Hedge Fund Liquidity and Performance: Evidence from the Financial Crisis*

Tobias Maier, Nic Schaub, and Markus Schmid[#]

University of Mannheim, Finance Area, D-68131 Mannheim, Germany

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Abstract

In this paper, we investigate how share restrictions affect hedge fund performance in crisis and non-crisis periods. Consistent with prior research, we find that more illiquid funds produce both higher returns and alphas in the pre-crisis period. Hence, funds generate a share illiquidity premium for investors as a compensation for limited liquidity. In contrast, in the crisis period, this share illiquidity premium turns into an illiquidity discount. While share restrictions enable funds to manage illiquid assets effectively in the pre-crisis period, they do not seem to be sufficient to ensure effective management of illiquid portfolios in crisis periods. Our results also show that more rigorous share restrictions do not effectively prevent fund outflows in the crisis periods. Share restrictions also do not protect hedge funds from margin calls and forced deleveraging. Thus, funds are often not able to liquidate positions in an orderly fashion during a financial crisis and asset fire sales might take place.

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Corresponding author: Tel.: +49-621-181-37-54; E-mail: schmid@bwl.uni-mannheim.de.
Address: University of Mannheim, Finance Area, Chair for Business Administration and Corporate Governance, D-68131 Mannheim, Germany.

1. Introduction

In this paper, we investigate how share restrictions, such as lockup periods, redemption notice periods, and redemption frequency periods, affect hedge fund performance in crisis and non-crisis periods. Moreover, we investigate how share restrictions relate to the hedge funds' asset portfolio liquidity and relative fund flows to shed some light on potential channels through which illiquidity premia and discounts may arise in non-crisis and crisis periods.

In a seminal study, Amihud and Mendelson (1986) find that stock returns are positively related to transaction costs measured by bid-ask spreads. Bid-ask spreads are a measure of stock specific liquidity. Hence, less liquid stocks offer investors an illiquidity premium. In the aftermath of Amihud and Mendelson (1986) many empirical studies, measuring asset specific liquidity in a variety of ways, analyze the relation between performance and liquidity for stocks, bonds, and mutual funds.[1] More recently, focus has turned on the relation between performance and asset specific liquidity of private equity and hedge funds.

The hedge fund industry provides an ideal environment in which to examine liquidity issues (see also Aragon, 2007). Many hedge funds impose restrictions on investor redemptions, thereby making hedge funds an illiquid investment.[2] In contrast, the transaction data from standardized exchange-traded equity securities, as usually used in the market microstructure literature, focuses on extremely liquid assets. While transaction costs still matter even in these highly competitive markets, their stochastic properties may have little bearing on the illiquidity risk premia that characterize the broader universe of investment opportunities available to investors (Khandani and Lo, 2011). Many hedge funds, however, invest in illiquid assets and generate a significant portion of their returns from bearing illiquidity risk. Moreover, hedge funds' share restrictions are easy to identify as they are directly observable from the fund's limited partnership agreement and available in various commercial databases. Hence, hedge funds are an ideal place to search for illiquidity premia.

Liang (1999) was among the first to analyze the relation between hedge fund returns and lockup periods. Lockup periods and other share restrictions can be interpreted as transaction costs which

[1] Amihud, Mendelson, and Pedersen (2005) provide a comprehensive literature review.
[2] In contrast, mutual funds always provide investors an option to sell at the net asset value on the close of each trading day.

are sufficiently high to prevent an investor from selling the fund. Hence, lockup periods and other share restrictions measure hedge fund liquidity for investors. Liang (1999) discovers a positive and significant relation between hedge fund returns and lockup periods. Thus, hedge funds imposing lockup periods offer investors an illiquidity premium. Liang (1999) argues that lockup periods may effectively prevent early redemption, reduce cash holdings, and allow managers to focus on relatively long horizons.

Aragon (2007) also finds a positive relation between hedge fund performance and share restrictions as measured by lockup periods and redemption notice periods. The difference in alphas between portfolios of hedge funds with and without lockup periods is 4% to 7% per annum. This finding reflects that investors require a share illiquidity premium. Previously positive alphas become either significantly negative or insignificant after controlling for lockup periods and redemption notice periods. Hence, lockup periods and redemption notice periods can explain hedge fund abnormal returns. Moreover, he finds lockup periods to be significantly negatively related to asset portfolio liquidity. Thus, hedge funds imposing lockup periods are invested in illiquid assets. Aragon (2007) argues that share restrictions provide fund managers with greater managerial discretion and thus, allow them to efficiently manage illiquid assets.

More recent studies confirm a positive relation between hedge fund performance and share restrictions indicating the existence of a share illiquidity premium (Agarwal et al., 2009; Liang and Park, 2007). Furthermore, some recent studies also confirm the negative relation between share restrictions and asset portfolio liquidity indicating that the share illiquidity premium is at least partially generated by investments in illiquid assets (Khandani and Lo, 2011; Liang and Park, 2007).

In this paper, we investigate how share restrictions affect hedge fund performance in non-crisis periods as well as a crisis period such as the recent financial crisis of 2007/2008. In robustness tests, we use a number of alternative (liquidity) crisis definitions including one that includes the Russian crisis and the collapse of Long-Term Capital Management (LTCM) in 1998 and the burst of the dot-com bubble in 2000 in addition to the recent financial crisis or all recession months as defined by the National Bureau of Economic Research (NBER). Moreover, we also use the marketwide liquidity measure developed by Pastor and Stambaugh (2003) to measure liquidity crises more directly. Second, we investigate whether the use of alternative share restrictions, such as lockup periods, redemption notice periods, and redemption frequency periods, is correlated and whether share restrictions are used to prevent an asset-liability mismatch and, therefore, are significantly related to the hedge funds' asset portfolio liquidity as measured by the smoothing parameter of Getmansky et al. (2004). Third, we investigate the relation between illiquid asset portfolios and hedge fund performance in crisis and non-crisis periods. This allows us to separate the effect of share restrictions on hedge fund performance from the effect of the asset portfolio liquidity. Finally, we investigate whether fund flows effectively prevented withdrawals of funds in the crisis.

Our main results are the following. First, we show that, consistent with Aragon (2007), in the pre-crisis period (his sample ends in 2001), more illiquid funds produce both higher returns and alphas. Hence, funds generate a share illiquidity premium for investors as a compensation for limited liquidity. In contrast, in the crisis period, this share illiquidity premium turns into an illiquidity discount. Hence, greater managerial discretion seems to be harmful and share restrictions do not seem to be sufficient to manage illiquid assets effectively in a severe financial markets crisis. In fact, Agarwal et al. (2009) argue that hedge funds with stronger share restrictions and greater managerial discretion have fewer incentives to perform better because investors cannot immediately withdraw their money after poor performance. While these missing incentives do not seem to matter in the pre-crisis period, they might provide an explanation why hedge funds with stronger share restrictions underperform funds with weaker restrictions in the recent financial crisis.

Second, our results show that the use of alternative share restrictions is positively correlated and funds using one of the three alternative share restrictions considered in this study are significantly more likely to use the other two share restrictions as well. Moreover, funds with more stringent share restrictions indeed use the greater managerial discretion provided by these restrictions to become more heavily invested in illiquid assets as compared to funds with weaker restrictions for investors. It is not unexpected that redemption notice periods have the strongest relation to both fund performance and asset portfolio liquidity because lockup periods expire and redemption frequency periods only restrict redemptions to a certain point in time.

Third, we find weak evidence for a positive relation between asset portfolio liquidity and hedge fund alpha and strong evidence for a positive relation between asset portfolio liquidity and returns in the financial crisis. Our results are consistent with recent research on the relation between equity-specific (Sadka, 2010) and global (Kessler and Scherer, 2011) liquidity factors and hedge fund returns. These studies find negative return shocks in times of decreasing liquidity and argue that in a distressed environment investment funds cannot reduce their exposure to less liquid assets and remain exposed to the market downturn. However, we find that the liquidity of the hedge funds' asset portfolios does not fully explain the share illiquidity premium (discount) in the pre-crisis (crisis) period. This finding is consistent with Aragon (2007) and Liang and Park (2007), who both investigate the relation between hedge fund returns and the marketwide liquidity measure of Pastor and Stambaugh (2003). It is also consistent with Sadka (2010) who captures marketwide liquidity by a measure developed in Sadka (2006). All studies do not find a significant difference in liquidity risk exposure across funds with and without share restrictions. Thus, asset portfolio liquidity risk exposure cannot explain the share illiquidity premium. Consistently, Teo (2011) finds that funds with weak share restrictions are exposing themselves excessively to liquidity risk as measured by the Pastor and Stambaugh (2003) index. Thus, hedge funds do not always use share restrictions to manage liquidity risk exposure resulting in an asset-liability mismatch. Teo (2011) argues that agency problems at hedge funds can at least partially explain excessive liquidity risk exposure.

Finally, we find the above results to be corroborated by an analysis of relative fund flows which shows that rigorous share restrictions do not effectively prevent fund outflows in a crisis period. This is remarkable as share restrictions make the withdrawal of money from funds more difficult. Our results are in line with findings by Ding et al. (2009) on the pre-crisis period (their sample ends in 2004). They claim that investors withdraw their invested money more strongly in response to poor performance if funds impose more rigorous share restrictions. Investors anticipate future binding restrictions on withdrawal and redeem their money.

The remainder of the paper is organized as follows. Section 2 describes the data and variables. Section 3 presents the empirical results. Section 4 concludes.

2. Data and Variables

2.1 Data and biases

The data on hedge funds are provided by Lipper TASS (hereafter TASS). The investigation period starts in January 1994 and ends in December 2008. For a fund to be included in our sample, the database needs to provide monthly net of fee returns and information on liquidity characteristics. We require funds to have at least 24 months of observations. We exclude funds of funds since they invest in hedge funds with share restrictions and funds of funds themselves impose share restrictions. While the latter liquidity characteristics are observable, the former are not. Thus, funds of funds differ from other hedge fund strategies. Moreover, we exclude hedge funds denoted in currencies other than USD. Finally, we do not take into account hedge funds whose assets under management do not exceed USD 5 million at least once during the investigation period in order to ensure that our results are not driven by hedge funds with insignificant holdings. This leaves us with a sample of 2,886 funds. 1,103 funds are still alive as of December 2008 and 1,783 funds are defunct.[3] The assets under management of all 1,103 live funds as of December 2008 amount to approximately USD 271 billion. The average (median) fund has USD 161 million (USD 46 million) assets under management.

A majority of relevant prior studies is also based on the TASS database (Agarwal et al., 2009; Aragon, 2007; Liang and Park, 2007; Khandani and Lo, 2011; Sadka, 2010; Teo, 2011). Hence, the sample in this study is similar to samples in previous studies. The investigation period of most of these studies starts in January 1994 (Agarwal et al, 2009; Aragon, 2007; Liang, 1999; Liang and Park, 2007; Sadka, 2010; Teo, 2011), but none of these studies except for Sadka (2010) and Teo (2011) includes the time period of the recent financial crisis of 2007/2008.

We attempt to account for various biases in our sample: the survivorship bias, the backfill bias, the infrequent pricing and illiquidity bias, and the multi-period sampling bias. Before January 1994 TASS only kept track of surviving funds. This leads to a survivorship bias in the database. However, from January 1994 onwards the TASS database contains not only live but also defunct funds. Since our investigation period begins in January 1994 our sample should be free of a survivorship bias.

[3] Defunct hedge funds are either liquidated, restructured, merged with other hedge funds, or stopped reporting.

TASS allows hedge fund managers to backfill returns when they enter the database. This introduces a backfill bias. However, TASS also reports the date a fund enters the database. Hence, to eliminate the backfill bias we delete all backfilled entries which were added to the database for time periods before the fund started reporting to TASS. The date the fund joins the database is known for roughly 95% of all funds in our sample. For the remaining 5% of hedge funds with missing entry dates we follow common practice and delete the first 12 months of observations (e.g., Fung and Hsieh, 2000).

Hedge funds often invest in illiquid assets for which market prices are not readily available. These assets tend to be infrequently priced. This smoothing of prices leads to the infrequent pricing and illiquidity bias in hedge fund returns. To account for this bias we follow the approach proposed by Getmansky et al. (2004). We assume that unobserved ("true") returns (R_t) are serially uncorrelated while observed returns (R_t^0) are serially correlated. Furthermore, we assume that it may take up to two months for the full information to be incorporated in the hedge funds' prices. We apply a second order moving average process (MA(2)) to uncover the unobserved ("true") returns:

$$R_t^0 = \theta_0 R_t + \theta_1 R_{t-1} + \theta_2 R_{t-2}, \tag{1}$$

$$\text{with } \theta_j \in [0,1],\ j = 0,1,2, \tag{2}$$

$$\text{and } 1 = \theta_0 + \theta_1 + \theta_2. \tag{3}$$

We estimate the parameters of the model for each hedge fund strategy by maximum likelihood. The estimated parameters are then used to desmooth returns. The smoothing parameter theta (θ_0) captures the fraction of a fund's unobserved ("true") return that is incorporated in its observed return. The higher the smoothing parameter, the more frequently are assets priced, and the more liquid the fund's investment portfolio.[4]

[4] We follow Getmansky et al. (2004) and use a standard MA(k) estimation package (Stata) and transform the resulting estimates by dividing each theta by $1 + \theta_1 + \theta_2$ to satisfy $1 = \theta_0 + \theta_1 + \theta_2$. In contrast, and also consistent with Getmansky et al. (2004), we do not impose $\theta_j \in [0,1]$ when estimating the thetas and use this restriction as a specification test.

Hedge funds are required to have at least 24 months of observations to be included in our sample. This introduces a multi-period sampling bias. However, Ammann et al. (2011a, 2011b) investigate this bias for a similar sample and find it to be very small.

2.2 Performance measures

To measure hedge fund performance, we use monthly desmoothed returns and alphas. Monthly alphas are determined by the Fung and Hsieh (2004) seven-factor model and a stepwise regression approach. The factors of the Fung and Hsieh (2004) seven-factor model cover the most important asset classes hedge funds are invested in: equities, bonds and credit, interest rates, currencies, options, and commodities. The factors comprise the S&P 500 monthly total return and a size spread factor constructed as the difference between the Russel 2000 monthly total return minus the S&P 500 monthly total return, the monthly change in the 10-year treasury constant maturity yield and the monthly change in spread between the Moody's Baa yield less the 10-year Treasury constant maturity yield, and three trend-following factors on bonds, currencies, and commodities.[5] Factors are either excess returns above the risk free rate or zero-investment portfolios. We use the one-month Treasury bill rate as our risk free rate. Monthly desmoothed excess returns are regressed on the excess returns or zero-investment portfolios of the seven factors to determine monthly risk-adjusted performance. Parameters are estimated over 24-month rolling windows.

Hedge funds are typically exposed to more than just the seven asset classes captured by the Fung and Hsieh (2004) seven-factor model. However, the inclusion of additional factors reduces the degrees of freedom in estimating the model. Therefore, we follow Agarwal and Naik (2004), Ammann et al. (2011a, 2011b), and Titman and Tiu (2011) and additionally estimate monthly alphas based on factor models in which we select factors by means of a forward stepwise regression approach. This stepwise regression approach is an attempt to capture the different factor exposures of hedge funds while keeping the number of factors included in the model as low as possible. We start with 15 factors from a wide range of asset classes hedge funds might be invested in, such as equities, bonds and credit, interest rates, currencies, options, volatility, commodities, real estate, and convertible bonds as well as equity-based trading strategies such as the four Car-

[5] David Hsieh generously provides the data on the trend-following factors on his website: http://faculty.fuqua.duke.edu/~dah7/HFRFData.htm.

hart (1997) factors. In addition, we account for a potential non-linear factor exposure by including four primitive trend following strategy factors on equities, bonds, currencies, and commodities (see Fung and Hsieh, 2001, 2004) and four call and put option factors on the S&P 500 (see Agarwal and Naik, 2004). See Appendix A for a detailed description of all 23 factors. Returns of an equally-weighted index of all funds within a strategy are regressed on the various factors. A factor is added to the model if it is significant at the 5% level. It remains in the model as long as it remains significant at the 10% level after inclusion of additional factors. This iterative approach is continued until a maximum of seven factors for each investment style is found or until no more factors can be identified. For every strategy, we identify one factor model which is then used for all funds within this strategy. Monthly desmoothed excess returns are regressed on the excess returns or zero-investment portfolios of the factors found by the stepwise approach to determine monthly risk-adjusted performance. Parameters are estimated over 24-month rolling windows.

The stepwise regression approach is prone to data mining. However, Ammann et al. (2011a, 2011b) show for a similar sample that their multi-factor models found by the stepwise regression approach work well in an in-sample test and an out-of-sample test. Thus, data mining should not be a major issue. Robustness tests show that the results found with the stepwise regression alphas (not reported for space reasons) are qualitatively similar but slightly weaker than results found with the Fung and Hsieh (2004) seven-factor model alphas. This is due to the fact that some factors of the stepwise regression approach also work as proxies for hedge fund liquidity for certain investment styles (e.g., the convertible bond factor captures part of the illiquidity of convertible arbitrage hedge funds).

Table 1 reports the descriptive statistics. The average (median) fund in our sample generates a return of 6.9% (6.4%) per annum. The average (median) alpha is 3.8% (3.3%) per annum for the Fung and Hsieh (2004) seven-factor model and 1.8% (1.3%) for the factor models based on the stepwise regression approach. Hence, on average, hedge fund managers outperform common benchmarks. However, risk-adjusted performance is substantially reduced when using the stepwise regression model and resulting strategy specific multi-factor models.

Strategy-wise, we find managed futures managers to be the most successful followed by emerging markets funds and multi-strategy funds when looking at returns. When looking at Fung and Hsieh (2004) alphas, managed futures funds are again the most successful ones followed by emerging market funds and event driven funds. Based on strategy specific factor models, emerging markets managers generate the highest alphas followed by managed futures funds and multi-strategy funds. Least successful are fixed income funds, convertible arbitrage funds, and dedicated short bias funds when focusing on returns. When looking at Fung and Hsieh (2004) alphas equity market neutral funds, global macro funds, and dedicated short bias funds perform worst. Global macro funds, convertible arbitrage funds, and equity market neutral funds have the lowest performance based on alphas generated by strategy specific models.

2.3 Liquidity measures

We measure fund liquidity for investors by means of three share restrictions: the lockup period, the redemption notice period, and the redemption frequency period. The lockup period is the time period during which the investor cannot withdraw the money after investing in the fund. The redemption notice period is the amount of notice the investor is required to provide to the fund before being able to redeem the money from the fund. Moreover, the redemption frequency makes redemption only possible at certain points in time.[6] While the lockup period expires, the redemption notice period and the redemption frequency period apply as long as the investor is invested in the hedge fund.

The TASS database only reports the most recent characteristics of hedge funds. Hence, if funds change their share restrictions in the course of the financial crisis this is not captured by the database. This introduces an endogeneity problem. Fund performance might influence the choice of share restrictions. In order to analyze whether our sample suffers from an endogeneity bias we compare share restrictions of funds in our TASS database ending December 2008 with share restrictions of funds in a previous version of the TASS database ending September 2005. 79% of all funds can be identified in both downloads. 69% are alive and 31% are defunct as of September 2005. An overwhelming majority (88%) of funds that are alive as of September 2005 does not change any share restriction in the course of the recent financial crisis. Only 7% of all live funds

[6] TASS reports lockup periods in months and the redemption notice periods in days. The redemption frequency period, however, is only reported qualitatively (e.g., daily, monthly, quarterly, semi-annually, annually, etc.). We transform these qualitative entries into days assuming seven days per week, 30 days per month, 90 days per quarter, 180 days per half-year, and 360 days per annum. For the qualitative entries “daily”, “not defined”, and “NA” we assume a zero redemption frequency period. For the qualitative entry “other” we set a redemption frequency period of four years. Liang and Park (2007) apply a similar transformation.

strengthen at least one share restriction. 4% of all live funds weaken at least one restriction. 1% strengthens at least one restriction while weakening another. Thus, endogeneity should not be an issue in our sample. We cannot observe hedge funds "raising gates" in the recent financial crisis. This can be explained by the fact that hedge funds are typically regulated by a limited partnership agreement. Provisions of the limited partnership agreement can only be adapted under certain circumstances and with the majority consent of the limited partners. If a general partner wishes to change share restrictions then he most likely either starts a new fund or creates an additional class of shares (Agarwal et al, 2009; Aragon, 2007). Aragon (2007) shows, based on a proprietary sample which captures changes in share characteristics over time, that the impact of the endogeneity bias is limited.

The descriptive statistics in Table 1 show that 37% of funds in our sample have a lockup period. The mean (median) lockup period is 4.5 months (0 months). The mean (median) fund has a redemption notice period of 37 days (30 days) and a redemption frequency period of 80 days (30 days). Aragon (2007) reports only 17% of funds with lockup periods in his sample (his sample ends in 2001). The average (median) lockup period is 3 months (0 months) and the average redemption notice period in Aragon's (2007) sample is 26 days.

Since only a minority of funds has a lockup period and most lockup periods are clustered around 12 months we later use a dummy variable indicating whether a fund has a lockup period instead of the exact lockup period.

Share restrictions differ significantly across hedge fund strategies. When comparing lockup periods, redemption notice periods, and redemption frequency periods across strategies, we find managed future funds, global macro funds, and equity market neutral funds to be the most liquid for their investors while event driven funds, long/short equity hedge funds, and fixed income arbitrage funds are rather illiquid from an investor's perspective.

To measure the liquidity of fund portfolios we would ideally look directly at portfolio assets held by hedge funds. However, hedge funds generally do not disclose data on portfolio assets. Therefore, we use the approach proposed by Getmansky et al. (2004) to desmooth returns. The smoothing parameter (θ_0) serves also as a measure for the liquidity of the hedge funds' portfolios. The higher the smoothing parameter, the more frequently are assets priced, and the more liquid are portfolios. As before, we apply a second order moving average process (MA(2)) and estimate the parameters by maximum likelihood. However, this time we do not estimate the parameters for each hedge fund strategy but for each individual fund.[7] Such an approach is also used in previous studies to measure asset liquidity (Aragon, 2007; Liang and Park, 2007).

When comparing the liquidity of the asset portfolio of funds across investment styles again managed future funds, global macro funds, and equity market neutral funds hold the most liquid portfolios while convertible arbitrage managers, fixed income arbitrage managers, and event driven managers invest in rather illiquid assets. Hence, those managers investing in the most illiquid assets are also those imposing the most rigorous share restrictions. This makes sense from an asset and liability perspective.

Finally, we also measure a hedge funds' exposure to marketwide liquidity risk. Liquidity risk is measured by the Pastor and Stambaugh (2003) marketwide liquidity risk measure.[8] Monthly hedge fund returns are regressed on the returns of the marketwide traded liquidity factor and the S&P 500 monthly total returns. The higher the liquidity risk beta, the higher is the exposure to marketwide liquidity risk. A similar approach is used in previous analyses (Sadka, 2010).

2.4 Definition of the financial crisis

The hedge fund attrition rate measures the number of hedge funds exiting the TASS database relative to the number of live funds in the database. Figure 1 presents the attrition rate. The attrition rate has a first spike around the burst of the dot-com bubble in spring 2000. However, the number of funds leaving the database has never been as high as in the recent financial crisis of 2007/2008. This highlights the severity of this recent financial crisis for the hedge fund industry.

[7] When estimating the model parameters for each hedge fund strategy to desmooth returns we require funds to have at least five years of return history. In order not to lose too many funds we do not make this assumption when estimating the model parameters for each individual hedge fund. Instead, we drop funds with $\theta_0 < 0$ and $\theta_0 > 5$. For these funds the model does not seem to be well specified. This results in the exclusion of 106 funds and reduces the sample to 2,780 funds. Thereof, 93 funds have three years or less of return history. Aragon (2007) applies a similar filter and deletes funds with smoothing parameters $\theta_0 < -5$ and $\theta_0 > 5$.

[8] Lubos Pastor generously provides the return data on the marketwide traded liquidity factor on his website: http://faculty.chicagobooth.edu/lubos.pastor/research.

We measure the crisis by means of a dummy variable which equals one in the crisis period starting in July 2007 and ending in December 2008.[9] Hence, it lasts for 18 months in our analysis and accounts for 10% of our sample period. Other studies dealing with the recent financial crisis apply similar crisis definitions (Beltratti and Stulz, 2011; Ben-David et al., 2011; Cao et al., 2011; Fahlenbrach and Stulz, 2011; Kessler and Scherer, 2010; Sadka, 2010).

We rerun the analysis with alternative definitions of the crisis period. The first alternative measure additionally includes the Russian crisis and the collapse of Long-Term Capital Management (LTCM) (July 1998 to December 1998) and the burst of the dot-com bubble (March 2000 to December 2001). Fung et al. (2008) identify structural breaks in hedge fund risk exposure at the time of the collapse of Long-Term Capital Management (LTCM) in 1998 and the burst of the dot-com bubble in 2000. As a second alternative crisis variable we use recession months as defined by the National Bureau of Economic Research (NBER). This variable includes the burst of the dot-com bubble (March 2001 to November 2001) and the recent financial crisis (December 2007 to December 2008). However, results for alternative definitions of the crisis period (not reported for space reasons) are similar to results for our primary definition.

We also use the marketwide liquidity measure developed by Pastor and Stambaugh (2003) to measure liquidity crises.[10] Even though this measure is derived from the liquidity of individual stocks listed on the NYSE and the Amex, it can be applied to hedge funds because liquidity across different markets (Chordia et al., 2005; Goyenko and Ukhov, 2009) and across different countries (Karolyi et al., 2010) is highly correlated. Furthermore, many hedge funds take bets on individual stocks and, hence, are directly affected by the liquidity of these stocks. Substantial downward spikes in marketwide liquidity occur during the Asian crisis, the Russian crisis and the subsequent collapse of Long-Term Capital Management (LTCM), the burst of the dot-com bubble, the collapse of Bear Sterns, and the bankruptcy of Lehman Brothers. Results found with the Pastor and Stambaugh (2003) liquidity measure (not reported for space reasons) are similar to

[9] At the end of June 2007, hedge funds of the investment bank Bear Stearns, which invested in the subprime mortgage market, were among the first to struggle ("$3.2 Billion Move by Bear Stearns to Rescue Fund", New York Times, June 23, 2007; "Bear Stearns Says Battered Hedge Funds Are Worth Little", New York Times, July 18, 2007).

[10] Here, we use the level of aggregate liquidity. Lubos Pastor also generously provides this data on his website: http://faculty.chicagobooth.edu/lubos.pastor/research.

results found with our primary crisis definition. Figure 1 provides an overview of the various crisis definitions.

3. Empirical Results

3.1 Share restrictions and hedge fund performance

We first analyze how fund liquidity for investors affects hedge fund performance in the pre-crisis period and during the recent financial crisis. We run univariate comparisons of the performance of funds with share restrictions and the performance of funds without share restrictions both in the pre-crisis period and the crisis period.

Table 2 reports the results. In the pre-crisis period, funds with lockup periods significantly outperform funds without lockup periods (Panel A). Returns of funds with lockup period are 3.6% per annum higher than returns of funds without lockup period. The alpha of funds with lockup period is 4.3% per annum higher than the alpha of funds without lockup period. Aragon (2007) measures alpha by various multi-factor models. For the time period from 1994 to 2001, he finds a 4% to 7% difference in alphas for portfolios of funds with and without lockup period. However, looking at the financial crisis, we find hedge funds with lockup period to perform significantly worse than hedge funds without lockup period. The former underperform the latter by a significant -5.2% per annum in returns and by an insignificant -0.1% in alpha.

The results for redemption notice periods (Panel B) and redemption frequency periods (Panel C) are similar. Funds with a redemption notice period above the median significantly outperform funds with a redemption notice period below the median by 1.7% in returns and 3.1% in alpha in the pre-crisis period. In the financial crisis, hedge funds with longer redemption notice period, however, significantly underperform funds with shorter redemption notice period by -6.5% and -0.9% in returns and alpha, respectively. Also, funds with a redemption frequency period above the median outperform funds with a redemption frequency period below the median in the pre-crisis period. The difference is 0.6% in returns per annum and 0.6% in alpha per annum. In the crisis months, however, funds with longer redemption frequencies underperform funds with shorter redemption frequencies by a significant -5.0% and -1.1% per annum in returns and alpha, respectively.

The findings from the univariate comparisons are corroborated by multivariate tests. We run panel regressions with hedge fund performance as the dependent variable and a financial crisis dummy variable, the various share restrictions, interaction terms of the financial crisis dummy variable with these share restrictions, and a set of control variables as independent variables. To account for the skewness of the redemption notice period and redemption frequency period variables we use the natural logarithm of these fund characteristics as explanatory variables. The control variables capture various other fund characteristics: assets under management, incentive fees, management fees, dummy variables whether a fund uses leverage, whether the fund manager(s) is (are) invested in the fund, whether the fund is closed to new investment, the length of the subscription period, the relative fund flow, and the age of the fund (see Appendix B for a summary of the control variables). Prior research uses similar control variables (Agarwal et al., 2009; Liang, 1999; Teo, 2011). In addition, we include strategy fixed effects in all regressions. Since the observations for one specific fund for different years are clearly not independent (within correlation), we use cluster-robust standard errors and treat each fund as a cluster.[11]

Table 3 reports the results. The dependent variable in Columns 1 to 5 is the alpha from the Fung and Hsieh (2004) seven-factor model and in Columns 6 to 10 the funds' desmoothed returns. The crisis dummy variable is either insignificant or positive and significant in the first five columns. In contrast, it is negative and significant in Columns 6 to 10. Hence, during the crisis funds suffer from negative returns, however, they still generate positive alphas. Thus, funds indeed do outperform common benchmarks in the financial crisis, however, they do not generate absolute returns completely independent of any market movements as often claimed by hedge fund managers after controlling for various hedge fund characteristics.[12]

Share restrictions are significantly positively correlated with alphas and returns (with one exception: the relation between alpha and redemption frequency days in Column 5). This is in line with

[11] Aragon (2007) and Teo (2011) do not use cluster-robust but only heteroscedasticity-robust standard errors. Therefore, the significance levels in their analyses are expected to be higher than in our analysis. For comparative purposes, we also conduct our analysis with heteroscedasticity-robust standard errors. In fact, the significance levels increase substantially in size as compared to the results in this section. This, however, confirms that clustering at the fund level is an important concern in our sample and, therefore, we only report the more conservative estimates based on the cluster-robust standard errors.

[12] Hedge funds betting against the subprime mortgage market were among the few that did not only outperform common benchmarks but did also generate positive returns in the financial crisis ("What Crisis? Some Hedge Funds Are Gaining", New York Times, November 11, 2008).

the share illiquidity rent for lockup periods and redemption notice periods documented by Aragon (2007) for a non-crisis period. However, the interaction terms between the financial crisis dummy variable and the alternative share restrictions are significantly negatively related to fund performance in Columns 2 to 4 and 7 to 9. Hence, the positive relation between share restrictions and hedge fund performance turns negative in the crisis period indicating that illiquid funds suffer during crisis periods, both in absolute returns as well as on a risk-adjusted basis. When we include all three share restrictions and their interaction terms simultaneously in Columns 5 and 10, both the generally positive effect as well as the negative crisis effect of the redemption frequency period disappear. Moreover, when looking at alphas, the effect of the lockup period also turns insignificant. It is not unexpected that redemption notice periods have the strongest relation to fund performance because lockup periods expire and redemption frequency periods only restrict redemptions to a certain point in time. For instance, if the lockup period has expired and a fund has a quarterly redemption frequency but no redemption notice period, the fund is exposed to the risk of redemptions without prior notice at the end of every quarter. This would not be the case if the fund would impose a redemption notice period. Thus, redemption notice periods tend to be the strongest share restriction.

To further investigate the relation between hedge fund performance and share restrictions, we split our sample funds into portfolios based on different share restrictions and compare the alphas and returns in the pre-crisis and crisis periods. Specifically, we split the sample funds into two portfolios based on the existence of a lockup period (Panel A), four portfolios based on the length of the redemption notice period (Panel B), and four portfolios based on the length of the redemption frequency period (Panel C).[13]

The results are reported in Table 4. In all three panels, more stringent share restrictions are associated with both higher alphas and higher returns in the pre-crisis period. In contrast, in the crisis period, the relation between share restrictions and performance turns and more illiquid funds have both lower alphas and lower returns. In Panels B and C, the relation between alpha and returns and the length of redemption notice and redemption frequency period is always monotonic

[13] A split of the sample into equally-sized quartiles is not possible as the distribution of share restrictions is often concentrated around a few values (e.g., 63% of funds have no lockup period; 34% of funds have a redemption notice period of 30 days; 45% of funds have a redemption frequency period of 30 days). Therefore, absent any additional criterion, funds with identical share restrictions will be classified into the same portfolio.

(with two exceptions: the relation between alpha and redemption notice days in the crisis and the relation between alpha and redemption frequency days in the pre-crisis period). Moreover, the results in Table 4 show that share restrictions are highly correlated and restricted funds tend to rely on several share restrictions. For example, the mean number of redemption notice and redemption frequency days is substantially larger for funds with a lockup period than for funds without a lockup period (50 vs. 28 redemption notice days and 107 vs. 60 redemption frequency days, respectively). Finally, the results in Table 4 show that more stringent share restrictions are associated with lower smoothing parameters and, thereby, less liquid investment portfolios. Hence, funds which plan to invest in more illiquid assets in general impose more rigorous share restrictions to match their assets and liabilities. We will analyze the relation between share restrictions and the liquidity of the portfolio in more detail in the next section. Moreover, we will investigate how the hedge funds' portfolio liquidity impacts performance in the pre-crisis and the crisis-periods.

In Table 5, we reevaluate these univariate findings based on multivariate analyses. As compared to Table 3, we replace the variables that measure the length of the notice and redemption frequency periods by dummy variables that indicate whether the fund belongs into the second, third, or fourth portfolio of the distribution of these two variables. We then also interact these six dummy variables with the crisis dummy variable. Consistent with the results in Table 4, the results indicate that the longer the redemption notice period, the higher are returns and the higher are alphas in the pre-crisis period, but the lower are both returns and alphas during the financial crisis. The same holds true for the redemption frequency period. As in Table 3, due to the correlation among share restrictions, the coefficients lose significance when all share restrictions are included simultaneously in the regression (Columns 4 and 8). And again, the redemption notice period seems to be the most important share restriction that is significantly related to both pre-crisis and crisis alphas and returns.

To summarize the results in this section, Aragon (2007) documents a share illiquidity premium for hedge funds when investigating the relation between performance and fund liquidity in a non-crisis period. The more rigorous the share restrictions are, the better is hedge fund performance in good times. He argues that share restrictions provide hedge funds with greater managerial discretion and allow them to effectively manage illiquid assets. Our results for the pre-crisis period confirm the findings of Aragon (2007). However, we show that this share illiquidity premium of Aragon (2007) turns into an illiquidity discount in the recent financial crisis (and unreported robustness tests show that this holds in crisis periods more generally). Hence, greater managerial discretion seems to be harmful and share restrictions do not seem to be sufficient to manage illiquid assets effectively in a severe financial markets crisis. In fact, Agarwal et al. (2009) argue that hedge funds with stronger share restrictions and greater managerial discretion have fewer incentives to perform better because investors cannot immediately withdraw their money after poor performance. While these missing incentives do not seem to matter in the pre-crisis period, they might provide an explanation why hedge funds with stronger share restrictions underperform funds with weaker restrictions in the recent financial crisis. We will analyze in the next section whether portfolio liquidity can provide another explanation for the underperformance of funds with more stringent share restrictions in the crisis period. First, we investigate whether hedge funds with share restrictions indeed invest in illiquid assets and how funds with illiquid asset portfolios perform in the recent financial crisis. Second, we analyze the relation between hedge funds' liquidity risk exposure and share restrictions and the relation between liquidity risk exposure and the performance of funds in the financial crisis.

3.2 Share restrictions, asset portfolio liquidity, and hedge fund performance

We next assess the relation between fund liquidity for investors and the funds' asset portfolio liquidity. The univariate analysis in Table 4 shows a positive relation between more stringent share restrictions and illiquid asset portfolios. To reevaluate these findings in a multivariate setting, we estimate cross-sectional regressions with the smoothing parameter as the dependent variable and the three share restrictions and the nine control variables as independent variables.

Table 6 presents the results. In Columns 1 to 3, the coefficients on the three share restrictions are all negative and significant. When we include all three share restrictions simultaneously in Columns 4 and 5, the coefficients on all three share restrictions remain negative, but the coefficients on the lockup period dummy and the redemption frequency period variables turn insignificant. Hence, the results in Table 6 confirm the findings in Table 4 that hedge fund managers who plan to hold an illiquid asset portfolio tend to set up funds with more rigorous share restrictions. Moreover, redemption notice periods seem to be the most important share restriction to prevent an asset-liability mismatch. The negative relation between share restrictions and asset portfolio liquidity is also documented by Aragon (2007), Khandani and Lo (2011), and Liang and Park (2007).

Moreover, we analyze the relation between share restrictions and hedge funds' liquidity exposure. In a cross-sectional analysis, we regress the liquidity factor beta on the three share restrictions and the nine control variables. Results are also presented in Table 6. In Columns 6 to 8, the coefficients on the share restrictions are all positive and those on the lockup period dummy and the redemption notice period variables are significant at the 1% level. When we include all share restrictions simultaneously in Column 9, the coefficients on the lockup period and the redemption notice period variables remain both positive and significant while the coefficient on the redemption frequency period turns negative and becomes significant. This latter finding of a negative and significant coefficient on the redemption frequency period variable, however, disappears when we include the full set of control variables in Column 10. Moreover, the coefficient on the lockup period dummy variable also turns insignificant. These results support previous findings that hedge funds with more stringent share restrictions take on higher liquidity risk. Again redemption notice periods seem to be the most important restriction for hedge funds exposing themselves to liquidity risk.

We next investigate how asset portfolio liquidity impacts hedge fund performance in the pre-crisis and the crisis periods. We first perform univariate comparisons of the performance of hedge funds with high and low smoothing parameters in the pre-crisis and the crisis period. The results are reported in Table 7. In the pre-crisis period, funds holding less liquid assets significantly outperform funds holding more liquid assets by 1.1% per annum in terms of returns and by 0.8% per annum in terms of alphas. In the crisis period, the performance difference between funds holding less liquid assets and funds holding more liquid assets is -22.0% per annum in terms of returns and -2.3% per annum in terms of alphas. Hence, hedge funds with illiquid assets significantly outperform in the pre-crisis period and significantly underperform in the crisis period.

In Table 8, we reevaluate these findings in multivariate tests. We regress hedge fund performance on a crisis dummy variable, the smoothing parameter, an interaction term between the crisis dummy variable and the smoothing parameter, share restrictions, interaction terms between the crisis dummy and share restrictions, and the full set of control variables. In Columns 1 to 5, the dependent variable is the alpha from the Fung and Hsieh (2004) seven-factor model and in Columns 6 to 10 the desmoothed returns. With respect to the three share restrictions, the results confirm those in Table 3 and show a positive relation between share restrictions and performance which turns negative in the crisis period. The smoothing parameter is negatively related to hedge fund returns indicating that more liquid asset portfolios underperform more illiquid portfolios in terms of returns (Columns 6 to 10). However, the coefficient on the interaction term between the smoothing parameter and the crisis dummy is positive, significant, and much higher in magnitude indicating a positive relation between asset portfolio liquidity and crisis returns. In Columns 1 to 5, the coefficient on the smoothing parameter is always insignificant and the coefficient on the interaction term between the smoothing parameter and the crisis dummy is always positive and borderline significant in Column 1. Hence, in a multivariate setting there is only weak evidence for a positive relation between asset portfolio liquidity and hedge fund alpha in the pre-crisis and crisis periods.

We also evaluate the relation between liquidity risk exposure and hedge fund performance. We perform univariate as well as multivariate tests (not reported for space reasons) and confirm results found by Kessler and Scherer (2011), Sadka (2010), and Teo (2011) that there is a positive and significant relation between hedge fund returns and the exposure to marketwide liquidity risk factors in the non-crisis period. Moreover, there is a negative and significant relation between hedge fund returns and the exposure to marketwide liquidity risk in the crisis period. However, our results show that liquidity risk exposure cannot explain the share illiquidity premium and discount in the pre-crisis period and the crisis period, respectively.

To summarize the findings in this section, funds with more stringent share restrictions indeed use the greater managerial discretion provided by these restrictions to become more heavily invested in illiquid assets and to become more exposed to liquidity risk as compared to funds with weaker restrictions for investors. However, these illiquid investments and the liquidity risk exposure can explain only a small part of the outperformance of hedge funds with stringent share restrictions in the pre-crisis period and of the underperformance of these funds in the course of the financial crisis. While share restrictions enable funds to manage illiquid assets effectively in the pre-crisis period, they do not seem to be sufficient to ensure effective management of illiquid portfolios in the recent financial crisis (and other crisis periods as revealed by unreported robustness tests based on the alternative crisis measures). Managerial discretion in general and missing incentives might be other explanations for the share illiquidity premium and discount, respectively (Agarwal et al., 2009).

3.3 Fund flows and share restrictions

To further investigate the channels through which the illiquidity premium found in non-crisis periods and the illiquidity discount observed in crisis periods arise, we investigate the relation between relative fund flows and share restrictions in the pre-crisis and crisis period, respectively. If share restrictions do not effectively prevent hedge funds from withdrawals during a crisis period, the illiquidity discount in the crisis period may in fact result from asset-liability mismatches at certain illiquid hedge funds.[14] Hedge fund managers holding illiquid asset portfolios might be forced to liquidate securities to meet the rush of redemptions. To investigate this empirically, we regress relative fund flows on the crisis dummy variable, alpha, share restrictions, interaction terms between the crisis dummy variable and share restrictions, and the set of controls.

The results are reported in Table 9. Not surprisingly, the crisis dummy is always negative and significant indicating that hedge funds on average experience fund outflows in the crisis. Lockup periods do not seem to be significantly related to fund flows. In contrast, redemption notice periods and redemption frequency periods are both associated with fund inflows in the pre-crisis period. The coefficient on redemption frequency periods, however, turns insignificant in Column 5 when all share restrictions are included simultaneously. Most importantly, in Column 5, when accounting for all three share restrictions simultaneously, we find a positive and significant coefficient on the redemption frequency variable and a negative and significant coefficient on the redemption notice period variable when interacted with the crisis dummy. Hence, while redemption frequency periods in fact mitigate fund withdrawals in the crisis, funds with longer redemption notice periods even suffer from more outflows indicating that investors exit funds with longer redemption notice periods even more excessively than funds with weaker restrictions in a severe financial crisis. Moreover, in comparison to the crisis dummy variable, the coefficients on the interaction term between both share restrictions and the crisis dummy are quite small in mag-

[14] Cao et al. (2011) find that the majority of hedge fund managers are not able to time their asset liquidity exposure. However, the around 20% of hedge funds, which are able to time liquidity exposure successfully, significantly outperform those without timing abilities.

nitude (0.004 for redemption frequency days and -0.002 for redemption notice days, respectively, as compared to -0.019 for the crisis dummy). Hence, share restrictions are not very effective in preventing hedge funds from fund withdrawals in the recent financial crisis. These findings are remarkable as share restrictions make the withdrawal of money from funds more difficult. Our results are in line with findings by Ding et al. (2009). For their sample, which ends in 2004, they show that investors withdraw their invested money more strongly in response to poor performance if funds impose more rigorous share restrictions. Investors anticipate future binding restrictions on withdrawal and redeem their money.

Moreover, in financial crises, as asset prices drop, lenders issue margin calls and ask for additional collateral. Hence, hedge fund managers might be forced to liquidate assets to meet these margin calls and to deleverage. Consistently, Ben-David et al. (2011) report evidence for fire sales in the recent financial crisis. They show that hedge funds sold roughly 32% of their assets in the course of the crisis. Investor redemptions are responsible for approximately 50% of these selloffs. If hedge funds employ stringent share restrictions, some of these redemptions may be delayed in a crisis period. Forced deleveraging is responsible for about 40% of selloffs. Share restrictions, however, do not protect funds from margin calls and forced deleveraging. Hence, hedge funds with stringent share restrictions suffer similarly as funds without or with less stringent share restrictions from margin calls and forced deleveraging. Margin calls and forced deleveraging are particularly harmful for funds holding illiquid assets. Moreover, investor redemptions and margin calls force hedge funds to liquidate positions when asset prices are already tumbling. This leads to additional pressure on prices and creates a loss spiral (Brunnermeier and Pedersen, 2009). Ben-David et al. (2011) show that hedge funds cover investor redemptions and margin calls mainly by selling their most liquid assets. Thereby, funds try to limit the price impact during fire sales and weaken the loss spiral.

4. Conclusion

In this paper, we investigate the relation between hedge fund performance and both the liquidity provided to investors, as measured by share restrictions, and the portfolio liquidity. First, we investigate how share restrictions affect hedge fund performance in non-crisis periods as well as in crisis periods such as the recent financial crisis of 2007/2008. Our results show that, consistent with prior research, more illiquid funds produce both higher returns and alphas in non-crisis periods. Hence, funds generate a share illiquidity premium for investors as a compensation for limited liquidity. In contrast, in the crisis period, this share illiquidity premium turns into an illiquidity discount. Hence, greater managerial discretion seems to be harmful and share restrictions do not seem to be sufficient to manage illiquid assets effectively in a severe financial markets crisis. In fact, Agarwal et al. (2009) argue that hedge funds with stronger share restrictions and greater managerial discretion have fewer incentives to perform better because investors cannot immediately withdraw their money after poor performance. While these missing incentives do not seem to matter in the pre-crisis period, they might provide an explanation why hedge funds with stronger share restrictions underperform funds with weaker restrictions in the recent financial crisis.

Second, we investigate whether the use of alternative share restrictions, such as lockup periods, redemption notice periods, and redemption frequency periods, is correlated and whether share restrictions are used to prevent an asset-liability mismatch. Our results show that the use of alternative share restrictions is positively correlated and funds using one share restriction are significantly more likely to use others as well. Moreover, funds with more stringent share restrictions indeed use the greater managerial discretion provided by these restrictions to become more heavily invested in illiquid assets as compared to funds with weaker restrictions for investors.

Third, we investigate the relation between illiquid asset portfolios and hedge fund performance in both crisis and non-crisis periods. This allows us to separate the effect of share restrictions on hedge fund performance from the effect of the asset portfolio liquidity. We find weak evidence for a positive relation between asset portfolio liquidity and hedge fund alpha and strong evidence for a positive relation between asset portfolio liquidity and returns in the financial crisis. Our results are consistent with recent research on the relation between marketwide liquidity and hedge fund returns which in general shows negative return shocks in times of decreasing liquidity. However, we show that the liquidity of the hedge funds' asset portfolios does not fully explain the share illiquidity premium (discount) in the pre-crisis (crisis) period.

Finally, we investigate whether fund flows effectively prevented withdrawals of funds in crisis periods. Our results show that rigorous share restrictions do not effectively prevent fund outflows in the crisis. This is remarkable as share restrictions make the withdrawal of money from funds more difficult. However, our results are in line with findings by Ding et al. (2009). Using data from 1994 to 2004, they find that investors in funds with more rigorous share restrictions withdraw their invested money more strongly in response to poor performance. Investors anticipate future binding restrictions on withdrawal and redeem their money.

Hence, while share restrictions allow hedge fund managers to focus on relatively long time horizons resulting in significantly higher returns and alphas in good and normal markets, a combination of more illiquid portfolio holdings, the failure to prevent withdrawals of funds, and the failure to protect funds from margin calls and forced deleveraging (Ben-David et al., 2011) lead to significantly lower crisis returns of funds with stricter share restrictions.

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Figure 1: Attrition rate and alternative crisis definitions

The figure shows the hedge fund attrition rate in the TASS database (solid bold line). The attrition rate is defined as the number of funds exiting the TASS database during the previous 12 months divided by the average number of active funds over the past 12 months. Our *Crisis* dummy variable only takes into account the recent financial crisis and equals one if the observation is within the time period from July 2007 to December 2008 (crossed line). The *Structural Break* dummy variable also takes into account the Russian crisis and the collapse of Long-Term Capital Management (LTCM) and the burst of the dot-com bubble in addition to the recent financial crisis and equals one if the observation is within the periods from July 1998 to December 1998, from March 2000 to December 2001, or from July 2007 to December 2008 (dotted line). The *NBER* dummy variable follows the crisis definition of the National Bureau of Economic Research (NBER) and equals one if the observation is within the period from March 2001 to November 2001 or within the period from December 2007 to December 2008 (dashed line). The figure also shows the marketwide liquidity measure as defined by *Pastor and Stambaugh (2003)* (solid thin line).

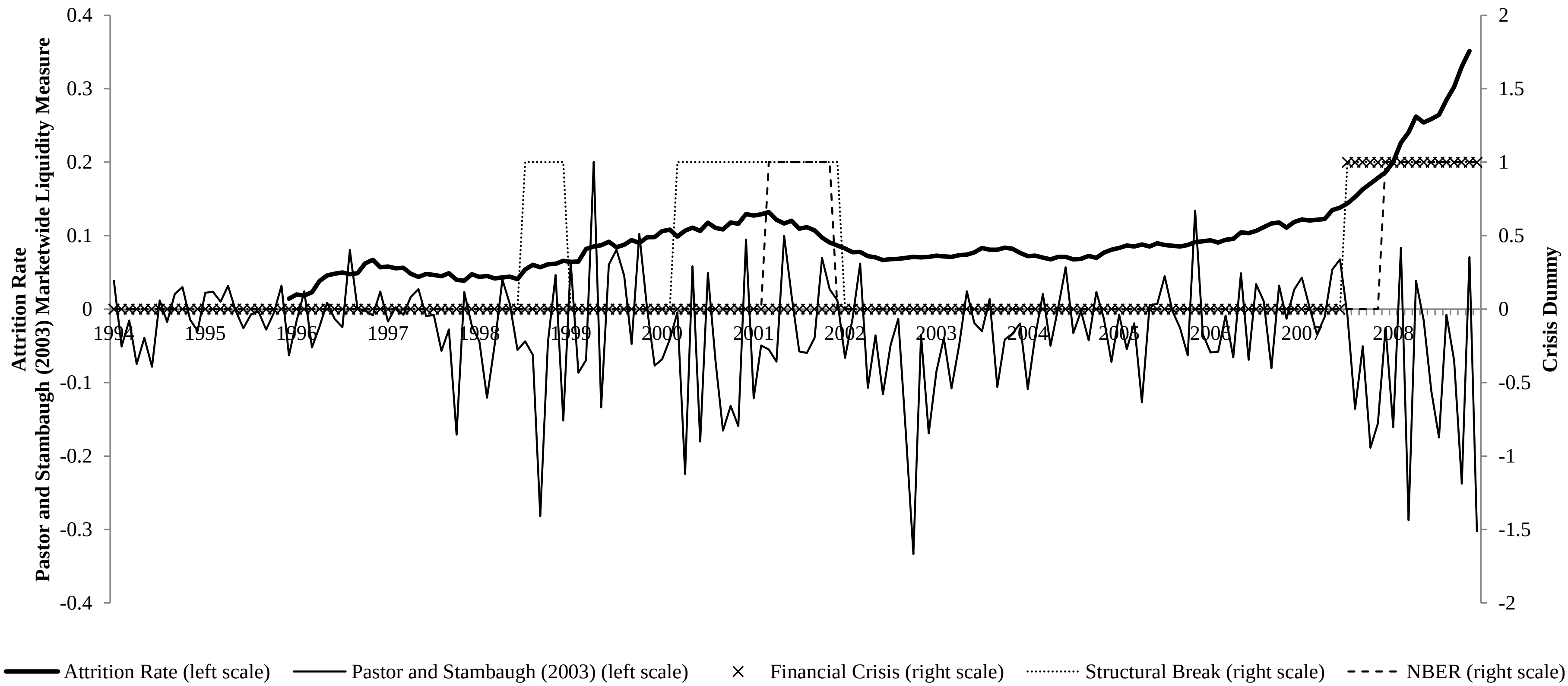

Table 1: Descriptive sample statistics

The table reports descriptive statistics of the main variables for all 10 strategies separately and for all funds in the sample. *Lockup* is a dummy variable which equals one if the respective fund has a lockup provision. *Notice days* is the length of the redemption notice period in days. *Redemption days* is the length of the redemption frequency period in days. *Asset under management* represents the funds' assets under management (in million USD). *Monthly returns (%)* are returns which are desmoothed based on the procedure proposed by Getmansky et al. (2004) as explained in equations 1 to 3. *Monthly alphas (%)* are calculated over 24-month rolling windows and are based on the Fung and Hsieh (2004) seven-factor model and on the stepwise regression approach, respectively. *Theta (θ_0)* is obtained from a maximum likelihood estimation of the MA(2) model of observed returns as proposed by Getmansky et al. (2004).

			Notice days				*Redemption days*			
Strategy	# Funds	*Lockup*	[0 ; 7]	[> 7; 30]	[> 30 ; 90]	[> 90 ; ∞]	[0 ; 7]	[> 7 ; 30]	[> 30 ; 90]	[> 90 ; ∞]
Convertible Arbitrage	126	37%	10%	38%	52%	1%	6%	33%	58%	3%
Dedicated Short Bias	19	32%	32%	47%	21%	0%	0%	37%	58%	5%
Emerging Markets	225	21%	21%	44%	34%	1%	14%	52%	30%	4%
Equity Market Neutral	191	28%	12%	59%	29%	1%	5%	59%	32%	4%
Event Driven	358	50%	5%	31%	59%	4%	1%	28%	48%	23%
Fixed Income Arbitrage	167	43%	12%	35%	51%	2%	5%	41%	47%	7%
Global Macro	162	21%	27%	59%	14%	1%	10%	62%	27%	1%
Long/Short Equity Hedge	1,137	46%	9%	54%	36%	0%	2%	38%	48%	12%
Managed Futures	334	10%	58%	37%	4%	0%	19%	74%	7%	1%
Multi-Strategy	167	41%	10%	35%	49%	5%	1%	49%	46%	5%
All funds	2,886	37%	17%	46%	36%	1%	6%	45%	40%	9%

	Assets under management (in million USD)		*Monthly returns (%)*		*Monthly alphas (%)* *Fung and Hsieh (2004)*		*Stepwise approach*		*Theta (θ_0)*	
Strategy	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	# Funds$_{adj.}$
Convertible Arbitrage	223,150	71,576	0.317	0.380	0.223	0.212	0.046	0.076	0.646	125
Dedicated Short Bias	44,239	36,158	0.356	0.273	0.180	-0.038	0.092	-0.069	0.945	19
Emerging Markets	141,730	49,791	0.676	0.599	0.426	0.498	0.356	0.133	0.786	223
Equity Market Neutral	93,442	44,040	0.413	0.420	0.155	0.133	0.084	0.059	1.014	176
Event Driven	248,324	77,385	0.494	0.534	0.345	0.370	0.117	0.066	0.759	355
Fixed Income Arbitrage	203,595	106,430	0.263	0.375	0.196	0.248	0.200	0.224	0.757	163
Global Macro	199,599	42,502	0.525	0.555	0.156	0.168	-0.073	0.033	1.070	154
Long/Short Equity Hedge	126,391	42,543	0.569	0.586	0.300	0.284	0.089	0.109	0.902	1,084
Managed Futures	114,725	21,155	0.980	0.743	0.516	0.251	0.342	0.054	1.085	318
Multi-Strategy	288,954	61,769	0.595	0.546	0.320	0.329	0.306	0.270	0.796	163
All funds	160,849	46,480	0.574	0.537	0.313	0.275	0.150	0.112	0.886	2,780

Table 2: Univariate comparisons of illiquid and liquid funds

The table reports tests for differences in means of monthly returns and alphas between portfolios sorted based on the funds' lockup period (Panel A), redemption notice period (Panel B), and redemption frequency period (Panel C). "*Lockup* = 1" refers to fund observations with a lockup provision, while "*Lockup* = 0" refers to fund observations without lockup provision. "*NoticeHigh*" ("*Red High*") refers to fund observations with redemption notice periods (redemption frequency periods) above the median, "*NoticeLow*" ("*RedLow*") refers to fund observations with redemption notice periods (redemption frequency periods) below the median. The returns are desmoothed based on the procedure proposed by Getmansky et al. (2004) as explained in equations 1 to 3. The alphas are calculated over 24-month rolling windows and are based on the Fung and Hsieh (2004) seven-factor model. The table reports results for the pre-crisis period (left side) and crisis period (right side) separately. Funds are required to have at least 24 monthly observations to be included in the analysis. The equality of means is tested using a standard *t*-test. ***, **, * denotes statistical significance at the 1%, 5%, 10% level.

Panel A: Performance difference between funds with and without lockup periods

	01/1994 - 06/2007					07/2007 - 12/2008				
	Lockup = 1	*Lockup*=0	Difference	Std. Error	*t*-values	*Lockup* = 1	*Lockup*=0	Difference	Std. Error	*t*-values
Return	1.098	0.799	0.299	0.037	8.007***	-0.986	-0.551	-0.435	0.086	-5.040***
Alpha	0.633	0.272	0.360	0.018	19.662***	0.413	0.419	-0.007	0.013	-0.512

Panel B: Performance difference between funds with redemption notice periods above and below the median

	01/1994 - 06/2007					07/2007 - 12/2008				
	NoticeHigh	*NoticeLow*	Difference	Std. Error	*t*-values	*NoticeHigh*	*NoticeLow*	Difference	Std. Error	*t*-values
Return	0.996	0.851	0.145	0.037	3.904***	-1.052	-0.512	-0.540	0.087	-6.237***
Alpha	0.562	0.303	0.258	0.018	14.184***	0.374	0.447	-0.074	0.013	-5.726***

Panel C: Performance difference between funds with redemption frequency periods above and below the median

	01/1994 - 06/2007					07/2007 - 12/2008				
	RedHigh	*RedLow*	Difference	Std. Error	*t*-values	*RedHigh*	*RedLow*	Difference	Std. Error	*t*-values
Return	0.929	0.877	0.052	.036	1.458	-0.956	-0.540	-0.416	0.086	-4.850***
Alpha	0.418	0.368	0.051	.017	2.927***	0.372	0.460	-0.089	0.013	-6.982***

Table 3: Panel regressions of alphas and returns on different measures of fund liquidity

The table reports the results from pooled OLS regressions with strategy fixed effects. The dependent variables is either a 24-month rolling window alpha based on the Fung and Hsieh (2004) seven-factor model (Columns 1 to 5) or returns, which are desmoothed based on the procedure proposed by Getmansky et al. (2004) (Columns 6 to 10). *Crisis* is a dummy variable which equals one if the observation is within the time period from July 2007 to December 2008. *Lockup* is a dummy variable which equals one if the respective fund has a lockup provision. *ln(Notice days)* denotes the natural logarithm of the number of redemption notice days and *ln(Redemption days)* the natural logarithm of the number of redemption frequency days. All regressions include the full set of nine control variables as summarized in Appendix B (not reported for space reasons). Funds are required to have at least 24 observations (months) to be included in the analysis. The *t*-values (in parentheses) are based on the cluster-robust variant of the Huber-White (Huber, 1967; White, 1982) sandwich estimator which accounts for the dependence of observations within clusters (different month-observations for one specific fund). ***, **, * denotes statistical significance at the 1%, 5%, 10% level.

	Dependent Variables									
	Alpha					*Returns*				
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	-1.518**	-1.537**	-1.815***	-1.624***	-1.779***	-0.255	-0.269	-0.545***	-0.416**	-0.540***
	(-2.545)	(-2.545)	(-2.722)	(-2.733)	(-2.830)	(-1.288)	(-1.360)	(-2.810)	(-2.134)	(-2.817)
Crisis	-0.046	0.050	0.502***	0.399**	0.512**	-1.644***	-1.478***	-0.182	-0.628**	-0.185
	(-0.710)	(1.136)	(3.277)	(2.435)	(2.313)	(-24.474)	(-17.973)	(-0.777)	(-2.336)	(-0.615)
Lockup		0.320*			0.267		0.164***			0.086**
		(1.803)			(1.517)		(4.478)			(2.232)
*Crisis*Lockup*		-0.344**			-0.236		-0.497***			-0.221
		(-2.574)			(-1.539)		(-3.705)			(-1.458)
ln(Notice days)			0.139***		0.120***			0.128***		0.117***
			(3.114)		(3.168)			(6.198)		(5.286)
*Crisis*ln(Notice days)*			-0.170***		-0.137***			-0.438***		-0.403***
			(-5.134)		(-3.395)			(-6.692)		(-5.130)
ln(Redemption days)				0.055**	-0.027				0.075***	0.010
				(2.090)	(-0.704)				(3.418)	(0.414)
*Crisis*ln(Redemption days)*				-0.113***	-0.015				-0.258***	-0.010
				(-3.518)	(-0.381)				(-4.058)	(-0.130)
# Observations	91,153	91,153	91,153	91,153	91,153	145,596	145,596	145,596	145,596	145,596
# Funds	2,488	2,488	2,488	2,488	2,488	2,488	2,488	2,488	2,488	2,488
Adjusted R^2	0.023	0.026	0.026	0.024	0.028	0.024	0.024	0.025	0.024	0.025

Table 4: Univariate comparisons of liquid and illiquid funds

The table reports summary statistics on the main variables for two portfolios based on whether the fund has a lockup period or not (Panel A), for four portfolios based on the length of the fund's redemption notice period (Panel B), and for four portfolios based on the length of the fund's redemption frequency period (Panel C). *Lockup* is a dummy variable which equals one if the respective fund has a lockup provision. *Notice days* is the length of the redemption notice period in days. *Redemption days* is the length of the redemption frequency period in days. *Theta* (θ_0) is obtained from a maximum likelihood estimation of the MA(2) model of observed returns as proposed by Getmansky et al. (2004). *Monthly alphas (%)* are calculated over 24-month rolling windows and are based on the Fung and Hsieh (2004) seven-factor model. *Monthly returns (%)* are desmoothed based on the procedure proposed by Getmansky et al. (2004) as explained in equations 1 to 3.

Panel A: Lockup

					Monthly alpha (%)		*Monthly returns (%)*	
			Redemption		01/1994 -	07/2007 -	01/1994 -	07/2007 -
		Notice days	*days*	*Theta* (θ_0)	06/2007	12/2008	06/2007	12/2008
Lockup	# Funds	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0	1,829	28	60	0.911	0.233	0.401	0.793	-0.497
1	1,057	50	107	0.843	0.549	0.398	1.077	-0.909
All	2,886	36	77	0.886	0.344	0.400	0.897	-0.683

Panel B: Notice days

							Monthly alpha (%)		*Monthly returns (%)*	
					Redemption		01/1994 -	07/2007 -	01/1994 -	07/2007 -
	Notice			*Lockup*	*days*	*Theta* (θ_0)	06/2007	12/2008	06/2007	12/2008
Portfolio	*days*	Variable	# Funds	Mean	Mean	Mean	Mean	Mean	Mean	Mean
1	[0; 20]	*Notice(P1)*	827	11%	39	0.986	0.213	0.522	0.784	-0.158
2	[>20; 30]	*Notice(P2)*	993	35%	73	0.898	0.281	0.344	0.849	-0.693
3	[>30; 60]	*Notice(P3)*	723	56%	110	0.823	0.462	0.345	0.949	-0.933
4	[>60; ∞]	*Notice(P4)*	343	62%	113	0.744	0.642	0.449	1.198	-0.948
All			2,886	37%	77	0.886	0.344	0.400	0.897	-0.683

Panel C: Redemption days

							Monthly alpha (%)		*Monthly returns (%)*	
	Re-						01/1994 -	07/2007 -	01/1994 -	07/2007 -
	demption			*Lockup*	*Notice days*	*Theta* (θ_0)	06/2007	12/2008	06/2007	12/2008
Portfolio	*days*	Variable	# Funds	Mean	Mean	Mean	Mean	Mean	Mean	Mean
1	[0; 14]	*Red(P1)*	180	9%	7	0.984	0.016	0.498	0.648	-0.179
2	[>14; 30]	*Red(P2)*	1,294	20%	28	0.921	0.373	0.419	0.902	-0.578
3	[>30; 90]	*Red(P3)*	1,146	54%	46	0.841	0.324	0.387	0.913	-0.770
4	[>90; ∞]	*Red(P4)*	266	61%	56	0.843	0.499	0.320	0.976	-1.043
All			2,886	37%	36	0.886	0.344	0.400	0.897	-0.683

Table 5: Panel regressions of alphas and returns on indicator variables for redemption notice period portfolios and redemption frequency period portfolios

The table reports the results from pooled OLS regressions with strategy fixed effects. The dependent variable is either a 24-month rolling window alpha based on the Fung and Hsieh (2004) seven-factor model (Columns 1 to 4) or returns, which are desmoothed based on the procedure proposed by Getmansky et al. (2004) (Columns 5 to 8). *Crisis* is a dummy variable which equals one if the observation is within the time period from July 2007 to December 2008. *Lockup* is a dummy variable which equals one if the respective fund has a lockup provision. *Notice(P2)*, *Notice(P3)*, and *Notice(P4)*, and *Red(P2)*, *Red(P3)*, and *Red(P4)*, indicate that these funds are in the second, third, and fourth portfolio, respectively, with respect to the length of the redemption notice period and the redemption frequency period, respectively (see Table 4). All regressions include the full set of nine control variables as summarized in Appendix B (not reported for space reasons). Funds are required to have at least 24 observations (months) to be included in the analysis. The *t*-values (in parentheses) are based on the cluster-robust variant of the Huber-White (Huber, 1967; White, 1982) sandwich estimator which accounts for the dependence of observations within clusters (different month-observations for one specific fund). ***, **, * denotes statistical significance at the 1%, 5%, 10% level.

	Dependent Variables							
	Alpha				*Returns*			
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	-1.537**	-1.553**	-1.649***	-1.717**	-0.269	-0.340*	-0.248	-0.272
	(-2.545)	(-2.575)	(-2.580)	(-2.541)	(-1.360)	(-1.751)	(-1.214)	(-1.350)
Crisis	0.050	0.152	0.342**	0.389**	-1.478***	-0.894***	-1.310***	-1.195***
	(1.136)	(0.960)	(2.053)	(2.334)	(-17.973)	(-6.350)	(-3.345)	(-3.135)
Lockup	0.320*			0.308	0.164***			0.094**
	(1.803)			(1.519)	(4.478)			(2.381)
*Crisis*Lockup*	-0.344**			-0.269	-0.497***			-0.223
	(-2.574)			(-1.483)	(-3.705)			(-1.424)
Notice(P2)		0.107*		0.070		0.230***		0.219***
		(1.944)		(1.096)		(4.875)		(4.464)
Notice(P3)		0.247***		0.206**		0.277***		0.243***
		(3.997)		(2.544)		(5.317)		(4.324)
Notice(P4)		0.255***		0.186		0.408***		0.369***
		(2.723)		(1.376)		(5.273)		(4.384)
*Crisis*Notice(P2)*		-0.160		-0.103		-0.841***		-0.871***
		(-1.231)		(-0.618)		(-4.802)		(-4.681)
*Crisis*Notice(P3)*		-0.387***		-0.308*		-1.137***		-1.121***
		(-2.700)		(-1.650)		(-6.378)		(-5.448)
*Crisis*Notice(P4)*		-0.386**		-0.283		-1.167***		-1.145***
		(-2.407)		(-1.322)		(-5.216)		(-4.538)
Red(P2)			0.303*	0.219			0.122	-0.008
			(1.871)	(1.318)			(0.984)	(-0.067)
Red(P3)			0.313**	0.096			0.220*	-0.013
			(1.974)	(0.629)			(1.703)	(-0.102)
Red(P4)			0.383**	0.127			0.331**	0.078
			(2.196)	(0.763)			(2.282)	(0.528)
*Crisis*Red(P2)*			-0.350*	-0.259			-0.147	0.379
			(-1.867)	(-1.109)			(-0.367)	(0.937)
*Crisis*Red(P3)*			-0.430**	-0.176			-0.494	0.467
			(-2.499)	(-0.810)			(-1.227)	(1.097)
*Crisis*Red(P4)*			-0.605***	-0.299			-0.839*	0.190
			(-3.273)	(-1.350)			(-1.956)	(0.417)
# Observations	91,153	91,153	91,153	91,153	145,596	145,596	145,596	145,596
# Funds	2,488	2,488	2,488	2,488	2,488	2,488	2,488	2,488
Adjusted R^2	0.026	0.025	0.024	0.027	0.024	0.025	0.024	0.025

Table 6: Cross-sectional regressions of the smoothing parameter theta (θ_0) and the liquidity factor beta on different measures of fund liquidity

The table reports the results from cross-sectional OLS regressions with strategy fixed effects. The dependent variable is either the smoothing parameter (θ_0) obtained from a maximum likelihood estimation of the MA(2) model of observed returns as proposed by Getmansky et al. (2004) or the liquidity factor beta based on the Pastor and Stambaugh (2003) market wide liquidity measure. *Lockup* is a dummy variable which equals one if the respective fund has a lockup provision. *ln(Notice days)* denotes the natural logarithm of the number of redemption notice days. *ln(Redemption days)* is the natural logarithm of the number of redemption frequency days. Column 6 includes the full set of nine control variables as summarized in Appendix B (not reported for space reasons). Means of time varying control variables are used. The *t*-values (in parentheses) are based on heteroskedasticity-robust White (1980) standard errors. ***, **, * denotes statistical significance at the 1%, 5%, 10% level.

	Dependent Variable									
	Theta (θ_0)					*Liquidity factor beta*				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	0.657***	0.713***	0.689***	0.717***	0.895***	0.125***	0.049	0.147***	0.104*	0.158
	(35.436)	(26.435)	(21.068)	(20.843)	(10.207)	(3.871)	(1.149)	(2.928)	(1.960)	(1.242)
Lockup	-0.028**			-0.016	-0.001	0.080***			0.070***	0.034
	(-2.193)			(-1.185)	(-0.063)	(3.927)			(3.333)	(1.383)
ln(Notice days)		-0.019***		-0.017***	-0.016**		0.030***		0.028***	0.025***
		(-3.601)		(-2.848)	(-2.520)		(4.154)		(3.789)	(3.064)
ln(Redemption days)			-0.011*	-0.002	-0.010			0.002	-0.019**	0.002
			(-1.679)	(-0.218)	(-0.974)			(0.227)	(-1.992)	(0.191)
# Observations	2,780	2,780	2,780	2,780	2,390	2,886	2,886	2,886	2,886	2,488
# Funds	2,780	2,780	2,780	2,780	2,390	2,886	2,886	2,886	2,886	2,488
Adjusted R^2	0.123	0.125	0.122	0.125	0.130	0.099	0.098	0.091	0.103	0.114
Control Variables	No	No	No	No	Yes	No	No	No	No	Yes

Table 7: Univariate comparisons of funds with high and low smoothing parameters theta (θ_0)

The table reports tests for differences in means of monthly returns and alphas of portfolios sorted based on the smoothing parameter of funds. "*High* θ_0" refers to fund observations with smoothing parameters above the median, "*Low* θ_0" refers to fund observations with smoothing parameters below the median. The returns are desmoothed based on the procedure proposed by Getmansky et al. (2004) as explained in equations 1 to 3. The alphas are calculated over 24-month rolling windows and are based on the Fung and Hsieh (2004) seven-factor model. The table reports results for the pre-crisis period (left side) and crisis period (right side) separately. Funds are required to have at least 24 monthly observations to be included in the analysis. The equality of means is tested using a standard *t*-test. ***, **, * denotes statistical significance at the 1%, 5%, 10% level.

Performance differences of funds with high and low smoothing parameter										
	01/1994 - 06/2007					07/2007 – 12/2008				
	High θ_0	*Low* θ_0	Difference	Std. Error	*t*-values	*High* θ_0	*Low* θ_0	Difference	Std. Error	*t*-values
Return	0.864	0.956	-0.093	0.036	-2.578***	0.271	-1.562	1.833	0.085	21.561***
Alpha	0.363	0.433	-0.070	0.018	-4.004***	0.527	0.335	0.192	0.013	14.925***

Table 8: Panel regressions of alphas and returns on different measures of fund liquidity and the smoothing parameter theta (θ_0)

The table reports the results from pooled OLS regressions with strategy fixed effects. The dependent variable is either a 24-month rolling window alpha based on the Fung and Hsieh (2004) seven-factor model (Columns 1 to 5) or returns, which are desmoothed based on the procedure proposed by Getmansky et al. (2004) (Columns 6 to 10). *Crisis* is a dummy variable which equals one if the observation is within the time period from July 2007 to December 2008. *Theta (θ_0)* is obtained from a maximum likelihood estimation of the MA(2) model of observed returns as proposed by Getmansky et al. (2004). *Lockup* is a dummy variable which equals one if the respective fund has a lockup provision. *ln(Notice days)* denotes the natural logarithm of the number of redemption notice days. *ln(Redemption days)* is the natural logarithm of the number of redemption frequency days. All regressions include the full set of nine control variables as summarized in Appendix B (not reported for space reasons). Funds are required to have at least 24 observations (months) to be included in the analysis. The *t*-values (in parentheses) are based on the cluster-robust variant of the Huber-White (Huber, 1967; White, 1982) sandwich estimator which accounts for the dependence of observations within clusters (different month-observations for one specific fund). ***, **, * denotes statistical significance at the 1%, 5%, 10% level.

	Dependent Variables									
	Alpha					*Returns*				
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	-1.487**	-1.504**	-1.834**	-1.597**	-1.787**	0.062	0.045	-0.234	-0.038	-0.200
	(-2.252)	(-2.257)	(-2.465)	(-2.408)	(-2.554)	(0.298)	(0.216)	(-1.135)	(-0.186)	(-0.982)
Crisis	-0.279***	-0.169	0.330**	0.157	0.331*	-3.996***	-3.852***	-3.001***	-3.553***	-3.180***
	(-2.884)	(-1.382)	(2.139)	(0.985)	(1.813)	(-19.029)	(-17.858)	(-8.958)	(-9.638)	(-7.858)
Theta (θ_0)	0.008	0.006	0.056	0.018	0.045	-0.267***	-0.264***	-0.225***	-0.259***	-0.227***
	(0.086)	(0.068)	(0.553)	(0.185)	(0.471)	(-3.950)	(-3.992)	(-3.307)	(-3.819)	(-3.383)
*Crisis*Theta (θ_0)*	0.276*	0.256	0.159	0.234	0.160	2.755***	2.720***	2.586***	2.713***	2.595***
	(1.707)	(1.546)	(0.984)	(1.477)	(1.020)	(11.966)	(11.921)	(11.303)	(11.622)	(11.258)
Lockup		0.318*			0.266		0.167***			0.104***
		(1.771)			(1.502)		(4.520)			(2.683)
*Crisis*Lockup*		-0.333**			-0.238		-0.353***			-0.230
		(-2.398)			(-1.554)		(-2.793)			(-1.627)
ln(Notice days)			0.141***		0.122***			0.120***		0.110***
			(3.011)		(3.074)			(5.558)		(4.776)
*Crisis*ln(Notice days)*			-0.159***		-0.126***			-0.258***		-0.253***
			(-4.930)		(-3.311)			(-4.099)		(-3.456)
ln(Redemption days)				0.055**	-0.027				0.061***	0.000
				(2.028)	(-0.705)				(2.790)	(0.015)
*Crisis*ln(Redemption days)*				-0.101***	-0.011				-0.103	0.059
				(-3.285)	(-0.308)				(-1.642)	(0.806)
# Observations	90,266	90,266	90,266	90,266	90,266	142,584	142,584	142,584	142,584	142,584
# Funds	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390	2,390
Adjusted R^2	0.023	0.028	0.026	0.024	0.030	0.027	0.028	0.028	0.028	0.028

Table 9: Panel regressions of relative fund flows on different measures of fund liquidity

The table reports the results from pooled OLS regressions with strategy fixed effects. The dependent variable is relative fund flows measured by monthly fund flows relative to the fund's assets under management. *Crisis* is a dummy variable which equals one if the observation is within the time period from July 2007 to December 2008. *Alpha* and *Lagged alpha* are 24-month rolling window alphas based on the Fung and Hsieh (2004) seven-factor model. *Lockup* is a dummy variable which equals one if the respective fund has a lockup provision. *ln(Notice days)* denotes the natural logarithm of the number of redemption notice days. *ln(Redemption days)* is the natural logarithm of the number of redemption frequency days. All regressions include the full set of eight control variables (excl. relative funds flows) as summarized in Appendix B (not reported for space reasons). Funds are required to have at least 24 observations (months) to be included in the analysis. The *t*-values (in parentheses) are based on the cluster-robust variant of the Huber-White (Huber, 1967; White, 1982) sandwich estimator which accounts for the dependence of observations within clusters (different month-observations for one specific fund). ***, **, * denotes statistical significance at the 1%, 5%, 10% level.

	Dependent Variable				
	Relative fund flows				
Independent Variables	(1)	(2)	(3)	(4)	(5)
Constant	-0.027***	-0.027***	-0.032***	-0.026***	-0.029***
	(-4.597)	(-4.621)	(-5.220)	(-4.342)	(-4.715)
Crisis	-0.008***	-0.008***	-0.008*	-0.021***	-0.019***
	(-7.535)	(-5.926)	(-1.838)	(-3.845)	(-3.085)
Alpha	-0.002	-0.002	-0.002	-0.002	-0.002
	(-1.631)	(-1.632)	(-1.636)	(-1.630)	(-1.637)
Lagged alpha	0.004	0.004	0.004	0.004	0.004
	(1.477)	(1.472)	(1.472)	(1.475)	(1.471)
Lockup		0.002			0.001
		(1.613)			(0.690)
*Crisis*Lockup*		0.000			-0.002
		(0.084)			(-0.700)
ln(Notice days)			0.002***		0.002***
			(3.380)		(3.144)
*Crisis*ln(Notice days)*			-0.000		-0.002*
			(-0.206)		(-1.689)
ln(Redemption days)				0.002*	0.001
				(1.945)	(0.752)
*Crisis*ln(Redemption days)*				0.003**	0.004***
				(2.548)	(3.387)
# Observations	88,274	88,274	88,274	88,274	88,274
# Funds	2,428	2,428	2,428	2,428	2,428
Adjusted R^2	0.012	0.012	0.012	0.012	0.013

Appendix A: Factors considered in the stepwise model

- *Equity indices*: excess returns of the following indices: MSCI World EX USA Index total return (USD), MSCI Emerging Markets Index total return (USD), MSCI Emerging Markets Latam Index total return (USD), MSCI Emerging Markets ASIA Index total return (USD), Russel 3000 Index total return
- *Bond indices/credit risk/interest rates*: excess returns, yields, and first differences of the following indices: Citi World Government Bond Index excess return, CS High Yield Index II excess return, monthly first difference of the Moody's Baa Corporate Bond Index 30-year 100m minus the 30-year generic US government bond yield, 3m Treasury-Eurodollar spread (TED spread)
- *Currency index*: excess return of the US Dollar Index return
- *Options/volatility/dynamic trading strategies*: excess returns of the following indices/portfolios: S&P 500 Volatility Index, SMB (Fama and French, 1993), HML (Fama and French, 1993), MOM (Carhart, 1997) [15], Black Scholes S&P 500 ATM/OTM call and put options based on historical implied volatilities and historical realized dividend yields and interest rates of the following moneyness: ATM call, 107.5% call, 92.5% put, ATM put, lookback straddles on equities, bonds, currencies, and commodities[16]
- *Commodities*: excess returns of the S&P Goldman Sachs Commodity Index (SP GCSI) total return
- *Real estate*: excess returns of the S&P/Citigroup World REIT Index total return
- *Convertible bonds*: excess returns for the Merrill Lynch Convertible Bond Index (investment grade)

[15] Kenneth French generously provides the data on the SMB, HML, and MOM factors on his website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

[16] David Hsieh generously provides the data on the trend-following factors on his website: http://faculty.fuqua.duke.edu/~dah7/HFRFData.htm.

Appendix B: Control variables

Variable	Description
ln(AuM)	The natural logarithm of the fund's assets under management (AuM) in million USD.
Incentive fee	The fund's incentive fee in percent.
Management fee	The fund's management fee in percent.
Leverage	Dummy variable which equals one if the fund uses debt to finance its investments.
Personal capital	Dummy variable which equals one if the fund manager is a shareholder of the fund.
Closed to investment	Dummy variable which equals one if the fund is closed to new investments.
ln(Subscription days)	The natural logarithm of the fund's subscription period in trading days.
Relative fund flows	The fund's monthly fund flows relative to its assets under management in percent (winsorized at the 99% level): $\frac{AuM_{i,t}-AuM_{i,t-1}(1+R_{i,t})}{AuM_{i,t-1}} \cdot 100$
ln(Fund age)	The fund's age in months.