Systemic Risk and Cross-Sectional Hedge Fund Returns

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Abstract

This paper examines a cross-sectional relation between the systemic risk contribution of hedge fund and hedge fund returns. Measuring the systemic risk of an individual hedge fund by using the marginal expected shortfall (MES) proposed by Acharya et al. (2010), we find evidence for a positive and statistically significant relation between systemic risk and hedge fund returns. Hedge fund portfolios with a high systemic risk contribution outperform those with a low systemic risk contribution by 1.38% per month (or 16.61% per year). The relation between systemic risk and hedge fund returns holds not only for live funds but also for defunct funds. Moreover, the relation holds even after controlling for fund characteristics related to fund risk such as age, asset size, and liquidity. The strength of the relation is complicated by these fund characteristics. In particular, the relation is the strongest for young and small funds. Finally, the systemic risk contribution of a hedge fund as measured by MES is one of the most important factors in explaining the cross-sectional variation in hedge fund returns.

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1. Introduction

The hedge fund industry has been one of the most rapidly growing areas of the financial sector over the last decade. Its rapid growth results from its important benefits to financial markets and investors in the form of improved investment opportunity, price discovery, liquidity, risk sharing, and portfolio diversification. For example, hedge funds have provided funds to build infrastructures in emerging countries over the past years. In spite of these benefits, the role of hedge funds in the financial system has been controversial, because hedge funds can be a source of systemic risk [1] to the financial system, potentially exacerbating market failures. These concerns have especially deepened since the market collapse triggered by long-term capital management in 1998 and the recent U.S. subprime crisis.

The relation between hedge fund and systemic risk can be described conceptually as the linkage from hedge funds to real economic activity. To be more exact, hedge funds can pose systemic risk by obstructing the ability of financial intermediaries or the financial market to efficiently provide credit through several different mechanisms or channels (see Chan et al., 2006; McCarthy, 2006; Hildebrand, 2007; Kambhu et al., 2007) The first channel is the direct risk exposure of financial institutions to hedge funds. Financial intermediaries are directly connected to hedge funds through their counterparty credit risk exposures, as in prime brokerage activity, short-run financing for leveraged positions, and trading counterparty exposures in over-the-counter and other markets. If a bank has a large exposure to a hedge fund that fails or suffers losses on its investments, the increased risk exposure or

[1] Although financial stability and systemic risk have become major policy concerns around the world due to the rapid growth in global capital markets and the recent financial crises, systemic risk is not well defined and remains a little vague. Systemic risk usually refers to the risk or probability of collapse of an entire financial system or entire market, as opposed to the risk associated with any individual entity, group, or component of a system (see Kaufman, 2000).

eroded bank capital may reduce its ability or willingness to provide credit to worthy borrowers.

The second channel is disruptions to the efficient functioning of capital markets that impede credit provision. This disruption fundamentally reflects a reduced ability or willingness to bear risk through credit provision due to the loss of investor confidence. The third channel is indirect effects of the feedback of the bank problem in broader financial markets. Because financial intermediaries provide a significant source of liquidity to the hedge fund industry, a shock induced by hedge funds to financial intermediaries can trigger a chain reaction by reducing the liquidity provision of these banks to other hedge funds or to other banks, thus leading to financial market disruption.

Despite the economic and regulatory significance of its implications, very few studies focus on the relation between hedge fund and systemic risk. This paper attempts to expand the literature by examining a cross-sectional relation between hedge fund returns and systemic risk. The primary questions addressed are the following: How is systemic risk related to hedge fund returns? How can we measure the systemic risk of a hedge fund? What is a cross-sectional relation between hedge fund returns and systemic risk? Can the systemic risk contribution of hedge funds explain the cross-sectional variation in hedge fund returns? Do defunct and live funds have different relations between hedge fund returns and systemic risk? Is the relation between hedge fund returns and systemic risk affected by fund characteristics related to fund risk such as age, asset size, and liquidity?

The most common trouble in hedge fund research is a short history of hedge fund returns, less than 20 years on a monthly basis at the longest. Furthermore, systemic events themselves are rare, making it even more difficult to measure systemic risk in the context of hedge funds. This paper employs the marginal expected shortfall (MES) proposed by Acharya et al. (2010) to measure the systemic risk of individual hedge funds. Although several other measures of systemic risk exist,[2] we focus on each individual hedge fund's contribution to systemic risk and are further interested in the regulatory implications of ways to limit systemic risk through taxes or regulation. Additionally, this measure is particularly proper to apply to individual hedge fund data.

To examine whether the systemic risk contribution of hedge funds plays a role in explaining the cross-sectional variation in hedge fund returns, we measure the systemic risk of a hedge fund and carry out analyses adopted from asset pricing framework, not only at the portfolio level (portfolio-based analysis) but also at the individual level (regression-based analysis).

Our paper's major findings can be summarized as follows. First, we find evidence for a positive and statistically significant relation between the systemic risk contribution of hedge funds measured by MES and hedge fund returns. Funds with a high systemic risk contribution outperform those with a low systemic risk contribution by 1.38% per month (or 16.61% per year). Second, the relation between systemic risk and hedge fund returns holds not only for live funds but also for defunct funds. Third, the relation between systemic risk and hedge fund returns holds even after controlling for fund characteristics related to fund risk such as age, asset size, and liquidity. Finally, the systemic risk contribution of hedge funds measured by MES is one of the most important factors in explaining the cross-sectional variation in hedge fund returns.

This paper basically relates to the recent literature on the risk profile of hedge funds, which has been largely focused on explaining a cross-sectional relation between expected

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[2] Several recent papers focus on measuring systemic risk. Using quantile regressions, Adrian and Brunnermeier (2009) introduce the value at risk (VaR) of the financial sector conditional on a bank being in distress, which the authors denote CoVaR. Gray and Jobst (2010) propose a measure of systemic risk based on contingent claims analysis, and Kritzman et al. (2010) propose an absorption ratio based on principal component analysis. Brownlees and Engle (2010) propose a multi-step modeling approach based on the DCC-GARCH model and nonparametric tail expectation estimators to estimate the measure of systemic risk, and Acharya et al. (2010) proposes the MES.

return, specific risk, and other explanatory hedge fund variables. Fung and Hsieh (2002, 2004) and Chan et al. (2006) show that hedge fund returns are nonlinearly related to equity market risk, credit risk, interest rate risk, exchange rate risk, and option-based factors. Bali et al. (2007) test the presence and significance of a relation between financial risk measured by value at risk (VaR) and expected returns on hedge funds. Buraschi et al. (2009) examine the relation between correlation risk and a cross section of hedge fund returns. Sadka (2010) shows that liquidity risk as measured by the covariation of fund returns with unexpected changes in aggregate liquidity explains cross-sectional variations in hedge fund returns. Brunnermeier and Petersen (2009), King and Maier (2009), and Klaus and Rzepkowski (2009) study the role of funding risk related to the interconnectedness of brokers and hedge funds. Compared with these previous works, we focus on the systemic risk of hedge funds as an important determinant in the cross section of hedge fund returns.

Moreover, this paper relates to the literature on the systemic risk of hedge funds and hedge fund contagion. Chan et al. (2006) develop a number of systemic risk measures for hedge funds based on illiquidity exposure and time-varying hedge fund correlations. Billio et al. (2010) propose several econometric measures of systemic risk to capture the interconnectedness between the finance and insurance sectors, including the hedge fund industry, based on principal components analysis and Granger causality tests. Boyson et al. (2010) analyze co-movement among hedge fund style indices by using quantile regression and logit models and find strong evidence of contagion across hedge fund styles. Whereas these studies largely use aggregate or index hedge fund data to examine whether the entire hedge fund industry or each hedge fund style is related to systemic risk, we focus on individual hedge fund data to use fund-specific information. Lastly, Joenväärä (2009) measures the systemic risk of an individual hedge fund by using the co-expected shortfall (CoES) approach proposed by Adrian and Brunnermeier (2009). Whereas Joenväärä (2009) examines the relation between hedge fund characteristics and the systemic risk of a hedge fund, we concentrate on the relation between hedge fund returns and the systemic risk contribution of hedge funds measured by the MES proposed by Acharya et al. (2010).

This paper makes several important contributions to the recent literature on measuring the systemic risk of individual hedge funds: It is the first to measure the systemic risk contribution of a hedge fund by using the MES proposed by Acharya et al. (2010), and it provides an example of how MES can be applied in the context of hedge funds. The paper also contributes to the literature on the risk profiles of hedge funds, none of which has considered the relation between systemic risk and individual hedge fund returns. To the best of our knowledge, this paper is the first to consider the cross-sectional relation between the systemic risk contribution of hedge funds and hedge fund returns in an asset pricing framework.

The rest of the paper is organized as follows. Section 2 describes the data set employed and descriptive statistics. Section 3 introduces the methodology, emphasizing the measure of systemic risk and cross-sectional approach based on an asset pricing framework. Section 4 presents our empirical results, and Section 5 presents our conclusions.

2. Data

The primary hedge fund database employed in this paper is that of the Tremont Advisory Shareholders Services (TASS),[3] the most commonly utilized database by academics and practitioners in the hedge fund industry.[4] In addition, we use returns on the value-weighted portfolio of the financial sector as the market return or, more exactly, the return on the

[3] For further information about this database, see http://www.lipperweb.com/products/LipperTASS.aspx.
[4] The TASS database is used by Fung and Hsieh (1997, 2000), Liang (2000), Brown et al. (2001), Lo (2001), Brown and Goetzmann (2003), Agarwal and Naik (2004), Getmansky et al. (2004a, 2004b), Chan et al. (2006), Bali et al. (2007), Kosowski et al. (2007), Agarwal et al. (2009), Kang et al. (2009), Aggarwal and Jorion (2010), among others.

financial system.[5] The TASS database includes 14,317 individual hedge funds over the period February 1977 to December 2009, of which 5,985 are live and 8,332 defunct.[6] These data cover almost half of the estimated total number of existing hedge funds. The majority of funds in the TASS database report returns net of management fees, incentive fees, and other fund expenses on a monthly basis. Moreover, the TASS database provides other fund-specific information, such as investment strategy,[7] assets under management (AUM), fee structure, minimum investment, leverage, subscription, redemption, and lockup information.

This paper applies several restrictions to filter the primary hedge fund database. First, we select the sample period from January 1994 to December 2009 to alleviate any survivorship bias, since the TASS database started tracking defunct funds in 1994 and therefore does not contain information on defunct funds prior to 1994. Second, we select hedge funds that report their returns in U.S. dollars, net of fee, and on a monthly basis. In other words, we eliminate funds that report returns denominated in currencies other than U.S. dollars or gross of fee, as well as funds that report returns on a weekly, quarterly, or annual basis. Third, we concentrate on the following strategies: convertible arbitrage, dedicated short bias, emerging markets, equity market neutral, event driven, fixed income arbitrage, global macro, long/short equity hedge, multi-strategy, and options strategy. As of December 2009, these strategies covered 54.5% of all hedge funds contained in the TASS database. Similar to Bali et al. (2007), we eliminate funds of funds and managed futures because we want to focus on individual hedge funds rather than funds of funds and CTAs. Fourth, we require that each fund have at least a 24-month return history for estimating a reliable measure of systemic risk.

These data are from Kenneth R. French's website

[6] The TASS database consists of two parts: "live" funds and "graveyard" (or defunct) funds. The live funds indicate actively reporting hedge funds as of the most recent database update, December 2009 in our case. By contrast, graveyard funds indicate hedge funds that have stopped reporting to TASS database due to liquidation, merger, and so forth.

[7] The TASS database classifies funds into 14 categories across different investment strategies: convertible arbitrage, dedicated short bias, emerging markets, equity market neutral, event driven, fixed income arbitrage, fund of funds, global macro, long/short equity hedge, managed futures, multi-strategy, options strategy, other hedge funds, and undefined hedge funds.

Finally, we exclude funds that did not report AUM or that reported only partial AUM. Funds with AUM less than $10 million are also excluded,[8] thus reducing any bias that might be caused by small funds.

[Insert Table 1 about here]

After applying all these restrictions, the remaining sample includes 1,406 funds, of which 645 are live and 761 defunct. Table 1 presents descriptive statistics for the monthly hedge fund returns in our sample, providing for each hedge fund group the number of observations, the average value of the sample mean, standard deviation, skewness, excess kurtosis, and the results of normality tests. The results of the normality tests show the percentage of funds for which the null hypothesis of normally distributed returns is rejected by the Jarque–Bera test. Table 1 reports that the average mean of hedge fund returns is positive and 0.86% per month (10.29% per annum) across all funds. The average standard deviation of hedge fund returns is 4.22% per month (14.61% per annum). The average mean and standard deviation of live funds are, respectively, 0.20% per month (2.43% per annum) and 0.57% per month (1.99% per annum) higher than for defunct funds. This result may be caused by the fact that successful funds, as well as failed funds, are also more likely to stop reporting to TASS because they do not have to advertise their performance. Not surprisingly, hedge fund returns have negative average skewness and positive average excess kurtosis, consistent with previous studies (see Fung and Hsieh, 1999; Brooks and Kat, 2002; Agarwal and Naik, 2004; Bali et al. 2007; Gupta and Liang, 2005) showing that hedge fund returns are not normally distributed. In addition, the Jarque–Bera test rejects normality for 73% of hedge funds, on average. This suggests that the VaR or expected shortfall (ES) is more suitable to

[8] Some indexes (e.g., Dow Jones Credit Suisse Hedge Fund Index) also require a minimum AUM of $10 million.

measure hedge fund risk than the standard deviation, because while the standard deviation focuses only on average variations from the mean, the VaR and ES take into account extreme outcomes. This paper uses the concept of ES rather than VaR, since ES is more sensitive to the shape of the loss distribution in the tails.

3. Methodology

3.1. Measure of systemic risk

This section introduces the measure of systemic risk employed in this paper, the MES of Acharya et al. (2010). These authors present a simple model of systemic risk based on externalities that spill over to the rest of the economy due to undercapitalization of the financial system. They propose a systemic expected shortfall (SES), which is a financial institution's propensity to be undercapitalized when the system as a whole is undercapitalized, as a measure of each financial institution's contribution to systemic risk. According to their model, the SES increases with the institution's leverage and its MES, which is an expected loss in the tail of the system's loss distribution. However, leverage is hard to use in the context of hedge funds to measure systemic risk, because there are almost no time series data related to information on hedge fund leverage. For that reason, we use only MES to measure a hedge fund's contribution to systemic risk.

Here MES is defined as the marginal contribution of an individual entity to the system's risk. Let I denote the set of individual entities in the system. The return of the entire system can be calculated by the value-weighted average return of all individual entities, which denotes the market return:

$$r_m = \sum_{i \in I} w_i r_i, \tag{1}$$

where r_i and w_i are the return and weight in the entire system of entity i, respectively. The risk of the entire system can be measured by VaR and ES. The VaR is the potential maximum loss for a given confidence level 1 - α:

$$\Pr(r_m < VaR_\alpha) = \alpha. \tag{2}$$

The ES is the expected loss conditional on the loss being greater than the VaR:

$$ES_\alpha = E[r_m | r_m \leq VaR_\alpha] = \sum_{i \in I} w_i E[r_i | r_m \leq VaR_\alpha]. \tag{3}$$

From this equation, we can derive entity i's MES, which is the marginal contribution of entity i to the overall risk, as the partial derivative of the system's ES with respect to the weight of entity i in the system:

$$MES_i^\alpha \equiv \frac{\partial ES_\alpha}{\partial w_i} = E[r_i | r_m \leq VaR_\alpha]. \tag{4}$$

This paper uses a 95% confidence level, that is, $\alpha \approx 5\%$. Here MES measures how entity i's risk taking adds to the system's overall risk. In brief, MES can be measured by estimating entity i's losses when the system as a whole is doing poorly (see Acharya et al., 2010; Brownlees and Engle, 2010).

3.2. Portfolio-based analysis

To investigate the cross-sectional relation between hedge fund returns and systemic risk, we use portfolios of individual hedge funds. The portfolio formation process is adopted from Fama and French (1992), except for the sorting criteria and the frequency of portfolio updates.

We form 10 decile portfolios of hedge funds every month based on their MES rank. Funds are kept in the portfolios for one month, that is, we update the portfolios on a monthly basis. We use equal-weighted portfolios with an equal number of funds in each portfolio and calculate the MES of each fund using non-missing return observations over the past 60 months. In any given month, we include only funds with at least 24 months of return observations over the estimation period, that is, the prior 60 months. These 60 months provide sufficient observations to estimate reliable MESs without losing too many observations in the beginning of the sample.[9] For this reason, we have 132 monthly observations (from January 1999 to December 2009) for the 10 equal-weighted portfolios formed based on their MES. We generate these portfolios for both live and defunct funds and then calculate their next month's returns.

Since portfolios 1 and 10 have the lowest and highest average value of MES, respectively, we examine the presence and significance of a cross-sectional relation between hedge fund returns and systemic risk using the difference of one-month-ahead returns between these two portfolios.

We repeat the above procedure by using fund characteristics related to fund risk, such as age, asset size, and liquidity instead of MES as the criteria for portfolio formation. We construct three age (or asset) portfolios and two liquidity portfolios, where age is measured in months. The asset size is measured by the natural logarithm of AUM. A lockup dummy is used to measure liquidity risk. If a hedge fund has a lockup provision, hedge fund investors cannot withdraw their money immediately and fund managers can mitigate liquidity problems stemming from investing in illiquid securities. If a fund has a non-zero lockup period, the dummy variable is set to one, and zero otherwise.[10]

To examine whether the cross-sectional relation between hedge fund returns and systemic risk is still statistically and economically significant after controlling for age, asset size, and liquidity effects, we conduct analyses based on bivariate as well as univariate

[9] The empirical results are robust to the length of the estimation period. For instance, we used 36 and 90 months instead of 60 months as the length of the estimation period and the main empirical results were similar and qualitatively unchanged. The results are available upon request.

[10] We use a dummy variable instead of a continuous variable because the lockup period does not have enough variation. According to TASS, the lockup period can be up to 7.5 years but mostly clusters around one year.

sorting. To put it concretely, we make groups first based on age (asset size or liquidity) and then form portfolios based on MES within each group. For example, in the case of separating the age effect from MES, we first sort hedge funds based on their ages and then categorize them into low, medium, and high age groups, with an equal number of funds in each group. Finally, within each age group, we re-sort the hedge funds based on their MESs and form 10 equal-weighted portfolios with an equal number of funds in each portfolio. This process is repeated every month from January 1999 to December 2009. Similar to the analysis based on univariate sorting, we have 132 monthly observations for the 10 equal-weighted portfolios formed based on their MESs within each age (asset size or liquidity) subgroup.

Since portfolios 1 and 10 formed based on bivariate sorting have the lowest and highest MESs, respectively, we examine the cross-sectional relation between hedge fund returns and systemic risk after controlling for age, asset size, and liquidity effects using the difference of one-month-ahead returns between these two portfolios.

3.3. Regression-based analysis

Although portfolio-based analysis makes it easy to mimic the risk factor in returns related to MES, this approach does not take into account fund-specific information. To consider the importance of risk factors in one model and fund-specific information, we utilize Fama and MacBeth (1973)'s cross-sectional regression framework and run monthly cross-sectional regressions for the following econometric specifications:

$$R_{i,t+1} = \alpha_t + \beta_{1,t} MES_{i,t} + I_{\{2\in M\}}\beta_{2,t} Age_{i,t} + I_{\{3\in M\}}\beta_{3,t} Asset_{i,t} + I_{\{4\in M\}}\beta_{4,t} LockupD_{i,t} + \varepsilon_{i,t+1}, \quad (5)$$

where $R_{i,t+1}$ is the realized return on fund i in month t + 1; $MES_{i,t}$ is the MES for fund i in month t; $Age_{i,t}$ is the age of fund i in month t; $Asset_{i,t}$ is the natural logarithm of the AUM of fund i in month t; $LockupD_{i,t}$ [11] is the dummy variable for the existing lockup period of fund i in month t; $I_{\{x \in X\}}$ is an indicator function whose value equals one if x is an element of X, and zero otherwise; and M is a set of independent variables in each regression model. Since we repeat running the above monthly cross-sectional regressions from January 1999 to December 2009, we have 132 time series of regression coefficients. We then calculate the average values of these coefficients and test their statistical significance using standard t-statistics.

4. Empirical results

4.1. Portfolio-based analysis (univariate sorting)

4.1.1. MES and cross-sectional hedge fund returns

[Insert Table 2 about here]

Table 2 reports the cross-sectional relation between MES and expected returns. To examine whether the cross-sectional relation between MES and expected returns of defunct funds is different from that of live funds, we form portfolios that use all funds, as well as live and defunct funds separately. The first panel presents the average returns of the MES for each decile portfolio for all, live, and defunct funds. Then we calculate the MES of each hedge fund, not performing any sign conversion. Thus a significantly negative MES value suggests that a specific group of funds poses a significant systemic risk or has a high systemic risk.

[11] If a fund has a non-zero lockup period, we set the dummy variable equal to one; otherwise, the dummy variable equals zero.

The second panel presents the average return differential between deciles 1 (low-MES portfolio) and 10 (high-MES portfolio) and the standard t-statistics for the average return differential.

The expected returns across different MES portfolios in Table 2 indicate that there is a positive relation between systemic risk measured by MES and hedge fund return. From deciles 1 to 10, the expected returns decrease almost monotonically. The highest portfolio return (1.63% per month) and the lowest (0.25% per month) correspond to the lowest-MES portfolio (-11.84% per month) and the highest (8.89% per month), respectively. Moreover, the second panel in Table 2 shows that average return differential between deciles 1 and 10 is positive and statistically significant. The average return difference between portfolios 1 and 10 is 1.38% per month (or 16.61% per year) and significant at the 1% level. This result means that if one invests in the lowest-MES portfolio while short-selling the highest-MES portfolio, one will achieve an annual profit of 16.61%.

According to Bali et al. (2007), the risk profile of defunct funds may be different from that of live funds because of the nature of voluntary closure. Although Liang (2000) and Getmansky et al. (2004b) indicate that the main reason for a fund to transfer from the live database to the graveyard database is poor performance, funds can be assigned to the graveyard for other reasons, such as mergers and acquisitions, voluntary withdrawals, and name changes.[12] For example, successful funds, as well as failed funds, are also more likely to withdraw from the TASS database because they no longer need investors and want to keep away from the public. Furthermore, the proportion of defunct funds in hedge funds is relatively larger than in mutual funds. Hence, when all funds are considered simultaneously, the actual underlying relation may seem to be hidden and unclear. For these reasons, we

[12] The TASS database provides one of eight distinct reasons for a fund being assigned to the graveyard: fund liquidated, fund no longer reporting, unable to contact fund, fund closed to new investment, fund has merged into another entity, program closed, fund dormant, and unknown.

investigate the cross-sectional relation between MES and hedge fund returns using live and defunct funds separately.

Table 2 shows that, regardless of whether a fund is live or defunct, the cross-sectional relation between systemic risk measured by MES and the expected returns on hedge funds is positive and statistically significant. In the case of live funds, the average return difference between portfolios 1 and 10 is 1.22% per month (or 14.69% per year) and significant at the 1% level. The relation for defunct funds is even a little stronger than that for live funds. Defunct funds have a slightly wider MES distribution (from -12.22% to 9.42% per month) across the 10 portfolios than live funds (from -11.04% to 8.65% per month), and the average return difference between the two extreme portfolios of defunct funds is also slightly higher (1.42% per month, or 17.10% per year) than that of live funds. The difference is significant at the 1% level.

In summary, the results in Table 2 provide evidence for a positive and statistically significant relation between the systemic risk contribution of hedge funds measured by MES and hedge fund returns. Furthermore, this relation holds even after taking into account differences in fund characteristics between live and defunct funds.

4.1.2. Fund characteristics related to fund risk (age, asset size, and liquidity) and cross-sectional hedge fund returns

Previous literature on the risk profile of hedge fund shows that fund characteristics such as age, size, and lockup provision are related to the cross section of hedge fund returns (see Liang, 1999; Bali et al., 2007). In other words, not only systemic risk measured by MES but also these fund characteristics can explain the cross-sectional variation in hedge fund returns.

[Insert Table 3 about here]

Table 3 reports the cross-sectional relation between age and expected returns. For all funds, returns seem to decrease with age, but the relation is not strong. While the average return differential between low-age and high-age portfolios has a positive value (0.13% per month), it is not statistically significant. This weak relation results from the weak relation between age and expected returns for defunct funds.

In the live fund group, portfolio returns generally decrease with age. In other words, younger funds outperform older funds, on average. The average return difference between the two extreme portfolios is 0.30% per month (or 3.61% per year), significant at the 5% level. This result is consistent with previous studies, where younger funds can be attractive because they are more eager to achieve good performance to attract new investors, whereas older funds that have survived already have track records for attracting and keeping investments (see Aggarwal and Jorion, 2010).[13] However, the age effect is much weaker for defunct funds: The average return difference between the two extreme portfolios is only 0.03% per month, which is not statistically significant. This result comes from our restriction on the primary hedge fund database, where each fund must have at least a 24-month return history. While the average age of defunct funds in the primary database is much lower than that of live funds, Table 3 reports that this difference lessens considerably after applying the above requirement. Hence, defunct funds can weaken their relation between age and expected returns through the data filtering process.[14]

[Insert Table 4 about here]

[13] The following are possible reasons why younger funds are attractive in the hedge fund industry: incentive effects (Agarwal et al., 2009), size effects (Goetzmann et al., 2003; Getmansky, 2004), newer ideas for trades, and career concerns of portfolio managers (Boyson, 2008).

[14] In fact, without restriction about number of non-missing return observations, we find that there is a statistically significant relation between age and expected returns for defunct funds.

Table 4 reports the cross-sectional relation between asset size and expected returns. Portfolio returns generally decease with portfolio rank across the 10 portfolios, from low to high asset size portfolios, in an almost monotonic relation. Specifically, while the smallest fund portfolio makes a profit of 1.25% per month, the largest one makes a profit of 0.67% per month. The average return difference between these two portfolios is 0.57% per month (or 6.85% per year), significant at the 1% level. The size effect is much stronger for live funds than for defunct funds. In the live fund group, the smallest fund portfolio (with a return of 1.43%) outperforms the largest one (with a return of 0.79%) by 0.64% per month (or 7.64% per year), which is significant at the 1% level. On the contrary, in the defunct fund group, the average return difference between the two extreme portfolios is 0.36% per month (or 4.26% per year) and significant at the 15% level. This result is consistent with previous literature, where hedge funds may provide decreasing returns to scale due to limited market opportunities and the high market impact of trades (see Goetzmann et al., 2003; Agarwal et al., 2004, Berk and Green, 2004; Getmansky, 2004). This literature reports that large hedge funds are closed to new investors because fund managers do not want their funds to become too large to manage. Since market opportunities are limited and the market impact of trades is high in the hedge fund industry, the asset size of a fund should be small enough for fund managers to fully invest fund assets into their favorable securities and move quickly between different market sectors when needed. Furthermore, these studies indicate that there is an optimal fund size, because fund managers with large assets may choose to close the funds to new investors before facing a decrease in returns and an increase in liquidation probabilities.

[Insert Table 5 about here]

Lastly, Table 5 reports the cross-sectional relation between a lockup provision and expected returns. Consistent with Liang (1999) and Aragon (2007), liquidity risk measured by the lockup dummy variable has a very important role in explaining the cross-sectional variation in hedge fund returns. Funds with a lockup provision outperform those without one by 0.21% per month (or 2.46% per year), significant at the 1% level. Moreover, the relation between a lockup provision and expected returns is positive and statistically significant for both live and defunct funds. As mentioned in Section 3.2, this result comes from the fact that fund managers with lockup provisions have the flexibility to invest in illiquid securities.

4.2. Portfolio-based analysis (bivariate sorting)

The results in Section 4.1.1 show that hedge fund returns are related to fund characteristics such as age, asset size, and lockup provisions. Hence, to examine the actual underlying relation between systemic risk and hedge fund returns, we must control for age, asset size, and lockup provisions. In other words, the relation between systemic risk and hedge fund returns can be affected by these fund characteristics. To separate the age (asset size or liquidity) effect from MES, we form portfolios using bivariate sorting: We first make fund groups based on individual fund age (asset size or lockup provision) and then form 10 portfolios based on funds' MESs within each age (asset size or lockup provision) group. After constructing portfolios through the above process, we confirm whether the relation between systemic risk contribution and expected returns still holds within each age (asset size or lockup provision) group.

[Insert Table 6 about here]

Table 6 reports the cross-sectional relation between MES and expected returns, controlling for age effect. We first construct three age groups with equal amounts of funds in each group; we then form 10 portfolios within each age group based on their MESs. The results for all funds in Panel A of Table 6 indicate that the relation between systemic risk measured by MES and expected return is positive and statistically significant across all three age groups. In particular, the relation is the strongest in the low-age group, where the average return difference between the two extreme portfolios is 1.89% per month (or 22.63% per year) and significant at the 1% level. The relation in the medium- and high-age groups is a little weaker, but still statistically significant. Furthermore, the relation for all funds is similar to that for both live and defunct funds. The positive relation between systemic risk measured by MES and expected return holds across all three age groups and is statistically significant except for the high-age group.

[Insert Table 7 about here]

Table 7 reports the cross-sectional relation between MES and expected returns, controlling for asset size. We first construct three asset size groups with equal amounts of funds in each group; we then form 10 portfolios within each age group based on their MESs. Similar to the results in Table 6, the results for all funds in Panel A of Table 7 indicate that the relation between systemic risk measured by MES and expected return is positive and statistically significant across all three asset size groups. In particular, this relation is strongest in the low-asset group, where the low-MES portfolio (with a return of 1.83%) outperforms the high-MES portfolio (with a return of 0.15%) by 1.67% per month (or 20.08% per year), which is significant at the 1% level. The relation in the medium- and high-asset groups is a little weaker, but still statistically significant at the 1% level. Furthermore, the relation for all funds is similar to that for both live and defunct funds. The positive relation between systemic risk measured by MES and expected return holds across all three age groups and is the strongest in the low-asset group.

[Insert Table 8 about here]

Table 8 reports the cross-sectional relation between MES and expected returns, controlling for liquidity. We first construct two liquidity groups based on the lockup dummy; we then form 10 portfolios within each age group based on their MESs. The results for all funds in Panel A of Table 8 indicate that the relation between systemic risk measured by MES and expected return is positive and statistically significant across both liquidity groups. The average return difference between the two extreme portfolios for funds with and without a lockup provision is 1.20% per month (or 14.34% per year) and 1.25% per month (or 14.96% per year), respectively, both statistically significant at the 1% level. Moreover, regardless of whether a fund is live or defunct, the relation between systemic risk measured by MES and expected return is positive and statistically significant across both liquidity groups.

In summary, these results show that, regardless of whether a fund is live or defunct, the relation between the systemic risk contribution of a hedge fund measured by MES and hedge fund returns is positive and statistically significant even after controlling for age, asset size, and lockup provision effects. However, the strength of the relation is complicated by fund characteristics related to fund risk. In particular, the relation is the strongest for young and small funds.

4.3. Regression-based analysis

Since Section 4.1 investigates the relation between the systemic risk contribution of a hedge fund measured by MES and hedge fund returns at the portfolio level, we lose fund-specific information. To consider different risk factors in one model and include fund-specific information, we run the cross-sectional one-month-ahead predictive regressions to examine the predictive power of MES at the individual fund level.

[Insert Table 9 about here]

Table 9 reports the results from the cross-sectional regressions of the one-month-ahead returns on MES, age, asset size, and lockup provision for all, live, and defunct funds. The regression models can be represented as equation (5) in Section 3.3, where MES is that when the market return is below its fifth percentile, and Age, Asset, and LockupD are the age, the natural logarithm of AUM, and the dummy variable for the lockup provision of an individual hedge fund, respectively. For each regression model, the first row presents the time series averages of the monthly slope coefficients over the 132 monthly observations (from January 1999 to December 2009). The second row presents the standard t-statistic, which is the average slope divided by its time series standard error.

Consistent with the results from portfolio-based analysis based on univariate sorting in Section 4.1, the result from the univariate regressions (equations 1–4) shows that hedge fund returns have a statistically significant negative relation to MES, age, and asset size, whereas the relation between hedge fund returns and the lockup dummy is positive and statistically significant. Although the regression coefficients for the live funds are more significant than for the defunct funds, the signs of the regression coefficients for both live and defunct funds are in the same direction. In addition, the average adjusted R^2 values are much higher for MES regression (about 6%) than for age, asset size, or liquidity regressions (below 1%). This result indicates that MES plays a more important role than the others in explaining the cross-sectional variation in hedge fund returns.

Consistent with the results from portfolio-based analysis based on bivariate sorting in Section 4.1, the results from the multivariate regressions (equations 5–8) report that MES is statistically significant across all models. While the age variable is statistically significant at the 10% significance level, at least, for all regression specifications, the asset size variable and lockup dummy lose their significance in some of the models; they are subdued by the other factors, such as MES and age variable. For example, the lockup dummy loses its significance for live funds and both the asset size variable and lockup dummy lose their significance for defunct funds. Therefore, MES and fund age are more important variables than asset size and liquidity in explaining the cross-sectional variation in hedge fund returns based on multivariate regression analysis. Lastly, the sign of each variable in multivariate regression is the same as that in univariate regression.

In summary, the results from regression-based analysis are consistent with those from portfolio-based analysis. The cross-sectional relation between the systemic risk contribution of a hedge fund measured by MES and hedge fund returns are statistically and economically significant after controlling for age, asset size, and liquidity effects. Moreover, the systemic risk contribution of a hedge fund measured by MES is one of the most important factors in explaining the cross-sectional variation in hedge fund returns. In addition, significant factors in explaining the cross-sectional variation in hedge fund returns are slightly different between live and defunct funds. Whereas MES, age, and asset size are important factors for live funds, only MES and age are important for defunct funds. Lastly, the result indicates that young and small funds with a high systemic risk contribution and a non-zero lockup period outperform old, large funds with a low systemic risk contribution and zero lockup period, on average.

5. Conclusion

This paper examines the cross-sectional relation between systemic risk and hedge fund returns. The systemic risk of individual hedge funds is measured using the MES proposed by Acharya et al. (2010). This paper's main research question is whether the systemic risk contribution of hedge funds explains the cross-sectional variation in hedge fund returns. To answer this question, we conduct analyses adopted from asset pricing framework, not only at the portfolio level (portfolio-based analysis) but also at the individual level (regression-based analysis).

Our paper's major findings can be summarized as follows. First, we find evidence of a positive and statistically significant relation between the systemic risk contribution of hedge funds measured by MES and hedge fund returns. Moving from a low- to a high-MES portfolio, expected portfolio returns decrease almost monotonically. The low-MES portfolio outperformed the high-MES portfolio by 1.38% per month (or 16.61% per year) during the period from January 1999 to December 2009.

Second, the relation between systemic risk and hedge fund returns holds regardless of whether a fund is live or defunct. Although the strength of the relation for live funds is slightly different from that for defunct funds, these two relations are economically same. The low-MES portfolio outperforms the high-MES portfolio by 1.22% per month (or 14.69% per year) and 1.42% per month (or 17.10% per year) for the live and defunct funds, respectively.

Third, the relation between systemic risk and hedge fund returns holds even after controlling for fund characteristics related to fund risk such as fund age, asset size, and liquidity factors. However, the strength of the relation is complicated by these fund characteristics. In particular, this relation is the strongest for young and small funds.

Finally, the systemic risk contribution of hedge funds measured by MES is one of the most important factors in explaining the cross-sectional variation in hedge fund returns, even after taking into account fund characteristics such as age, asset size, and liquidity factors. Moreover, the important risk factors are different for live and defunct funds. Whereas MES, age, and asset size are significant factors for live funds, only MES and age are significant factors for defunct funds. Overall, young, small funds with a high systemic risk contribution and a non-zero lockup period outperform old, large funds with a low systemic risk contribution and zero lockup period.

Our findings provide some insights into the financial regulation and risk management of hedge funds and imply that hedge fund managers have an incentive to take systemic risks unless the external costs thereof are internalized by each hedge fund. Whereas current financial regulations and risk management are designed to limit each entity's risk seen in isolation, this paper supports the attitude that they should be focused on limiting systemic risk, which is the risk of a financial crisis and its spillover to the economy at large.

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Table 1
Descriptive statistics for hedge fund returns

This table shows the descriptive statistics of monthly hedge fund returns for each hedge fund category (all, live, and defunct funds), including the number of funds, the average value of the sample mean, the standard deviation, skewness, and the excess kurtosis of individual hedge fund returns for each hedge fund category. This table also reports the percentage of funds for which the null hypothesis of normally distributed returns is rejected by the Jarque–Bera test at the 10% confidence level. The data are from the TASS database and the sample period is from January 1994 to December 2009. To be included in the analysis, a fund should report its returns in US dollars, net of fee, on a monthly basis and have at least a 24-month return history. Funds of funds and managed futures are excluded. Funds with AUM less than $10 million are also excluded. Under the null of normality, the Jarque–Bera test statistics follow a chi-squared distribution with two degrees of freedom.

	Number of funds	Mean (%)	Standard deviation (%)	Skewness	Excess kurtosis	Test of normality
						% of funds with Jarque–Bera p < 0.1
All funds	1406	0.86	4.22	-0.33	4.52	73.33
Live funds	645	0.97	4.53	-0.34	4.57	78.45
Defunct funds	761	0.76	3.95	-0.33	4.48	68.99

Table 2
Average returns of hedge fund portfolios sorted by MES (January 1999 to December 2009)

The first panel presents the average value of the MES and the one-month-ahead returns for each MES portfolio for all, live, and defunct funds. The MES portfolios are formed based on MES, where the MES is that when the market return is below its fifth percentile. The MES of each fund is calculated using non-missing return observations over the past 60 months. In any given month, we include only funds with at least 24 months of return observations over the estimation period. When we calculate the MES of each hedge fund, we do not perform sign conversion. The second panel presents the average return differential between deciles 1 and 10 and the standard t-statistics for the average return differential. Here *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

All funds			Live funds			Defunct funds		
Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)
Low MES	-11.84	1.63	Low MES	-11.04	2.08	Low MES	-12.22	1.34
2	-5.80	1.16	2	-5.36	1.37	2	-5.69	0.74
3	-3.23	1.20	3	-3.09	1.22	3	-2.88	0.84
4	-1.75	0.78	4	-1.85	0.91	4	-1.45	0.55
5	-0.73	0.76	5	-0.86	0.82	5	-0.51	0.48
6	0.02	0.66	6	-0.02	0.96	6	0.12	0.35
7	0.63	0.55	7	0.76	0.78	7	0.61	0.28
8	1.39	0.51	8	1.62	0.59	8	1.34	0.18
9	2.83	0.63	9	3.02	0.78	9	2.76	0.47
High MES	8.89	0.25	High MES	8.65	0.85	High MES	9.42	-0.08
Average return differential for MES			Average return differential for MES			Average return differential for MES		
Low MES - high MES		1.38	Low MES - high MES		1.22	Low MES - high MES		1.42
t-Statistic		3.23***	t-Statistic		2.93***	t-Statistic		3.07***

Table 3

Average returns of hedge fund portfolios sorted by age (January 1999 to December 2009)

The first panel presents the average value of the age and the one-month-ahead returns for each age portfolio for all, live, and defunct funds. The age portfolios are formed based on age, where age is measured in months. The second panel presents the average return differential between deciles 1 and 10 and the standard t-statistics for the average return differential. Here *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

All funds			Live funds			Defunct funds		
Decile	Age (in months)	Return (%)	Decile	Age (in months)	Return (%)	Decile	Age (in months)	Return (%)
Low age	25.44	0.83	Low age	25.74	1.27	Low age	25.35	0.33
2	31.25	0.97	2	31.95	1.30	2	30.66	0.59
3	37.63	0.84	3	38.80	1.09	3	36.56	0.55
4	44.85	0.90	4	46.31	1.04	4	43.65	0.77
5	53.13	0.79	5	54.93	0.93	5	51.96	0.77
6	62.95	0.83	6	64.95	1.14	6	62.28	0.53
7	74.83	0.82	7	76.54	0.80	7	75.51	0.61
8	88.74	0.78	8	90.43	1.16	8	89.29	0.42
9	107.86	0.78	9	109.10	0.90	9	108.18	0.40
High age	154.74	0.69	High age	150.91	0.97	High age	159.80	0.30
Average return differential for age			Average return differential for age			Average return differential for age		
Low age - high age		0.13	Low age - high age		0.30	Low age - high age		0.03
t-Statistic		1.33	t-Statistic		2.10**	t-Statistic		0.20

Table 4
Average returns of hedge fund portfolios sorted by asset size (January 1999 to December 2009)

The first panel presents the average value of the asset size and the one-month-ahead returns for each asset size portfolio for all, live, and defunct funds. The asset size portfolios are formed based on asset size, with the asset size is measured by the natural logarithm of AUM. The second panel presents the average return differential between deciles 1 and 10 and the standard t-statistics for the average return differential. Here *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

All funds			Live funds			Defunct funds		
Decile	Ln(Asset)	Return (%)	Decile	Ln(Asset)	Return (%)	Decile	Ln(Asset)	Return (%)
Low Ln(Asset)	15.59	1.25	Low Ln(Asset)	15.78	1.43	Low Ln(Asset)	15.38	0.92
2	16.56	0.88	2	16.67	1.35	2	16.43	0.65
3	17.02	0.88	3	17.16	1.32	3	16.88	0.43
4	17.37	0.80	4	17.51	0.98	4	17.22	0.45
5	17.72	0.82	5	17.84	0.77	5	17.56	0.64
6	18.07	0.72	6	18.20	1.03	6	17.93	0.53
7	18.46	0.78	7	18.61	1.22	7	18.31	0.23
8	18.91	0.70	8	19.07	0.91	8	18.76	0.39
9	19.48	0.72	9	19.62	0.78	9	19.36	0.38
High Ln(Asset)	20.49	0.67	High Ln(Asset)	20.54	0.79	High Ln(Asset)	20.54	0.57
Average return differential for asset			Average return differential for asset			Average return differential for asset		
Low asset - high asset		0.57	Low asset - high asset		0.64	Low asset - high asset		0.36
t-Statistic		3.63***	t-Statistic		3.85***	t-Statistic		1.61

Table 5
Average returns of hedge fund portfolios sorted by lockup period (January 1999 to December 2009)

The first panel presents the average value of the lockup dummy and the one-month-ahead returns for each liquidity portfolio for all, live, and defunct funds. The liquidity portfolios are formed based on lockup dummy. If a fund has a non-zero lockup period, we set the dummy variable equal to one; otherwise, the dummy variable equals 0. The second panel presents the average return differential between two liquidity portfolios and the standard t-statistics for the average return differential. Here *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

All funds			Live funds			Defunct funds		
Portfolio	LockupD	Return (%)	Portfolio	LockupD	Return (%)	Portfolio	LockupD	Return (%)
Lockup	1	0.95	Lockup	1	1.16	Lockup	1	0.65
No lockup	0	0.75	No lockup	0	1.00	No lockup	0	0.47
Average return differential for lockup			Average return differential for lockup			Average return differential for lockup		
Lockup - no lockup		0.21	Lockup - no lockup		0.17	Lockup - no lockup		0.18
t-Statistic		2.90***	t-Statistic		2.22**	t-Statistic		1.91*

Table 6
Average returns of hedge fund portfolios for bivariate sorts, first by age and then by MES (January 1999 to December 2009)

This table presents the average value of the MES and the one-month-ahead returns for each MES portfolio for all, live, and defunct funds. The MES portfolios are formed first, sorted by three age groups (low, medium, and high) and then by MES. The MES is that when the market return is below its fifth percentile. The MES of each fund is calculated using non-missing return observations over the past 60 months. In any given month, we include only funds with at least 24 months of return observations over the estimation period. When we calculate the MES of each hedge fund, we do not perform any sign conversion. This table also reports the average return differential between deciles 1 and 10 and the standard t-statistics for the average return differential. Panels A, B, and C use all, live, and defunct funds, respectively. Here *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: All funds								
Low age group			Medium age group			High age group		
Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)
Low MES	-10.47	1.75	Low MES	-11.24	1.66	Low MES	-12.48	1.36
2	-4.61	1.42	2	-5.57	1.31	2	-6.79	1.14
3	-2.53	1.19	3	-3.25	1.20	3	-3.81	0.99
4	-1.22	0.74	4	-1.67	0.77	4	-2.17	0.86
5	-0.21	0.71	5	-0.62	0.86	5	-1.19	0.55
6	0.59	0.73	6	0.09	0.56	6	-0.51	0.89
7	1.36	0.52	7	0.64	0.54	7	0.20	0.60
8	2.45	0.86	8	1.30	0.39	8	0.86	0.38
9	4.25	0.78	9	2.64	0.70	9	1.98	0.21
High MES	12.20	-0.14	High MES	7.20	0.29	High MES	5.76	0.39
Low age group			Low age group			Low age group		
Low MES - high MES		1.89	Low MES - high MES		1.36	Low MES - high MES		0.97
t-Statistic		3.75***	t-Statistic		3.23***	t-Statistic		2.04**

Panel B: Live funds								
Low age group			Medium age group			High age group		
Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)
Low MES	-9.64	2.61	Low MES	-10.68	1.81	Low MES	-10.98	1.11
2	-4.55	1.45	2	-5.19	1.12	2	-5.93	1.91
3	-2.43	1.42	3	-2.99	1.13	3	-3.25	1.20
4	-1.13	0.83	4	-1.53	0.75	4	-2.20	0.99
5	-0.08	0.97	5	-0.53	0.92	5	-1.40	0.57
6	0.69	0.86	6	0.14	0.86	6	-0.68	1.03
7	1.52	0.74	7	0.79	1.00	7	0.08	0.63
8	2.70	0.99	8	1.71	0.70	8	1.01	0.32
9	4.21	0.91	9	2.93	0.82	9	2.43	0.75
High MES	11.31	0.64	High MES	7.23	0.62	High MES	6.05	0.90
Low age group			Low age group			Low age group		
Low MES - high MES		1.97	Low MES - high MES		1.19	Low MES - high MES		0.21
t-Statistic		3.43***	t-Statistic		2.67***	t-Statistic		0.37

Panel C: Defunct funds								
Low age group			Medium age group			High age group		
Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)
Low MES	-10.90	0.92	Low MES	-11.16	1.72	Low MES	-12.35	0.88
2	-4.33	0.83	2	-5.24	1.71	2	-6.69	0.67
3	-2.16	0.75	3	-2.98	0.92	3	-3.73	0.32
4	-0.98	0.65	4	-1.47	0.58	4	-1.70	0.55
5	-0.15	0.32	5	-0.48	0.40	5	-0.78	0.21
6	0.64	0.32	6	0.15	0.22	6	-0.09	0.67
7	1.37	0.53	7	0.74	0.19	7	0.44	0.41
8	2.47	0.32	8	1.46	0.35	8	0.92	0.01
9	4.34	0.30	9	2.73	0.41	9	1.97	0.10
High MES	12.83	-0.19	High MES	8.36	-0.10	High MES	5.74	0.02
Low age group			Low age group			Low age group		
Low MES - high MES		1.10	Low MES - high MES		1.82	Low MES - high MES		0.86
t-Statistic		1.87*	t-Statistic		3.29***	t-Statistic		1.40

Table 7
Average returns of hedge fund portfolios for bivariate sorts, first by asset size and then by MES (January 1999 to December 2009)

This table presents the average value of the MES and the one-month-ahead returns for each MES portfolio for all, live, and defunct funds. The MES portfolios are formed first, sorted by three asset size groups (low, medium, and high) and then by MES. The MES is that when the market return is below its fifth percentile. The MES of each fund is calculated using non-missing return observations over the past 60 months. In any given month, we include only funds with at least 24 months of return observations over the estimation period. When we calculate the MES of each hedge fund, we do not perform any sign conversion. This table also reports the average return differential between deciles 1 and 10 and the standard t-statistics for the average return differential. Panels A, B, and C use all, live, and defunct funds, respectively. Here *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: All funds								
Low asset group			Medium asset group			High asset group		
Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)
Low MES	-14.10	1.83	Low MES	-11.46	1.57	Low MES	-7.66	0.99
2	-7.78	1.64	2	-6.12	1.09	2	-3.24	1.10
3	-4.76	1.40	3	-3.36	1.22	3	-1.68	0.82
4	-2.90	1.16	4	-1.88	0.62	4	-0.75	0.92
5	-1.53	0.83	5	-0.92	0.60	5	-0.13	0.74
6	-0.42	0.60	6	-0.07	0.68	6	0.36	0.67
7	0.41	0.60	7	0.61	0.48	7	0.89	0.46
8	1.33	0.73	8	1.39	0.42	8	1.65	0.58
9	3.00	0.63	9	2.83	0.59	9	2.86	0.61
High MES	10.82	0.15	High MES	8.31	0.56	High MES	7.60	-0.06
Low age group			Low age group			Low age group		
Low MES - high MES		1.67	Low MES - high MES		1.01	Low MES - high MES		1.04
t-Statistic		2.86***	t-Statistic		2.71***	t-Statistic		2.57***

Panel B: Live funds								
Low asset group			Medium asset group			High asset group		
Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)
Low MES	-13.16	2.64	Low MES	-9.68	1.90	Low MES	-5.86	1.29
2	-8.16	1.84	2	-5.16	0.84	2	-2.95	1.04
3	-4.77	1.70	3	-3.16	1.10	3	-1.85	0.99
4	-2.94	1.47	4	-1.94	0.48	4	-0.99	1.05
5	-1.57	1.00	5	-0.83	0.75	5	-0.31	0.94
6	-0.49	0.77	6	0.12	0.89	6	0.30	0.69
7	0.44	0.89	7	0.95	0.73	7	1.11	0.54
8	1.48	0.83	8	1.92	0.60	8	1.84	0.70
9	3.09	0.74	9	3.46	0.82	9	2.73	0.62
High MES	10.29	0.73	High MES	8.48	1.27	High MES	7.55	0.64
Low age group			Low age group			Low age group		
Low MES - high MES		1.91	Low MES - high MES		0.64	Low MES - high MES		0.66
t-Statistic		2.97***	t-Statistic		1.38	t-Statistic		1.75*

Panel C: Defunct funds								
Low asset group			Medium asset group			High asset group		
Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)
Low MES	-14.12	1.33	Low MES	-11.73	1.23	Low MES	-8.14	0.72
2	-7.50	1.41	2	-5.96	0.93	2	-2.81	0.58
3	-4.50	0.53	3	-2.95	0.77	3	-1.26	0.46
4	-2.43	0.84	4	-1.56	0.47	4	-0.43	0.66
5	-1.17	0.46	5	-0.67	0.54	5	0.01	0.75
6	-0.19	0.22	6	0.06	0.48	6	0.39	0.05
7	0.61	0.33	7	0.67	0.13	7	0.83	0.07
8	1.55	0.28	8	1.46	0.15	8	1.42	0.41
9	3.36	0.64	9	2.91	0.10	9	2.73	0.64
High MES	11.17	-0.17	High MES	10.23	0.34	High MES	7.11	-0.42
Low age group			Low age group			Low age group		
Low MES - high MES		1.50	Low MES - high MES		0.89	Low MES - high MES		1.13
t-Statistic		2.32**	t-Statistic		1.82*	t-Statistic		2.26**

Table 8
Average returns of hedge fund portfolios from bivariate sorts, first by lockup period and then by MES (January 1999 to December 2009)

This table presents the average value of the MES and the one-month-ahead returns for each MES portfolio for all, live, and defunct funds. The MES portfolios are formed first, sorted by two liquidity groups (lockup and non-lockup) and then by MES. The MES is that when the market return is below its fifth percentile. The MES of each fund is calculated using non-missing return observations over the past 60 months. In any given month, we include only funds with at least 24 months of return observations over the estimation period. When we calculate the MES of each hedge fund, we do not perform any sign conversion. This table also reports the average return differential between deciles 1 and 10 and the standard t-statistics for the average return differential. Panels A, B, and C use all, live, and defunct funds, respectively. Here *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: All funds					
Lockup funds			Non-lockup funds		
Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)
Low MES	-12.78	1.75	Low MES	-10.88	1.33
2	-7.11	1.31	2	-4.80	1.20
3	-4.54	1.29	3	-2.56	1.12
4	-2.56	0.90	4	-1.30	0.75
5	-1.33	0.92	5	-0.37	0.72
6	-0.43	0.53	6	0.24	0.65
7	0.36	0.64	7	0.78	0.46
8	1.23	0.71	8	1.57	0.45
9	2.70	0.85	9	3.00	0.52
High MES	8.72	0.55	High MES	9.03	0.08
Lockup funds			Non-lockup funds		
Low MES - high MES		1.20	Low MES - high MES		1.25
t-Statistic		2.59***	t-Statistic		2.66***
Panel B: Live funds					
Lockup funds			Non-lockup funds		
Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)
Low MES	-11.71	2.08	Low MES	-9.57	2.01
2	-6.94	1.42	2	-4.00	1.21
3	-4.34	1.50	3	-2.27	1.08
4	-2.59	1.13	4	-1.31	0.95
5	-1.52	0.89	5	-0.42	0.86
6	-0.57	0.74	6	0.32	0.84
7	0.42	0.87	7	1.03	0.50
8	1.36	0.97	8	1.90	0.64
9	2.83	0.90	9	3.28	0.65
High MES	9.87	0.86	High MES	8.02	0.85
Lockup funds			Non-lockup funds		
Low MES - high MES		1.22	Low MES - high MES		1.15
t-Statistic		2.50**	t-Statistic		2.70***
Panel C: Defunct funds					
Lockup funds			Non-lockup funds		
Decile	MES (%)	Return (%)	Decile	MES (%)	Return (%)
Low MES	-12.77	1.59	Low MES	-11.41	0.81
2	-6.70	0.80	2	-4.74	1.00
3	-4.17	0.93	3	-2.26	0.90
4	-2.14	0.46	4	-1.08	0.51
5	-0.88	0.48	5	-0.23	0.48
6	-0.07	0.41	6	0.31	0.31
7	0.60	0.29	7	0.76	0.27
8	1.41	0.31	8	1.43	0.13
9	2.96	0.64	9	2.84	0.31
High MES	9.04	0.49	High MES	9.56	-0.28
Lockup funds			Non-lockup funds		
Low MES - high MES		1.11	Low MES - high MES		1.09
t-Statistic		2.06**	t-Statistic		1.95*

Table 9
Cross-sectional regression of hedge fund returns on MES, age, asset size, and lockup period with a constant (January 1999 to December 2009)

This table presents the time series average of the monthly regression coefficients obtained from the cross-sectional regression framework of Fama and MacBeth (1973). The MES is that when the market return is below its fifth percentile. Age, Asset, and LockupD are the age, the natural logarithm of AUM, and the dummy variable for the lockup provision of an individual hedge fund, respectively. This table also reports the standard t-statistic, which is the average slope divided by its time series standard error. The average adjusted R^2 values are reported in the last column. Here *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: All funds								
Model	1	2	3	4	5	6	7	8
Constant	0.702	0.899	2.342	0.733	0.845	1.512	0.647	1.393
	4.45***	5.26***	3.41***	4.24***	5.32***	2.80***	4.21***	2.57**
MES	-0.048				-0.049	-0.046	-0.046	-0.046
	-2.17**				-2.23**	-2.13**	-2.10**	-2.12**
Age		-0.001			-0.002			-0.002
		-2.12**			-3.66***			-2.49**
Asset			-0.087			-0.046		-0.036
			-2.70***			-1.77*		-1.31
LockupD				0.217			0.142	0.143
				3.04***			2.08**	2.09**
Average adj. R^2	5.80%	0.11%	0.70%	0.41%	5.90%	6.32%	6.11%	6.80%
Panel B: Live funds								
Model	1	2	3	4	5	6	7	8
Constant	0.920	1.205	3.328	0.977	1.114	2.383	0.878	2.165
	5.27***	6.42***	4.71***	5.03***	6.34***	4.68***	4.95***	4.15***
MES	-0.049				-0.051	-0.047	-0.048	-0.048
	-2.06**				-2.13**	-1.98**	-2.00**	-2.00**
Age		-0.002			-0.003			-0.002
		-3.04***			-3.74***			-2.48**
Asset			-0.128			-0.082		-0.063
			-3.70***			-3.01***		-2.14**
LockupD				0.171			0.101	0.087
				2.26**			1.34	1.18
Average adj. R^2	6.14%	-0.07%	0.86%	0.22%	6.10%	6.61%	6.34%	6.76%
Panel C: Defunct funds								
Model	1	2	3	4	5	6	7	8
Constant	0.457	0.579	1.425	0.454	0.578	0.847	0.418	0.699
	3.25***	3.66***	1.68*	2.95***	3.96***	1.12	3.08***	0.92
MES	-0.039				-0.041	-0.039	-0.037	-0.039
	-1.78*				-1.84*	-1.81*	-1.68*	-1.80*
Age		-0.001			-0.002			-0.002
		-1.08			-2.37**			-1.69*
Asset			-0.052			-0.023		-0.011
			-1.25			-0.61		-0.28
LockupD				0.182			0.101	0.119
				1.86*			1.08	1.24
Average adj. R^2	7.26%	0.06%	0.79%	0.62%	7.30%	7.96%	7.81%	8.68%