Are investors better off with small hedge funds in times of crisis?

The time-varying nature of the relationship between hedge fund performance and size

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Abstract
With the benefit of a more comprehensive dataset than previous authors in this area, in this paper we revisit the relationship between hedge fund performance and size. Our results indicate that there is a strong, negative relationship between hedge fund performance and size. But, in addition, we also find that rather than dissipating during the two recent periods of financial crisis, other things equal, investors would have been better off with smaller hedge funds than with large ones during these crisis periods. Finally, we also document clear cross-sectional variation in this relationship by broad hedge fund strategy.

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1. Introduction

Over the last ten to fifteen years the fund management industry has become increasingly bifurcated. On the one hand so called passive[1] funds, by which people generally invest in index funds where component weights are determined by their market capitalisations, continue to attract huge inflows. For example, in the US where the idea of 'passive' investing began, according to the 2014 Investment Company Fact Book[2] (ICFB), the share of assets invested in index equity mutual funds relative to all equity mutual fund assets was 18.4% at the end of 2013, up from 9.5% in 2000, and between 2007 and 2013 passive US equity mutual funds (and ETFs) experienced cumulated net inflows of $795bn while equivalent actively managed investment vehicles experienced a net outflow of $575bn over the same period. Similar trends are well established both outside the US market and amongst institutional investors too, to such an extent that the world's three largest asset managers by global AUM – Blackrock, Vanguard Asset Management and State Street Global Advisers – all have substantial passive businesses.

The antithesis of the sort of passive investment techniques that have helped some asset management firms gather in billions and billions of assets, garnering increasing economies of scale as they do so, is the active fund management industry. As millions of both retail and institutional investors have moved money into passive investment vehicles, the active fund management industry's performance and fees has come under increasing scrutiny. The debate about 'active share', following Cremers and Petajisto (2009), brought into even sharper focus the idea that active fund managers should be truly active rather than simply being 'benchmark huggers' that charge active fees for essentially passive performance. For active mutual fund managers, capacity issues are a more pressing concern, particularly if the fund focuses on niche

[1] Actually there is nothing overtly passive about choosing to invest one's assets on the basis of market capitalisation weights – it is an overt investment strategy.
[2] http://www.icifactbook.org/fb_ch2.html#index

parts of any market. Because of this managers will specify, though normally only when prompted, a maximum AUM for their fund and strategy. A number of academic studies have investigated the relationship between mutual fund performance and fund size. Berk and Green (2004) found that although more highly-skilled managers tended to manage more assets, diseconomies of scale meant that the expected returns on their funds were no different than those managed by less skilled managers. Other authors, including Chen *et al* (2004) also find a negative relationship between the size of a mutual fund and its subsequent performance. However, in a more recent paper Reuter and Zitzewitz (2013) find "little evidence of net diseconomies of scale" amongst long only US mutual funds.

Capacity constraints may then be an issue for active mutual fund managers, but it seems likely that any constraints and associated diseconomies of scale are more likely to be found in the hedge fund industry where managers: employ (in many cases) highly focussed investment strategies; make extensive use of leverage; invest in illiquid asset classes; concentrate on very specific segments of the capital markets; and use complex derivative instruments. This is the hypothesis that we test in this paper.

The nature of the performance of hedge funds has been the subject of interest for a number of authors who generally employ factor models based originally on the work of Sharpe (1992) to assess this performance (see Fung and Hsieh (1997), Agarwal and Naik (2000), or Gehin and Vaissie (2006) for early examples). But the enhanced potential in the hedge fund industry for diseconomies of scale have led others to investigate the impact on hedge fund performance of size. However, early investigations into this relationship by Clarke (2003) using data between 1991 and 2001, by Herzberg and Mozes (2003) using data spanning the period from 1996 to 2001 and by Gregoriou and Rouah (2003) using data from 1994 to 1999 indicated that no such

relationship existed. But using a slightly longer, and more recent span of data from 1994 to 2005 Ammann and Moerth (2005) do find evidence to suggest the existence of a strong negative relationship between fund size and performance. And using data on hedge fund performance from 1994 to 2008 (just prior to the onset of the Global Financial Crisis) Teo (2009) also documents very strong evidence of an inverse relationship between hedge fund performance and size. After adjusting for risk, Teo finds that that small hedge funds outperform large hedge funds by an economically meaningful 3.65%pa.

Compared to the mutual fund industry, the hedge fund industry is still, if not in its infancy, barely a toddler. Indeed, an investigation of the relationship between hedge fund size and performance using data predominantly from the 1990s clearly suffers unavoidably from limited time series information and limited cross-sectional information, that is, there were relatively few hedge funds and not much dispersion in AUMs. The relative scarcity of hedge funds in those early days also meant less competition for the available investment opportunities. Furthermore, according to the TASS database that we use in this study, the largest decile of hedge funds in 1994 had an average AUM of just over $300mn compared to $1.6bn at the end of 2014. It is possible then, for a number of reasons, that the relationship between hedge fund size and performance has changed over time, or even that it changes with the financial market environment. To this end we undertake, in terms of time span, the most comprehensive study to date of the relationship between hedge fund performance and size. Our data spans the period from January 1994 to 2014. Because of the relatively long span of data and the fact that it encompasses two major financial market crises we employ a methodology that allows us to investigate this relationship as it changes over time.

Our results indicate that there is a strong, negative relationship between hedge fund performance and size. But, in addition, we also find that rather than dissipating during the two periods of financial crisis, other things equal, investors would have been better off with a small hedge fund rather than a large one during these periods. Finally, we also document clear cross-sectional variation in this relationship by broad hedge fund strategy. In particular we find that the relationship between size and performance is positive for the Managed Futures hedged fund strategy. The rest of this paper is organised as follows: in section 2 we describe our data and methodology; in section 3 we present our main results, while in section 4 we present our results by hedge fund strategy; and finally we conclude our paper in section 5.

2. Data and Methodology

2.1 Data

To investigate the relationship between hedge fund performance and size we use Thomson Reuters' Lipper Hedge Fund Database[3] (formerly referred to as the TASS database). This database is comprised of data on hedge funds: inception dates, profiles, strategies, manager biographies, fee structures and much more. Most importantly for our purposes the database contains monthly information on net-of-fee hedge fund performance figures and net asset values (NAVs) for funds that are currently trading and for those that have ceased trading – live and 'dead' funds. Prior to 1994 the TASS incarnation of this database did not contain information on funds that died before 1993, however for our study the sample period spans the period from January 1995 to December 2014. We analyse the performance of the live and dead funds in the database over this sample which means that our results are not affected by survivorship biases.

[3] http://www.lipperweb.com/products/LipperHedgeFundDatabase.aspx

In Table 1 we provide some basic descriptive statistics of the data. In total we analyse the performance of 7,261 hedge funds. Column 2 in the table shows that the style with the largest population is the Long/Short Equity Hedge (2,702 funds) and the smallest is the Options Strategy (30). We conduct the main analysis using funds from all 11 strategies, and also undertake strategy-specific analysis, but only with those categories with a large enough population. The third column in Table 1 presents the average number of monthly observations that we have for all funds (just under six years) and for each hedge fund strategy. Finally, the fourth column in the Table presents the average, raw monthly percentage return of the all funds (0.62%) and for each hedge fund category.

Columns 5 to 8 in the table demonstrate the potential bias that might occur from focussing only on funds that are alive today. As at December 2014, there were 1,473 funds that were trading, while 5,788 funds (approximately 80% of the total sample) were 'born' and then subsequently died over the twenty year sample period. Overall, and for most individual strategies, the average monthly return for the live funds is higher than for the dead funds. The most significant exception to this rule is the convertible arbitrage segment of the industry, where the average monthly return of funds trading at December 2014 was 0.18% compared with 0.59% for the dead funds in this strategy. This simple comparison does not allow for changes in the capital market environment, but it does nonetheless emphasise that the issue of survivorship bias is a multiple of the equivalent problem in studies of the performance of mutual funds.

Table 2 gives an initial, informal indication of the relationship between hedge fund performance and size. The table presents the average returns, standard deviation of returns and average Sharpe ratios of the sample by size decile, where the size deciles have been reformed annually. Panel A in the table presents results based upon unconditional average monthly

returns. The largest decile (1) of funds generated an average return of 0.61% per month, with an associated standard deviation of 0.66% and Sharpe ratio of 0.62; while the smallest decile (10) produced an average returns of 0.74% with standard deviation of 0.72% and Sharpe ratio of 0.74. The results in panel A indicate a broad improvement in performance and in risk-adjusted performance as we move from decile 1 to decile 10. Although it is not a monotonic performance improvement from decile 1 to decile 10, the trend is certainly for performance to improve as average fund size falls. Table 1 presents the hedge funds in the sample by strategy. Using unconditional returns implies that we would expect, on average, similar performance from each strategy which, given the range of strategies and asset classes, would seem unreasonable. For example, why would we expect funds with an Event Driven strategy to have the same risk and return characteristics as funds with an Equity Market Neutral strategy? Because of the heterogeneity of fund strategies Panel B presents returns that have been strategy-adjusted. That is, from the return on each fund we subtract the return on an index representing that strategy's broad approach using the appropriate HFR return indices. The results in Panel B are essentially based upon hedge fund returns in excess of strategy-specific, average returns. Unsurprisingly the average, monthly excess returns for each decile are lower in Panel B than in Panel A, as are the associated standard deviations and Sharpe ratios. However, the relationship between size and return (in this case excess return) and risk-adjusted return is unaffected: as hedge fund size falls, average excess returns and Sharpe ratios generally rise.

In this paper we wish to study the relationship between hedge fund performance and size over time. Table 3 highlights a potential issue with regard to our aim (and with regard to the results presented in Table 2). Table 3 presents the average NAV of the hedge funds calculated at the end of each year in our sample and then presents these values averaged across size deciles. The

Table shows that over the whole sample the average NAV of the top decile was just under $900mn, and that the average size of the smallest decile was just under $1.2m. However, at the start of the sample (1995) the average NAVs of deciles 1 and 10 were around $333mn and $0.5mn respectively, while at the end of the sample the equivalent figures were around $1,570mn and $1mn. The figures in this table indicate that both big and small funds are today 'bigger than they used to be'. To overcome this temporal issue we considered a number of approaches, including: the truncation of the sample according to an arbitrary NAV value to exclude funds, for example, with a NAV of less than $50m; and the rescaling of NAV's by, for example, the AUM of the hedge fund industry over time. However, in the end, as other authors in this area have previously done, we preferred to work with the full sample rather than choose an arbitrary selection of the sample, and instead use a methodology that is not affected by the temporal impact on size. We now move on to describe this methodology.

2.2 Methodology

To investigate the relationship between hedge fund performance and hedge fund size (NAV) over time we employ a variant of a methodology originally developed by Fama and MacBeth (1973) to test the CAPM. This methodology has been used in other studies of the kind reported here, including Agarwal et al (2009). In our context the Fama-MacBeth methodology allows us to test the relationship between hedge fund performance over the full sample but by estimating discrete cross-sectional regressions for each year[4] in our sample as follows:

$$ER_{i,t} = \lambda_0 + \lambda_1 Size_{i,t-1} + \xi_{i,t} \qquad (1)$$

[4] Results are also available on request from the authors on a month by month basis too.

where $ER_{i,t}$ represents the return on hedge fund i in year t in excess of the return in year t of the return on fund i's representative, HFR strategy index; $Size_{i,t-1}$ is the natural log of the NAV of hedge fund i at time t-1; $\xi_{i,t}$ is an OLS error term; λ_0 and λ_1 are OLS coefficients. λ_1 is the key parameter of interest here; a positive value for λ_1 indicates a positive relationship between size and performance, while a negative coefficient indicates an inverse relationship between the two variables. Following the Fama-MacBeth methodology, we estimate expression (1) for every year in our sample, this gives 120 estimates of both λ_0 and λ_1, allowing us to estimate the following Fama-MacBeth t-statistic:

$$t = \frac{\overline{\lambda_1} - 0}{sd_{\lambda_1}} \qquad (2)$$

where $\overline{\lambda_1}$ is the arithmetic average of λ_1 over the whole sample period (1995 to 2014) or any sub-period, for example, any given year; and where sd_{λ_1} is the standard deviation of λ_1 estimates over the same sample period. The test is standard normally distributed.

As indicated, the advantage of this approach is that it allows us to test the relationship between size and performance over the whole sample or over any sub-sample, allowing us to study the possible time-varying nature of the relationship. But most importantly, since each λ_1 is estimated independently of all others, the results are not influenced by the change in average hedge fund sizes over time (see Table 3). Another advantage of this approach is that expression (1) can be augmented with other fund characteristics. For example, in their study of the impact of managerial incentives on hedge fund performance Agarwal et al (2009) augment expression (1) with fund characteristics such as the expected change in manager compensation, hurdle rates and high water marks. Our focus here is firmly on the relationship between size and

performance, though we do augment expression (1) with fund age as a robustness test of this relationship and the square of fund size to test for possible non-linearity in the relationship.

3. Full sample results

3.1 Size and performance

The full sample results are presented in Table 4. In Panel A of this table we present the results of estimating expression (1); we present both the average values of the two OLS coefficients, λ_0 and λ_1, as well as the associated Fama-MacBeth t-statistics. The results in this panel confirm those derived from the less formal analysis of returns by size decile presented in table 2: there is a negative relationship between hedge fund size and performance. Indeed, the associated Fama-MacBeth t-value on the λ_1 coefficient of -3.03 indicates that this relationship is highly statistically significant at well beyond the 99% confidence level. Figure 1 presents this same relationship but over time. The Figure presents the average λ_1 coefficient estimated from expression (1) for each year in our sample. Thus each point in the Figure represents the relationship between hedge fund size and performance for each year in our sample. The figure shows that the relationship does change from year to year, but that in all but three of the twenty years the relationship has been negative. More interestingly, three periods arguably stand out in particular: 1999 to 2000, 2003 to 2004 and 2008 to 2010. The Fama-MacBeth t-statistics for both of these periods show that the relationship was highly statistically significant. These periods were marked by financial market crisis. Other things equal, these results suggest, perhaps surprisingly, that investors would have been better off with small rather than big hedge funds over these crisis periods.

Panel B of Table 4 presents the results of an augmented version of expression (1):

$$ER_{i,t} = \lambda_0 + \lambda_1 Size_{i,t-1} + \lambda_2 \left(Size_{i,t-1}^2\right) + \xi_{i,t} \quad (3)$$

where the addition of the $Size_{i,t-1}^2$ term allows us to test the linearity of the hedge fund size/performance relationship. The negative coefficient on (λ_1) and the positive coefficient on the squared term (λ_2) indicates that as hedge funds get bigger their performance declines, but that it declines at a decreasing rate. However, the Fama-MacBeth t-statistic on the squared term of -0.60 indicates that it is not significantly different from zero. We therefore reject the implicit hypothesis of a non-linear relationship between size and performance.

3.2 Age and performance

We now turn to the related issue of fund age. The relationship between a hedge fund's age and its subsequent performance has also been a focus of attention in the academic literature. Indeed, fund age and fund size are likely to be quite closely related. For example, it seems unlikely that a fund will be in the lowest size decile in the 1990s and still be there at the end of our sample. A small hedge fund that remains small for a long period of time is one that probably failed to perform well and as such, failed to attract investor funds. The fund would be more likely to close than still be in business twenty years later with only a small AUM. Hence, big funds are likely to be older than small funds. One would hope that a hedge fund's performance would – like a vintage wine – improve with fund age, as the fund's managers became more experienced at managing their funds and strategies. To test this hypothesis we adjust expression (1) again and estimate the following expression:

$$ER_{i,t} = \lambda_0 + \lambda_1 Age_{i,t-1} + \xi_{i,t} \quad (4)$$

where $Age_{i,t-1}$ represents the age of the fund at time t-1 (essentially the number of monthly observations on the fund's performance up to and including the performance in t-1). The results are presented in Panel C of Table 4.

We find that the relationship between age and performance is negative, that is, the older the fund the lower the performance. This result indicates that hedge fund managers do not age well! However, over the whole sample we find that the age coefficient is only -0.013 which is one third of the value of the size coefficient of -0.04 as shown in Panel A of Table 4. Economically speaking then, the age effect is much smaller than the size effect on hedge fund performance. However, having said this, the Fama-MacBeth t-statistic is still highly significant at -2.46. Figure 2 sheds more light on this relationship. It presents the average λ_1 coefficient estimated from expression (4) for each year in our sample and is therefore comparable to Figure 1. The result for the full sample, shown in Panel C of Table 4, is dominated by the period from 1996 to 2002, where we find the average negative relationship between age and performance to be statistically significant.

However, in the latter period from 2003, particularly post 2009, the Figure shows that in the majority of the years that there was a positive relationship between fund age and performance. However, this does not mean that older funds produce better returns, because average relationship is not only statistically small (a coefficient of -0.001 – still negative) it is also, unsurprisingly, not significantly different from zero. Overall then we can conclude that the relationship between hedge fund age and performance may have been more negative in the early part of our sample. Furthermore, although it was negative overall, this relationship is much weaker than the relationship between hedge fund performance and hedge fund size.

The final panel in Table 4, Panel D, explores the relationship between performance, size and age. The results in the panel confirm the dominance of size as an explanatory variable for hedge fund performance. The coefficient on the Size variable is -0.028 and has an associated Fama-MacBeth t-statistic of -1.82, significant at the 90% confidence level. By contrast the coefficient on the Age variable is -0.007 and is clearly insignificantly different from zero at conventional levels of statistical confidence.

3.3 Full sample results summary

The results in section 3 demonstrate that over the full sample there has been an inverse relationship between benchmark-adjusted hedge fund returns and hedge fund size, and a similar but weaker relationship between benchmark-adjusted hedge fund returns and hedge fund age. We also found that the negative relationship between hedge fund size and performance was particularly pronounced around the two financial market crisis periods covered by our sample. Our results suggest that rather than protecting clients from these crises, being "bigger" was a disadvantage for investors in larger funds compared to those invested in smaller funds.

As well as there being time variation in the relationship between hedge fund size and performance it is possible that the relationship may vary from strategy to strategy. In the next section of this paper we focus on sectoral level results.

4. Sectoral results

Why might the relationship between hedge fund performance and size vary between different sectors of the hedge fund industry? If capacity constraints, liquidity and other factors play a role in explaining why, other things equal, big hedge funds tend to underperform smaller ones then, given that these factors may vary in importance from one hedge fund style to another, it

is also possible that there is cross-sectional variation in this relationship too. To test for any strategy-specific effects we have re-estimated expressions (1) to (4) for the most popular hedge fund strategies: Emerging Markets, Event Driven, Global Macro, Long/Short Equity Hedge, Managed Futures and Multi Strategy.

4.1 The relationship between hedge fund performance and size by strategy

Table 4 presents results for models 1 to 4 for the four hedge fund strategies with the greatest number of funds: Long/Short Equity, Emerging Markets, Event Driven and Managed Futures. The results show clearly that the relationship between performance, size and age does vary from strategy to strategy. Panel A shows that the relationship between size and performance is negative for the Long/Short Equity, Emerging Markets and Event Driven strategies, but we find that it is only statistically significant for the Long/Short Equities strategy (with a t-value of -2.74), not for the Emerging Markets and Event Driven strategies. Perhaps more interestingly we find that the relationship is positive for Managed Futures. This implies, perhaps, that this strategy is less constrained than others by size and indeed, benefits from being larger rather than from being smaller. However, although the coefficient is positive we find that it is not statically different from zero since the Fama-MacBeth t-value is only 0.63.

In Figure 3 we have plotted the relationship between hedge fund size and performance over time for each of the four strategies. Panel A of the Figure shows that the negative relationship for the Long/Short Equity strategy was particularly prominent following the South East Asian financial crisis and during the more recent Global Financial Crisis; it was also particularly negative following the collapse of the high tech bubble. The same relationship shown in Panel B for the Emerging Markets strategy is more unstable than for the Long/Short Equity strategy, although it is particularly negative following the South East Asian crisis. Panel C shows that

the relationship between size and performance for the Event Driven Strategy has been negative on average, but again has been particularly negative during the high tech bubble and global financial crises. Interestingly, after 2011 the average relationship between Event Driven hedge fund size and performance has been positive. Finally, Panel D shows that the positive average relationship between the performance of the Managed Futures strategy and size is driven almost entirely by the period from 1998 to 2003; since that time the relationship has been either negative or marginally positive. For the Managed Futures hedge fund strategy, big might have been beautiful ten years ago, but it seems that size has been less of an advantage over the last ten years.

Panel B in Table 4 presents the results from estimating Model 2 for the four hedge fund strategies. The results for the Long/Short Equity strategy confirm the results from Panel A with regard to the relationship between performance and size and in addition indicate that the relationship is non-linear since λ_2 is estimated to be significant. The negative coefficient on λ_1 and the positive coefficient on λ_2 indicates that the negative relationship between performance and size becomes more negative, but at a decreasing rate as funds get bigger. We find no evidence of a non-linear relationship between size and performance for the Emerging Markets strategy, but clear evidence for both the Event Driven and Managed Futures strategies. Indeed for the Event Driven strategy, compared to the results of Model 1, we find strong evidence of size's negative impact on performance given the negative coefficient on λ_1 of -0.74 and associated Fama-MacBeth t-value of -2.91, but find again that performance deteriorates as funds get bigger, but at a decreasing rate as evidenced by the positive value on λ_2 of 0.02 with associated Fama-MacBeth t-value of 2.89. We find the opposite relationship for the Managed Futures strategy; that is, a positive relationship between size and performance

which increases at a decreasing rate as funds get bigger as evidenced by the positive value of 0.94 for λ_1 and the negative value of -0.03 for λ_2.

4.2 The relationship between hedge fund performance and age by strategy

Panel C of Table 4 presents the results of our estimates of Model 3. The results confirm that there is a negative relationship between fund age and performance; λ_1 is found to be negative in all four cases. However, we only find this relationship to be statistically significant for the Long/Short Equity and Event Driven strategies. Figure 4 presents the times series values of λ_1 from this model for each strategy. For the Long/Short Equities strategy, Panel A of the Figure shows that between 1995 and 2002 that there was a persistent negative relationship between hedge fund age and performance. However, since 2003 (when the relationship was positive) the time series of λ_1 coefficients indicate no clear relationship between age and performance. Arguably, Panel B shows a similarly declining negative relationship between the age of Emerging Market hedge funds and performance; the relationship is generally negative between 1995 and 2002, but either marginally positive or negative after that period. Panel C presents the results for the Event Driven hedge funds. Here the relationship does appear to be more persistently negative, indicating that younger Event Driven hedge funds have had a slight performance advantage over larger ones. Finally, Panel D shows that with the exceptions of 1998, 2000 and 2001, there has been virtually no relationship between age and the performance of Managed Futures hedge funds given that the λ_1 coefficient has been very close to 0.0 since 2002.

Panel D of Table 4 presents the results of Model 4. On the whole the results show that the Size and Age variables are correlated – as one might expect. In most cases the λ_1 and λ_2 coefficients are negative, but are generally not statistically significant, with the main exception being the

coefficient for the Event Driven Strategy. Overall then the sectoral results do not vary significantly from the main results where we find fund size to be a more powerful tool for understanding the cross-sectional performance compared to the age of a fund.

5. Conclusions

The longer sample period that we have managed to use in our study has allowed us to look deeper into the relationship between hedge performance, size and age. Like previous authors who have addressed this topic, albeit with often much shorter sample periods, we confirm that on average over the sample period of 1995 to 2014 there is a negative relationship between hedge fund performance and size, and a similar, though weaker, negative relationship between performance and age. However, our focus on the time-varying nature of these inverse relationships in this paper has revealed that they are far from stable over time. Indeed, in some cases there is clear evidence of 'structural break' in the relationship, where it may switch from being a strongly negative relationship to an insignificant, or even positive, relationship.

Perhaps the most interesting results that spring from the analysis of these relationships over time relate to the crisis periods encompassed in our study. In particular it seems that on average investors were better off investing with a small hedge fund instead of a large one in times of crisis – following the collapse of the high tech bubble and again during the more recent global financial crisis. There may be a number of reasons for this. First, the AUM of bigger hedge funds would tend to comprise more potentially flighty fund of fund investments; and the flight of such money from the industry may have hampered the performance of those funds as they dealt with large redemptions rather than on their investment strategies. Second, it could be that smaller hedge funds had more stringent gating arrangements that limited the potentially damaging impact of redemptions on performance over these periods. Third, although this is

essentially a truism, it may be that smaller hedge funds have less ‘beta’, or market risk embedded in their portfolios. In future research we aim to shed more light on the performance of large and small hedge funds over these crisis periods.

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Table 1: Summary Statistics, full sample

Average monthly returns have been calculated as the average fund return over the time period returns. Returns are reported as monthly percentages.

	Live and Dead Funds			Live Funds		Dead Funds	
	Number of Funds	Average months of data	Average monthly return	Number of Funds	Average monthly return	Number of Funds	Average monthly return
Convertible Arbitrage	255	76	0.50%	60	0.18%	195	0.59%
Emerging Markets	829	74	0.55%	208	0.66%	621	0.51%
Equity Market Neutral	448	64	0.52%	51	0.58%	397	0.51%
Event Driven	708	83	0.76%	133	0.73%	575	0.76%
Fixed Income Arbitrage	279	73	0.52%	41	0.55%	238	0.52%
Global Macro	528	61	0.56%	103	0.57%	425	0.55%
Long/Short Equity Hedge	2702	77	0.74%	528	0.80%	2174	0.72%
Managed Futures	744	78	0.50%	169	0.64%	575	0.46%
Multi-Strategy	679	73	0.52%	163	0.76%	516	0.44%
Options Strategy	39	62	0.68%	13	0.89%	26	0.58%
Dedicated Short Bias	50	82	0.15%	4	0.36%	46	0.13%
All Funds	7261	75	0.62%	1473	0.70%	5788	0.61%

Table 2: Unconditional and excess returns by decile, full sample

The decile portfolios have been constructed based on assets size. Portfolio 1 refers to the largest HF's whereas portfolio 10 reports statistics of the smallest HFs. The returns and other statistics are monthly percentages. They represent averages of the individual funds in the particular decile. The Sharpe ratio refers to the traditional Sharpe ratio where the excess return is measured over the risk free rate.

	Panel A: Unconditional returns			Panel B: Excess returns		
Decile	Return	SD	Sharpe Ratio	Return	SD	Sharpe Ratio
1	0.61%	0.66%	0.63	-0.08%	0.12%	-0.69
2	0.58%	0.74%	0.52	-0.09%	0.19%	-0.49
3	0.66%	0.74%	0.61	-0.06%	0.23%	-0.25
4	0.63%	0.76%	0.57	-0.08%	0.24%	-0.32
5	0.70%	0.72%	0.71	-0.04%	0.24%	-0.15
6	0.75%	0.82%	0.69	0.04%	0.26%	0.15
7	0.77%	0.86%	0.69	0.06%	0.33%	0.19
8	0.77%	0.79%	0.76	0.08%	0.38%	0.22
9	0.80%	0.80%	0.77	0.13%	0.51%	0.26
10	0.75%	0.72%	0.74	0.11%	0.43%	0.24

Table 3: Hedge fund NAV over time, full sample

Average proportions of each fund hedge fund style in asset size decile.

Decile	Average of Asset Size (USD)	Start of sample	Start of sample %	End of sample	End of sample %
1	896,949,189	333,037,234	0.3713	1,569,571,386	1.7499
2	210,066,688	67,830,534	0.3229	400,534,154	1.9067
3	105,798,851	30,734,566	0.2905	176,419,584	1.6675
4	62,454,830	18,773,922	0.3006	100,864,550	1.6150
5	38,718,411	13,481,751	0.3482	61,051,190	1.5768
6	24,674,711	8,288,235	0.3359	35,778,331	1.4500
7	15,331,986	4,990,561	0.3255	21,653,364	1.4123
8	8,679,302	2,930,132	0.3376	11,724,869	1.3509
9	4,222,542	1,461,000	0.3460	5,200,483	1.2316
10	1,198,070	485,338	0.4051	1,087,488	0.9077

Table 5A: Fama-MacBeth Test Statistics – Size, Age and Performance

Average coefficients and Fama-MacBeth t-values are reported. The test is standard normally distributed.

Model 1 : $ER_{i,t} = \lambda_0 + \lambda_1 Size_{i,t-1} + \xi_{i,t}$
Model 2 : $ER_{i,t} = \lambda_0 + \lambda_1 Size_{i,t-1} + \lambda_2 (Size^2_{i,t-1}) + \xi_{i,t}$
Model 3 : $ER_{i,t} = \lambda_0 + \lambda_1 Age_{i,t-1} + \xi_{i,t}$
Model 4 : $ER_{i,t} = \lambda_0 + \lambda_1 Size_{i,t-1} + \lambda_2 Age_{i,t-1} + \xi_{i,t}$

	Panel A: Model 1		Panel B: Model 2			Panel C: Model 3		Panel D: Model 4		
	λ_0	λ_1	λ_0	λ_1	λ_2	λ_0	λ_1	λ_0	λ_1	λ_2
All funds										
Average coeff values	0.6778	-0.0400	0.2113	0.0221	-0.0020	0.0604	-0.0132	0.4798	-0.0278	-0.0072
Fama-MacBeth t-stat	2.59	-3.03	0.24	0.20	-0.60	1.21	-2.46	1.75	-1.82	-0.98
L/S Equity										
Average coeff values	1.0552	-0.0628	2.7664	-0.2693	0.0062	0.0952	-0.0216	0.6820	-0.0389	-0.0132
Fama-MacBeth t-stat	2.39	-2.74	3.07	-2.56	1.95	1.23	-2.55	1.55	-1.63	-1.14
Emerging Markets										
Average coeff values	1.4641	-0.0806	-1.5584	0.2985	-0.0118	0.2011	-0.0430	1.4542	-0.0805	-0.0005
Fama-MacBeth t-stat	1.51	-1.55	-0.19	0.32	-0.44	1.54	-1.32	1.18	-1.10	-0.01
Event Driven										
Average coeff values	0.2547	-0.0199	6.4817	-0.7408	0.0207	0.0622	-0.0236	-0.1670	0.0098	-0.0250
Fama-MacBeth t-stat	0.67	-0.96	2.89	-2.91	2.89	0.99	-3.95	-0.43	0.45	-2.50
Managed Futures										
Average coeff values	-0.0967	0.0136	-7.3369	0.9428	-0.0295	0.1456	-0.0055	-0.1793	0.0203	-0.0038
Fama-MacBeth t-stat	-0.26	0.63	-2.81	2.89	-2.95	1.36	-0.81	-0.45	0.84	-0.50

Table 5B: Fixed Effects panel estimates of the relationship between Performance, Size and Age

Average coefficients and Fama-MacBeth t-values are reported. The test is standard normally distributed.

Model 1 : $ER_{i,t} = \lambda_1 Size_{i,t-1} + \xi_{i,t}$
Model 2 : $ER_{i,t} = \lambda_1 Size_{i,t-1} + \lambda_2 (Size^2_{i,t-1}) + \xi_{i,t}$
Model 3 : $ER_{i,t} = \lambda_1 Age_{i,t-1} + \xi_{i,t}$
Model 4 : $ER_{i,t} = \lambda_1 Size_{i,t-1} + \lambda_2 Age_{i,t-1} + \xi_{i,t}$

	Panel A: Model 1	Panel B: Model 2		Panel C: Model 3	Panel D: Model 4	
	λ_1	λ_1	λ_2	λ_1	λ_1	λ_2
All funds						
Coeff value	-0.52	-0.3022	-0.0021	-0.0817	-0.3260	-0.0477
t-stat	-41.43	-3.11	-0.74	-22.44	-27.89	-12.58
L/S Equity						
Average coeff values	-0.4620	-0.1402	-0.0097	-0.0907	-0.4133	-0.0521
Fama-MacBeth t-stat	-23.92	-0.88	-2.03	-14.59	-20.52	-8.19
Emerging Markets						
Average coeff values	-0.6230	0.4651	-0.0328	-0.0977	-0.5905	-0.0354
Fama-MacBeth t-stat	-13.94	1.26	-2.99	-6.27	-12.56	-2.22
Event Driven						
Average coeff values	-0.2673	-0.1376	-0.0037	-0.0545	-0.2348	-0.0245
Fama-MacBeth t-stat	-11.24	-0.51	-0.48	-7.29	-9.01	-3.02
Managed Futures						
Average coeff values	-0.3515	-0.2598	-0.0028	-0.0991	-0.2763	-0.0747
Fama-MacBeth t-stat	-10.35	-0.93	-0.33	-9.83	-7.83	-7.14

Figure 1
The relationship between hedge fund performance and size
(see expression (1) in text)

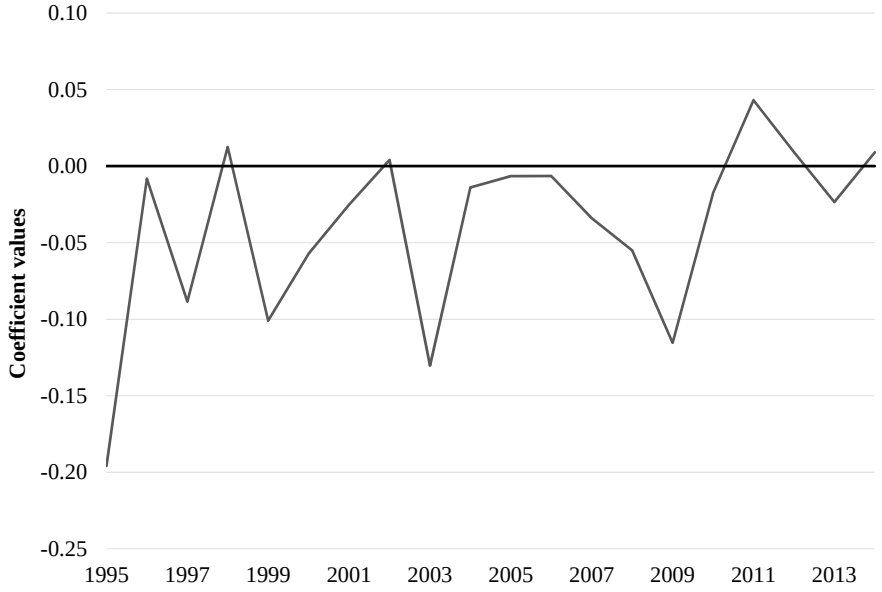

Figure 2
The relationship between hedge fund performance and age
(see expression (4) in text)

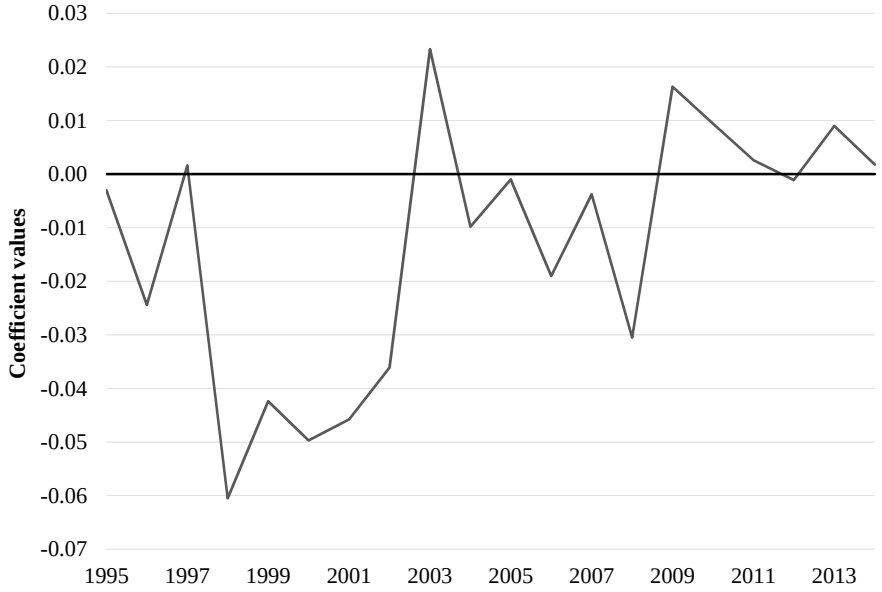

Figure 3
The relationship between hedge fund performance and size

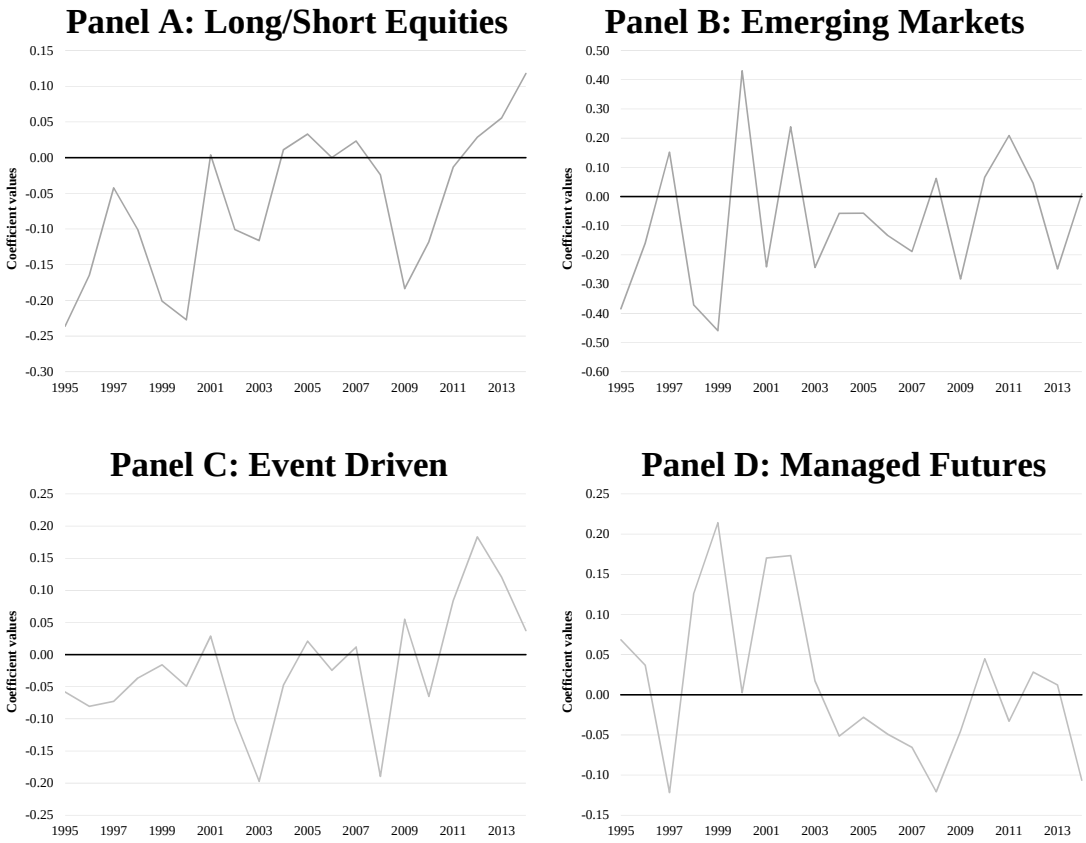

Figure 4
The relationship between hedge fund performance and age