Asset liquidity and share restrictions: Evidence from equity hedge funds

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ABSTRACT

This paper examines the interaction between managed assets and share restrictions in the context of equity-oriented hedge funds. Small-cap/value oriented funds manage less liquid assets, take higher liquidity risk, and are more likely to use a lockup restriction than large-cap/growth oriented funds. Moreover, I find a positive interaction effect of managed assets' illiquidity and share restrictions on fund performance. Small-cap/value funds with strong share restrictions outperform both small-cap/value funds with weak share restrictions and large-cap/growth funds with strong share restrictions. Empirical results suggest that the outperformance is mostly driven by two components: first, small-cap/value funds earn a higher risk premium from greater exposure to the SMB, HML, and liquidity risk factors, and second, strong share restrictions are helpful for small-cap/value funds by mitigating a fire-sale problem as these hedge funds suffer the most from low market liquidity.

JEL Classification: G11, G14, G23

Keywords: Liquidity; Share restrictions; Small-cap/Value; Hedge fund performance

1. Introduction

Unlike mutual funds, hedge funds often impose lockup periods, that is, periods that can last up to several years during which hedge fund investors cannot withdraw their capital. By definition, lockup restrictions are costly because they limit the liquidity of investors' portfolios. In equilibrium, investors would not invest in lockup funds unless they expect these funds to perform better than non-lockup funds. From the perspective of fund managers, lockup restrictions enable fund managers to invest in less liquid assets where returns may be higher, and during the lockup period, managers are less concerned about making losses that may trigger unanticipated demands for redemptions. Again, lockup funds are expected to perform better than non-lockup funds. Consistent with the prediction, Aragon (2007) finds that lockup funds outperform non-lockup funds by 4-7% per year.

This paper extends the previous literature by examining the interaction between managed assets (small-cap vs. large-cap stocks or value vs. growth stocks) and share restrictions (lockup periods plus redemption notice periods) for equity-oriented hedge funds. Hedge funds face a tradeoff in choosing whether to have a lockup and the extent of the lockup. The lockup allows funds to invest in more illiquid assets, but it reduces the willingness of investors to invest in the fund as their holdings in the fund are less liquid. I therefore expect funds that focus on strategies requiring investment in illiquid securities to have lockups and, when they do have lockups, to have longer lockups. Furthermore, a potential risk to funds managing illiquid assets is a fire-sale problem. Funds are often forced to sell securities at fire-sale prices when they face capital withdrawals by investors (Coval and Stafford (2007)). A negative shock in funding liquidity and a deterioration in market liquidity can reinforce each other and lead to liquidity spirals (Brunnermeier and Pedersen (2009)). Since share restrictions reduce a negative shock in capital

withdrawals and, consequently, mitigate fire-sale risks, they should be helpful for funds managing illiquid assets particularly when these funds would suffer the most without restrictions. Therefore, I examine whether there are differences in asset liquidity or liquidity risk between small-cap/value oriented funds and large-cap/growth oriented funds, whether funds managing less liquid assets are more likely to use lockups, and whether illiquid style funds with strong share restrictions outperform the other funds, and the outperformance is achieved, in part, by mitigating a fire-sale problem.

Why do I examine the interaction between managed assets and share restrictions in equity-oriented hedge funds? First, I focus on equity-oriented hedge funds for a careful performance evaluation. In the hedge fund industry, it is not an easy task to measure risk-adjusted performance because hedge funds often invest in many different asset classes, use derivatives and leverage, and take short positions. By focusing on equity-oriented funds, I can apply asset pricing models, such as the CAPM and the Fama and French three-factor model, to evaluate risk-adjusted performance. Second, the interaction effect between equity styles and share restrictions on fund performance may provide new insight into the performance of mutual funds and hedge funds. Hedge funds are often viewed as liquidity providers (e.g., Brophy, Ouimet and Sialm (2009) and Aragon and Strahan (2009)). Griffin and Xu (2009) also document that hedge funds prefer smaller and opaque value stocks compared to mutual funds although they find that hedge funds perform better than mutual funds by only a small margin. Moreover, the mutual fund literature (e.g., Davis (2001), Chan, Chen and Lakonishok (2002), and Houge and Loughran (2006)) find that small-cap/value mutual funds do not outperform large-cap/growth mutual funds. It is possible that small-cap/value mutual funds and hedge funds do not outperform because they do not have share restrictions and, as a result, are restricted from investing in less

liquid stocks (in order to earn higher expected returns), and/or could suffer the most when they face sudden capital withdrawals due to a significant drop in asset prices.

Using a major hedge fund database (TASS) and focusing on equity-oriented hedge funds, I define four managed-asset styles (small-cap, large-cap, value, and growth funds) based on each fund's self-reported information. Over the sample period from 1996 to 2008, I compute measures of asset liquidity (developed and used in Getmansky, Lo and Makarov (2004), Getmansky, Lo and Mei (2004), and Khandani and Lo (2009)) and liquidity risk (defined as loadings on the liquidity risk factor in Sadka (2010)) at the fund and portfolio level. The estimated measures show that small-cap/value oriented funds manage less liquid assets and take higher liquidity risk than large-cap/growth oriented funds. Moreover, a probit analysis reports that small-cap/value funds are more likely to use a lockup restriction than large-cap/growth funds (11.66% more by small-cap funds relative to large-cap funds; 19.94% more by value funds relative to growth funds) even after adjusting for the effects of other control variables (as suggested by the literature on fund lockups). Hence, the style classification is important for understanding the determinants of having lockup restrictions in the equity-oriented hedge fund industry.

To see whether funds managing less liquid assets, such as small-cap/value stocks, benefit more from having strong share restrictions, I examine the returns on portfolios where individual funds are sorted by managed-asset styles and the degree of share restrictions.[1] Small-cap funds with strong share restrictions outperform large-cap funds with strong share restrictions by 0.48% per month (t-stat=2.38). Similarly, value funds with strong restrictions outperform growth funds with strong restrictions by 0.79% per month (t-stat=2.53). However, the margins of outperformance are 0.03% (t-stat=0.17) for the former and 0.20% (t-stat=1.06) for the latter after

[1] Strong share restrictions are defined as having a lockup and requiring at least 30-day redemption notice periods, while weak share restrictions are defined as having no lockup and requiring less-than-30-day redemption notice periods.

adjusting for loadings on the liquidity risk factor by Sadka (2010) and three factors by Fama and French (1993). Thus, the results suggest that small-cap/value funds use strong share restrictions more effectively by taking higher SMB-, HML-, and liquidity risks and consequently outperform large-cap/growth funds.

Funds are often forced to sell securities at fire-sale prices when they face capital withdrawals by investors (Coval and Stafford (2007)). In a model of Brunnermeier and Pedersen (2009), a negative shock in funding liquidity and a deterioration in market liquidity can mutually reinforce and lead to liquidity spirals. Thus, a potential fire-sale risk is expected to be larger for funds managing less liquid assets. In a related work, Sadka (2010) shows that hedge funds with high liquidity risk underperform those with low liquidity risk during liquidity crises although the former outperforms the latter during a normal period. Since share restrictions could reduce a negative shock in capital withdrawals and, consequently, mitigate the fire-sale problem, share restrictions should be more helpful for funds managing less liquid assets, and the benefits are expected to be larger when market liquidity is low. Consistent with the prediction, small-cap funds with strong restrictions outperform small-cap funds with weak restrictions by 0.73% per month (t-stat=3.00), while large-cap funds with strong restrictions underperform large-cap funds with weak restrictions by -0.06% (t-stat=-0.37). Similarly, value funds with strong restrictions outperform value funds with weak restrictions by 0.36% per month (t-stat=2.76), while growth funds with strong restrictions underperform growth funds with weak restrictions by -0.16% (t-stat=-0.82).

Strong share restrictions help funds managing less liquid assets particularly when market liquidity is low. For example, small-cap funds with weak share restrictions have a significantly high loading, 0.94 (t-stat=3.96), on Sadka's liquidity risk factor when the monthly return on the

liquidity factor portfolio is less than -5%[2], suggesting that these funds suffer the most from low market liquidity. However, I find that small-cap funds with strong share restrictions have a low loading, 0.18 (t-stat=1.14), on the liquidity risk factor during the same period, suggesting that strong share restrictions mitigate the fire-sale problem during the period of low market liquidity.

Presumably, funds could mitigate a fire-sale problem by having low leverage. Funds with high leverage are likely to suffer more from a fire-sale problem when they face sudden redemption requests that force them to deleverage their positions in potentially illiquid assets. Consistent with this view, I find that small-cap/value funds are less levered than large-cap/growth funds, suggesting that funds managing less liquid assets have less leverage. However, the positive interaction effect between managed assets' illiquidity and share restrictions on fund performance still holds even after controlling for a leverage effect on performance.

Share restrictions may not always have a positive impact on fund performance. Strong restrictions potentially increase agency costs to fund investors. Strong restrictions are expected to discipline less fund managers because they could face sudden capital withdrawals without restrictions. I find that funds with lockup restrictions charge higher incentive fees than funds without lockups. Furthermore, the difference in incentive fees is larger within large-cap/growth funds relative to small-cap/value funds. Hence, large-cap/growth funds with strong restrictions may have higher agency costs, while they do not earn a higher risk premium due to their exposure to liquidity risk as well as SMB and HML risks. High agency costs and low risk premia may explain the underperformance of large-cap/growth funds with strong restrictions.

[2] The cutoff value, -5%, corresponds approximately to μ-2σ, the mean value of factor returns minus two times the standard deviation of factor returns.

The rest of this paper is organized as follows. Section 2 describes the sample selection, defines managed-asset styles, and explains how several measures of performance and liquidity are constructed and computed. Section 3 examines whether small-cap/value funds manage less liquid assets, take higher liquidity risk, and are more likely to use lockups than large-cap/growth funds. Section 4 studies the interaction effect between the illiquidity of managed assets and lockups on fund performance using both a weighted least squares regression model and a portfolio analysis. Section 5 extends lockup restrictions to share restrictions by including redemption notice periods and aims to understand whether funds managing less liquid assets gain more benefits from share restrictions due to their mitigating effect on fire-sale risk. Section 6 concludes.

2. Data Descriptions, Performance Measures, and Liquidity Measures

2.1. Sample Selection, Managed-Asset Styles, and Lockup Variable

In this paper, I use the TASS database and focus on individual hedge funds whose principal activity is the investments in equities (while removing hedge funds whose principal investments are in either fixed income securities, commodities, currencies, or properties) so as to construct a dataset of equity-oriented hedge funds.

Following the hedge fund literature, I also focus on funds that report monthly net-of-fee returns in U.S. dollars. To mitigate backfill bias, I remove fund return observations that were realized before the fund entered the database.[3] I account for survivorship bias and include a

[3] TASS has an advantage to study backfill bias because it records the date on which a hedge fund enters the database. Malkiel and Saha (2005) and Ibbotson and Peng (2005) document that backfill bias is 4~5% per year. However, it is not clear ex ante how backfill bias affects the difference in fund performance across styles (e.g.,

reasonable number of funds across managed assets (small-cap vs. large-cap stocks or value vs. growth stocks), which leads to the sample period covering from January 1996 to December 2008. In addition, I require each fund to have at least 12 consecutive monthly returns that enable me to compute measures of performance and measures of asset liquidity at the fund level.

Hedge funds also report their sector focus information (see Appendix).[4] Based on this, I define four managed-asset styles: (1) *small-cap* fund if a fund invests in micro-cap and/or small-cap stocks while not investing in large-cap stocks, (2) *large-cap* fund if a fund invests in medium-cap and/or large-cap stocks while not investing in micro-cap and small-cap stocks, (3) *value* fund if a fund invests in value stocks while not investing in growth stocks, and (4) *growth* fund if a fund invests in growth stocks while not investing in value stocks. I exclude the fund from my sample if it claims investment in both small-cap and large-cap stocks (or in both value and growth stocks). Also, a small-cap fund may be assigned to either value or growth fund.

I use a lockup indicator variable, following Aragon (2007) who studies the impact of lockups on hedge fund performance and finds that lockup funds outperform non-lockup funds by 4-7% per year. He documents that lockup periods are clustered around one year and his analysis focuses on an indicator variable, *dlock*, which equals one if a fund has a lockup restriction.

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small-cap vs. large-cap or value vs. growth). In fact, I find that the inference on the difference in performance across styles does not change in the sample with backfilled returns although backfilled returns increase the level of risk-adjusted return for each group.

[4] This paper uses self-reported information on the assets that hedge funds invest in without knowing the exact amount of their asset holdings. Similarly, Chen (2009) uses self-reported information on hedge funds' derivatives usage without knowing the information on their derivatives holdings. In contrast, Brunnermeier and Nagel (2004) and Griffin and Xu (2009) use the information on hedge funds' actual stock holdings. Due to a light regulation on hedge funds, the stock holding information is limited to only long positions (without knowing short positions) and a relatively smaller number of hedge funds compared to the studies using self-reported information.

2.2. Measures of Performance

I consider the average excess return and the average risk-adjusted return as measures of performance. These measures are computed at the fund and portfolio level. The average excess return is defined as the average monthly return minus the average 1-month T-bill rate.

To compute the average risk-adjusted return, four different risk models are used. The first model is the CAPM that controls for the effect of the loading on excess market returns on fund performance. The regression form of the CAPM is:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i MKTRF_t + \varepsilon_{i,t}, \quad (1)$$

where $r_{i,t}$ is the fund's return in month t, $r_{f,t}$ is 1-month T-bill rate in month t, $MKTRF_t$ is the excess market return in month t (CRSP value-weighted index is used as a proxy for the market portfolio), and α_i is the fund's average risk-adjusted return.

The second model is the three-factor model by Fama and French (1993). The model controls for the effects of the loadings on excess market returns, the SMB factor, and the HML factor on fund performance. For example, small-cap funds could outperform large-cap funds because the former has higher loadings on the SMB factor. If so, the difference in the average risk-adjusted returns based on the CAPM between small-cap and large-cap funds may be positive but the difference in the average risk-adjusted returns based on the Fama and French three-factor model may be close to zero. The regression form of the three-factor model is:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_{1i} MKTRF_t + \beta_{2i} SMB_t + \beta_{3i} HML_t + \varepsilon_{i,t}, \quad (2)$$

where SMB_t is the difference in returns between small-cap stocks and large-cap stocks in month t, HML_t is the difference in returns between high book-to-market (value) stocks and low book-to-market (growth) stocks in month t, and α_i is the fund's risk-adjusted return.

The third model is the seven-factor model by Fung and Hsieh (2004). Since hedge funds manage different classes of assets and create nonlinear payoffs, the previous Fama and French three factors may not be sufficient to capture the time-variation of hedge fund returns. In consequence, Fung and Hsieh propose seven factors that include two equity factors (MKTRF and SMB), two bond factors, and three (bonds, currencies, and commodities) trend-following factors based on the return on look-back straddle options. Since this paper focuses on equity-oriented hedge funds, the two bond factors and three trend-following factors may not be as important. However, Fung and Hsieh ignore the HML factor in their analysis whereas in my work I would expect it to be important. The regression form of Fung and Hsieh's seven-factor model is:

$$\begin{aligned} r_{i,t} - r_{f,t} = {} & \alpha_i + \beta_{1i} MKTRF_t + \beta_{2i} SMB_t + \beta_{3i} (\Delta DEF)_t + \beta_{4i} (\Delta Y10)_t \\ & + \beta_{5i} PTFBD_t + \beta_{6i} PTFFX_t + \beta_{7i} PTFCOM_t + \varepsilon_{i,t} \end{aligned}, \qquad (3)$$

where ΔDEF is the change in credit spread (Moody's Baa yield minus 10-year treasury yield), $\Delta Y10$ is the change in 10-year treasury yields, $PTFBD$ is the trend-following factor on bonds, $PTFFX$ is the trend-following factor on currencies, $PTFCOM$ is the trend-following factor on commodities, and α_i is the fund's risk-adjusted return.[5]

The fourth model is a four-factor model that includes three Fama and French factors and the liquidity risk factor by Sadka (2010). Sadka shows that hedge funds with high liquidity risk outperform hedge funds with low liquidity risk by 6% per year. In his paper, liquidity risk is

[5] I obtain Moody's Baa yields and 10-year treasury yields from H.15 reports of Federal Reserve statistical release. Fung and Hsieh (2001) explain the construction of trend-following factors in detail. Also, trend following factors are available at http://faculty.fuqua.duke.edu/~dah7/DataLibrary/TF-FAC.xls.

measured by the covariance of fund returns with unexpected changes in aggregate liquidity where the unexpected changes in aggregate liquidity are from Sadka (2006). In this paper, the difference in monthly returns between funds with high liquidity risk and funds with low liquidity risk is referred to Sadka's liquidity risk factor. The regression form of the four-factor model is:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_{1i} MKTRF_t + \beta_{2i} SMB_t + \beta_{3i} HML_t + \beta_{4i} LIQ_t + \varepsilon_{i,t}, \quad (4)$$

where LIQ_t is Sadka's liquidity risk factor mimicking portfolio return in month t, and α_i is the fund's risk-adjusted return.

2.3. Measures of Liquidity

I consider three types of measures of liquidity at the fund level. First, there is the fund's liquidity risk, which is measured by the loading on the liquidity risk factor by Sadka (2010) (β_{4i} measures the fund's liquidity risk in equation (4)).

The second type measures asset liquidity and follows Khandani and Lo (2009) who document that hedge funds with positive autocorrelations in returns manage illiquid assets and long/short portfolios sorted by autocorrelations yield positive illiquidity premium. Hence, autocorrelations in fund returns represent the illiquidity of managed assets in the fund. More formally, I also use the model developed by Getmansky, Lo and Makarov (2004), where a fund's reported return in period t (R_t^0) is a weighted average of the fund's true economic returns (R_{t-j}):

$$R_t^0 = \theta_0 R_t + \theta_1 R_{t-1} + \cdots + \theta_k R_{t-k} \quad (5)$$

$$\theta_j \in [0,1], \quad j = 0,1,...,k \quad (6)$$

$$1 = \theta_0 + \theta_1 + \cdots + \theta_k . \quad (7)$$

By definition, θ_0 is the fraction of the fund's contemporaneous economic returns reflected in the fund's reported returns. Thus, a higher θ_0 implies that the fund has higher asset liquidity. To obtain reliable parameter estimates, I require the fund to have at least 12 consecutive monthly returns. Using the maximum likelihood method, I estimate an MA(2) process for each fund's reported returns (after their mean value is subtracted) based on the assumption that errors are normally distributed and the MA coefficients sum to 1, where the first coefficient is θ_0. By imposing equation (6), θ_0 is restricted to be between 0 and 1. The restricted θ_0 is used to measure the fund's asset liquidity.

The third type is the fund's share illiquidity. In addition to the lockup indicator variable (*dlock*), I also examine lockup and redemption notice periods to measure the fund's share illiquidity. The typical lockup period is one year and the typical redemption notice period is 30 days. Over the restricted period, fund investors cannot withdraw their capital, reducing the fund managers' concerns about having to meet redemption requests.

3. Interaction between Managed Assets and Lockup Restrictions

3.1. Performance and Liquidity across Managed Assets

My final sample contains 765 equity-oriented hedge funds, and each fund is assigned to at least one managed-asset style (small-cap vs. large-cap or value vs. growth). In the first column of Table 1, I report the average characteristic of the entire sample of funds. The average excess return on equity-oriented funds is 0.08% per month, which becomes 0.02% per month after adjusting for factor loadings (the three factors by Fama and French (1993) and the liquidity risk

factor by Sadka (2010)). Hence, the four factors explain most of the time-variation in returns on the typical equity-oriented hedge fund.

Table 1 also reports measures of performance (in Panel A), factor loadings, and measures of liquidity (in Panel B) across managed assets. To test any difference in a variable between two groups, I use the unpaired two-sample t-test.[6] To be robust, I also perform the Wilcoxon rank sum test, which is a nonparametric alternative to the t-test.[7]

I find the following differences in fund performance across managed assets. Small-cap funds outperform large-cap funds, where the difference in average return between small-cap and large-cap funds is 0.21% per month (Wilcoxon-test p-value<0.01), which becomes 0.03% (Wilcoxon-test p-value<0.10) after adjusting for loadings on four risk factors. Value funds outperform growth funds, where the difference in average return between value and growth funds is 0.40% per month (Wilcoxon-test p-value<0.01), which becomes 0.26% (Wilcoxon-test p-value<0.05) after adjusting for loadings on four risk factors.

Stock market research suggests that small-cap/value stocks outperform large-cap/growth stocks (e.g., Fama and French (1992)), and consequently, I expect that the outperformance of small-cap/value funds relative to large-cap/growth funds is driven by higher loadings on SMB and HML risk factors in the Fama and French three-factor model. Consistent with the prediction, the difference in loadings on the SMB factor between small-cap and large-cap funds is 0.24 (Wilcoxon-test p-value<0.01). Similarly, the difference in loadings on the HML factor between value and growth funds is 0.34 (Wilcoxon-test p-value<0.01).

I also examine whether there are differences in measures of liquidity between small-cap/value funds and large-cap/growth funds. The first type of measure used is the factor loading

[6] The unpaired t-test in my analysis assumes that the two population variances are different.
[7] The Wilcoxon rank sum test can have better statistical power than the t-test when the normality assumption does not hold.

on the liquidity factor by Sadka (2010), where I find that the difference between small-cap and large-cap funds is 0.10 (Wilcoxon-test p-value<0.05). Similarly, the difference in the liquidity factor loadings between value and growth funds is 0.08 (Wilcoxon-test p-value>0.10). The second type of measures of liquidity examines the illiquidity of managed assets and uses both first-order autocorrelations in Khandani and Lo (2009) and restricted θ_0 (lower θ_0 means higher illiquidity) in Getmansky, Lo and Makarov (2004). The difference in first-order autocorrelations and restricted θ_0 between small-cap and large-cap funds is 0.05 and -0.05, respectively (Wilcoxon-test p-value<0.01 for both measures). The difference in first-order autocorrelations and restricted θ_0 between value and growth funds is 0.05 (Wilcoxon-test p-value<0.01) and -0.02 (Wilcoxon-test p-value>0.10), respectively. The third type of measures of liquidity captures funding liquidity and uses the presence of lockups and the length of lockup and redemption notice periods. The proportion of using lockups is higher in small-cap/value funds than in large-cap/growth funds. Moreover, small-cap/value funds impose longer share restriction periods than large-cap/growth funds. Therefore, the results suggest that small-cap/value funds manage less liquid assets and take higher liquidity risk than large-cap/growth funds, and as a result, the former has better economic reasons to have lockup restrictions in place (share restrictions help manage less liquid assets).

3.2. Other Fund Characteristics across Managed Assets

I examine several fund characteristics across managed assets in Panel C of Table 1. Liang and Park (2008) find that offshore funds earn a higher illiquidity premium associated with using lockups than onshore funds. If small-cap/value funds are more likely to be offshore funds than large-cap/growth funds, the outperformance of small-cap/value funds could be explained by fund

location. However, I find that 43% of small-cap funds are offshore funds, while 68% of large-cap funds are offshore funds.

Higher fees (either management fees or incentives fees) and lower ownership (personal capital investment) may increase agency costs in the fund. I do not find any meaningful difference in fees between small-cap/value funds and large-cap/growth funds. However, small-cap funds have higher managerial ownership than large-cap funds, suggesting that large-cap funds have potentially higher agency costs than small-cap funds.

I expect that one important advantage of lockups is to mitigate a fire-sale problem, which can be triggered when fund managers face sudden capital withdrawals. Presumably, funds could reduce the fire-sale risk by having low leverage because funds with high leverage are likely to suffer more when they are forced to meet suddenly increasing redemption requests and consequently have to deleverage their positions in potentially illiquid assets. Thus, funds managing less liquid assets may want to use lower leverage. Consistent with the prediction, small-cap funds are less levered by 8% (Wilcoxon-test p-value<0.10) than large-cap funds, and value funds are less levered by 9% (Wilcoxon-test p-value<0.05) than growth funds.

3.3. Probability of Using Lockup Restrictions across Managed Assets

Hedge funds face a tradeoff in their choice of having a lockup restriction (as well as the length of the lockup period) because having a lockup period in place allows funds to invest in more illiquid assets but reduces the willingness of investors to invest in the fund (the fund becomes less liquid for the fund investors). I therefore expect funds that focus on strategies requiring investment in illiquid securities to have lockups and when they do have lockups to have longer lockups. In this subsection, I use probit analysis to examine the likelihood of funds using lockup restrictions.

Table 2 reports the results from a probit analysis of *dlock*, an indicator variable that equals one if the fund has a lockup restriction, and zero otherwise. For comparability, all continuous variables are standardized to have a mean of zero and a variance of one across funds. To see economic significance, the marginal effect of each variable is computed as the change in estimated probability when a continuous variable increases by one standard deviation at its mean value, or a binary variable moves from zero to one, *ceteris paribus*. Model 1 is a benchmark model from Aragon (2007), where he shows that lower θ_0 (lower θ_0 means higher illiquidity) increases the probability of a lockup. My findings do not confirm Aragon's (2007) result, suggesting that θ_0 may not be the best in measuring the level of asset liquidity within equity-oriented hedge funds.

In Model 2, I add *Small*, which is an indicator variable that equals one if the fund is a small-cap fund and zero if the fund is a large-cap fund, to Model 1. The results show that the probability of a lockup in small-cap funds is higher by 11.7% (t-stat=2.17) than the probability of a lockup in large-cap funds. By including the indicator variable, the model's power of explaining the probability of a lockup increases (the pseudo-R^2 of McFadden (1974)[8] increases by 3.7%, from 9.95% to 13.67%). In Model 3, I add *Value*, which is an indicator variable that equals one if the fund is a value fund and zero if the fund is a growth fund, to Model 1. I find that the probability of a lockup in value funds is higher by 19.9% (t-stat=3.55) than the probability of a lockup in growth funds. The pseudo-R^2 also increases by 3.3%, from 9.95% to 13.24%. Therefore, the results from the probit analysis suggest that small-cap/value funds are more likely to use lockup restrictions than large-cap/growth funds even after controlling for the effects of other variables on the probability of a lockup. Among other variables in the regression analysis,

[8] In each regression model, the pseudo-R^2 of McFadden (1974) is computed as $1-L_1/L_0$ where L_1 is the log likelihood of the model, and L_0 is the log likelihood of a null model with only a constant term.

Offshore, an indicator variable that equals one if the fund is located offshore, has a significantly negative effect on the probability of a lockup. The probability of using a lockup in offshore funds is lower by about 30% than the probability of a lockup in onshore funds.

4. Regression Analysis

4.1. Pooled Regressions

In this section, I examine, using a pooled regression model, whether there is a positive interaction effect of the illiquidity of managed assets and lockup restrictions on fund performance. Funds managing less liquid assets are expected to gain more benefits from using lockup restrictions because lockups help manage less liquid assets more effectively. In addition, there could be a negative side of using lockups. Lockup restrictions may increase agency costs to investors because investors could discipline the fund manager by quickly withdrawing capitals if there were no lockups. Since there are no good reasons to have lockups for large-cap/growth funds, there could be higher agency costs to investors in large-cap/growth lockup funds relative to small-cap/value lockup funds. Hence, I expect that small-cap/value lockup funds outperform large-cap/growth lockup funds. To examine whether small-cap funds gain significantly more benefits from lockup restrictions than large-cap funds, I run the following regression model:

$$\alpha_i = b_0 + b_1 Small_i \times Dlock_i + b_2 Small_i + b_3 Dlock_i + b_4 Lev_i + \varepsilon_i , \quad (8)$$

where α_i is the average risk-adjusted return of the fund (depending on which risk model is used, alpha changes), *Small* is an indicator variable that equals one if the fund is a small-cap fund and zero if the fund is a large-cap fund, *Dlock* is an indicator variable that equals one if the fund uses

a lockup restriction, and *Lev* is an indicator variable that equals one if the fund uses leverage. *Lev* is included in the regression model to control for any leverage effect on fund performance (I include this variable because the previous section documents that small-cap/value funds are less levered than large-cap/growth funds and that lower leverage could help mitigate potential fire-sale risks). I use the weighted least squares method instead of OLS because the dependent variable (alpha) in equation (8) is an estimated value from a time-series regression and with different estimation errors across funds. I estimate the regression model where each weight is equal to the reciprocal of the variance of the estimated alpha.[9]

To examine whether value funds gain significantly more benefits from lockup restrictions than growth funds, I specify the following regression model:

$$\alpha_i = b_0 + b_1 Value_i \times Dlock_i + b_2 Value_i + b_3 Dlock_i + b_4 Lev_i + \varepsilon_i , \quad (9)$$

where *Value* is an indicator variable that equals one if the fund is a value fund and zero if the fund is a growth fund. If the estimated coefficient, b_1, on the interaction term in equation (8) or (9) is positive, the result implies the positive interaction effect of the illiquidity of managed assets and lockup restrictions on fund performance even after controlling for the effects of factor loadings, managed assets, lockup restrictions, and leverage on fund performance.

The overall regression results are reported in Table 3 and support that small-cap/value funds gain more benefits from lockup restrictions than large-cap/growth funds. In Panel A, the estimated coefficients on the interaction term, *Small×Dlock*, are positive and statistically significant. Specifically, when the fund's alpha is estimated using a four-factor model that includes three Fama and French factors and the liquidity factor by Sadka (2010), the estimated

[9] If each weight is equal to the reciprocal of the variance of the error, the estimated coefficient is a best linear unbiased estimator (BLUE) when a weighted sum of squared residuals is minimized.

coefficient on the interaction term is 0.21 (t-stat=2.64). Since the estimated coefficient on *Small* is 0.03, the coefficient on the interaction term implies that small-cap funds with lockups outperform large-cap funds with lockups by 0.24% per month, while small-cap funds without lockups outperform large-cap funds without lockups by 0.03% per month after adjusting for the effects of factor loadings and leverage on fund performance. In Panel B, the estimated coefficients on the interaction term, *Value*×*Dlock*, are positive but statistically insignificant in three out of four risk models. For example, when the fund's alpha is estimated using the four factor model, the coefficient on the interaction term is 0.12 (t-stat=1.27). Since the estimated coefficient on *Value* is 0.04, the coefficient on the interaction term implies that value funds with lockups outperform growth funds with lockups by 0.16% per month, while value funds without lockups outperform growth funds without lockups by 0.04% per month. Moreover, the estimated coefficients on *Dlock* are negative after adjusting for the interaction between managed assets and lockup restrictions on performance, suggesting that lockups provide benefits only when funds manage less liquid assets such as small-cap/value stocks. This could be due to the fact that lockups may increase agency costs to investors. Thus, the results suggest that there is the positive interaction effect of the illiquidity of managed assets and lockup restrictions on fund performance, and small-cap funds gain the most benefits from using lockup restrictions.

4.2. Portfolios sorted by Managed Assets and Lockup Restrictions

Previous tests use the cross-sectional difference in the average performance at the fund level. However, there could be a concern that the cross-sectional difference in the average fund performance is driven by a particular time period. In order to test this, I construct equally-weighted portfolios sorted by managed assets and lockup restrictions and examine the time-series monthly returns on the portfolios using the four different risk models (equation (1)-(4)). If a

portfolio of small-cap/value funds with lockup restrictions outperforms the other portfolios throughout the sample period, the result would suggest that the positive interaction effect of the illiquidity of managed assets and lockup restrictions is not driven by a single period. To mitigate a potential concern that a portfolio consists of too few funds, each portfolio is required to have at least five funds at the beginning of each year, and as a consequence, the analysis period becomes January 2000 to December 2008.

In Panel A of Table 4, the sample is sorted into four portfolios (large-cap/non-lockup, large-cap/lockup, small-cap/non-lockup, and small-cap/lockup). Among the four portfolios, the portfolio of small-cap funds with lockups earns the highest average return, 0.72% per month (t-stat=2.85). Furthermore, the portfolio of small-cap funds with lockups outperforms the portfolio of large-cap funds with lockups by 0.47% per month (t-stat=2.43). However, the outperformance margin becomes only 0.06% (t-stat=0.35) after adjusting for the four factor loadings, where the loadings on the SMB factor, the HML factor, and the liquidity factor are 0.19 (t-stat=4.46), 0.30 (t-stat=5.64), and 0.26 (t-stat=3.49), respectively. Thus, small-cap funds with lockups outperform large-cap funds with lockups largely because the former use lockups more effectively by investing in more opaque and less liquid small-cap/value stocks and by taking higher liquidity risk. In addition, the portfolio of small-cap funds with lockups outperforms the portfolio of small-cap funds without lockups by 0.45% per month (t-stat=3.27), while the portfolio of large-cap funds with lockups outperforms the portfolio of large-cap funds without lockups only by 0.02% (t-stat=0.16). Hence, the results confirm that funds managing less liquid assets gain more benefits from using lockup restrictions.

In Panel B, the sample is sorted into another four portfolios (growth/non-lockup, growth/lockup, value/non-lockup, and value/lockup). Among the four portfolios, the portfolio of

value funds with lockups earns the highest average return, 0.77% per month (t-stat=2.97). Moreover, the portfolio of value funds with lockups outperforms the portfolio of growth funds with lockups by 0.74% per month (t-stat=2.45). However, the outperformance margin is significantly reduced to 0.23% (t-stat=1.19) after adjusting for the four factor loadings, where the loadings on the HML factor and the liquidity factor are 0.56 (t-stat=9.01) and 0.19 (t-stat=2.20), respectively. Hence, value funds with lockups outperform growth funds with lockups largely because the former use lockups more effectively by earning higher returns from investing in less liquid value stocks. In addition, the portfolio of value funds with lockups outperforms the portfolio of value funds without lockups by 0.30% per month (t-stat=2.86), while the portfolio of growth funds with lockups does not outperform the portfolio of growth funds without lockups. Again, the results confirm that funds managing less liquid assets gain more benefits from using lockup restrictions.

5. Interaction between Managed Assets and Share Restrictions

5.1. Extending Lockup Restrictions to Share Restrictions

Hedge fund investors cannot withdraw their capital until a pre-specified lockup period ends. In addition to the lockup period, many hedge funds also require a redemption notice period (typically, 30 days) before investors start to pull out their money. The additional restriction on top of lockup provisions is another type of share restrictions which limit the liquidity of investors and allow fund managers to invest more of the fund's capital in less liquid assets. Furthermore, if share restrictions help mitigate a negative shock in capital withdrawals after poor performance and, as a result, reduce a potential fire-sale risk, the benefits from share restrictions are expected

to be larger for funds managing less liquid assets. In this section, I replace lockup restrictions with share restrictions by including redemption notice periods and examine the interaction effect of managed assets and share restrictions on fund performance. Strong share restrictions are defined as having a lockup plus at least 30-day redemption notice periods, while weak share restrictions are defined as having no lockup and requiring less-than-30-day redemption notice periods. Then, I form equally-weighted portfolios sorted by managed assets and the degree (strong vs. weak) of share restrictions and examine the time-series monthly returns on the portfolios using four different risk models (equation (1)-(4)).[10]

Table 5 reports the results from the portfolio analysis. The overall results are similar to or improved from the results reported in Table 4. In Panel A, the portfolio of small-cap funds with strong share restrictions outperforms the portfolio of large-cap funds with strong share restrictions by 0.48% per month (t-stat=2.38), but the outperformance margin becomes only 0.03% (t-stat=0.17) after adjusting for the four factor loadings. In addition, the portfolio of small-cap funds with strong restrictions outperforms the portfolio of small-cap funds with weak restrictions by 0.73% per month (t-stat=3.00), while the portfolio of large-cap funds with strong restrictions even underperforms the portfolio of large-cap funds with weak restrictions by -0.06% (t-stat=-0.37). In Panel B, the portfolio of value funds with strong restrictions outperforms the portfolio of growth funds with strong restrictions by 0.79% per month (t-stat=2.53), but the outperformance margin becomes 0.20% (t-stat=1.06) after adjusting for the four factor loadings. Furthermore, the portfolio of value funds with strong restrictions outperforms the portfolio of value funds with weak restrictions by 0.36% per month (t-stat=2.76), while the portfolio of growth funds with strong restrictions even underperforms the portfolio of growth funds with

[10] I require each portfolio to have at least five funds at the beginning of each year, and as a result, the analysis period is January 2000 to December 2008.

weak restrictions by -0.16% (t-stat=-0.82). Therefore, the results suggest that small-cap/value funds with strong restrictions earn a higher risk premium from exposure to the SMB, HML, and liquidity factors than large-cap/growth funds with strong restrictions, and funds managing less liquid assets gain more benefits from using strong share restrictions.

5.2. Benefits from Strong Share Restrictions by Mitigating Fire-Sale Risks

Funds are often forced to sell securities at fire-sale prices when they face capital withdrawals by investors (Coval and Stafford (2007)). In a model developed by Brunnermeier and Pedersen (2009), a negative shock in funding liquidity and a deterioration in market liquidity can be mutually reinforcing and lead to liquidity spirals. Thus, a potential fire-sale risk is expected to be larger for funds managing less liquid assets. In a related work, Sadka (2010) shows that hedge funds with high liquidity risk underperform those with low liquidity risk during liquidity crises although the former outperforms the latter during a normal period. Since share restrictions could reduce a negative shock in capital withdrawals and, consequently, mitigate the fire-sale problem, share restrictions should be more helpful for funds managing less liquid assets, especially during times of low market liquidity.

I define a period of low market liquidity as monthly returns when the return on the liquidity factor portfolio by Sadka (2010) is less than -5%.[11] During such a period, hedge funds with high liquidity risk suffer the most. Table 6 reports the loadings on the liquidity factor in the liquidity crisis period as well as in the normal period across the portfolios considered in Table 5. Panel A shows that small-cap funds with weak share restrictions have a significantly high loading, 0.94 (t-stat=3.96), on Sadka's liquidity risk factor when the monthly return on the

[11] The cutoff value, -5%, corresponds approximately to $\mu-2\sigma$, the mean value of factor returns minus two times the standard deviation of factor returns.

liquidity risk factor is less than -5%, suggesting that these funds suffer the most from low market liquidity. However, I find that small-cap funds with strong share restrictions have a low loading, 0.18 (t-stat=1.14), on the liquidity risk factor during the same period, suggesting that strong share restrictions mitigate the fire-sale problem during the period of low market liquidity. Similarly, Panel B shows that value funds with weak restrictions have a significantly high loading, 0.53 (t-stat=2.98), on the liquidity risk factor during the liquidity crisis period, while value funds with strong restrictions have a lower loading, 0.29 (t-stat=1.68), on the liquidity risk factor during the same period. My results suggest that share restrictions are helpful for funds managing less liquid assets particularly when these funds would suffer the most without restrictions.

6. Conclusion

The previous hedge fund literature documents that lockup funds outperform non-lockup funds. This paper extends the previous literature by examining the interaction between managed assets (small-cap vs. large-cap stocks or value vs. growth stocks) and share restrictions (lockup periods plus redemption notice periods) in the context of equity-oriented hedge funds. Using self-reported information on the managed-asset style of individual hedge funds, I find that small-cap/value oriented funds manage less liquid assets, take higher liquidity risk, and are more likely to use a lockup restriction than large-cap/growth oriented funds. Moreover, I document a positive interaction effect of managed assets' illiquidity and share restrictions on fund performance. Small-cap (value) funds with strong share restrictions outperform large-cap (growth) funds with strong share restrictions by 5.8% (9.5%) per year. Small-cap (value) funds with strong share restrictions outperform small-cap (value) funds with weak share restrictions by 8.8% (4.3%) per

year. Empirical results suggest that the outperformance is mostly driven by two components: first, small-cap/value funds earn a higher risk premium for bearing exposure to the SMB, HML, and liquidity risk factors than large-cap/growth funds, and second, strong share restrictions are helpful for small-cap/value funds in mitigating a potential fire-sale problem particularly when hedge funds suffer from low market liquidity.

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Appendix: TASS Survey Questionnaire (The Portion Regarding Sector Focus)

The following forms are extracted from the Lipper TASS Questionnaire to hedge funds.

Sector Focus *(Please check all relevant boxes)*			
☐ Agriculturals	☐ Base Metals	☐ Bio-Technology	☐ Close-Ended Funds
☐ Consumer	☐ Corporate Bonds	☐ Diversified	☐ Emerging Market Bonds
☐ Emerging Market Equities	☐ Energies	☐ Financial	☐ Gold
☐ Government Bonds	☐ Growth Stocks	☐ Health Care	☐ Large Cap
☐ Media / Communications	☐ Medium Cap	☐ Micro Cap	☐ Money Markets
☐ Natural Resources	☐ New Issues	☐ Oil/Energy	☐ Other
☐ Precious Metals	☐ Private Equity	☐ Pure Currency	☐ Pure Emerging Market
☐ Pure Managed Futures	☐ Real Estate/ Property	☐ Shipping	☐ Small Cap
☐ Soft Commodities	☐ Sovereign Debt	☐ Technology	☐ Turnarounds/Spin-Offs
☐ Utilities	☐ Value Stocks		

Questionnaire Definitions:

Sector Focus	
Growth Stocks	Equity of a corporation that has displayed faster-than-average earnings gains over the past few years, and is expected to continue to show high rates of earnings growth. Growth stocks will typically have a higher price/earnings ratio because of their higher earnings growth.
Value Stocks	The Shares of a company are considered attractive because the company is undervalued, usually because it has a low price/earnings ratio. These stocks are seen as "cheap".
Micro Cap	The percent of a mutual fund invested in companies with a market capitalization of under $250 million.
Small Cap	The definition of small can vary, but generally a company below $1 Billion in market cap is considered to be a small-cap.
Medium Cap	Stocks with a market Capitalization of between $1 Billion and $5 Billion
Large Cap	Large Cap Stocks have a market capitalization of greater than $5 Billion.

Table 1
Performance, Liquidity, and Other Fund Characteristics across Managed Assets in the Equity-Oriented Hedge Fund Industry

This table reports performance, liquidity, and other fund characteristics across managed assets (small-cap vs. large-cap stocks or value vs. growth stocks) in the equity-oriented hedge fund industry. Panel A reports performance measures (monthly excess return and risk-adjusted return based on four different risk models). Panel B reports factor loadings and several liquidity measures. Panel C reports other fund characteristics. The columns, *S-L* and *V-G*, report the results from the unpaired two-sample t-test. The column labeled by *Wilcoxon* reports the results on statistical significance from the Wilcoxon rank-sum test. * indicates statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level. The sample period is January 1996 to December 2008.

Panel A: Average Performance of Equity-Oriented Hedge Funds across Managed Assets

		Small-cap vs. Large-cap				Value vs. Growth			
Variable	All Funds	Large	Small	S - L	Wilcoxon	Growth	Value	V - G	Wilcoxon
Avg. Excess Return (%/month)	0.08	-0.01	0.21	0.21*	***	-0.04	0.35	0.40***	***
CAPM Alpha (%/month)	0.10	0.04	0.14	0.10	**	-0.04	0.31	0.34***	***
FF 3-Factor Alpha (%/month)	0.05	0.02	0.08	0.06	*	-0.09	0.19	0.27***	**
FH 7-Factor Alpha (%/month)	0.10	0.06	0.19	0.14	***	-0.12	0.34	0.46***	***
FF3 + Sadka Alpha (%/month)	0.02	-0.01	0.03	0.03	*	-0.11	0.15	0.26***	**
N(funds)	765	289	254			196	230		

Panel B: Factor Loadings, Asset Liquidity, and Fund Liquidity of Equity-Oriented Hedge Funds across Managed Assets

		Small-cap vs. Large-cap				Value vs. Growth			
Variable	All Funds	Large	Small	S - L	Wilcoxon	Growth	Value	V - G	Wilcoxon
Factor Loading on MKTRF	0.40	0.32	0.43	0.11**	***	0.54	0.43	-0.10*	
Factor Loading on SMB	0.16	0.03	0.27	0.24***	***	0.25	0.14	-0.11***	***
Factor Loading on HML	0.04	0.06	0.06	0.00	**	-0.17	0.17	0.34***	***
Sadka's Liquidity Risk Factor Loading	0.17	0.13	0.23	0.10*	**	0.11	0.20	0.08	
1st-order Autocorrelation	0.12	0.09	0.14	0.05***	***	0.10	0.15	0.05***	***
Restricted θ_0	0.83	0.85	0.80	-0.05***	***	0.84	0.82	-0.02	
Lockup Presence (0/1)	0.33	0.25	0.40	0.15***	***	0.27	0.46	0.19***	***
Lockup Period (month)	3.80	2.81	4.54	1.74***	***	2.95	5.75	2.80***	***
Redemption Period (month)	1.14	0.95	1.30	0.35***	***	0.98	1.35	0.37***	***

Panel C: Other Fund Characteristics of Equity-Oriented Hedge Funds across Managed Assets

		Small-cap vs. Large-cap				Value vs. Growth			
Variable	All Funds	Large	Small	S - L	Wilcoxon	Growth	Value	V - G	Wilcoxon
Offshore (0/1)	0.53	0.68	0.43	-0.25***	***	0.45	0.48	0.02	
Management Fee (%)	1.29	1.32	1.27	-0.04		1.21	1.29	0.08*	*
Incentive Fee (%)	18.64	18.53	18.91	0.38		18.54	18.67	0.13	
Personal Capital (0/1)	0.46	0.38	0.51	0.13***	***	0.48	0.53	0.05	
Avg. Fund Size (million)	116.75	176.07	81.38	-94.69**	*	45.59	116.39	70.80***	***
Leverage (0/1)	0.64	0.67	0.59	-0.08*	*	0.70	0.60	-0.09**	**
Return Volatility (%/month)	4.95	4.34	5.01	0.67*	***	5.92	4.64	-1.28***	***

Table 2
Probit Analysis of Lockup Restrictions in Equity-Oriented Hedge Funds

This table reports the results from a probit analysis of *dlock*, an indicator variable that equals one if the fund has a lockup period, and zero otherwise. Model 1 is a benchmark model from Aragon (2007). Model 2 adds *Small*, an indicator variable that equals one if the fund's style is small-cap oriented, and zero if the fund's style is large-cap oriented. Model 3 adds *Value*, an indicator variable that equals one if the fund's style is value oriented, and zero if the fund's style is growth oriented. Continuous variables, *Restricted* θ_0, *Return Volatility*, *Log(Age*$_0$*)*, and *Log(Size*$_0$*)*, are standardized to have a zero mean and variance of one across funds. The marginal effect of a continuous variable implies the change in estimated probability as the variable increases by one standard deviation, holding every other variable fixed at its sample mean. The marginal effect of an indicator variable implies the change in estimated probability from changing the variable from zero to one, holding every other variable fixed at its sample mean. * indicates statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level. McFadden's pseudo-R^2 is computed as $1\text{-}L_1/L_0$ where L_1 is the log likelihood of the model and L_0 is the log likelihood of a null model with only a constant term. The sample period is January 1996 to December 2008.

Probit Analysis of Lockup Restrictions in Equity-Oriented Hedge Funds

	Model (1)		Model (2)		Model (3)	
	Coeff/t-stat	Marginal	Coeff/t-stat	Marginal	Coeff/t-stat	Marginal
Small (0/1)			0.33**	11.66%		
			(2.17)			
Value (0/1)					0.54***	19.94%
					(3.55)	
Restricted θ_0	0.01	0.42%	0.02	0.57%	-0.01	-0.29%
	(0.20)		(0.22)		(-0.11)	
Return Volatility	-0.14**	-4.83%	-0.12	-4.27%	-0.09	-3.51%
	(-2.10)		(-1.43)		(-1.22)	
Leverage (0/1)	-0.12	-4.33%	0.06	2.16%	-0.22	-8.27%
	(-1.01)		(0.41)		(-1.41)	
Offshore (0/1)	-0.89***	-31.12%	-1.00***	-34.28%	-0.81***	-29.10%
	(-7.34)		(-6.31)		(-5.13)	
Log(Age_0)	0.03	1.18%	-0.03	-1.05%	0.13	5.11%
	(0.49)		(-0.36)		(1.56)	
Log($Size_0$)	0.05	1.90%	-0.02	-0.61%	0.09	3.30%
	(0.83)		(-0.21)		(1.06)	
McFadden's R^2	9.95%		13.67%		13.24%	

Table 3
The Interaction Effect of the Illiquidity of Managed Assets and Lockup Restrictions on Fund Performance: Pooled Regressions

This table examines the interaction effect of the illiquidity of managed assets and lockup restrictions on fund performance using a pooled regression model. The regression model is designed to estimate the interaction effect on fund performance even after controlling for the effects of factor loadings, managed-asset styles, lockups, and leverage on fund performance. The regression model is estimated using a weighted least-squares method where each weight is equal to the reciprocal of the variance of the dependent variable, estimated alpha. In Panel A, small-cap and large-cap stocks are considered as managed assets. In Panel B, value and growth stocks are considered as managed assets. * indicates statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level. The sample period is January 1996 to December 2008.

Panel A: The Interaction Effect of Small-cap/Large-cap Styles and Lockups on Performance

	Model (1) CAPM Alpha	Model (2) FF3 Alpha	Model (3) FH7 Alpha	Model (4) FF3+Sadka Alpha
Small*Dlock	0.13*	0.20**	0.21***	0.21***
	(1.75)	(2.52)	(2.62)	(2.64)
Small (0/1)	0.09**	0.05	0.08*	0.03
	(2.08)	(1.02)	(1.80)	(0.72)
Dlock (0/1)	-0.04	-0.08	-0.08	-0.09
	(-0.78)	(-1.37)	(-1.31)	(-1.53)
Leverage (0/1)	0.08**	0.07**	0.08**	0.07*
	(2.28)	(2.02)	(2.30)	(1.93)
Intercept	0.15***	0.11***	0.15***	0.10***
	(5.16)	(3.45)	(4.58)	(3.26)

Panel B: The Interaction Effect of Value/Growth Styles and Lockups on Performance

	Model (1) CAPM Alpha	Model (2) FF3 Alpha	Model (3) FH7 Alpha	Model (4) FF3+Sadka Alpha
Value*Dlock	0.23**	0.16	0.11	0.12
	(2.28)	(1.60)	(1.04)	(1.27)
Value (0/1)	0.03	0.01	0.12**	0.04
	(0.48)	(0.26)	(2.01)	(0.73)
Dlock (0/1)	-0.16*	-0.14*	-0.06	-0.12
	(-1.86)	(-1.67)	(-0.73)	(-1.43)
Leverage (0/1)	0.09**	0.08*	0.06	0.08*
	(2.02)	(1.87)	(1.21)	(1.83)
Intercept	0.16***	0.12**	0.12**	0.10**
	(3.20)	(2.40)	(2.36)	(2.01)

Table 4
The Interaction Effect of Managed Assets and Lockups on Performance: Portfolio Analysis

This table examines the interaction effect of managed assets and lockups on fund performance using a portfolio analysis. In Panel A, the sample is sorted into four portfolios (large-cap/non-lockup, large-cap/lockup, small-cap/non-lockup, and small-cap/lockup). In Panel B, the sample is sorted into four portfolios (growth/non-lockup, growth/lockup, value/non-lockup, and value/lockup). Each portfolio is equally-weighted. I report each portfolio's monthly average return and risk-adjusted return (alpha) based on four different risk models. For the fourth risk model (using Fama and French's three factors and Sadka's liquidity risk factor), I also report each portfolio's factor loadings. For each regression, I report parameter estimates with t-statistics in parentheses and adjusted R^2. I require each portfolio to contain at least five funds at the beginning of each year, and as a result, the analysis period is January 2000 to December 2008.

Panel A: The Interaction Effect of Small-cap/Large-cap Styles and Lockups on Performance

					FF3+Sadka Alpha and Factor Loadings					
Portfolio	Raw Ret	CAPM α	FF3 α	FH7 α	Alpha	Mkt-Rf	SMB	HML	Sadka's Liq	Adj-R2
Large/Nonlockup	0.23	0.09	0.01	0.08	-0.01	0.27	0.07	0.04	0.10	0.58
	(1.26)	(0.78)	(0.11)	(0.65)	(-0.05)	(7.53)	(2.18)	(0.89)	(1.68)	
Large/Lockup	0.25	0.16	0.21	0.12	0.21	0.41	0.02	-0.07	-0.01	0.68
	(1.06)	(1.21)	(1.48)	(0.84)	(1.48)	(10.39)	(0.53)	(-1.63)	(-0.18)	
Small/Nonlockup	0.27	0.22	0.00	0.14	-0.06	0.39	0.26	0.03	0.32	0.83
	(0.90)	(1.33)	(0.03)	(1.00)	(-0.47)	(10.68)	(7.55)	(0.72)	(5.36)	
Small/Lockup	0.72	0.63	0.32	0.69	0.27	0.36	0.21	0.22	0.25	0.76
	(2.85)	(3.91)	(2.28)	(4.47)	(2.06)	(9.91)	(6.15)	(5.26)	(4.17)	

Panel B: The Interaction Effect of Value/Growth Styles and Lockups on Performance

					FF3+Sadka Alpha and Factor Loadings					
Portfolio	Raw Ret	CAPM α	FF3 α	FH7 α	Alpha	Mkt-Rf	SMB	HML	Sadka's Liq	Adj-R2
Growth/Nonlockup	0.03	0.01	-0.05	-0.27	-0.07	0.48	0.33	-0.18	0.06	0.80
	(0.07)	(0.04)	(-0.32)	(-1.60)	(-0.39)	(10.13)	(7.34)	(-3.34)	(0.83)	
Growth/Lockup	0.02	0.03	0.08	-0.17	0.07	0.53	0.21	-0.26	0.07	0.80
	(0.06)	(0.12)	(0.46)	(-0.87)	(0.38)	(10.65)	(4.50)	(-4.54)	(0.83)	
Value/Nonlockup	0.47	0.39	0.13	0.52	0.05	0.36	0.13	0.18	0.40	0.72
	(1.67)	(2.10)	(0.72)	(3.03)	(0.30)	(8.01)	(3.13)	(3.55)	(5.51)	
Value/Lockup	0.77	0.67	0.35	0.78	0.29	0.39	0.14	0.30	0.26	0.75
	(2.97)	(3.85)	(2.37)	(4.65)	(2.15)	(10.05)	(3.78)	(6.70)	(4.14)	

Table 5
The Interaction Effect of Managed Assets and Share Restrictions on Performance

This table examines the interaction effect of managed assets and share restrictions on fund performance using a portfolio analysis. *Strong* share restrictions are defined as having a lockup plus at least 30-day redemption notice periods, while *weak* share restrictions are defined as having no lockup and requiring less-than-30-day redemption notice periods. In Panel A, the sample is sorted into four portfolios (large-cap/weak, large-cap/strong, small-cap/weak, and small-cap/strong). In Panel B, the sample is sorted into four portfolios (growth/weak, growth/strong, value/weak, and value/strong). Each portfolio is equally-weighted. I report each portfolio's monthly average return and risk-adjusted return (alpha) based on four different risk models. For the fourth risk model (using Fama and French's three factors and Sadka's liquidity risk factor), I also report each portfolio's factor loadings. For each regression, I report parameter estimates with t-statistics in parentheses and adjusted R^2. I require each portfolio to contain at least five funds at the beginning of each year, and as a result, the analysis period is January 2000 to December 2008.

Panel A: The Interaction Effect of Small-cap/Large-cap Styles and Share Restrictions on Performance

					FF3+Sadka Alpha and Factor Loadings					
Portfolio	Raw Ret	CAPM α	FF3 α	FH7 α	Alpha	Mkt-Rf	SMB	HML	Sadka's Liq	Adj-R2
Large/Weak-restriction	0.29	0.15	0.04	0.14	0.01	0.23	0.11	0.04	0.14	0.56
	(1.59)	(1.17)	(0.33)	(1.13)	(0.12)	(6.44)	(3.16)	(0.85)	(2.38)	
Large/Strong-restriction	0.23	0.16	0.21	0.11	0.21	0.46	0.02	-0.09	-0.02	0.70
	(0.88)	(1.08)	(1.41)	(0.76)	(1.42)	(10.73)	(0.47)	(-1.79)	(-0.26)	
Small/Weak-restriction	-0.03	-0.01	-0.19	0.02	-0.29	0.47	0.27	-0.07	0.49	0.76
	(-0.07)	(-0.05)	(-0.85)	(0.09)	(-1.44)	(8.19)	(5.00)	(-1.04)	(5.24)	
Small/Strong-restriction	0.71	0.62	0.29	0.66	0.24	0.35	0.24	0.22	0.25	0.77
	(2.79)	(3.80)	(2.13)	(4.30)	(1.89)	(9.79)	(6.95)	(5.21)	(4.31)	

Panel B: The Interaction Effect of Value/Growth Styles and Share Restrictions on Performance

					FF3+Sadka Alpha and Factor Loadings					
Portfolio	Raw Ret	CAPM α	FF3 α	FH7 α	Alpha	Mkt-Rf	SMB	HML	Sadka's Liq	Adj-R2
Growth/Weak-restriction	0.14	0.09	0.17	-0.06	0.15	0.42	0.15	-0.24	0.08	0.69
	(0.42)	(0.43)	(0.87)	(-0.28)	(0.78)	(7.75)	(2.92)	(-3.86)	(0.91)	
Growth/Strong-restriction	-0.02	0.01	0.10	-0.18	0.09	0.59	0.18	-0.29	0.06	0.80
	(-0.04)	(0.03)	(0.56)	(-0.88)	(0.49)	(11.29)	(3.52)	(-4.76)	(0.71)	
Value/Weak-restriction	0.41	0.33	0.13	0.43	0.06	0.36	0.09	0.13	0.33	0.71
	(1.56)	(1.97)	(0.81)	(2.75)	(0.43)	(8.64)	(2.20)	(2.75)	(4.84)	
Value/Strong-restriction	0.77	0.68	0.35	0.77	0.29	0.38	0.15	0.29	0.27	0.73
	(2.97)	(3.82)	(2.30)	(4.51)	(2.07)	(9.51)	(4.10)	(6.32)	(4.12)	

Table 6
Benefits from Share Restrictions in a Liquidity Crisis Period

This table examines the potential benefits from share restrictions when hedge funds with high liquidity risk suffer the most. A liquidity crisis period is defined as a month in which monthly returns on the liquidity factor portfolio by Sadka (2010) are less than -5%. The cutoff value, -5%, corresponds approximately to μ-2σ, the mean value of factor returns minus two times the standard deviation of factor returns. If share restrictions are particularly helpful for funds when liquidity risk is very high, the returns on funds with share restrictions are expected to have lower loadings on the liquidity risk factor during the liquidity crisis period, relative to funds without share restrictions. *Strong* share restrictions are defined as having a lockup plus at least 30-day redemption notice periods, while *weak* share restrictions are defined as having no lockup and requiring less-than-30-day redemption notice periods. In Panel A, the sample is sorted into four portfolios (large-cap/weak, large-cap/strong, small-cap/weak, and small-cap/strong). In Panel B, the sample is sorted into four portfolios (growth/weak, growth/strong, value/weak, and value/strong). Each portfolio is equally-weighted. I report each portfolio's monthly average return, and risk-adjusted return (alpha) based on a risk model where risk factors are Fama and French's three factors plus two sets of Sadka's liquidity risk factor (depending on the monthly return on the liquidity factor is greater than -5% or less than -5%). I also report each portfolio's factor loadings. For each regression, I report parameter estimates with t-statistics in parentheses and adjusted R^2. I require each portfolio to contain at least five funds at the beginning of each year, and as a result, the analysis period is January 2000 to December 2008.

Panel A: Non-linear Loadings on Liquidity Factor - Small-cap/Large-cap Styles and Share Restrictions

		FF3+Liq(>-5%)+Liq(<-5%) Alpha and Factor Loadings						
Portfolio	Raw Ret	Alpha	Mkt-Rf	SMB	HML	Liq > -5%	Liq < -5%	Adj-R2
Large/Weak-restriction	0.29	0.17	0.23	0.11	0.04	0.16	0.04	0.56
	(1.59)	(0.21)	(6.45)	(3.22)	(0.98)	(2.48)	(0.23)	
Large/Strong-restriction	0.23	-1.12	0.47	0.03	-0.07	0.02	-0.26	0.70
	(0.88)	(-1.20)	(10.87)	(0.63)	(-1.48)	(0.32)	(-1.43)	
Small/Weak-restriction	-0.03	4.53	0.45	0.26	-0.10	0.41	0.94	0.77
	(-0.07)	(3.64)	(7.83)	(4.83)	(-1.45)	(4.10)	(3.96)	
Small/Strong-restriction	0.71	1.10	0.36	0.24	0.22	0.27	0.18	0.77
	(2.79)	(1.37)	(9.70)	(6.94)	(5.20)	(4.17)	(1.14)	

Panel B: Non-linear Loadings on Liquidity Factor - Value/Growth Styles and Share Restrictions

		FF3+Liq(>-5%)+Liq(<-5%) Alpha and Factor Loadings						
Portfolio	Raw Ret	Alpha	Mkt-Rf	SMB	HML	Liq > -5%	Liq < -5%	Adj-R2
Growth/Weak-restriction	0.14	-1.77	0.44	0.16	-0.22	0.16	-0.37	0.70
	(0.42)	(-1.49)	(8.13)	(3.18)	(-3.43)	(1.68)	(-1.60)	
Growth/Strong-restriction	-0.02	-0.72	0.60	0.18	-0.28	0.10	-0.15	0.80
	(-0.04)	(-0.62)	(11.30)	(3.61)	(-4.46)	(1.06)	(-0.69)	
Value/Weak-restriction	0.41	2.75	0.35	0.08	0.12	0.29	0.53	0.71
	(1.56)	(2.98)	(8.30)	(2.06)	(2.46)	(3.99)	(2.98)	
Value/Strong-restriction	0.77	1.73	0.38	0.15	0.29	0.26	0.29	0.73
	(2.97)	(1.94)	(9.29)	(4.04)	(6.14)	(3.73)	(1.68)	