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Are fund of hedge fund returns asymmetric?

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Abstract

We examine the return distributions of 332 funds of hedge funds and associated indices. Over half of the sample is significantly skewed according to the skewness statistic, and these are split 50/50 positive and negative. However, we argue that the skewness statistic can lead to erroneous inferences regarding the nature of the return distribution, because the test statistic is based on the normal distribution. Using a series of tests that make minimal assumptions about the shape of the underlying distribution, we find very little skewness in the returns of funds of funds, and when we do find evidence of asymmetry it is close to the mean rather than in the tails.

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1. Introduction

It is now well established that the returns reported by hedge funds are not normally distributed. Hedge fund returns show strong excess kurtosis, and using the skewness statistic it appears that many hedge funds and hedge fund indices have negatively skewed return distributions. Previous researchers investigating the distributional characteristics of asset returns have usually relied on parametric tests of asymmetry, and this is no different in hedge fund research. Prior studies of hedge fund performance that have included an analysis of asymmetry (for example, Brooks and Kat, 2001, Kat and Lu, 2002 and Lamm, 2003) use the skewness statistic, and generally find that hedge funds and hedge fund indices are either not significantly skewed or negatively skewed. However, as Peiró (1999, 2002) has shown, this parametric approach to investigating asymmetry can lead to erroneous inferences regarding the nature of the return distribution, because the asymptotic distribution of the sample skewness statistic is valid only in conditions of normality.

The issue of hedge fund return asymmetry is of prime importance given the phenomenal growth in hedge funds and funds of hedge funds over the past two decades. Many wholesale and increasingly retail investors consider hedge funds as a new and important addition to the asset class universe. In this paper we examine the distributional characteristics, and in particular the asymmetry, of 332 funds of funds and associated indices. We argue that fund of fund data should be used in preference to hedge fund index data to examine asymmetry, because funds of funds do not suffer from the data conditioning biases that are well understood to affect hedge fund returns data (Fung and Hsieh, 2002a).

Following Peiró (1999, 2002), we use two approaches to testing for asymmetry. First, we test for the symmetry of returns using a formal binomial distribution test. We examine the numbers of excess returns (defined as the return minus the mean) in two intervals of the distribution that are symmetric with respect to the mean. If the distribution is symmetric, then the numbers of positive and negative excess returns will follow a binomial distribution, with parameters $n$ and $p$, where $p = 0.5$. Second, we use two distribution-free tests to examine the equality of the distributions in the overall negative and positive excess returns. For the distribution free tests we subtract
the mean from each observation, effectively shifting the axis of symmetry to zero. We define positive excess returns to be returns above the mean and negative excess returns to those below the mean. These two tests, the Wilcoxon Rank Sum and the Seigel-Tukey, can be regarded as analogous to the parametric t-test for equality of means and the F-test for variance, but they require only mild assumptions concerning the underlying distribution, and are relatively insensitive to the presence of extreme returns.

We find very little evidence of significant asymmetry in fund of fund returns. While it is generally assumed that hedge fund skewness is due to observations in the left tail of the return distribution (because the nature of many hedge fund strategies means that occasional large negative returns would be a feature of the expected payoff),\(^1\) when we do find evidence of asymmetry, it is close to the mean rather than in the tails. In addition, consistent with Peiro (1999, 2002) who examined stock index returns, we find that for funds of funds the skewness statistic can overstate return asymmetry, and using an example we show that the skewness statistic can lead to incorrect conclusions about the nature of return distributions.

The remainder of our paper is as follows. In the next section we review the evidence on hedge fund and fund of fund performance, including the most recent research on non-normality issues. In section 3 we describe the binomial and non-parametric techniques that we use to test for asymmetry. Section 4 presents the data and discusses the summary performance statistics for the sample, and section 5 presents the results. In the final section we summarise the paper and conclude.

2. **Hedge funds: background**

The massive growth in hedge funds in the last few years has been matched by burgeoning academic evidence on their performance. Most extant research on hedge fund performance has found that hedge funds exhibit superior performance on a risk-adjusted basis relative to standard asset classes such as equity and bonds (Ackerman, McEnally and Ravenscraft, 1999, Asness, Krail and Liew, 2001, Brown, Goetzmann

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\(^1\) Fung and Hsieh (1999), for example, argue that many hedge fund strategies set up an insurance-like payoff with the hedge fund being the insurer.
and Ibbotson, 1999, and others). On the face of it, hedge funds in general earn excellent returns relative to the risk that they bear. However, research on hedge fund performance is hampered by several well-understood shortcomings. The main obstacle to gaining reliable insights into hedge fund performance is that the data suffer from several conditioning biases. Most of these biases result from the fact hedge funds are largely unregulated, and thus (unlike mutual funds) are not required to report performance. Hedge funds report voluntarily to several commercial hedge fund data providers such as CSFB/Tremont, Hedge Fund Research (HFR), Managed Account Reports (now Zurich Capital Markets), MSCI, and Van Hedge Fund Advisors. While most of these providers claim to control for survivorship bias by retaining the data on defunct and withdrawn funds in their databases and in their various performance indices, there are several related biases that are more difficult to correct. Liquidation bias occurs when underperforming funds withdraw from reporting in the lead up to their liquidation. Assuming liquidation follows very poor or possibly catastrophically poor performance (a la LTCM) the effect of this bias is clearly to overestimate hedge fund returns and underestimate their risk. Termination bias usually refers to funds that disappear through mergers and reorganisations, and it could lead either to the underestimation or overestimation of hedge fund returns. Self-selection (or simply selection) bias is caused by funds that cease reporting voluntarily, because, for example, they have reached capacity and no longer need the publicity associated with reporting performance (Fung and Hsieh 2002a). This bias typically includes funds that choose not to report at all, and it leads to the underestimation of hedge fund returns. With the best will in the world on the part of the data providers these biases are difficult to eliminate, at least until regulation requires hedge funds to report performance publicly. They are generally grouped under the heading ‘survivorship bias,’ and the findings generally are that the biases leading to underestimation of risk and return dominate those that might cause its underestimation. Survivorship bias has been estimated by various studies to be in the range 1.4 to 3.4 percent annually (see Amin and Kat, 2002a, Brown, Goetzmann and Ibbotson, 1999, Fung and Hsieh, 1997b, 2000, and Liang, 2001, and others).

More recently, a second major shortcoming of hedge fund data has come to light. Many hedge funds hold assets for which regular arm’s length market prices are not available, such as securities traded in illiquid markets, or over-the-counter products
such as swaps. At the end of each month when net asset values are calculated by hedge funds, the values of these assets must sometimes be estimated. Kao (2002) argues that such ‘marking to market’ and ‘marking to model’ estimates of net asset value are questionable, and “most likely contribute(s) to hedge funds’ low return volatilities and low correlations with other asset classes.” (23). Asness, Krail and Liew (2001) argue that hedge funds have an incentive to ‘smooth’ the return series, and find that when returns are adjusted for stale prices many of the return and diversification benefits of hedge fund investing disappear.

Most of the early studies of hedge fund performance used assessment techniques such as the Sharpe ratio and Jensen’s alpha, which assume that returns are normally distributed. However, non-normality is being increasingly recognised as a feature of hedge fund return distributions (Agarwal and Naik, 2001, Amin and Kat, 2003, Fung and Hsieh, 1999, and Lo, 2001). More recently there have been several studies specifically examining the distributional properties of hedge fund returns.

Before discussing some of these studies it must be remembered that there is an important difference between average skewness for individual funds and skewness figures for indices or portfolios of hedge funds, including funds of funds. This is because skewness changes in ways that are incompletely understood when portfolios are formed. In an analysis of optimal portfolios of hedge funds, Amin and Kat (2002b) find that as the number of funds increases, standard deviation falls, but median skewness becomes more negative. Kat and Lu (2002) find that amongst individual hedge funds, funds in most strategy categories are associated with negative skewness, and all have excess kurtosis. Similar to Amin and Kat (2000b), when within-strategy portfolios are formed, standard deviation falls but skewness decreases. They conclude that “…it appears that when things go bad for one fund, they tend to go bad for other funds in the same sector as well.” (6).

Research using hedge fund indices has found evidence of non-normality, with the findings very strong on excess kurtosis and, generally speaking, negative skewness. Brooks and Kat (2001) find significant skewness across a range of hedge fund strategies in 48 hedge fund indices. Interestingly, of 6 aggregate hedge fund indices from different data providers, only 2 show significant asymmetry, and these are left-
skewed (including the HFR index that we use). They also find statistically significant negative skewness (across all of the data providers) for the convertible arbitrage, risk arbitrage, distressed and emerging markets strategies, while equity market neutral, long-short equity and macro strategies are generally not significantly skewed. Lamm (2003) finds that for the HFR composite hedge fund index from 1995-2002, skewness is -.46 (which is not significant) and excess kurtosis of 2.5% (significant at the 1 percent level).

2.1 Funds of hedge funds

During the past few years the growth in funds of hedge funds, which are vehicles offering pooled investments in hedge funds, has been phenomenal. The number of funds of funds increased from 550 in 2001 to approximately 780 in mid-2003, and now comprises almost one-third of the $650 billion invested in hedge funds (The Economist, 18th September, 2003). At the same time, funds of funds are becoming available to a greater range of potential investors. While most regulation around the world restricts direct investment in hedge funds to institutions and high net-worth individuals, recent changes to regulations in various jurisdictions have opened investment in funds of funds to retail investors.2 Indeed, one of the claimed benefits of funds of funds is that moderately wealthy investors are able to participate in hedge fund investment. The assumption amongst regulators appears to be that being portfolios, funds of funds must be less risky than individual hedge funds. While by definition holding a portfolio of hedge funds must be less risky than holding only one or two hedge funds, their risk and return characteristics are not well understood.

Relative to hedge fund managers, fund of fund managers require a different set of skills. Like active mutual fund managers, fund of fund managers must attempt to ‘pick winners’. The challenge of trying to choose between 15 and 30 hedge funds from amongst a hedge fund universe of over 6000 must be immense, even relative to the challenge facing active mutual fund managers. Hedge fund managers offer other benefits for their services vis-à-vis investing directly in hedge funds. As well as

2 In the US, registered funds of funds are permitted to offer minimum investments as small as $25,000. In the UK, funds of funds are listed on the London Stock exchange, and many specifically target the retail market. Funds of funds are available to the retail public in Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Sweden and Switzerland; and in most of these countries there is no stipulated minimum investment amount (PriceWaterhouseCoopers, 2003).
diversification, fund of funds managers claim ongoing monitoring of hedge funds, access to good funds that are closed to new investors, lower minimum investments and more flexible redemption policies. For these services, fund of fund managers charge a management fee and usually a cut of performance.\(^3\)

The existing evidence on fund of fund performance is that they tend to underperform hedge fund indices by small but significant amounts. Most studies of fund of fund performance have concluded that the ‘double fee structure’ inherent in funds of funds (that is, the funds of funds as well as the underlying hedge funds charge fees) offsets any diversification benefit. Brown, Goetzmann and Liang (2002), for example, find that funds of funds offer consistently lower average returns and Sharpe ratios than hedge funds over the period 1990-1999. Amin and Kat (2003), who examined the performance of 11 funds of funds as well as other categories of hedge funds, commented that “…it is worrisome to see fund of funds perform so badly.”

The findings on skewness in funds of funds is not as consistent, but in general it appears to be less negative than that of hedge fund indices using parametric statistics. Brown, Goetzmann and Liang (2002) find that fund of fund returns are more left skewed (a mean of -.307) relative to individual funds of funds (-0.126). However, using the same data but extended to May 2001, Kat and Lu (2002) find that the mean skewness of the funds of funds in their sample is considerably less (-0.16). Gupta, Cerrahoglu and Daglioglu (2003) report a similar skewness statistic of −0.17 for a constructed portfolio of 657 funds of funds. Lastly, out of 5 hedge fund indices from different data providers, Brooks and Kat (2001) find that only one of the funds of funds is negatively skewed, while for the others the skewness statistics are not significant.

One explanation that is seldom advanced for the apparent underperformance of funds of funds is that their reported returns, in contrast to hedge fund indices, do not suffer to the same extent from the biases discussed above. Because funds of funds are

\(^3\) The most visible fund of funds fees are management fees which are usually set at 1 per cent of the total of assets under management and performance fees which are usually set at 10 per cent of return. This is on top of standard hedge fund fees of typically 2 per cent of assets under management and 20 percent of return (Jaffer, 2003).
essentially clients of hedge funds, fund of fund returns reflect the full range of hedge fund performance, from the poor performers who eventually liquidate to the best outperformers. Survivorship, liquidation and backfilling biases should be absent from the track record of an individual fund of fund (Fung and Hsieh, 2002a). Self-selection bias should also be less in evidence because funds of funds would not suffer from the same sorts of capacity constraints that might lead hedge funds to close to new investors and withdraw from supplying data to information providers. As for the survivorship bias of the funds of funds themselves, because the rate of attrition is much lower than for hedge funds, survivorship bias is also lower. Fung and Hsieh (2000) estimated survivorship bias for funds of funds at 1.4 percent annually, and Amin and Kat (2002a) estimated it at only 0.63 percent over the period 1994-2001, compared to 1.89 percent for hedge funds. In addition, funds of funds report more accurately than other categories of hedge funds, so the stale pricing bias is less in evidence in funds of funds relative to hedge funds (Liang, 2003). For all these reasons, fund of fund data are more reliable than hedge fund data. They are less likely to understate risk-adjusted performance, and so the apparent underperformance reported in studies such as Amin and Kat (2003) is probably not explained simply by the double fee structure inherent in funds of funds.

3. Testing for asymmetry

Peiró (1999, 2002) points out that researchers studying asymmetry in asset prices may in the past have concluded that returns are asymmetric when the parent distribution is symmetric but not normal. For several world stock market indices Peiró (1999) found, contrary to prior studies, no strong evidence of asymmetry. Like prior studies of stock markets, studies examining non-normality and asymmetry issues in hedge funds have also made conclusions based upon the sample skewness statistic:

$$\hat{\alpha} = \frac{\sum_{t=1}^{T} (R_t - \bar{R})^3 / T}{\hat{\sigma}^3}$$

where $T$ is the sample size, $R_t$ is the return at time $t$, $\bar{R}$ is the sample mean and $\hat{\sigma}$ is the sample standard deviation. If the distribution is normal, then the asymptotic distribution of $\hat{\alpha}$ is
The asymptotic distribution of this statistic is tied to the assumption of normality in the time series being analysed, and its behaviour can be very different under alternative distributions in the series. For example, its characteristic behaviour can be very different in the case of non-normality, and it is not safe to conclude the symmetry or asymmetry of returns to financial assets on the basis of results obtained using this statistic.

In hedge fund research, asymmetry or ‘negative skewness’ has often been concluded on the basis of some extreme realisations found in the far tails. We examine the intervals of the return distributions within $\frac{1}{2}$, $\frac{1}{2}$ to 1, 1 to $1\frac{1}{2}$, $1\frac{1}{2}$ to 2, 2 to 3, 3 to 4 and 4 to 5 standard deviations from the mean, and find that negative skewness, where it exists, is more likely in probability to be located within half a standard deviation of the mean than in the far tails.

3.1 Distribution-free tests

Distribution-free tests of asymmetry are preferred since they require no assumptions concerning the distribution of returns in the underlying population. The two tests that we employ in this paper, the Wilcoxon Rank Sum test and the Siegel-Tukey test, are two-sample tests that are designed to detect differences in location and dispersion about the mean. We construct two sub-samples from each of our 332 funds of funds returns series: one formed by negative excess returns and one formed by positive excess returns, where excess return is the return observation minus the mean. With the Wilcoxon Rank Sum test, we are testing the null hypothesis that the means of these two sub-samples is equal, and the Siegel-Tukey tests the null hypothesis of equality of the variance of the two sub-samples.

In the Wilcoxon Rank Sum test the absolute values of positive and negative excess returns are combined into one ordered sample. The test statistic is the sum of the ranks of the absolute values of the negative excess returns in the combined ordered sample. The Wilcoxon test statistic is:

$$\hat{\alpha} \to N\left(0, \frac{6}{\sqrt{T}}\right)$$ (2)
\[ W_N = \sum_{i=1}^{N} iZ_i \]  

(3)

where the \( Z_i \) are indicator random variables defined as follows. Let

\[ Z = (Z_1, Z_2, \ldots, Z_N) \]  

(4)

where \( Z_i = 1 \) if the \( i \)th random variable in the combined ordered sample is from the set of negative excess returns and \( Z_i = 0 \) otherwise. Under the null hypothesis of equal distributions the exact mean and variance of \( W_N \) are

\[
E(W_N) = \frac{m(N+1)}{2} \quad \text{var}(W_N) = \frac{mn(N+1)}{12}
\]  

(5)

where \( m \) is the number of negative excess returns and \( n \) is the number of positive excess returns, and \( m + n = N \).

In the Siegel-Tukey test, the absolute values of positive and negative excess returns are also combined into one ordered sample. Like the Wilcoxon Rank Sum test, the Siegel-Tukey belongs to a class of statistics called the linear rank statistic. The weights are constructed so that the higher weights are assigned to the middle of the combined sample and the smaller weights to the extremes. The Siegel-Tukey statistic is

\[ S_N = \sum_{i=1}^{N} \alpha_i Z_i \]  

(6)

where \( Z_i \) are the indicator random variables as defined in Equation (4) and \( \alpha_i \) is defined as

\[
\begin{align*}
2i & \quad \text{for } i \text{ even, } 1 < i \leq \frac{N}{2} \\
2i - 1 & \quad \text{for } i \text{ odd, } 1 \leq i \leq \frac{N}{2} \\
2(N-1) + 2 & \quad \text{for } i \text{ even, } \frac{N}{2} < i \leq N \\
2(N-1) + 1 & \quad \text{for } i \text{ odd, } \frac{N}{2} < i < N
\end{align*}
\]  

(7)
Under the null hypothesis of equal distributions, the asymptotic distribution of $S_N$ is the same as $W_N$

$$S_N \rightarrow N \left( \frac{m(N+1)}{2}, \frac{mn(N+1)}{12} \right)$$ (8)

### 3.2 Binomial tests

We posit that funds of funds returns are symmetric if two conditions hold: (a) if the probability of obtaining a positive excess return equals the probability of obtaining a negative excess return, after zero excess returns have been excluded, and (b) if the distribution of negative excess returns in absolute values is equal to the distribution of positive excess returns. The binomial test is used to compare intervals on either side of the excess return distribution in order to address the following question. Is there asymmetric behaviour occurring in the tails as is often assumed, or is there asymmetry closer to the mean? We calculate the probability of obtaining a negative versus a positive excess return within $\frac{1}{2}$, $\frac{1}{2} - 1$, $1 - 1\frac{1}{2}$, and $1\frac{1}{2} - 2$ standard deviations of the mean, and in the tails between $2$ and $3$, $3$ and $4$, and $4$ and $5$ standard deviations either side of the mean.

The null distribution is the binomial distribution with parameters $p = p^* (0.5)$ and $n =$ number of observations. Because the values of $n$ are large the normal approximation is used.

$$x_q = n \cdot p + z_q \sqrt{n \cdot p (1 - p)}$$ (9)

Where $x_q$ is the $q^{th}$ quantile of a standard normal random variable.

The hypothesis takes the form of a two-tailed test: $H_0$: $p = \frac{1}{2}$ and $H_1$: $p \neq \frac{1}{2}$. The rejection region of desired size $\alpha$ corresponds to the two tails of the null distribution of $T$. We use Equation (9) to approximate the $\alpha/2$ quantile $t_{1}$ and the $(1-\alpha/2)$ quantile $t_{2}$.
of a binomial random variable with parameters \( p^* = 0.5 \) and \( n \) = number of observations. The parameter \( t_1 \) is a number such that

\[
P(Y \leq t_1) = \alpha_1 ,
\]

(10)

and \( t_2 \) is a number such that

\[
P(Y \leq t_2) = 1 - \alpha_2
\]

(11)

The p-value is found using

\[
P(Y \leq t_\gamma) = \frac{P(Z \leq t_\gamma - n.p^* + 0.5)}{\sqrt{n.p^*(1 + p^*)}}
\]

(12)

where \( t_\gamma \) represents the choice of test statistic; see Conover (1999) and Brown, Hollander (1977) for a discussion.

4. Data and summary performance information

The data for this study were obtained from Hedge Fund Research, Inc. (HFR), which is the main provider of funds of funds information. It includes return data on 525 hedge funds for the period from January 1988 to May 2003. Returns are monthly and represent the change in net asset value during the month relative to net asset value at the beginning of the month. All returns are in US dollars, and are net of all fees and expenses. HFR data include both domestic (US) and offshore funds, and in order to avoid survivorship bias in returns it also includes defunct funds.

The age profile of these funds is summarised in Table 1, which confirms the massive growth in funds of funds formation in recent years. The mean (median) fund age is 57 (45) months, and over half (53 percent) are less than 4 years old, with only 10 percent being more than 10 years old. While the data for the individual funds of funds begins in January 1988, because the hedge fund indices are available only from January 1990, we eliminate observations before January 1990. Due to data

\footnote{According to Ackerman, McEnally and Ravenscraft (1999) HFR began keeping data on funds that stop reporting in December 1992. However, this should not affect our findings unduly because between January 1990 (the start of our data period) and December 1992, funds of funds were rare. Approximately 10 percent of funds of funds in the database started before December 1992.}
limitations, we also remove funds that have been in existence for less than $2\frac{1}{2}$ years, leaving a data set of 332 funds of funds. The attrition rate for the sample is low. Of the 525 funds in the data set, 14 had ceased reporting by March 2003. Of these, 10 had more than 30 return observations and so were retained, leaving more than 70 percent of the defunct funds in the sample, which is greater than the 63 percent of the full sample that had greater than 30 observations.

HFR produces several hedge fund and funds of funds indices, for which it adjusts for survivorship and instant history biases. If a fund liquidates or closes, that fund’s performance will be included in the HFR index as of that fund’s last reported performance update. For the aggregate hedge fund index we use HFR’s weighted composite index. HFR produces several equally weighted fund of fund indices: a funds of funds composite index and four sub-indices. These sub-strategy indices are defined as conservative, diversified, market defensive and strategic. The funds of funds composite is an index of 380 funds of funds for which there is no minimum asset size and no minimum age requirement. A fund of fund is classified as conservative if it either primarily invests in hedge funds with conservative strategies such as ‘fixed income arbitrage’ and ‘equity market neutral’, or if it exhibits a lower historical annual standard deviation than the funds of funds composite. The constituent funds are assumed to be constructed to earn consistent returns regardless of market conditions. Strategic funds of funds invest in hedge funds with opportunistic strategies such as emerging markets, or they exhibit higher volatility than the funds of funds composite. These funds are expected to outperform the funds of funds index in up-markets and underperform in down-markets. Diversified funds invest in hedge funds with a variety of strategies. They exhibit historical volatility that is similar to the funds of funds index, and are designed for minimal loss in down-markets together with superior returns in up-markets. Finally, market defensive funds invest in short-biased hedge funds such as those specialising in short-selling, and these are designed to be negatively correlated with the returns of standard asset classes. These funds are expected to exhibit superior returns in down-markets.

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\(^5\) Some funds had missing observations for April and May 2003. We assume that these funds were simply late reporting their asset values rather than had ceased reporting.
Table 2 presents descriptive statistics for the indices and for the S&P 500 for the period January 1990 to May 2003. Consistent with prior studies of hedge fund performance, the hedge fund index appears to generate higher returns (13.9 percent versus 10.9 percent) and lower volatility (a standard deviation of 7.22 percent compared with 15.25 percent) than the S&P 500 over the same period. All of the funds of funds indices show lower annual average returns than the hedge fund index, but these lower returns are offset by lower standard deviations for all of the sub-indices except for the strategic index (which is to be expected given that strategic funds of funds specialise in hedge funds with aggressive strategies). Also consistent with its construction, the conservative index has both the lowest return and the lowest standard deviation of all the fund of funds indices. It appears that the funds’ diversification benefits are outweighed by the double fee structure inherent in funds of funds.

Relative to the hedge fund index, lower average annual returns do not seem to be compensated for by substantial reductions in standard deviation. This is confirmed by the Sharpe ratios and Jensen’s alphas. All of the indices have monthly Sharpe ratios that are much higher than that of the S&P index of 0.12, but apart from the conservative index which has a comparable Sharpe ratio, the funds of funds indices have Sharpe ratios that are between 26 and 42 percent lower than for the hedge fund index. The alphas for all of the indices are positive and significant, although the hedge fund index has a higher alpha (0.61) than any of the others, with the strategic (0.57) and market defensive (0.50) not far behind. Interestingly, the alpha for the funds of funds composite index is about 60 percent the size of the alpha for the hedge fund index, and the comparable proportion for the Sharpe ratio is 70 percent.

Table 3 presents the summary statistics and performance measures for the 332 funds of funds. The table presents the mean for the average and standard deviation of returns, mean values for skewness and kurtosis, and monthly Sharpe ratio and Jensen’s alpha for the full sample, and then for the four sub-strategies. For the full sample the summary statistics are as would be expected. Fifty-six percent of the sample recorded significant alphas, and these were all positive. Six percent of funds of funds’ alphas are negative, and the majority fall between 0 and 1. In 96 cases (29
percent) the fund alpha is greater than that of the hedge fund index, and 199 (60 percent) exceed the alpha for the funds of funds index.

Of the 332 funds of funds in our sample, 74 are classified as conservative, 153 are diversified, 34 are market defensive and 71 are strategic. The lower part of Table 3 presents the summary statistics for the four sub-strategy categories. The average returns and standard deviations for the conservative, diversified and market defensive sub-strategies are comparable to the statistics for the equivalent indices. For the strategic sub-strategy, however, the average return is much lower than the strategic sub-index and the standard deviation much higher. Amongst the other performance parameters, the Sharpe ratios and alphas are higher and the betas lower than for the equivalent indices for the conservative, diversified and market defensive sub-strategies. However, the mean Sharpe ratio and alpha for the strategic funds of funds are lower than for the index. This is difficult to explain. They are not over-represented in the newer funds which have been removed from the sample (they represent 21 percent of the deleted young funds), nor are these young strategic funds particularly good performers (the average annual return for these 37 funds is 5.68 percent, which is even lower than that for the included strategic funds of 8.05 percent). They are also not over-represented in the defunct funds (of which they comprise 20 percent).

4.1 Distribution issues

The last column of Table 2 reports the results of the Jarque-Bera test for normality. For all of the funds of funds indices, the null hypothesis of normality is rejected at the 1 percent level, whereas for the S&P 500 normality is rejected only at the 10 percent level. In all cases the index return distributions show significant excess kurtosis, but the findings for skewness are not as consistent. Interestingly, while the hedge fund index is significantly left-skewed, the funds of funds composite is negatively skewed but not significantly so. This is consistent with Brooks and Kat (2001) who found that all but one of the funds of funds indices in their sample were not significantly skewed. The conservative and strategic sub-indices are significantly negatively skewed, but there is no significant skewness for the market defensive and diversified sub-indices. While investing in funds of funds on the face of it looks like an inferior
risk-return tradeoff relative to the hedge fund index, the skewness statistics give some indication that this may be offset by a distribution of returns with fewer small or negative values. Figure 1 presents histograms for all of the indices, including the S&P 500.

For the individual funds of funds, more than two-thirds (229/332 cases or 69 percent) have non-normal return distributions according to the Jarque-Bera statistic (at the 5 percent level of significance). This is a smaller proportion than reported for hedge funds by Amin and Kat (2003), who found that 86 percent of their sample of 77 hedge funds had significantly non-normal return distributions. Table 4 shows the mean and median skewness and kurtosis for the full sample. The sample overall appears to show excess kurtosis rather than skewness. The mean (median) kurtosis is rather high at 7.03 (5.19) but the skewness is small at an average (median) of −0.12 (0.01). This is very close to the mean skewness statistic of −0.16 calculated for funds of funds by Kat and Lu (2002) using the TASS database.

Almost all of the funds of funds (331/332) have return distributions with significant excess kurtosis. Skewness, however, is not only rarer, but is equally positive and negative. In only half of the sample (177 or 53 percent) does the skewness statistic show significant asymmetry. In contrast with the apparent negative skewness of hedge fund returns, these significantly skewed funds of funds exhibit both positive and negative skewness in almost equal measure. Ninety-one (51 percent) are negatively skewed and 86 (49 percent) are positively skewed. For the individual funds, between 46 and 58 percent of significantly skewed cases are negatively skewed. Of these significantly skewed cases (not reported in the table), the conservative funds of funds appear to be the most negatively skewed (36 out of 43 or 84 percent). However, as we will see in the next section, the case of the conservative funds of funds illustrates very well the danger of making strong inferences about the shape of the underlying distribution simply from the skewness statistic.

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6 Amin and Kat (2003) state that their sample is highly skewed but do not report skewness statistics.
5. Results

5.1 Binomial tests

Table 4 presents the results for the binomial tests of the S&P 500, the hedge fund index, the funds of funds index, and the four sub-strategy indices. There are two significant findings in the table. For the S&P 500, there are significantly more positive excess returns than negative excess returns within half a standard deviation of the mean. The only other significant finding is for the conservative fund of fund index. Between ½ and 1 standard deviation either side of the mean, positive excess returns significantly outnumber negative excess returns. Also of interest is the positives outnumbering the negatives close to the mean (by about 25 percent) for the hedge fund index and the funds of funds strategic index, although these differences are not statistically significant.

As can be seen on the right hand side of the table, there is a very low frequency of observations in the tails. At between 4 and 5 standard deviations from the mean there is no more than one observation for each index, and the situation is similar for between 3 and 4 standard deviations. Interesting, while those between 4 and 5 standard deviations away from the mean are all negative, observations between 3 and 4 standard deviations are both negative and positive. There is more activity at between 2 and 3 standard deviations from the mean, but here the positives outnumber the negatives. It is clear that if asymmetry in hedge fund portfolio returns is found, it is likely to be due to asymmetry in the intervals close to the mean. In addition, for the indices when there is substantial asymmetry close to the mean it is more likely to be positive rather than negative.

Table 5 summarises the findings on the binomial tests for the 332 funds of funds. Panel A summarises the cases in which significant asymmetry was found in any interval of the distribution, and Panel B separates these results into three regions within the distribution: ½, ½ to 1, and 1 to 1½ standard deviations either side of the mean. No results are presented for further out in the distributions because we found very little significant asymmetry in the tails.
As can be seen in the first row of Panel A, between 18 and 22 percent of the funds of funds in each sub-strategy are significantly asymmetric. However, there are vast differences between the sub-strategies when the asymmetrical cases are separated into negative and positive asymmetries. For the diversified, market defensive and strategic sub-strategies, most of the asymmetry is negative; this is particularly so for the diversified sub-strategy where all cases of significant skewness are negative. Of particular interest is the conservative sub-strategy: 16 percent of these funds of funds have significantly positive asymmetry. This positive asymmetry advantage was not picked up in the standard summary statistics. In fact, Table 3 shows that the mean skewness value for the conservative funds of funds was –0.96, and that 58 percent of conservative funds of funds demonstrated significant skewness. Most of these are negatively skewed, so that over 50 percent of the sample ended up being significantly negatively skewed according to the standard skewness statistic. However, our binomial testing finds only 1 conservative case of significant negative asymmetry. Figure 3, which presents a histogram of the skewness statistics for the conservative funds of funds, clearly shows there is no error here. There is heavy skewness to the right close to the mean. The figure demonstrates that mean skewness figures can give a very misleading picture of the skewness of a particular sample.

Delineation of the asymmetry by distribution interval (Panel B) gives further insights into the distributional characteristics of the funds of funds. Most of the asymmetry occurs within one standard deviation of the mean, and the vast majority of this asymmetry is negative. This bunching of negative observations just below the mean in approximately 12 percent of funds of funds is consistent with the argument that the double fee structure of funds of funds reduces month-to-month returns. But this is a very small proportion of the sample; it must be remembered that most funds of funds show no significant asymmetry either way.

5.2 Distribution-free tests

The Wilcoxon Rank Sum test identified asymmetry in only 15 funds of funds (and in none of the indices), 12 of which were identified in the binomial tests as being significantly asymmetric within 1 standard deviation of the mean. The Wilcoxon test is particularly appropriate for identifying differences between the means, and the
rejection of the null hypothesis of equality in the underlying distributions adds depth
to the finding from the binomial tests that asymmetry is found very close to the mean
in this small set of significant cases. The Siegel-Tukey test also identified 15 cases of
significant asymmetry, but only 4 of these overlap with the significant cases found in
the binomial tests. The Siegel-Tukey test is particularly appropriate for detecting
differences in dispersion, and it is clear that these findings suggest no difference in
spread of negative and positive excess returns about their means.

6. Summary and conclusions

Using data for 332 funds of hedge funds for the period from January 1990 to May
2003, we address two major issues relating to the distributions of fund of funds
returns. First, are returns asymmetric? Second, if they are asymmetric, is this due to
observations in the tails (in particular the left tails, as is often assumed for hedge fund
returns), or it due to asymmetry closer to the mean? We argue that funds of hedge
funds’ returns are the most appropriate data to use in examining the issue of non-
normality in hedge funds, because funds of funds do not suffer to the same extent
from several well-recognised data conditioning and other biases.

Consistent with prior studies, we find that the funds of funds composite index and the
indices for the sub-strategies (with the exception of the conservative index) appear to
underperform the hedge fund index on a risk-adjusted basis. Mean figures for the full
fund of fund sample are comparable. Over half the sample is significantly skewed
according to the skewness statistic, and these significantly skewed cases are split
50/50 positive and negative. Using the binomial test of asymmetry in various
intervals of the distribution, we find no evidence of significant asymmetry in the
funds of funds composite index, nor in the indices for the sub-strategies diversified,
market defensive and strategic. However, we find evidence of positive asymmetry in
the interval ½ to 1 standard deviation either side of the mean for the conservative
index.

For the individual funds of funds, we find evidence of asymmetry using the binomial
test in about 20 percent of cases. Most of this asymmetry occurs within half a
standard deviation of the mean, and in most cases the asymmetry is negative. This
finding is consistent with the explanation found in prior studies for the apparent below-par performance of hedge funds: that they underperform to the extent of their ‘double fee’ structure. However, the findings for the conservative funds are very different. Sixteen percent of conservative funds of funds show significant positive asymmetry within 1½ standard deviations of the mean. This skewness advantage is not apparent in the skewness statistics; in fact the skewness statistic (and the average skewness for the conservative funds) paints a picture of conservative fund of fund performance that is highly misleading.

An important finding of this paper is that extreme realisations of returns do occur in the funds of funds data, but not at frequencies sufficient to register at standard levels of statistical significance in tests that make no strong assumptions about the underlying distributions. This may be due to the relatively short return histories that are an unavoidable feature of funds of funds data. Nevertheless this is precisely why a non-parametric approach is appropriate. By making no strong assumptions about the distributional properties of funds of funds, we gain clearer insights into the return behaviour of a relatively new asset sub-class.
References


Amin, G.S. and H.M. Kat (2002b) “Portfolios of hedge funds” ISMA discussion papers in finance 2002-07, University of Reading.


Kat, H.M. and S. Lu (2002) “An excursion into the statistical properties of hedge funds” ISMA discussion paper 2002-12, University of Reading.


Peiró, A. (2002), Skewness in Individual Stocks at Different Investment Horizons, Quantitative Finance 2, 139-146

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<tr>
<th>Age</th>
<th>Count</th>
<th>Cumulative count</th>
<th>Proportion of sample (%)</th>
<th>Cumulative proportion (%)</th>
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<td>&lt; 6 months</td>
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<td>6 – 12 months</td>
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<td>58</td>
<td>6.1</td>
<td>11.1</td>
</tr>
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<td>119</td>
<td>11.6</td>
<td>22.7</td>
</tr>
<tr>
<td>18 – 24 months</td>
<td>38</td>
<td>157</td>
<td>7.2</td>
<td>29.9</td>
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<td>24 – 30 months</td>
<td>36</td>
<td>193</td>
<td>6.9</td>
<td>36.8</td>
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<td>74.9</td>
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<td>469</td>
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<td>100.0</td>
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<td>Annual standard deviation</td>
<td>Monthly Sharpe ratio</td>
<td>Jensen’s $\hat{\alpha}$</td>
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<td>------------------------</td>
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<td>0.12</td>
<td>-</td>
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<td>5.86</td>
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<td>0.37*</td>
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<td>0.37</td>
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<td>Diversified</td>
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<td>0.50*</td>
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<td>Strategic index</td>
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<td>9.51</td>
<td>0.26</td>
<td>0.57*</td>
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</tbody>
</table>

**Notes.** This table shows the average annualised return, the annualised standard deviation, Sharpe ratio, Jensen’s alpha and skewness and kurtosis statistics for the various fund and market indices (these kurtosis statistics have been standardised such that the kurtosis of the normal distribution is zero). The asterisks denote significant different from zero at the 5 percent level. The last column reports the Jarque-Bera statistic, and in brackets the p-value for the test that the returns distribution is normal against the alternate hypothesis that it is non-normal.
### Table 3 Summary statistics and basic performance measures for individual funds of funds

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<th></th>
<th>annualised average return</th>
<th>annualised standard deviation</th>
<th>skewness</th>
<th>kurtosis</th>
<th>Sharpe ratio</th>
<th>Jensen’s ( \hat{\alpha} )</th>
</tr>
</thead>
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<td>9.48</td>
<td>7.76</td>
<td>-0.12</td>
<td>7.03</td>
<td>0.27</td>
<td>0.45 (56%)</td>
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<td><strong>Sub-strategies</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>conservative (n = 74)</td>
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<td>3.50</td>
<td>-0.96</td>
<td>9.64</td>
<td>0.44</td>
<td>0.38 (81%)</td>
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<td>diversified (n = 153)</td>
<td>10.11</td>
<td>7.15</td>
<td>0.11</td>
<td>6.68</td>
<td>0.26</td>
<td>0.51 (59%)</td>
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<tr>
<td>market defensive (n = 34)</td>
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<td>0.17</td>
<td>6.52</td>
<td>0.31</td>
<td>0.70 (68%)</td>
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<tr>
<td>strategic (n = 71)</td>
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<td>12.88</td>
<td>0.11</td>
<td>5.32</td>
<td>0.09</td>
<td>0.28 (20%)</td>
</tr>
</tbody>
</table>

**Notes.** This table shows the mean values for the sample’s average annualised return, annualised standard deviation, skewness and kurtosis statistics (the kurtosis statistics have been standardised such that the kurtosis of the normal distribution is zero), monthly Sharpe ratio and Jensen’s alpha. In brackets under the values for skewness, kurtosis and alpha is the proportion of the sample or sub-sample where the parameter is significantly different from zero at the 5 percent level.
### Table 4 Distribution characteristics of indices: binomial test of intervals

<table>
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<tr>
<th></th>
<th>±½σ</th>
<th>½σ - 1½σ</th>
<th>1½σ - 2σ</th>
<th>2σ-3σ</th>
<th>3σ-4σ</th>
<th>4σ-5σ</th>
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<td></td>
</tr>
<tr>
<td>negative</td>
<td>22</td>
<td>26</td>
<td>10</td>
<td>8</td>
<td>4</td>
<td>1</td>
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<td>16</td>
<td>7</td>
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<td><strong>hedge fund</strong></td>
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<td></td>
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<td></td>
<td></td>
</tr>
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<td>negative</td>
<td>28</td>
<td>23</td>
<td>12</td>
<td>7</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>positive</td>
<td>40</td>
<td>28</td>
<td>14</td>
<td>4</td>
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<td>1</td>
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<td>9</td>
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<tr>
<td>p-value</td>
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<td></td>
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<td>negative</td>
<td>36</td>
<td>16</td>
<td>11</td>
<td>6</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>positive</td>
<td>40</td>
<td>32</td>
<td>9</td>
<td>1</td>
<td>4</td>
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</tr>
<tr>
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<td>0.03*</td>
<td>0.82</td>
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<td>1</td>
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<td>12</td>
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<td>20</td>
<td>9</td>
<td>6</td>
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<td>p-value</td>
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<td></td>
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<td>0.56</td>
<td>1</td>
<td>0.45</td>
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</table>

**Notes.** This table gives the proportion of the sample between the mean and ±½, ½-1, 1-1½, and 1½-2, 2-3, 3-4 and 4-5 standard deviations either side of the mean. For each index, the negative and positive counts and in brackets the proportions of the sample in that category, and the p-value for the test that the distributions of the absolute value of the excess returns are equal. * denotes significance at the 5 percent level.
Table 5 Distribution characteristics of funds of funds: significant cases of asymmetry using the Binomial test

<table>
<thead>
<tr>
<th></th>
<th>conservative</th>
<th>diversified</th>
<th>market defensive</th>
<th>strategic</th>
<th>Total</th>
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<td><strong>Panel A: Cases of significant asymmetry anywhere in the distribution</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>count</td>
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<td>33</td>
<td>7</td>
<td>13</td>
<td>66</td>
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<tr>
<td></td>
<td>(18%)</td>
<td>(22%)</td>
<td>(21%)</td>
<td>(18%)</td>
<td>(20%)</td>
</tr>
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<td>negative</td>
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<tr>
<td></td>
<td>(1%)</td>
<td>(17%)</td>
<td>(21%)</td>
<td>(15%)</td>
<td>(14%)</td>
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<td>21</td>
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<tr>
<td></td>
<td>(16%)</td>
<td>(5%)</td>
<td>(0%)</td>
<td>(3%)</td>
<td>(6%)</td>
</tr>
</tbody>
</table>

| **Panel B: Asymmetry in different intervals either side of the mean** |          |             |                  |           |       |
| count          | 3            | 18          | 4                | 8         | 33    |
| ±½σ            |              |             |                  |           |       |
| negative       | 1            | 16          | 4                | 6         | 27    |
| positive       | 2            | 2           | 0                | 2         | 6     |
| ½σ-1σ count    | 7            | 12          | 3                | 4         | 26    |
| negative       | 0            | 8           | 3                | 4         | 15    |
| positive       | 7            | 4           | 0                | 0         | 11    |
| 1σ-1½σ count   | 3            | 3           | 0                | 1         | 7     |
| negative       | 0            | 2           | 0                | 1         | 3     |
| positive       | 3            | 1           | 0                | 0         | 4     |

Notes. The cells in this table show the count of cases where significant asymmetry was found using the Binomial test. Panel A summarises the cases where asymmetry was found anywhere in the distribution, and in brackets underneath count is the proportion of cases in each listed sub-strategy found significant. Panel B separates the significant cases into locational categories: ½ standard deviation, ½ to 1 standard deviation, and 1 to 1½ standard deviations either side of the mean. No significant asymmetry was found further out toward the tails than 1½ standard deviations from the mean. Four cases appear twice; 1 each of strategic, conservative and diversified were found significant in both the ½ to 1σ and the 1-1½σ regions, and 1 diversified case was found significant in both the ±½σ and 1-1½σ regions.
Figure 1: Histograms of returns on the S&P 500, hedge fund and funds of funds composite indices, January 1990 to May 2003.
Figure 2: Histograms of the returns for the funds of funds sub-strategy indices, January 1990 to May 2003.
Figure 3: Histogram of skewness statistics for conservative funds of funds (n = 74)

mean skewness = -0.96