3.38	1.32	3.38	1.99	3.18	0.99	2.53			1.99	3.18	0.99	2.53		
Liquidity restrictions																
Evaluate: Rela α	0.05	0.49	0.08	0.44	0.74	0.78	0.41	0.43			0.46	0.46	0.38	0.37		
t-statistic	0.19	2.15	0.27	1.93	1.80	3.13	1.31	2.62			1.13	1.83	1.03	1.77		
B3: Semiannual – annual																
Rebalancing frequency																
Evaluate: Rela α	0.87	0.85	0.87	0.85	0.52	0.40	0.28	0.73	0.47	0.87	0.52	0.40	0.28	0.73	0.47	0.87
t-statistic	3.11	3.58	3.11	3.58	2.01	2.09	0.70	2.59	1.28	2.30	2.01	2.09	0.70	2.59	1.28	2.30
Liquidity restrictions																
Evaluate: Rela α	0.76	0.62	0.81	0.57	0.27	0.29	0.27	0.70	0.47	0.87	0.14	0.05	0.19	0.52	0.53	0.65
t-statistic	2.23	2.30	2.31	2.02	0.89	0.99	0.66	2.51	1.30	2.30	0.40	0.15	0.47	1.55	1.24	1.47

Table A4: Style Allocation and Hypothetical Investor Performance.

This table provides an extension to Table 9 in the main paper and provides further results on the effect of the style allocation constraint C6. It shows the performance of hypothetical investor portfolios that are diversified across styles or based only on one of the broad investment styles. Hypothetical investors' portfolios are constructed as in Tables 7 and 8 of the main paper. Table 9 reports the ex-post FH alphas for the strategy that is equally diversified across four broad styles: Directional Traders, Relative Value, Security Selection, and Multiprocess. Panel A, B, C and D of Table A4 below report the Fung and Hsieh (2004) alphas (FH α) for each of the single styles. Panel E reports the marginal effects of style allocation. We compute equal-weighted returns for each portfolio sorted on FH alpha or relative alpha (Rela α) *t*-statistic and estimate the post-formation FH alpha and its *t*-statistic for each of the portfolios. The *t*-statistics of the alpha are reported in parentheses. The time period covered is January 1994 through December 2012.

	Imposed liquidity constraints (C2)							
			Lockup, redemption, and notice periods					
	Only lockup and redemption periods		Notice ≤ 1m		Notice ≤ 3m		Notice ≤ 6m	
Evaluate	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α
Predict	FH α	FH α	FH α	FH α	FH α	FH α	FH α	FH α
Panel A: Only Directional Traders (constraints C1–C5)								
$100 mn.	1.36	3.84	0.72	3.84	2.17	3.87	−0.55	4.01
	(0.75)	(2.15)	(0.38)	(2.51)	(1.23)	(2.19)	(−0.33)	(2.50)
$500 mn.	0.74	2.07	−1.33	0.85	1.82	1.98	−0.17	0.35
	(0.42)	(1.30)	(−0.68)	(0.53)	(1.03)	(1.18)	(−0.09)	(0.20)
$1 bn.	1.19	1.75	−0.40	0.72	1.40	0.97	1.60	1.58
	(0.62)	(0.98)	(−0.19)	(0.39)	(0.67)	(0.50)	(0.77)	(0.81)
Panel B: Only Multiprocess (constraints C1–C5)								
$100 mn.	4.22	4.10	3.17	3.67	4.00	3.01	3.50	2.95
	(4.94)	(4.92)	(2.50)	(3.85)	(4.30)	(3.35)	(3.90)	(3.39)
$500 mn.	2.82	3.73	1.80	2.14	3.51	2.89	3.08	3.78
	(2.76)	(4.37)	(1.26)	(1.63)	(3.53)	(3.22)	(3.04)	(4.13)
$1 bn.	2.76	3.30	1.84	1.95	3.06	3.14	3.50	3.62
	(2.53)	(3.40)	(1.37)	(1.55)	(2.79)	(3.12)	(3.24)	(3.75)

Panel C: Only Relative Value (constraints C1–C5)								
$100 mn.	2.86	3.26	1.93	1.73	3.43	3.27	1.77	1.66
	(4.52)	(5.67)	(2.65)	(2.57)	(5.10)	(5.30)	(2.12)	(2.14)
$500 mn.	2.36	3.04	1.59	1.85	2.99	2.41	1.94	1.36
	(3.27)	(5.11)	(2.59)	(3.24)	(4.11)	(3.30)	(2.21)	(1.38)
$1 bn.	2.29	3.07	2.16	2.40	2.61	2.42	2.19	1.86
	(2.63)	(4.03)	(2.85)	(3.24)	(2.84)	(2.91)	(2.28)	(2.02)
Panel D: Only Security Selection (constraints C1–C5)								
$100 mn.	2.34	3.42	1.23	2.74	2.51	2.82	0.05	1.90
	(1.91)	(2.73)	(0.93)	(2.19)	(2.18)	(2.38)	(0.04)	(1.68)
$500 mn.	1.86	2.10	2.27	3.41	1.10	1.49	0.11	1.55
	(1.17)	(1.33)	(1.51)	(2.35)	(0.74)	(1.03)	(0.07)	(1.07)
$1 bn.	0.90	1.33	3.27	3.72	0.65	0.92	0.56	1.23
	(0.55)	(0.81)	(2.18)	(2.47)	(0.38)	(0.54)	(0.34)	(0.75)

Panel E: Style Diversified vs. Single Style (constraints C1–C5)

	Directional Traders		Multiprocess		Relative Value		Security Selection	
			Only lockup and redemption periods					
$100 mn.	2.73	2.49	−0.14	2.23	1.23	3.07	1.75	2.91
	(1.95)	(1.63)	(−0.13)	(2.64)	(1.21)	(3.49)	(1.88)	(2.51)
$500 mn.	3.15	1.56	1.07	−0.10	1.52	0.59	2.03	1.52
	(2.37)	(1.25)	(1.23)	(−0.16)	(1.86)	(0.86)	(1.67)	(1.24)
$1 bn.	0.16	0.69	−1.41	−0.86	−0.94	−0.63	0.45	1.11
	(0.11)	(0.53)	(−1.70)	(−1.01)	(−1.11)	(−0.66)	(0.36)	(0.94)
			Notice ≤ 1m					
$100 mn.	2.31	0.20	−0.15	0.38	1.09	2.31	1.79	1.30
	(1.82)	(0.17)	(−0.12)	(0.37)	(1.13)	(2.52)	(1.50)	(1.33)
$500 mn.	3.92	3.02	0.79	1.72	1.00	2.01	0.32	0.45
	(2.62)	(2.44)	(0.67)	(1.42)	(1.39)	(2.36)	(0.25)	(0.39)
$1 bn.	2.58	3.21	0.34	1.98	0.03	1.52	−1.09	0.21
	(1.77)	(2.39)	(0.34)	(1.90)	(0.03)	(1.74)	(−0.88)	(0.19)
			Notice ≤ 3m					
$100 mn.	0.13	1.41	−1.71	2.27	−1.13	2.01	−0.21	2.46
	(0.09)	(1.04)	(−1.81)	(2.21)	(−1.30)	(2.36)	(−0.20)	(2.26)
$500 mn.	0.01	1.55	−1.69	0.63	−1.16	1.11	0.72	2.04
	(0.01)	(1.19)	(−1.89)	(0.73)	(−1.50)	(1.34)	(0.51)	(1.81)
$1 bn.	0.71	1.67	−0.95	−0.49	−0.50	0.22	1.46	1.73
	(0.46)	(1.27)	(−0.99)	(−0.53)	(−0.49)	(0.24)	(1.08)	(1.36)
			Notice ≤ 6m					
$100 mn.	2.74	−1.04	−1.31	0.02	0.42	1.31	2.14	1.06
	(2.19)	(−0.83)	(−1.50)	(0.02)	(0.47)	(1.61)	(2.23)	(1.10)
$500 mn.	0.58	1.52	−2.67	−1.92	−1.54	0.50	0.30	0.31
	(0.38)	(1.14)	(−3.20)	(−2.48)	(−1.78)	(0.57)	(0.19)	(0.25)
$1 bn.	0.73	1.31	−1.16	−0.73	0.14	1.03	1.77	1.66
	(0.48)	(0.87)	(−1.41)	(−0.88)	(0.15)	(1.16)	(1.32)	(1.29)

Table A5: Rebalancing Frequency and Hypothetical Investor Performance.

This table shows the performance of assumed hypothetical investor portfolios when the rebalancing frequency (C1) constraint is relaxed to the one quarter (instead of one year in Table 8 of the main paper). Otherwise, hypothetical investors' portfolios are constructed as in previous tables. Panel A reports the performance results for top 30 portfolios. Panel B compares the top 30 and bottom fund performance. Panel C compares the top 30 and random 30 fund portfolios performance. Panel D reports the performance differences between quarterly and annually rebalanced portfolios. We compute equal-weighted returns for each portfolio sorted on Fung and Hsieh (2004) alpha (FH α) or relative alpha (Rela α) *t*-statistic and estimate the post-formation FH alpha and its *t*-statistic for each of the portfolios. The *t*-statistics of the FH alpha are reported in parentheses. The time period covered is January 1994 through December 2012.

	Imposed liquidity constraints (C2)					
			Lockup, redemption, and notice periods			
	Only lockup and redemption periods		Notice ≤ 1m		Notice ≤ 3m	
Predict	FH α	Rela α	FH α	Rela α	FH α	Rela α
Evaluate	FH α	FH α	FH α	FH α	FH α	FH α
Panel A: Constraints C1–C5 (effect of all constraints simultaneously)						
$100 mn.	4.70	5.93	1.81	4.95	3.26	4.35
	(6.03)	(8.97)	(1.61)	(4.71)	(3.67)	(5.04)
$500 mn.	4.55	4.43	0.66	2.34	2.87	2.64
	(4.90)	(5.68)	(0.55)	(2.53)	(3.36)	(3.01)
$1 bn.	3.02	4.13	0.61	1.16	2.29	2.67
	(3.00)	(4.51)	(0.45)	(1.03)	(2.35)	(2.71)
Panel B: Top 30 funds vs. Bottom 30 funds (all constraints simultaneously)						
$100 mn.	3.43	7.66	1.60	5.28	2.87	5.53
	(1.97)	(5.06)	(0.88)	(3.15)	(1.66)	(3.78)
$500 mn.	5.47	5.23	0.98	2.56	1.96	1.09
	(3.85)	(4.01)	(0.68)	(1.86)	(1.58)	(0.81)
$1 bn.	2.48	4.41	0.27	−0.07	1.64	1.34
	(2.13)	(3.61)	(0.21)	(−0.07)	(1.44)	(1.03)

Panel C: Top 30 funds vs Random 30 funds (all constraints simultaneously)						
$100 mn.	3.04	4.24	0.80	3.79	2.03	2.86
	(2.53)	(3.48)	(0.61)	(2.92)	(1.63)	(2.39)
$500 mn.	3.18	3.10	0.00	1.64	1.63	1.34
	(3.06)	(3.15)	(0.00)	(1.67)	(1.60)	(1.29)
$1 bn.	1.20	2.30	−0.32	0.18	0.92	1.44
	(1.44)	(2.61)	(−0.34)	(0.24)	(1.07)	(1.53)
Panel D: Quarterly vs. Annually Rebalanced Portfolios (Panel D of Table 8)						
$100 mn.	0.42	1.00	−0.69	1.11	0.42	0.07
	(0.58)	(1.27)	(−0.87)	(1.39)	(0.61)	(0.09)
$500 mn.	0.69	1.23	−0.38	−1.34	0.65	−0.47
	(0.89)	(1.52)	(−0.52)	(−2.00)	(0.88)	(−0.77)
$1 bn.	1.96	2.01	0.20	−1.11	0.05	0.12
	(2.17)	(2.34)	(0.28)	(−2.08)	(0.07)	(0.17)

Table A6: Percentage of Funds Available For Replacement and Hypothetical Investor Performance.

This table presents performance results for liquidity-diversified portfolios. The hypothetical investors' portfolios are constructed as in previous tables. Panel A reports performance results for top 30 portfolios that invest in 75% annually rebalanced portfolio and 25% quarterly rebalanced portfolio. Panel B reports results for top 30 portfolios that invest in 50% annually rebalanced portfolio and 50% quarterly rebalanced portfolio. Panel C reports for top 30 portfolios that invest in 25% annually rebalanced portfolio and 75% quarterly rebalanced portfolio. The out-of-sample performance is evaluated using Fung and Hsieh (2004) alphas (FH α) as in previous tables.

	Imposed liquidity constraints (C2)					
			Lockup, redemption, and notice periods			
	Only lockup and redemption periods		Notice ≤ 1m		Notice ≤ 3m	
Predict	FH α	Rela α	FH α	Rela α	FH α	Rela α
Evaluate	FH α	FH α	FH α	FH α	FH α	FH α
Panel A: 75% Allocated to Annual and 25% to Quarterly (constraints C1–C5 are imposed)						
$100 mn.	4.39	4.12	5.18	2.94	2.33	4.30
	(6.01)	(5.17)	(7.21)	(3.60)	(2.43)	(5.74)
$500 mn.	4.03	3.34	3.51	2.38	0.95	2.99
	(4.81)	(4.16)	(4.02)	(2.79)	(0.91)	(3.62)
$1 bn.	1.55	1.99	2.62	2.25	0.46	2.58
	(1.45)	(1.95)	(2.52)	(2.38)	(0.37)	(2.69)
Panel B: 50% Allocated to Annual and 50% to Quarterly (constraints C1–C5 are imposed)						
$100 mn.	4.49	4.39	5.43	3.05	2.16	4.32
	(6.39)	(5.21)	(8.45)	(3.78)	(2.20)	(5.83)
$500 mn.	4.21	3.01	3.81	2.54	0.85	2.87
	(5.09)	(3.70)	(4.81)	(3.13)	(0.80)	(3.53)
$1 bn.	2.04	1.71	3.12	2.26	0.51	2.61
	(2.04)	(1.65)	(3.27)	(2.46)	(0.41)	(2.79)
Panel C: 25% Allocated to Annual and 75% to Quarterly (constraints C1–C5 are imposed)						
$100 mn.	4.60	4.67	5.68	3.15	1.99	4.33
	(6.38)	(5.01)	(9.14)	(3.80)	(1.91)	(5.55)
$500 mn.	4.38	2.68	4.12	2.71	0.76	2.76
	(5.11)	(3.13)	(5.42)	(3.33)	(0.68)	(3.31)
$1 bn.	2.53	1.44	3.63	2.27	0.56	2.64
	(2.59)	(1.34)	(3.98)	(2.45)	(0.44)	(2.79)

Table A7: Delays in Reporting and Emerging Managers.

This table studies how sensitive the performance results are to reporting delays associated with fund performance and backfill bias related to emerging managers. Hypothetical investors' portfolios are constructed as in Tables 7 and 8 of the main paper. Panel A reports the results when an additional time lag is imposed to control for strategic data delays. Panel B measures the marginal impact of constraints. Panel C reports the results when backfill bias is not corrected for, i.e., all emerging managers are allowed. Panel D measures the marginal impact of the emerging manager assumption. We compute equal-weighted returns for each portfolio sorted on Fung and Hsieh (2004) alpha (FH α) or relative alpha (Rela α) *t*-statistic and estimate the post-formation FH alpha and its *t*-statistic for each of the portfolios. The *t*-statistics of the alpha are reported in parentheses. The time period covered is January 1994 through December 2012.

	Imposed liquidity constraints (C2)							
			Lockup, redemption, and notice periods					
	Only lockup and redemption periods		Notice ≤ 1m		Notice ≤ 3m		Notice ≤ 6m	
Predict	FH α	Rela α	FH α	Rela α	FH α	Rela α	FH α	Rela α
Evaluate	FH α	FH α	FH α	FH α	FH α	FH α	FH α	FH α
Panel A: Reporting delays (constraints C1–C5)								
$100 mn.	3.66	4.55	3.10	3.59	2.90	4.58	2.04	3.72
	(3.95)	(5.87)	(3.61)	(4.37)	(3.40)	(6.16)	(2.20)	(4.63)
$500 mn.	2.96	3.18	2.12	3.70	2.61	2.41	1.99	1.50
	(3.23)	(3.36)	(2.24)	(4.08)	(2.66)	(2.52)	(1.81)	(1.42)
$1 bn.	1.06	3.04	0.82	2.03	2.60	2.57	1.35	2.85
	(0.93)	(3.27)	(0.66)	(1.92)	(2.62)	(2.63)	(1.15)	(2.83)
Panel B: Marginal effects: Reporting delays vs. Baseline								
$100 mn.	0.39	0.29	−0.60	0.25	−0.06	−0.31	0.54	1.01
	(1.05)	(1.48)	(−1.09)	(0.75)	(−0.19)	(−0.75)	(1.36)	(2.12)
$500 mn.	0.72	−0.17	−1.08	−0.02	−0.39	0.70	−0.90	0.87
	(1.64)	(−0.62)	(−2.13)	(−0.04)	(−1.00)	(2.08)	(−2.52)	(2.35)
$1 bn.	−0.29	−1.19	−0.41	0.24	−0.36	−0.02	0.38	−0.22
	(−0.65)	(−2.40)	(−0.93)	(0.54)	(−0.86)	(−0.04)	(0.73)	(−0.50)

Panel C: Emerging managers (no backfill adjustment, constraints C1–C5)								
$100 mn.	4.69	6.93	2.01	4.45	3.61	5.61	2.98	4.41
	(5.45)	(10.48)	(1.95)	(5.57)	(3.43)	(7.02)	(2.77)	(4.64)
$500 mn.	3.82	3.54	0.98	3.45	2.58	2.96	0.68	1.59
	(4.41)	(3.52)	(0.87)	(3.68)	(2.73)	(3.07)	(0.53)	(1.44)
$1 bn.	1.97	1.95	0.56	3.36	1.50	2.04	1.99	3.20
	(1.90)	(1.65)	(0.46)	(3.28)	(1.50)	(1.99)	(1.80)	(2.94)
Panel D: Marginal effects of emerging funds: Non-backfill adjusted vs. backfill adjusted								
$100 mn.	0.40	2.00	−0.49	0.61	0.78	1.33	0.39	−0.32
	(0.86)	(4.29)	(−1.09)	(1.53)	(1.79)	(2.88)	(0.86)	(−0.53)
$500 mn.	−0.05	0.34	−0.07	−0.23	0.36	−0.15	−0.42	−0.78
	(−0.14)	(1.14)	(−0.20)	(−0.62)	(0.92)	(−0.34)	(−0.97)	(−1.58)
$1 bn.	0.92	−0.17	0.15	1.09	−0.74	−0.52	0.26	0.58
	(2.15)	(−0.45)	(0.52)	(2.89)	(−2.23)	(−1.27)	(0.85)	(1.33)