HEDGE FUNDS

By J. J. Caslin

[Presented to the Faculty of Actuaries, 16 February 2004]

ABSTRACT

The paper opens by showing how certain types of hedge funds can reduce the risk and increase the return on a traditional balanced managed fund. One of the key characteristics of such a hedge fund is that it has a low correlation with the balanced managed fund. The paper puts forward a new way of explaining correlation so that it can be more readily understood, and suggests methods of analysis for dealing with the fact that correlation is unstable. Volatility correlation is also examined because of its importance in reducing the risk of a portfolio.

An outline of the characteristics and risks of three types of hedge funds, namely, long/short equity, convertible arbitrage and merger arbitrage, together with some questions investors might put to prospective hedge fund managers is given in Section 5.

Some of the very basic statistical analysis techniques used in assessing the past performance of hedge funds are given in Section 6. Considerable emphasis is put on the need to examine daily return data as an insight into the quality of the manager's IT systems, his risk management, evidence of smoothing of returns, and to gain access to a higher number of data points for assessing the repeatability of performance.

An entire section of the paper is devoted to gaining a clear understanding of a prospective hedge fund manager's volatility management strategy because of its importance in the context of the fee structure of hedge funds and its importance for assessing the ability of a hedge fund to reduce the risk and increase the returns of a balanced managed fund.

Funds of hedge funds are examined in the final section, and the section concludes that large sophisticated institutional investors may wish to create a portfolio of hedge funds rather than invest in a fund of hedge funds.

CONTACT ADDRESS

John Caslin, Alder Capital, 59 Merrion Square, Dublin 2, Ireland. Tel: +353-1-614-7232; Fax: +353-1-614-7410; E-mail: john.caslin@aldercapital.com

1. INTRODUCTION

There is no universally agreed definition of a hedge fund. One possible definition of a hedge fund is as follows:

441

A hedge fund is an investment characterised by some or all of the following features:

(1) hedge fund investment vehicles may not be open to the general public;
(2) the minimum investment may be very high by the standards of mutual funds;
(3) there may be a general lack of transparency regarding the investment strategy;
(4) long and short positions can be taken as part of the investment strategy;
(5) positions may be leveraged;
(6) there may be capacity constraints on the amount of money that can be managed within a hedge fund investment strategy;
(7) the level of regulatory supervision of the investment vehicle may be low relative to long-only funds;
(8) fees are structured at two levels, namely, an annual management fee and a performance fee; and
(9) there may be a minimum investment time horizon or a rolling minimum notice period before investors can withdraw their money.

Performance fees are perhaps new to readers who are only familiar with long-only investment strategies. Performance fees are charged on the increase in value of a fund over the previous high, so, when the value of a hedge fund falls below the previous high, no performance fee is charged until the value of the fund rises above the previous high.

Equities were chosen as the asset class for illustrating many of the points in the paper because of most people's familiarity with equities. This is not to suggest that equity securities in some way make up the only asset class. The examples could easily have been based on other asset classes, like cash, commodities, bonds, currencies and derivatives.

The text applies equally to male and female hedge fund managers but the hedge fund manager is referred to as 'he' throughout to avoid the use of the clumsy 'he/she'.

2.   Summary and Conclusions

The paper is divided into six sections. Each section is summarised below and its main conclusion noted.

2.1   Section 3

Section 3 is an illustration of the need for assets that do not have their positive and negative return months of return at the same time (uncorrelated assets) to achieve a significant reduction in investment risk. The section shows that the reduction in investment risk from combining two 'balanced'

managers is relatively small compared with that achieved by combining a balanced manager with a certain kind of hedge fund. Combining a balanced manager and a hedge fund can, not only yield a significant reduction in investment risk, but also, in certain circumstances, can lead to an increase in investment return. This is not to say that any hedge fund chosen at random and combined with a balanced fund will yield a portfolio that has lower risk than the balanced fund.

2.2 *Section 4*

Section 4 looks at the characteristics that a hedge fund must have so that when it is added to a portfolio of assets, like that of a pension scheme, it will reduce the risk of the combined portfolio and increase its return.

Modern portfolio theory provides us with a starting point in the screening process to find hedge funds with the desired characteristics. To achieve the twin goals of higher returns and lower risk, we would need to screen hedge funds on the basis that they have higher returns than the existing portfolio and a low correlation to the existing portfolio.

This, however, is just a starting point. Correlation is not stable, and it is vital to check how the hedge fund performs when the existing portfolio has its worst and best returns. We must also take account of the hedge fund strategy, and consider whether there are extreme market events that would cause the hedge fund to move in line with the existing portfolio. The use of volatility correlation analysis is also described in this section.

2.3 *Section 5*

Section 5 explains why you cannot rely on past performance information as even a vague guide to the future, unless you understand the nature of the hedge fund manager's strategy and the risks that he takes in generating returns.

The concept of short selling is explained in considerable detail.

Three different types of hedge funds, long/short equity, convertible arbitrage and merger arbitrage, are examined in detail. For each type of hedge fund, the strategy is explained and the risks in the strategy are identified. As the risks are identified, a list of questions that you might like to ask your prospective hedge fund manager is identified.

The section closes with a discussion of the qualitative factors that one might like to consider before appointing a hedge fund manager. These include key personnel, fees, infrastructure and organisation, lockup periods and transparency.

2.4 *Section 6*

Section 6 looks at some of the more basic statistical analysis techniques for analysing the past performance of hedge funds. Data quality and number of observations are discussed.

Considerable emphasis is laid on 'playing' with the data, so both graphical and numerical analysis techniques are described.

The graphical techniques include: histogram, empirical cumulative distribution function, high-value versus low-value plots, box diagrams, assessing tail thickness, and the distribution of returns in time. The graphical techniques are used to gain a feel for the distribution of returns in terms of outliers, thickness of tails, skew, mean/median, and some idea of variability about the mean.

The numerical techniques focus on mean, median, standard deviation, co-efficient of variation, Sharpe ratio, ranking of returns, maximum drawdown, skewness and kurtosis. Particular emphasis is placed on kurtosis, as it is interpreted as a measure of the variability of the risk of the fund and an indicator of future surprises for investors. Volatility correlation analysis is also recommended as part of the statistical analysis.

Throughout the section the techniques are illustrated using data from an actual hedge fund.

2.5 *Section 7*

Section 7 explains the need for hedge fund investors to understand the volatility management strategy of a hedge fund. This is particularly so in hedge funds, because of the nature of their fee structure and the desire on the part of investors to minimise surprises.

Three factors that drive hedge fund volatility are listed, and their implications for investors discussed.

Risk monitoring by the investor and the benefits of a constant level of risk are discussed.

2.6 *Section 8*

Funds of hedge funds are discussed in Section 8. The attractive features of these vehicles in terms of diversification and professional management are outlined. However, for institutional investors, assessment of the fund of hedge funds manager is vital. There is a discussion of some of the main questions that an institutional investor might ask a fund-of-hedge-funds manager. The section concludes that large sophisticated institutional investors may wish to create a portfolio of hedge funds rather than invest in a fund of hedge funds.

3. WHY BOTHER WITH HEDGE FUNDS?

3.1 *Introduction*

Before we spend any time trying to understand hedge funds and how to select them, let us start by asking the question: "Why bother with hedge funds?"

We will begin to illustrate the answer by looking at the issues that might arise for pension fund trustees.

Table 3.1. Summary of performance for Manager A

Statistic	Value
Percentage of months with a positive return	65%
Percentage of months with a negative return	35%
Performance in month with the best return	+8.95%
Performance in month with the worst return	−10.39%
Average monthly return	+1.05%
Standard deviation of monthly returns	3.62%
Excess kurtosis of monthly returns	0.0116

Suppose that you have entrusted the investment management of your pension scheme to Manager A, and have decided to invest the scheme's assets in a 'managed fund'. Looking back over the last 130 months of his performance, you find that Manager A had a positive return in 65% of months and a negative return in 35% of months.

Over the 130-month period, the best monthly return for the period was +8.95%. The worst monthly return for the period was −10.39%.

The average monthly return for the period was +1.05%. To give us some idea of the spread of returns around the average, we look at the standard deviation of monthly returns for the period, and this comes out at 3.62%. The excess kurtosis of your manager's performance is 0.0116. We will discuss the calculation and possible interpretations of kurtosis later. For now, it is enough to note that the excess kurtosis of the normal distribution is zero, and that kurtosis is a measure of the extent to which the probability density of a distribution departs from that of the normal distribution.

Table 3.1 summarises some features of Manager A's performance.

3.2 *Diversifying the Portfolio using Another Managed Fund*

Suppose that you decide to give half of the pension scheme assets to another fund manager, called Manager B, and again choose a balanced portfolio and invest in Manager B's 'managed fund'. The idea is to 'diversify' the pension scheme's investment portfolio.

At the very minimum, this strategy of splitting the assets between two managers gives a diversification of credit risk (if the assets are on the managers' balance sheets), and possibly a diversification of investment style. Manager A's style may be different to that of Manager B.

Manager A and Manager B are actual investment managers of pension scheme assets, and have operated in Ireland for over ten years. Pension investment returns were chosen so that there would be as little tax distortion in the comparison as possible. The source of the data is MoneyMate.

The summary statistics for Manager B are given in Table 3.2.

If we looked at the month-by-month performance of two such managers of balanced pension funds over any long period, we would find a pattern in their returns. In general, if Manager A produces a positive return for its

Table 3.2.   Summary of performance for Manager B

Statistic	Value
Percentage of months with a positive return	65%
Percentage of months with a negative return	35%
Performance in month with the best return	+8.05%
Performance in month with the worst return	−8.09%
Average monthly return	+0.99%
Standard deviation of monthly returns	3.29%
Excess kurtosis of monthly returns	−0.1045

balanced pension fund in any given month, then Manager B will, in all likelihood, produce a positive return in that same month. Similarly, if Manager A produces a negative return in a month, in all likelihood Manager B will produce a negative return in that month too.

Let us look of the returns of Manager A and Manager B over the 130-month period. In all, we observe 130 months of performance for each manager. We could think of how the two managers performed over the 130 months in terms of a two × two matrix of outcomes.

The four possible outcomes in the matrix are as follows:

(1) Manager A posts a positive return in a month, while Manager B also posts a positive return in the same month;
(2) Manager A posts a positive return in a month, while Manager B posts a negative return in the same month;
(3) Manager A posts a negative return in a month, while Manager B posts a positive return in the same month; and
(4) Manager A posts a negative return in a month, while Manager B posts a negative return in the same month.

If we were looking for diversification, then it would be pleasing to find that, in the months when Manager A turned in a negative performance, Manager B turned in a positive performance. What would be even better is if the positive return of Manager B on his portion of the assets of the scheme were greater than that of the negative return of Manager A on his portion of the scheme.

Similar compensatory figures would be desirable, so that when Manager B turns in a negative return Manager A would turn in a positive return.

Table 3.3 shows the percentage of months in which the four outcomes occurred.

In 62% of the months, Manager A posted a positive return for the month and so did Manager B. In 30% of the months, Manager A showed a negative return for the month and so did Manager B. So, in 92% (62% + 30%) of the months, Manager B's performance was in the same direction as Manager A.

By contrast, when Manager A posted a negative return, Manager B made up for that negative return by a positive return in just 4% of months, and vice versa.

Table 3.3.   Percentage of months in which each of the four possible outcomes occurred

	Manager A posted a positive (+) outcome	Manager A posted a negative (−) outcome
Manager B posted a positive (+) outcome	62%	4%
Manager B posted a negative (−) outcome	4%	30%

Table 3.4.   Summary of performance for the (50/50) combination of Manager A and Manager B

Statistic	Value
Percentage of months with a positive return	63%
Percentage of months with a negative return	37%
Performance in month with the best return	+8.21%
Performance in month with the worst return	−9.11%
Average monthly return	+1.02%
Standard deviation of monthly returns	3.41%
Excess kurtosis of monthly returns	−0.0335

Table 3.3 shows that, if you chose Manager A as your main manager and have introduced Manager B for diversification purposes, then you have not got much diversification.

The good and bad outcomes of Manager A and Manager B tend to occur at the same time, so there is not much reduction in the dispersion of returns that you get by just investing in Manager A.

The returns of Manager B are said to be highly correlated with those of Manager A.

Table 3.4 has the summary statistics for the performance of the combination of Manager A and Manager B. It shows that there has been a slight reduction in the average monthly return and the standard deviation compared with investing all the scheme's assets in Manager A. The maximum and minimum returns of the combination of Manager A and Manager B have also come in slightly compared with those of Manager A.

All things considered, there is very little to be gained in terms of risk reduction or return by splitting your fund between two managers that invest in roughly the same underlying assets. As mentioned previously, there may be some reduction in credit risk.

3.3   *Diversifying the Portfolio using a Hedge Fund*

Now, let us split our investment between Manager A and a hedge fund, where the underlying assets are currencies (Currency Fund).

Table 3.5.   Summary of performance for Currency Fund

Statistic	Value
Percentage of months with a positive return	65%
Percentage of months with a negative return	35%
Performance in month with the best return	+13.29%
Performance in month with the worst return	−12.97%
Average monthly return	+1.47%
Standard deviation of monthly returns	4.45%
Excess kurtosis of monthly returns	0.4624

The summary statistics for Currency Fund are shown in Table 3.5.

The percentages of positive and negative return months for Currency Fund are not too dissimilar to those of either Manager A or Manager B. The range of performance, defined as that in the best month minus that in the worst month, is significantly wider than for either of the other two managers. This shows up in the standard deviation being higher than for either of Manager A or Manager B. The average return of Currency Fund is also higher than that of Manager A or Manager B.

Again, we look at the returns of Manager A and Currency Fund over a 130-month period starting in January 1993 and ending with the month of October 2003. The currency fund chosen for this example is based in the United States of America, and has operated since January 1993. In all, we observe 130 months of performance for Manager A and Currency Fund. Again, we could think of how the two managers performed over the 130 months in terms of a 2 × 2 matrix of outcomes.

The four possible outcomes in the matrix are as follows:
(1) Manager A posts a positive return in a month, while Currency Fund also posts a positive return in the same month;
(2) Manager A posts a positive return in a month, while Currency Fund posts a negative return in the same month;
(3) Manager A posts a negative return in a month, while Currency Fund posts a positive return in the same month; and
(4) Manager A posts a negative return in a month, while Currency Fund posts a negative return in the same month.

Table 3.6 shows the percentage of months in which the four outcomes occurred.

In 41% of the months, Manager A posted a positive return for the month, and so did Currency Fund.

In 11% of the months, Manager A showed a negative return for the month, and so did Currency Fund. Remember that the corresponding entry for this cell when Managers A and B were combined was 30%. So, we have significantly reduced the downside risk of the combination of Manager A and another manager.

Table 3.6.   Percentage of months in which of the four possible outcomes occurred

	Manager A posted a positive (+) outcome	Manager A posted a negative (−) outcome
Currency Fund posted a positive (+) outcome	41%	24%
Currency Fund posted a negative (−) outcome	24%	11%

In 52% (41% + 11%) of the months, the performance of the Currency Fund was in the same direction as Manager A — contrast this with a figure of 92% when Manager B is combined with Manager A.

When Manager A posted a negative return, Currency Fund made up for that negative return by a positive return in 24% of months, compared with just 4% of months in the case of Manager B. In such months, the combined portfolio, on average, turns in a return just slightly below zero, which is better than just taking all of Manager A's negative returns.

What about Currency Fund dragging down Manager A's positive returns with negative returns? In such months, the combined portfolio, on average, turns in a strong positive return.

You can see from Table 3.6 that, if you chose Manager A as your main manager and have introduced Currency Fund for diversification purposes, then you have achieved significant diversification. The good and bad outcomes of Manager A and Currency Fund tend to occur at different times, so there is a significant reduction in the spread of returns that you get compared with investing in Manager A alone.

Table 3.7 has the summary statistics for the combined portfolio of Manager A and Currency Fund.

The combined portfolio has a much lower range of performance compared with Manager A, and this shows up in the significant reduction in standard deviation compared with Manager A alone.

Table 3.7.   Summary of performance for the combined portfolio (Manager A (61%) and Currency Fund (39%))

Statistic	Value
Percentage of months with a positive return	68%
Percentage of months with a negative return	32%
Performance in month with the best return	+8.47%
Performance in month with the worst return	−7.90%
Average monthly return	+1.21%
Standard deviation of monthly returns	2.75%
Excess kurtosis of monthly returns	0.5577

The average return of the combined portfolio is higher than that of Manager A, and the risk (standard deviation of return) of the combined portfolio is of the order of 25% lower than that of Manager A.

3.4 *Reasons for including Hedge Funds in a Portfolio*

So, by combining assets that have their positive and negative months of return at different times, we have reduced the risk of the pension scheme assets and increased their return.

What are the implications of being able to do this?

On the face of it, we have:

(1) brought up the percentage of months with positive returns;
(2) reduced the spread of returns especially on the downside;
(3) increased the average monthly return; and
(4) reduced the standard deviation of returns.

The kurtosis of the monthly returns of the combined portfolio has increased from 0.0116 for Manager A alone to 0.5577 for the combination of Manager A and Currency Fund. This is an interesting development, given that the range of the combined portfolio is tighter than for Manager A alone, and demands a closer look.

Later in the paper, we shall see that kurtosis is a unit-less quantity, being the fourth moment of the data about the mean, divided by the standard deviation of return raised to the power of four. In the case in point, the fourth moment of the distribution of monthly returns of the combined portfolio has indeed reduced, but the standard deviation of return has reduced more rapidly, letting the kurtosis drift higher.

As kurtosis is unit-less, we always need to view it in terms of the size of the standard deviation of the same data set.

3.5 *FRS 17*

If you are the sponsoring employer of a pension scheme grappling with the new pension accounting standard (FRS 17), rising pensioner annuity costs and a rate of investment return that was behind salary inflation over the last three years or so, then this finding, on the face of it, may be of interest to you.

As a sponsoring employer of a defined benefit pension scheme, FRS 17 reporting obligations mean that your firm's pension expense charge in its performance statement (P&L account) is significantly influenced by the expected rate of return on the pension scheme assets. In the past, the pension expense in the performance statement tended to be the contributions paid by the sponsoring employer to the pension scheme. Under FRS 17, any increase in the expected return on the pension scheme assets will allow the sponsoring employer, subject to the sponsoring employer convincing the Scheme Actuary and the firm's auditor of the higher expected return, to

reduce the pension expense charged to the firm's performance statement. This is good news for companies hard pressed to show ever rising earnings from one year to the next.

Another implication of FRS 17 is that any surplus or deficit in a pension scheme finds its way onto the balance sheet of the sponsoring employer. So, asset volatility in the pension scheme leads to balance sheet volatility for the sponsoring employer. However, balance sheet volatility raises questions in the minds of analysts and lenders about dividend policy and the risk of breaching borrowing covenants. Reducing the spread of returns, especially on the downside, significantly improves the impact of this problem on the sponsoring employer. The reduction in the volatility of the pension scheme assets can also be seen in the reduction in the standard deviation of the returns on the combined portfolio. Reducing the range of returns is also very significant. It means reducing the number of surprises. This is good news, as analysts and shareholders hate surprises, particularly surprises with negative implications for earnings.

The general tightening up of the distribution of returns and the improvement of returns should also help on the funding side. There should be fewer periods where the investment return is less than salary inflation, and higher returns should go some way to lessening the extent of contribution increases to fund the cost of higher pension annuities arising from longer life expectancy.

This is what certain hedge funds can do for investors' portfolios. So, they are worth investigating further.

Putting all of what we have seen into more mathematical language, we would say that Currency Fund has a low correlation with Manager A, and it was this low correlation that lead to the reduction in the risk of the combined portfolio.

So, combining assets that are uncorrelated with each other (i.e. have their positive and negative return months at different times) can significantly reduce risk, and, in some cases, even increase return on a portfolio.

3.5.1 *High equity content leads to a coincidence of risks*
When the assets of a pension scheme are heavily invested in equities, there may be a coincidence of risks for the members. If the outlook for the growth in corporate earnings deteriorates, then share prices are likely to fall in value. So, a fall in the value of the assets of a pension scheme is likely to occur at a time when the sponsoring employer is least able (poor earnings outlook) to fund an increase in the contribution rate of the scheme. This is a coincidence of risks in the funding of pension schemes that needs to be brought to the attention of trustees by actuaries.

Further, if the outlook for the growth in corporate earnings is poor, and remains so for a considerable period of time, share prices are likely to fall in value, and, at the same time, the risk of the sponsoring employer being wound up increases. A fall in share prices may leave the scheme in a less than

fully-funded position. So, if the employer is wound up, not only will the employees lose their jobs, but they will also lose a substantial part of their accrued pension rights. This coincidence of risks needs to be brought to the attention of trustees, so that they can take this point into account in designing the asset distribution of the investment portfolio of their pension scheme.

This coincidence of risks is just an extension of the Irish rule, which limits the extent to which 'self investment' can be taken into account in valuing the assets of a defined benefit scheme for the purposes of giving a funding certificate to the Pensions Board.

A similar issue arises for a with-profits fund backed by a high level of equities, especially where a group of with-profits funds have a high concentration of equities in one market. When equities fall in value, with-profits funds are often forced to reduce their equity content, leading to further selling and a further reduction in the value of the with-profits fund, leading to a vicious downward spiral in value.

3.6 *Another Reason to Bother with Hedge Funds*

Apart from reducing risk and increasing return, investing in certain types of hedge funds may be justified simply on the basis of superior performance, provided that it does not add significantly to the risk of a portfolio.

4. CHOOSING A HEDGE FUND TO DIVERSIFY A PORTFOLIO

4.1 *Introduction*

Let us continue our discussion of hedge funds by looking at the problems facing the sponsoring employer of a pension scheme. Let us assume that the pension scheme's assets are invested in a unit-linked pension balanced fund. This assumption has been made, because returns for such funds are widely and readily available, and because tax does not distort the investment returns to any significant extent.

If the sponsoring employer and the trustees of a pension scheme want to invest some of the scheme's assets to get the benefits which we saw in Section 3, the question arises: "What kind of characteristics should a hedge fund have?"

The chosen hedge fund must have its good and bad return months at different times to those of our unit-linked balanced fund. Many hedge funds would claim this 'diversifying effect', but it is important to check the extent of the diversification.

So, are there any simple tests or a simple theory that will help us to find such funds?

4.2 *Modern Portfolio Theory*

Despite its limitations, modern portfolio theory is a starting point.

Modern portfolio theory tells us that, if we add an asset to our existing

portfolio, the expected return on the new portfolio is just a linear combination of the expected return on the two assets. Let us look at Example 1.

4.2.1 *Example 1*

Suppose that our estimate of the expected return on the pension scheme's assets is 14.5% p.a., and that the annualised standard deviation of monthly returns is 12.2%. (The annualised standard deviation is simply the monthly standard deviation multiplied by the square root of 12, which is approximately 3.464.)

Similarly, suppose that we have a range of hedge funds to choose from, all with an expected return of 20.0% p.a., and an annualised standard deviation of return of 18.3%.

The expected return on a new portfolio R_n, consisting of a proportion p of the unit-linked pension balanced fund and the proportion $(1 - p)$ of the hedge fund, is given by the equation:

$$R_n = p * 14.5\% + (1 - p) * 20.0\%. \tag{1}$$

Ignoring the possibility that we could sell either fund short, by varying p we can get any return between 14.5% p.a. and 20.0% p.a., but nothing outside this range. So, once we use some of the hedge fund in our new portfolio, we can bring up the expected return on the new portfolio.

However, what of the risk (as measured by standard deviation) of the new portfolio σ_n? Ideally, we would like to bring up the return on the new portfolio, and bring down the risk.

According to modern portfolio theory, the risk of the new portfolio is not a linear combination of the risks of the two assets being combined, rather it is given by the formula:

$$\sigma_n = \{p^2(12.2)^2 + (1 - p)^2(18.3)^2 + 2\rho(12.2)(18.3)p(1 - p)\}^{1/2} \tag{2}$$

where ρ is the coefficient of correlation between the two assets being combined.

So, the risk of the new portfolio depends very much on the value of ρ. The coefficient of correlation varies, ranging from +1 (perfectly positively correlated) through 0 (no correlation) to −1 (perfectly negatively correlated). You may say that it also depends on the proportion $(1 - p)$ invested in the hedge fund. It does; but we can choose the proportion invested in the hedge fund to minimise the risk for any given coefficient of correlation.

Figure 4.1 shows how the risk of the combined portfolio varies with the coefficient of correlation between the hedge fund and the unit-linked pension balanced fund. For each coefficient of correlation, the proportions have been chosen so as to minimise the risk of the new portfolio.
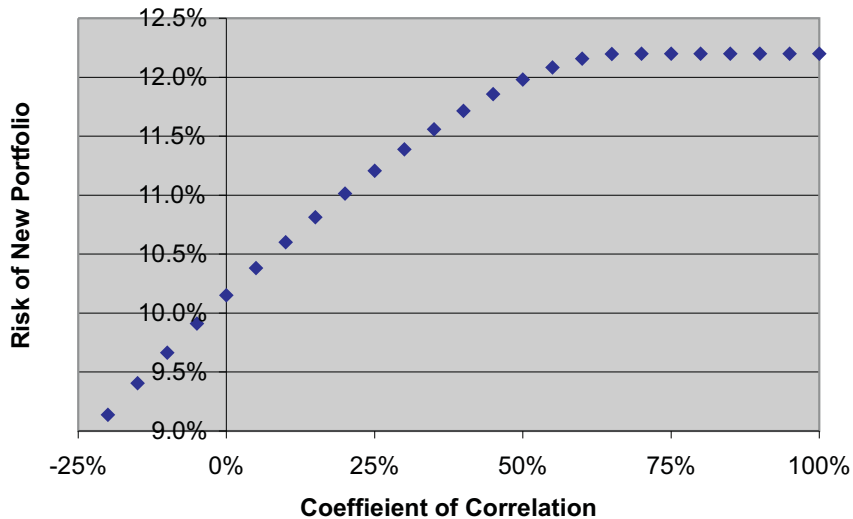
Figure 4.1.   Reducing risk by adding an uncorrelated asset

One idea jumps out at us from Figure 4.1. There is no significant reduction in the risk of the new portfolio unless the coefficient of correlation between the hedge fund and the unit-linked pension balanced fund is below 50%.

Where the hedge fund has a correlation of 50% or more with the unit-linked pension balanced fund, the expected return on the new portfolio may be higher, but it provides little in the way of risk reduction.

Once any percentage of the hedge fund is introduced into the portfolio, the return will rise, because of the linear combination rule for returns — see equation (1). The proportion in the hedge fund and the unit-linked pension balanced fund varies with the coefficient of correlation between the two funds. So, it is interesting to see how the return varies with the coefficient of correlation.

Figure 4.2 exhibits the expected return using the proportions that minimise the risk for each level of correlation. Combinations have been restricted so as to avoid short selling — hence the flat part of the curve between coefficients of correlation of 100% and 70% (approximately).

For coefficients of correlation of 50% or less, not only do we get a reduction in risk, but we also get a steady increase in return, reflecting the fact that more of the hedge fund is being used in the new portfolio.

A rise in the annual expected rate of return of just 1.5% may seem small, but it would reduce the funding rate for a new entrant with 30 years to retirement by 6.3% of salary. (The base funding rate before the rise in expected return was calculated using a rate of investment return of 7% p.a.
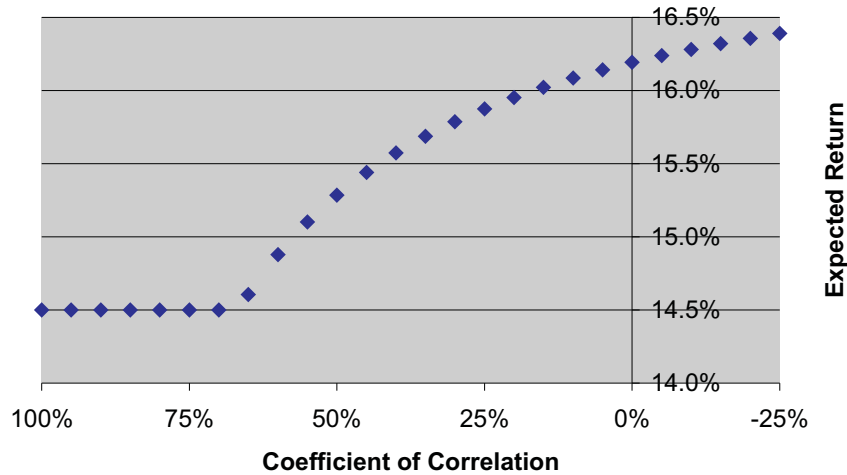
Figure 4.2.   Rise in expected return using proportions that minimise risk of new portfolio

and a rate of salary growth of 5% p.a. The employee is funding for 30 years for a 2/3rds pension with escalation in payment. An annuity factor of 18 was used. No allowance was made for pre-retirement mortality.)

Even a modest rise in the annual return of just 0.5% would reduce the funding rate by 2.2% of salary.

For a company with an annual salary roll of €10,000,000, the 0.5% p.a. increase in investment return represents a saving of €220,000.

Figure 4.3 shows the proportion that has to be allocated to the hedge fund to minimise the risk of the combined portfolio as the coefficient of correlation varies. Again, we see a flat line in the chart from 100% to 70% (approximately) correlation, representing our restriction on short selling. At zero correlation, the proportion is about 31% of the fund allocated to the hedge fund. This is a big proportion for a pension scheme to allocate, but remember that it comes with a reduction in risk from 12.2% to 10.2% and an increase in expected return from 14.5% to 16.2%.

4.3   *Stability of Correlation Coefficients*

A key assumption in all of the foregoing discussion is that we have assumed that the coefficient of correlation is constant. The coefficient of correlation between an investor's portfolio and the hedge fund being considered as a candidate to diversify the portfolio, or enhance its return, or do both, will, in general, not be stable. The coefficient of correlation may vary with the returns on the investor's portfolio.
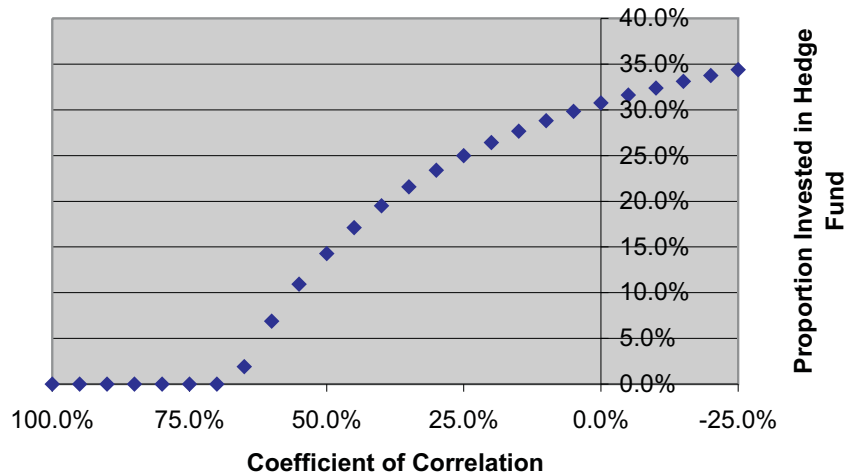
Figure 4.3. Proportion invested in hedge fund to minimise risk of new portfolio

Variability (over time and with events) in the coefficient of correlation between an investor's portfolio and the hedge fund being considered for addition to the portfolio is not necessarily a bad thing.

4.3.1 *Worst possible type of variation*

Probably the worse phenomena that one might observe are that, when the investor's portfolio suffers substantial falls in value, the coefficient of correlation increases, and when the investor's portfolio rises in value, the coefficient of correlation decreases. In these cases, just when we thought that we could rely on the hedge fund to act as a diversifier on the downside, it begins to behave as badly as the investor's original portfolio; and just as the investor's portfolio begins to improve, it acts as a break on performance.

4.3.2 *Best possible type of variation*

The ideal pattern of variation in the coefficient of correlation would be one where the coefficient of correlation becomes more negative when the investor's portfolio suffers substantial falls in value, and becomes more positive when the investor's portfolio rises.

For any given portfolio, there are no easy rules of thumb for finding hedge funds with the latter pattern of variation with the investor's portfolio. We need to do two things in this regard:

(1) Examine the return data for the hedge fund and the investor's portfolio, and try to get some feel for the way in which the correlation

coefficient varies. In particular, we need to look at what happens to the performance of the hedge fund that we propose to add to our portfolio:
(a) when the investor's portfolio suffers substantial falls in value; and
(b) when it goes onto a rising trend.

(2) Gain an understanding of the circumstances under which the investor's portfolio and the hedge fund might become highly correlated or uncorrelated.

This analysis can be greatly facilitated by developing the two-by-two matrix, shown in Section 3. It shows whether the hedge fund is detracting from, or adding to, the performance of the investor's portfolio when it is going up, and similarly when it is going down, in value.

We might look at the average performance of the investor's portfolio and the hedge fund in each cell; check if the weighted combination of the two makes a positive or negative contribution to overall returns; rank the monthly performance data for the investor's portfolio; identify the best 10% and the worst 10% of months for the investor's portfolio; and ask the questions: "How has the hedge fund behaved during the portfolio's best 10% of months, and how has it behaved during the portfolio's worst 10% of months?"

4.3.3 *Illustration of technique*

We will use the data in Section 2 to illustrate the technique.

Out of the 130 consecutive months observed for Manager A, there were 46 losing months. In six of these losing months, Manager B turned in a positive return. Let us look in the $(+, -)$ cell, which represents the six months when Manager A lost money and Manager B turned in a positive return. (The first entry in the bracket $(+, -)$ denotes the moves of Manager B; the second the moves of Manager A; $+$ denotes a positive return in a month; and $-$ a negative return in a month.) On average, the 50/50 combination of Manager A and Manager B turned in an average loss of 0.24%. So, on average, Manager B did not make up for Manager A's negative return.

Similarly in the $(-, +)$ cell, Manager A turned in, on average over the two months, a return of 0.84%, whereas Manager B showed an average loss of 1.32%. On average, this cell contributes a negative return to the period under review.

Overall, there is little or no diversification benefit from combining Manager B with Manager A.

In the context of our discussion of correlation stability, we can see that Manager B is positively correlated with Manager A, both when Manager A does well and when Manager A does poorly. The correlation coefficient seems to be quite stable in that regard.

Looking at the average returns of Manager B and the investor's portfolio

on a cell-by-cell basis, we find that, apart from the $(+, +)$ cell, the average return of the combination of the two managers in the three remaining cells is negative.

4.3.4 *Stress testing the correlation coefficient*

Looking now at the ten best months for the investor's portfolio and the ten worst months for the portfolio, we can see that the correlation coefficient is highly stable.

One feature of Table 4.1 is striking. Manager A and Manager B seem to have their good and bad months at the same time. In none of Manager A's worst ten months did Manager B turn in a positive return to compensate for Manager A's negative return. In fact, seven of Manager A's worst ten months were also in Manager B's list of worst ten months.

In Manager A's best ten months Manager B also produced a positive return. Again, seven out of Manager A's ten best months were among Manager B's best ten months.

Based on past data, Table 4.1 shows that Manager A and Manager B are

Table 4.1.   Ten worst and ten best months for Manager A and the returns of Manager B in those months (the months are not shown to preserve the anonymity of the managers)

Month	Manager A's performance	Manager B's performance
1	−10.39%	−7.84%
2	−7.30%	−8.09%
3	−7.20%	−7.18%
4	−5.68%	−5.60%
5	−5.64%	−5.45%
6	−5.17%	−5.04%
7	−4.91%	−2.79%
8	−4.68%	−3.04%
9	−4.60%	−4.92%
10	−4.32%	−1.78%
.	.	.
.	.	.
.	.	.
.	.	.
10	8.95%	7.48%
9	8.34%	8.05%
8	7.99%	6.77%
7	7.63%	4.79%
6	7.12%	6.34%
5	7.00%	6.15%
4	6.89%	4.96%
3	6.62%	6.65%
2	6.38%	4.44%
1	6.14%	5.52%

Table 4.2.   Ten worst and ten best months for Manager A and the returns
of Currency Fund in those months

Month	Manager A's performance	Currency Fund performance
1	−10.39%	2.42%
2	−7.30%	−3.34%
3	−7.20%	−9.00%
4	−5.68%	7.72%
5	−5.64%	−3.45%
6	−5.17%	−2.47%
7	−4.91%	3.01%
8	−4.68%	0.92%
9	−4.60%	−4.97%
10	−4.32%	3.08%
.	.	.
.	.	.
.	.	.
.	.	.
10	8.95%	−3.20%
9	8.34%	−0.17%
8	7.99%	0.98%
7	7.63%	−0.77%
6	7.12%	3.98%
5	7.00%	3.20%
4	6.89%	−2.09%
3	6.62%	−0.26%
2	6.38%	−7.62%
1	6.14%	4.33%

highly correlated, and that the correlation is quite stable in both the good
and bad times for Manager A.

4.3.5   *Illustration of technique — introducing a hedge fund*

Table 4.2 shows the ten worst and ten best months for the investor's
portfolio (Manager A) and the returns for Currency Fund in those months.

During the ten worst months of Manager A's performance — all of
which showed negative returns — Currency Fund turned in a positive return
in five out of those ten months. There is only one month in the intersection
between the set of ten worst months for Manager A and the same set for
Currency Fund.

Currency Fund produced positive returns in 50% of Manager A's ten
worst months.

So, in a portfolio consisting of Manager A and Currency Fund, the latter
pulls up the performance of the portfolio when Manager A turns in a
negative return in 50% of the months. During Manager A's worst ten
months, Currency Fund provided excellent compensation for Manager A's
return in 50% of the months.

During Manager A's best ten months, Currency Fund turned in four positive returns and five negative returns. The set of Manager A's best ten months and that of Currency Fund have no months in common. The set of Manager A's ten best months has two months in common with the set of ten worst months of Currency Fund.

So, in 40% of Manager A's best ten months, Currency Fund is turning in a positive return too, while in the other 60% it is turning in a negative return. So, Currency Fund is behaving independently of Manager A.

Out of the 130 consecutive months observed for Manager A, there were 46 losing months. In 31 of these losing months, Currency Fund turned in a positive return. Let us look in the $(+, -)$ cell, which represents the 31 months when Manager A lost money and Currency Fund turned in a positive return. (The first entry in the bracket $(+, -)$ denotes the moves of Currency Fund; the second the moves of Manager A; $+$ denotes a positive return in a month; and $-$ a negative return in a month.) On average, the return of Manager A was a loss of 3.02%, whereas Currency Fund turned in an average gain of 4.42%. This is a significant improvement compared with the Manager A/Manager B combination.

In the $(-, +)$ cell, Manager A turned in, on average over the 31 months, a return of 3.49%, whereas Currency Fund showed an average loss of 2.58%. While there are more entries in this cell compared to the Manager A/Manager B combination, on average its contribution is positive. This was not the case in the Manager A/Manager B combination.

There has been a significant reduction in the number of entries in the $(-, -)$ cell compared with the Manager A/Manager B combination, and clearly this improves the performance of the Manger A/Currency Fund combination.

4.4 *Conclusion*

When an institutional investor is choosing a hedge fund to diversify its portfolio and enhance its returns, it may firstly screen hedge funds on the basis of returns and correlation to its existing portfolio. (We will examine biases in the returns of hedge funds, reported by large hedge fund databases, in Section 8.)

4.4.1 *Reason for return screening*

The expected return on a portfolio, consisting of the chosen hedge fund and the investor's existing portfolio, is a linear combination of the expected returns on the hedge fund and the existing portfolio. To get higher returns, one must find a hedge fund which has a higher expected return than that of the investor's existing portfolio.

4.4.2 *Reason for correlation screening*

Risk reduction, especially when it is accompanied by an increase in return, is a very attractive feature; but, while a level of correlation below,

say, $+50\%$ may, at first sight, appear attractive, it is necessary to examine the behaviour of the hedge fund in the context of the performance of the institutional investor's portfolio.

The coefficient of correlation is a summary measure, where lots of terms can partially cancel each other out, so that one needs to take a close look at the underlying data.

Here are some of the key questions to ask when looking at the returns of the hedge fund and the investor's portfolio:

(1) How does the two × two matrix of returns look?

(2) How did the hedge fund behave during the ten best months (in terms of performance) of the investor's portfolio? (In the context of looking at best performing months and worst performing months, ten is an arbitrary number. It is best to look at the greater of 10% of the total number of observation periods and ten observation periods.)

(3) How did the hedge fund behave during the ten worst months (in terms of performance) of the investor's portfolio?

(4) What contribution to the overall correlation do the ten best and ten worst months' performances of the investor's portfolio make to the coefficient of correlation between the hedge fund and the investor's portfolio? (It is not enough to find the coefficient of correlation between the ten best/worst months of the investor's portfolio and the hedge fund. One must look at how much these months contribute to the denominator of the coefficient of correlation.)

All of this analysis can be done easily on a spreadsheet or using proprietary hedge fund analysis software. It merely involves sorting and ranking dates and the returns of the investor's portfolio and the hedge fund, calculating a few summary measures, and calculating the component parts of summary measures.

4.4.3 *Volatility correlation*

It is often instructive to examine volatility correlation, which can be measured by looking at the correlation of returns squared. This identifies the extent to which the two components of a portfolio have their 'big' moves at the same time.

If the correlation of returns between two investments is low, but volatility correlation is high, it may mean that the two investments had their big moves at the same time, but that these moves were in opposite directions. Investors might consider the economic or market circumstances in which the two investments might have their big moves in the same direction at the same time, in the future.

When volatility correlation is high and the return correlation is high, the risk of a very large move in the same direction by the two components of the portfolio is very high.

5. Issues to Consider in Choosing a Hedge Fund Manager

5.1 Introduction

We are all familiar with the, by now, famous statement in all investment advertisements, which goes something like this:

> "Past performance may not be a reliable guide to future investment performance."

In the context of hedge funds, the caveat might be rephrased as:

> "In the absence of an understanding of how the hedge fund manager generates returns and controls the risk of the fund, past performance is no guide to future investment performance."

Here is a simple illustration of the need for the preface to the normal caveat.

Suppose that a hedge fund manager simply invested his clients' money in cash deposits, and, to deliver the 'hedge fund' rather than just cash returns, he writes one-month out-of-money call and put options on the S&P 500 Index.

The strike prices of the put and call options that he writes are chosen to be at the edge of the 99% confidence interval for the monthly movements in the S&P 500 Index. This gives the hedge fund manager a small amount of additional income, in the form of the option premiums, which boost the monthly return on the fund — provided that the options are not exercised.

To understand the point being made here, let us assume that the monthly returns on the S&P 500 Index are normally distributed. So, on average, we would expect that the options would be exercised once in every 100 months, or, put another way, once in about every eight years.

Figure 5.1 shows the positive payoff for a wide range of movement in the S&P 500 Index and the sharp losses if the index moves outside the 2.5 standard deviation ranges. Zero represents the level of the index when the options were written. On average, in 99 out of every 100 months the manager
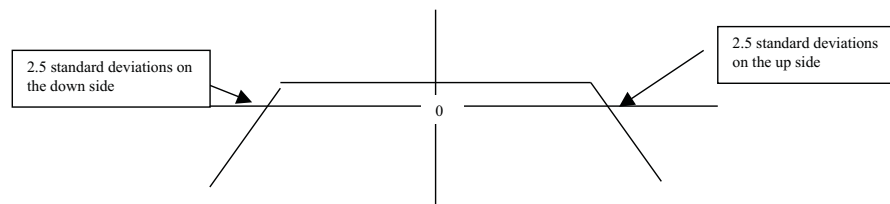

Figure 5.1.   Payoff profile of the hedge fund manager's option positions

will generate extra return — option premiums — from writing the options, but, until he is hit by the shock event, the extra risk will not show up in his standard deviation of returns.

If we were to examine, say, five years of performance history for the fund — during which the options were never exercised — we would find that it had an excellent Sharpe ratio. (The Sharpe ratio is the excess return on the fund above the risk free rate of interest divided by the standard deviation of the fund's returns.) Simulations suggest a Sharpe ratio somewhat in excess of ten for the months before the shock occurs; the shock being that the index moves by more than 2.5 standard deviations from its value at the beginning of a month, causing either the put or the call options to be exercised against the hedge fund manager. This hedge fund manager is, in effect, assuming a form of 'jump' risk — a low probability risk, but with serious consequences for the return of the hedge fund.

Based on past performance alone, one might be tempted to invest, only perhaps to find that the big shock comes a few months later. The S&P 500 Index suffers a three standard deviation move, and the hedge fund manager has to pay out on one of the options.

A simulation of the impact that this once-in-100-months event would have on the returns of the fund suggests that, up to the month prior to the shock move, the annualised return on the fund might be about 7% p.a. After the big move, the return falls to 2.5% p.a. The Sharpe ratio suddenly becomes negative — something of the order of minus ten!

A hedge fund investor who does not understand what the manager is doing is likely to get one, if not many, big surprises.

Now you can see the need for the preface to the caveat.

5.2 *Short Selling*

To understand the return opportunities and the risks in hedge funds, we need firstly to come to grips with the concept of short selling.

5.2.1 *Short selling — the concept*

A hedge fund that wants to 'sell short' the shares of a particular company, borrows the shares from another investor. This borrowing is usually done through a prime broker. Prime brokers provide three main services to hedge funds:

(1) clearing of trades and custody of purchased assets;
(2) margin financing to allow hedge fund managers to leverage their exposures to instruments and markets; and
(3) stock lending, in that prime brokers borrow securities from other market participants and lend them to hedge funds for short selling activities.

The prime broker acts as an intermediary for the hedge fund in the stock

borrowing process. The prime broker has relationships with other investors in the market, which are prepared to lend their securities to other market participants in return for a small fee. Lending is fully collateralised by the prime broker, so the risk to the lender of stock is relatively small.

5.2.1.1 *Short rebate*

When the hedge fund sells the borrowed securities, cash is generated. This cash is held on deposit by the prime broker, and usually earns a money market rate of interest. The interest on this cash is split three ways. The hedge fund manager generally gets the lion's share of the interest, followed, in order of share, by the prime broker and the lender of the stock, who gets the smallest part of the interest. This interest is often referred to as the 'short rebate'. A significant proportion of the income generated by a hedge fund engaged in short selling could arise from the short rebate.

If it becomes difficult to borrow a stock, then the split of the 'short rebate' can change significantly. The lender of the stock does not usually get any additional income, though sometimes he may. The prime broker takes a bigger slice of the interest income, and the borrower of the stock, the hedge fund, gets less than it would normally get. Occasionally, the hedge fund might have to pay to borrow stock.

5.2.1.2 *Returns from short sales*

Suppose that a hedge fund has borrowed a stock and sold it. If the price of the stock falls, the hedge fund manager will make a profit, as he can now buy the stock back in the market at a lower price than he sold it for, and return it to the stock lender via the prime broker. However, if the price of the stock rises, the hedge fund manager will have to pay more than he got for selling it to buy it back, which will result in a loss on the transaction.

5.2.1.3 *Short sales and dividends*

If any dividends arise during the period when the stock is borrowed, the hedge fund must make good these payments to the lender of stock. These payments will have to come from the hedge fund manager's own resources, as, not owning the stock, it does not receive the dividend. The recent changes in U.S. tax legislation regarding dividends increase the cost to short sellers of financing of manufactured dividends when shorting United States' stocks.

5.3 *Understanding what the Manager is Doing*

There are many different types of hedge funds, and each type has its own return and risk characteristics. In discussing the investment and risk management strategy of a hedge fund with its manager, focus on the returns that were achieved, how they were achieved, and the risks taken in achieving them. Look for a consistent approach, and ascertain the market conditions necessary to make returns for investors.

In this section we will analyse the risks that three different types of hedge fund managers take in generating returns. These three types of hedge funds illustrate many of the risks found in hedge funds. The three types are long/short equity, convertible arbitrage and merger arbitrage.

5.3.1 *Long/short equity*

Long/short equity funds may not be the biggest category of hedge funds by assets under management, but they are certainly the biggest category by number of funds.

5.3.1.1 *Background*

The theory is very simple. Long/short equity hedge fund managers buy equities that they think will rise in value in whatever markets they are operating, and sell equities that they think are going to fall in value. By analogy with a unit-linked life fund, the long/short equity fund manager goes long undervalued stocks, or stocks in sectors or countries which the manager expects to rise in the coming days, weeks or months; but, by contrast with the traditional unit-linked fund manager who reduces his exposure to stocks/sectors/countries that he thinks are overvalued or likely to under perform, the long/short equity fund manager borrows such stocks. He then sells them in the hope of buying them back at a lower price, and then returning the borrowed stock to the lenders via his prime broker. In addition, he earns interest on the cash which he generates when he sells stocks that he has borrowed.

In view of their familiarity with top-down asset allocation and/or bottom-up stock picking, many institutional fund managers offer long/short equity hedge funds to the investing public. In recent times, institutional investors have been to some extent forced into running such funds to retain their 'brightest and best' from among their long-only fund managers.

5.3.1.2 *Long/short strategies*

The manager may use his judgement to decide the stocks that will fall into the long and the short parts of the hedge fund portfolio. Alternatively, the manager may employ a model to generate the list of stocks to buy and the list to sell short. In either case, potential investors would need to get some understanding of how the selections are made and how the manager has performed on his long positions and on his short positions.

If a long/short equity hedge fund manager were short 20 pharmaceutical stocks and long 20 other pharmaceutical stocks, the investment strategy would appear to be one of stock selection. In the best case scenario, all of the manager's long stocks rise in value and all of his short stocks fall in value.

In the worst case scenario, the manager's long stocks could fall in value and his short stocks could rise in value, leading to severe losses on the portfolio. While the stocks in the long section of the portfolio might fall to

zero, those in the short section of the portfolio risk producing unlimited loss as the prices of the stocks rise.

Diversification of the portfolio across different market sectors can mitigate this risk, as can stop-loss arrangements. (The stop-loss arrangement may be an option (put, if it is a long position, and call, if it is a short position) or simply a rule to buy (for short positions), or sell (for long positions), or the arrangement may be underwritten by a market maker.) Details of stop-loss arrangements need to be investigated quite thoroughly by investors, as the loss may not stop at the stop-loss point. There is a temptation for stop-loss underwriters to push prices through the stop-loss limit to gain trading fees and dealing profits. This would be in breach of market manipulation rules, but it is difficult to detect. So, it is important to examine the wording of the stop-loss agreements.

Hidden in the portfolio there may be currency risk. Are all 40 stocks denominated in the same currency? If they are not, ask the manager how he is managing the currency risk in his portfolio.

Suppose that the manager is short 20 drug delivery companies and long 20 drug R&D companies. Currency risk aside, this portfolio reflects two very different investment views. A risk in this strategy is that the manager's views prove wrong, and that drug delivery companies rise in value while drug R&D companies fall in value; but the strategy shows just how flexible the long/short equity manager can be in developing investment strategies. Managers may also construct portfolios which have zero beta with respect to the market.

A key issue is the extent of diversification as a means of controlling the imperfect hedge of trying to be positioned somewhat long, or somewhat short, relative to the market.

5.3.1.3　*Liquidity risk*

Ask the manager how he is managing his liquidity risk. What are his liquidity criteria? Are the liquidity criteria able to liquidate 90% of the portfolio within one trading day and the balance within two trading days? What you are really trying to gauge is whether the manager has a handle on liquidity statistics for the stocks which he is buying or shorting.

In the second largest equity market in the world, Japan, liquidity was so bad in February 1999 that, on one particular day, there was more volume in one large stock, Dell Computer (traded on the NASDAQ exchange in the U.S.A.), than in the whole of the Tokyo Stock Exchange.

Liquidity risk is a 'jump' risk (a 'jump' risk is one which, when it happens, causes the value of the portfolio to move by several standard deviations in a very short period of time), and can lead to 'surprises' ('surprises' can be thought of as losses significantly in excess of what one might have expected based on the past performance data for the manager; there can be positive

surprises too) for investors. If a hedge fund manager is not measuring liquidity, then he probably is not monitoring it.

When it comes to liquidity risk, particularly in respect of the short side of the portfolio, your long/short equity hedge fund manager needs to be able to demonstrate a clear understanding of who the other market participants are.

Are they institutional investors, and, within the institutional investor class, are they active or passive fund managers? The chances are that passive fund managers will not recall stocks which they lent with anything like the frequency of active managers. Are they foreign institutional investors, or are they domestic institutional investors? Is it the case that liquidity could be severely hit if the foreign investors try to sell on bad macro-economic news, as there will be no natural buyers of the market? Foreign investors can have a huge impact on the performance of individual stocks.

Are they individual investors, and have they bought their shares on margin? Individual investors tend to be more 'emotional' than institutional investors, and, if they have bought on margin and their portfolios start to show losses, positions can be unwound with shocking haste, leaving it very difficult for a long/short equity hedge fund manager to unwind his long positions.

5.3.1.4 *Illustration of the liquidity risk*

Another aspect of liquidity risk to explore with your manager is the variation of liquidity risk with the market capitalisation of stocks. If the market is made up of a significant number of individual investors trading on margin and active, as opposed to passive managers, second line stocks can fall by up to three times the expected fall in a day. Just look at the falls in second line technology stocks in March 2000, if you need to get a feel for this issue. Ask your long/short equity hedge fund manager about the market capitalisation of the stocks which he goes long or short of in the fund. Compare his answers with the market capitalisation of the major stocks in the markets covered by the stated investment policy.

5.3.1.5 *Borrowing risk*

To continue to benefit from the short positions in a long/short equity hedge fund when the shorted stocks are falling in price, the hedge fund manager needs to be able to continue to borrow the stocks which he has sold short.

If the lender of the securities decides to recall his stock, and the hedge fund manager cannot borrow those securities elsewhere, then he must buy the stock in the market. The risk for the hedge fund manager, in such circumstances, is that the price of the stock may now have risen, and he may have to pay more for it than he originally got for it when he sold it. As part of the hedge fund strategy, the manager may also have to unwind some corresponding long position in another stock at the prevailing price, and he runs up unanticipated transaction costs on the two deals.

Care needs to be exercised when dealing with certain active fund managers who also provide stock lending services. If the active fund manager's performance is not up to scratch for a particular time period, he has the potential to manipulate his portfolio valuation at, say, month end by recalling a selection of the stocks which he lent. If there is not much of the stock available for borrowing, this could trigger a sharp rise in the price of the stock, as hedge fund managers rush to buy in the stock. This pushes up the valuation of such stocks, which helps the lender's month end valuation numbers. This type of activity is prohibited under the Central Bank of Ireland's Handbook for Investment Firms — it is, in effect, market manipulation. The problem is that it is very difficult to prove that it is market manipulation.

You need to assess the level of risk under this heading when talking to your long/short equity hedge fund manager. Here are some of the key issues:

— How does the hedge fund manager screen stocks to reduce this risk? If we start with a universe of stocks, we could rank them by market capitalisation. This would help us rule out those stocks, the market capitalisations of which are so small, that they could not be sold short in sufficient quantity to be of any use to the portfolio. This probably eliminates all small capitalisation stocks and most mid-cap stocks.

— If a hedge fund manager shorts these latter two types of stock, you would want to get a handle on how he manages the risk of not being able to borrow stock for his short positions.

— Having shortlisted stocks by market capitalisation, the next step is to get some idea of how much of each stock is available for trading, 'the free float', as opposed to tightly held and not traded. After that the key question is: "How much of the free float can be borrowed?"

— Borrowing stock from retail investors is not attractive. They are too disparate a group, and the amount of stock held by each one would be small by institutional standards. Institutional investors are a more attractive source from which to arrange a borrowing. However, a hedge fund manager can borrow only from those institutional investors that have stock lending agreements in place.

— Average daily trading volume, and the size of a stock's bid-offer spread and trends in these two measures, are also useful indicators of the liquidity of a stock.

— Within the institutional investor bracket, it is more stable to borrow from passive as opposed to active fund managers. Active fund managers tend to sell holdings more often than passive fund managers who are matching an index.

Many of the problems of stock borrowing are delegated by hedge fund managers to their prime brokers, and you may find that long/short equity

fund managers deflect all questions on this topic by saying: "The prime broker looks after it." However, the hedge fund manager needs to understand the prime broker's policy in relation to buying in stocks that must be returned to their lenders. The 'buying-in' policy differs from prime broker to prime broker. Broadly speaking, the policy may be to ask each hedge fund to buy in:

(1) pro rata to the total amount of the particular stock which the prime broker has borrowed;
(2) on a 'last in first out' basis;
(3) on the basis of type of client — for example, retail clients before institutional clients; or
(4) by size of assets under management — for example, clients with smallest assets under management first.

To manage the risk, hedge fund managers need to understand the policy, and, if necessary, work out where they are in the pecking order. If the lender of stock is a global custodian, which has stock lending agreements with several of its institutional clients, the risk of a 'short squeeze' is reduced because of the diversity of lenders of stock in the global custodian's portfolio.

5.3.1.6 *Trade execution risk*

In the U.S.A., shares can only be sold short on an 'up-tick'. In other words, the stock price has to have risen immediately before the stock is sold short. This presents a major execution risk for long/short equity managers when they are going short of a U.S. listed stock. If a hedge fund manager sells U.S. equities short, then you need to find out how he manages this risk. The risk arises, not only at the inception of the trade, but also arises if the hedge fund manager needs to sell more of the stock short for exposure or portfolio risk management purposes. It would be important to get a handle on how the manager handles this risk. It is believed that the U.S. Securities & Exchanges Commission (SEC) may soon rescind the rule. (Futures contracts covering individual shares are soon to be made available in the U.S. market. Shorting the futures contract on the stock will, in effect, allow traders to get around this rule. So, one might reasonably conclude that the rule will be abolished by the SEC when futures contracts on individual shares arrive.)

In Europe, there is no regulatory requirement for an 'up-tick' in the price of a stock before shares can be sold short.

5.3.1.7 *Regulatory risk*

The impact of events such as 11 September 2001 in the U.S.A. on markets can also affect a hedge fund manager's ability to sell stocks short. When the U.S. markets opened for the first few days after the tragedy, it was seen as unpatriotic to sell U.S. stocks short. In Hong Kong, after the

1987 crash, short selling was forbidden for a period. In the latter part of September 2001, the Financial Services Authority (FSA) in the United Kingdom asked insurance companies to stop lending stock. This would have caused a slight shortage of certain stocks, but did not have any significant effect on the market for borrowing stock.

5.3.1.8 *Other risks*

Short selling gives rise to some unusual position size effects compared with, say, a unit-linked fund. If the price of an individual stock in a unit-linked fund rises, the value of the portfolio rises along with the rise in the value of the stock. In a portfolio where shares are sold short, if the price of a stock *rises* above the level that it was sold for, the value of the portfolio will *fall*, and more margin must be paid over to the prime broker to collateralise the stock lender. So, the exposure of the portfolio to the stock rises. Position limits for individual stocks need to be put in place to ensure diversification of stock specific risk.

A similar problem arises where the price of a stock which has been sold short falls in value. In a unit-linked fund, when a stock falls in value, the value of the portfolio also falls in value, and the stock makes up a smaller percentage of the overall portfolio. When a stock which has been shorted falls in value, the value of the portfolio rises, but the value of the position in the stock falls. To keep the same exposure to the shorted stock, the manager must keep shorting the stock. Ask the manager how these problems are handled, and what position risk limits he operates.

In general, long/short equity funds tend to have a net long or net short position relative to the market, or markets, in which they operate. Some long/short equity hedge fund managers may claim to be neutral relative to the market. It is important to check claims of net long, net short or neutral, by examining the performance of the hedge fund during extreme market moves, and discussing the results with the hedge fund manager. The sensitivity of the long and the short sides of the long/short equity fund to market movements may not be the same. For example, the beta of the long side of the portfolio may be 0.6 whereas that of the short side of the portfolio might be 1.6. Depending on the relative value of the long and short sides of the portfolio, a 5% rise in the market could have a devastating effect on the portfolio.

Some long/short equity hedge fund managers claim to be neutral relative to the market. Managing risk relative to the market, unfortunately ignores absolute risk, which is likely to become increasingly important for pension schemes with the advent of FRS 17. Ask your manager how he measures and manages absolute risk.

5.3.2 *Convertible arbitrage*
5.3.2.1 *Background*

During the recent bear market, while revenues at investment banks fell, due to a slowdown in mergers and acquisitions activity and equity

underwriting, the convertible bond market was one of the few income streams preventing revenues from falling further.

By mid June of 2001, Wall Street underwriters had sold nearly as much in convertible bonds as they had in the whole of 2000. The *Financial Times*, quoting Thompson Financial Securities Data, reported that $49bn was raised in convertible bond sales in the U.S.A. by mid June 2001.

Hedge funds, especially those specialising in convertible arbitrage, have become big buyers of convertible bonds. By early June 2001, the convertible arbitrage section of the CSFB/Tremont hedge fund index had shown a return of +7.6% for 2001, compared with a loss of over 5% for the S&P 500 in the same period.

5.3.2.2 *Nature of convertible loan stocks*

A convertible bond is a hybrid security. It pays a regular coupon and has maturity proceeds, just like a bond, but it gives the holder the right, but without obligation, to convert the security into a fixed number of shares of the issuer of the security, at a fixed price, on a fixed date or fixed dates in the future. For equity investors, convertibles are seen as equity exposure, but with a bond floor. The equity investor hopes that, even if the underlying share price performs badly, the company will not default on its bond covenant, thus providing a floor to the value of the security. For bond investors, a convertible is a bond with upside potential.

5.3.2.3 *Looking at a convertible bond in different ways*

A convertible bond could be looked at as a bond with an embedded option on the equity shares of the issuer of the bond. Another approach would be to look at a convertible as the equivalent number of equity shares, as specified by the convertible loan stock documentation and a stream of excess income. The excess income is the excess of the convertible bond coupon over the dividend income from the equivalent number of shares. This latter approach ignores the option aspects of a convertible bond, but is a useful way of looking at one in certain circumstances. The general strategy in convertible arbitrage hedge funds is to buy the convertible loan stock and hedge some, or all, of the risks associated with holding a convertible loan stock.

5.3.2.4 *Convertible bond markets*

The major convertible bond markets of the world are located in Japan, Europe and the U.S.A. Table 5.1 has a summary of approximate market size and credit quality.

5.3.2.5 *Hedging the residual risks*

The risk that is most often hedged in convertible arbitrage hedge funds is the risk that the redemption (the exchange of the convertible bond for cash or equity securities of the issuer) or 'principal component' of the bond's price will fall. This is hedged by selling short the underlying equity security. So, the

Table 5.1.   Convertible bonds; approximate market size and credit quality

Convertible bond market	Approximate market size	Credit quality
U.S.A.	U.S.$180bn	Predominantly sub-investment grade issues
Europe	U.S.$180bn	Predominantly investment grade issues
Japan	U.S.$400bn	Predominantly investment grade issues

hedge fund manager buys a convertible loan stock, borrows an appropriate amount of the underlying security through his prime broker, and then sells this amount of the underlying security in the market. If the issuer goes into liquidation and its share price collapses, the loss on the bond should be made up by the gain on the short position in the issuer's shares.

Looking at a convertible bond as the equivalent amount of underlying shares and a stream of excess income, it is easy to see why, being long, the convertible bond and short the underlying equity effectively eliminates principal risk. If the price of the share underlying the convertible falls, the hedge fund manager's losses on the long shares' component of the convertible will be compensated by the profits on his short position in the underlying equities, assuming that the manager's hedging is correct. The manager is just left with the stream of excess income. The stream of excess income is, at the very minimum, subject to liquidity, credit and interest rate risk.

5.3.2.6   *Hedging the principal risk*

The key risk that convertible arbitrage hedge fund managers hedge is the principal risk, the risk that the equity securities of the issuer will have fallen in value by the time conversion must take place.

Hedging this risk is very specialised; the value of the convertible bond does not move exactly in line with the value of the appropriate number of shares underlying the convertible. There is an assumption here that the price of the convertible and the related securities are correlated in some way. That may be so in general, but the level of correlation may vary considerably during the life of the hedge, and it needs to be managed carefully. As a general rule, the lower the credit quality of the issue, the greater the volatility of the underlying stock and the more difficult it is to manage this risk.

If you intend to invest in a convertible arbitrage hedge fund, you will need to get some idea of the manager's skills in maintaining the principal risk hedge. Some managers use models to manage this risk. In any case, you will need to get a feel for where the model worked well and where it did not, and assess the contribution that this risk makes to overall portfolio risk.

Sometimes, as part of managing the principal risk, the hedge fund manager may need to short more stock. Managing the principal risk is, in effect, a form of delta hedging, but delta keeps changing. This requires him to borrow more stock. At other times the manager may have to repay the stock which he borrowed at a time that does not suit him in terms of managing his principal risk hedge. If the manager cannot borrow more stock or is forced to return stock already borrowed, he may have to unwind his convertible bond position, and this may occur at the same time as the bond's price is depressed. In essence, the manager is a forced seller, and may face serious losses.

The issues raised for the long/short equity hedge fund managers in relation to regulatory restrictions on shorting apply here. Changes in the regulatory rules surrounding short selling can also adversely affect the whole short selling process, witness the problems in Japan in the last quarter of 1998, when the Ministry of Finance decided to stamp out what it perceived as 'attacks' on Japanese stocks by short sellers.

Find out how the manager monitors and confines himself to the universe of stocks that can be borrowed. Then, look at the extent to which the issuers of this set of securities intersects with the issuers of types of convertibles which the manager says he buys. Ask how the manager's prime broker has performed for him on this front.

5.3.2.7 *Interest rate risk*

Convertible loan stocks, being in part bonds, are sensitive to interest rate risk. They have a yield, relative to the corresponding government security, which reflects their credit rating, liquidity and any unusual features of the structure. A rise in interest rates will cause the value of a convertible bond to fall. This phenomenon hit convertible arbitrage returns in 1994.

However, the reason for the rise in interest rates may have implications for the value of the convertible, too. If interest rates rise because a central bank is trying to dampen down economic growth, and there is plenty of access to capital, then that would generally be positive for credit spreads — the excess yield on the convertible due to its lower credit rating.

However, if the rise in interest rates were accompanied by a lack of access to capital, then this would, in all probability, be negative for credit spreads. If the credit spread between convertible loan stocks and government bonds widens, the value of convertible bonds falls. A rise in credit spreads is like a rise in interest rates that is confined to corporate bonds only. A rise in interest rates or credit spreads reduces the value of the excess income stream associated with the convertible.

5.3.2.8 *Managing interest rate risk*

The interest rate risk in convertible bonds can be hedged in a number of ways. The hedge fund manager could sell government bonds or go short on

interest rate futures. This latter strategy can lead to a double whammy when credit spreads widen. The prices of convertible bonds fall, giving rise to losses for managers in their long positions, and the prices of government bonds rise, giving rise to losses on their short positions used to hedge interest rate risk.

The key issue for a hedge fund manager is to match the average weighted duration of his convertible bonds and that of the securities which he is using to hedge the interest rate risk of the portfolio. Asset swaps are also used to hedge the interest rate risk of the hedge fund manager's portfolio.

5.3.2.9 *Call risk*

When interest rates fall, the price of convertible bonds rises in value. This happened in 1992, 1993 and 1995. However, when interest rates fall, some convertible bonds are 'called' by the issuing company. Callable convertible bonds allow the company to exchange the convertible bond:

(1) for the appropriate number of the underlying equity security; or
(2) for cash.

To understand the impact on returns that the calling of a convertible has, it is useful to use the 'stock plus excess income' view of a convertible. When a convertible bond is called, the investor gets stock in lieu of his convertible bond. He must use the stock to repay the short position in the security underlying the convertible, but he loses the stream of excess income. So, calling a convertible usually results in a loss for the hedge fund manager. Typically, companies that issue convertible bonds will call them when interest rates fall, and they can refinance the debt at a lower rate.

5.3.2.10 *Managing call risk*

Call risk can be managed using a number of techniques. Top of the list is to avoid convertible bonds with call features or purchase only those issues where the legal agreement between the investor and the issuer provides for the making good of any loss to the holder when a convertible is called. Another technique is to limit the number and value of callable convertible bonds in the portfolio.

Finally, some hedge fund managers seek out this risk, but manage it in a very proactive manner. The rationale behind this approach is that the rewards from investing in callable securities can exceed the losses that arise on early calls. When a convertible becomes callable, the proactive managers who seek out callable convertible bonds contact the company to get some idea of whether the company is going to call the bond, and manage the situation in line with the company's answer.

5.3.2.11 *Volatility risk*

In looking at volatility risk, it is useful to view the convertible bond as a

combination of a bond with an embedded call option on the equity of the issuer of the bond. (The holder of a call option has the right, but is not obliged, to buy the security underlying the option for a fixed price by a certain date. The fixed price is known as the strike price or exercise price.) When volatility increases, the value of a call option increases. This arises because, if the price of the stock underlying the option is more volatile, its price is more likely to move about more, making it more likely to rise above the exercise price of the option, and turn in a profit to the holder of the option.

Suppose that volatility in the equity market is very high, not difficult to imagine if you cast your mind back to the collapse in the value of technology and telecom stocks in the first half of 2000. At a time of high volatility, the value of a call option on a stock is very high. A sharp finance director, looking to raise capital, can see the opportunity a mile away. Rather than have a rights issue at depressed equity prices, he can issue a convertible bond to raise capital. With the value of call options pushed up from a rise in volatility, investors could be attracted to a convertible bond, a hybrid security involving a call option on the shares and a bond, especially if they can buy the option cheaply. The finance director can make the option cheap by using a lower volatility assumption in pricing the option component of the hybrid security. (One could argue that the finance director is not allowing for the impact that the convertible will have on earnings per share in this approach. However, some convertible bonds cannot be exercised unless the share price has reached a certain level by a certain date. This defers the date at which the issue of the convertible will impact fully diluted earnings per share. This feature has made raising finance in the convertible market more palatable for those companies concerned with dilution of earnings per share.) Investors perceive that they are getting cheap options, which they like in uncertain times. The finance director gets low cost, fixed income finance through the issue of the bond.

In the first half of 2001, the *Financial Times* reported (*Financial Times*, 15 June 2001, quoting Thomson Financial Securities Data) that convertible bond issues raised more money than IPOs or junk bonds. New issues are a source of trading profit for hedge fund managers, especially if they can pick up the new issues at prices that reflect low volatility when volatility is high. However, there is a risk here. If volatility reduces, so will the value of convertible securities. In April 2001, the Chicago Board Options Exchange index of implied volatility registered 40% p.a. By June 2001 it was down to 20% p.a., and this was reflected in lower prices for convertible bonds.

Changes in implied volatility affect the value of convertible bonds. In fact, changes in volatility provide trading opportunities for hedge fund managers holding convertible bonds. If expected volatility increases, the 'option component' of the convertible bonds will increase, increasing the value of the bonds.

5.3.2.12 *Liquidity risk*

Liquidity risk is greatest in the convertible bonds of the smaller capitalisation companies, especially those with low credit ratings. These are the convertible bonds that no one will want if there is a 'flight to quality', a stampede by investors out of corporate debt to government bond debt. Liquidity will tend to be driven by the size of the issue, capital flows into and out of the convertible bond market, market sentiment, the credit rating of the issuer, the frequency of trades in the convertible, and the mix of participants in the convertible bond market.

In the first half of 2001, there was considerable supply in the U.S. convertible bond market, and this was matched by strong demand, mainly from hedge funds. The market was very liquid in this period. The problem now is that hedge funds may be the dominant players in the convertible bond market in the U.S. If the prices of convertible bonds fall and hedge funds decide to offload their positions, as dominant players in the market, they will have few buyers. That will cause prices to drop significantly, bid/offer spreads will widen, and these falls may force other hedge funds to liquidate positions, exacerbating the problem.

Liquidity can also be affected by variations in credit extensions provided by prime brokers and lenders and market making by broker dealers. Where there is a general 'flight to quality', liquidity can dry up very quickly.

A key issue to look at in liquidity risk is what happens if liquidity dries up on both sides of the arbitrage. In this situation, it is difficult to close out the short position and it is difficult to sell the convertible, a double whammy for the hedge fund manager. Fluctuations in liquidity can provide profitable trading opportunities for hedge fund managers.

5.3.2.13 *Supply and demand*

Over supply of new issues of convertible bonds pushes down the prices of convertible bonds. Likewise, a shortage of convertible bonds relative to supply can push up prices. When investors flee credit products, such as when Long Term Capital Management nearly collapsed, there is a huge excess of supply over demand, with consequent implications for price. Changes in the buying patterns of conventional fund managers can also cause supply or demand to change. If convertibles are fashionable, and seen as attractive by traditional bond and equity fund managers, demand will rise, and vice versa. Fluctuations in supply and demand can provide profitable trading opportunities for hedge fund managers.

5.3.2.14 *Credit risk management*

Credit risk may be seen as a relatively low risk, especially for companies with good or average credit ratings, but cast your mind back to the downgrading of 'big name' issues, like those of Lucent Technologies and Xerox.

Corporate bondholders are paid a very small spread over government

bonds to take the risk that the value of their bond will fall something of the order of 70% in the event of a default. In the world of hedge funds, we say that: "Corporate bond holders are short volatility", meaning that corporate bond holders dislike a high level of volatility in the price of the underlying share, in the same way as the writer of a put option dislikes share price volatility. Before we begin to look at some issues in credit risk, it is important to understand the wider framework in which a corporate bond exists.

In a strategy where an investor holds a convertible bond, it is very important to examine the extent to which management is remunerated by stock options. Stock option holders are long volatility and prefer more volatility in the underlying share price, which can be diametrically opposed to the interests of bond holders.

Where management is remunerated by a significant amount of stock options, there may by a tendency for management to take riskier business decisions and to increase the degree of balance sheet leverage. Neither of these two actions is generally in the interests of corporate bondholders, as we saw in the recent bear market, with spreads on BBB-rated corporate bonds moving from 70 or so basis points to 200 basis points and more over U.S. Treasury bonds.

Credit risk needs to be looked at on three levels: credit default; the risk that the credit risk premium will change; and the risk that the convertible bond will be downgraded. Potential investors need to review the credit risk policies of a convertible arbitrage hedge fund manager at all three levels.

Ask prospective convertible arbitrage hedge fund managers the following questions in relation to their credit risk management:

(1) How is credit risk measured before transactions are executed?
(2) How is credit risk measured and monitored once convertible bonds have been purchased for the portfolio?
(3) In relation to the last question, focus particularly on bonds with ratings of BBB or lower. The default rates of these bonds are relatively high in the short term, the next 12 to 24 months. (Default will not necessarily result in a complete loss of capital. Much depends on the relative ranking of the bond in the capital structure of the company.)
(4) Does the manager use a model to monitor credit quality on a real time basis? If so, what are the inputs to the model, and how has it been useful in predicting credit losses? Did it 'miss' any major credit losses for the portfolio?
(5) What is the manager's policy on concentration of credit risk?
(6) What risk reduction techniques does the manager use?

As we saw earlier, the credit quality of convertible bonds tends to be better in Japan and Europe than in the U.S.A. Look at the geographical spread of issuers, as a first attempt to get to grips with credit quality. Ask for a breakdown of the portfolio by credit quality.

Look at the portfolio, and see if the issuers are diversified by industry sector, credit quality, geographic location, type of convertible and duration. Then, ask yourself if this is consistent with the manager's stated credit risk management policies. If you think that there are discrepancies between policy and what you see in the portfolio, seek explanations.

Some convertible arbitrage managers manage the credit risk in their portfolio by diversifying, some confine themselves to high credit quality issuers, and others use credit derivatives. Credit default swaps, total return swaps and credit spread options are often used to hedge credit risk in the portfolios of convertible arbitrage hedge fund managers.

In a credit default swap, a convertible arbitrage hedge fund manager would pay a counterparty, like an investment bank, a fee for the right to receive payment in the event of an agreed change in the credit status of a convertible bond held by the hedge fund manager. In a total return swap, also known as an asset swap, the hedge fund manager pays the total return on a convertible bond or a basket of convertible bonds to a counterparty. In return, the counterparty pays the hedge fund manager periodic floating rate payments, together with payments equal to any price depreciation in the convertible bond or basket of convertible bonds. In essence, the return on the convertible bond is swapped for the return on floating rate debt.

In a credit spread option, the hedge fund manager retains the right to sell a convertible bond to a counterparty, at a predetermined spread over some reference credit, like U.S. Treasury bond yields or LIBOR. The counterparty is paid a fee by the hedge fund manager for the option. For example, suppose that a convertible bond pays a coupon of 6% and is redeemable in 2009. Let us say that its spread over the equivalent government bond (6% coupon, redeemable in 2009) stands at 80bp. If the convertible were to be downgraded, its spread would widen to, say, 280bp. The hedge fund manager may buy a credit spread option which allows him to sell the convertible bond to a counterparty at a credit spread of 180bp over the equivalent government bond. So, if the spread on the bond widens to, say, 280bp, the hedge fund manager can sell the convertible to the counterparty at a spread of 180bp. The lower the credit quality of the convertible bond, the more susceptible it is to credit spread widening events.

Risk is reduced using these types of derivatives, but so too is the return, as the hedge fund manager has to pay a fee for the protection. A thorough analysis of a convertible arbitrage hedge fund manager's credit derivatives protection requires specialist skills, spanning hedge funds and credit derivatives. Improvements in the credit quality of a convertible bond issuer and narrowing of credit spreads over government bonds of similar term and coupon provide extra return for convertible arbitrage hedge managers.

5.3.2.15 *The risk of rising dividend payments*

Looking at a convertible as 'the equivalent number of equity securities

plus the excess income on the bond over the dividend income on the securities', it is easy to see that convertible arbitrage hedge fund managers hate companies that grow their dividends. This reduces the 'excess income' of the convertible, and, at the same time, can push up the price of the associated shares: a double whammy, due to a long position in a convertible bond, the price of which falls; and a short position in a stock, the price of which is rising. There is no easy way to manage this risk. Managers need to look at trends in the cash flow of the company and the company's plans for the use of that cash, in order to keep on top of this risk. Ask the manager how he manages this risk. The implications of recent changes in U.S. dividend taxation call for a thorough analysis of this risk where the hedge fund manager is using U.S. convertible bonds.

5.3.2.16 *Traps in the legal documentation*

Before buying a convertible bond, the manager should carry out a thorough examination of the issuer's legal agreement with the lenders (purchasers of securities). This will provide important information on what happens in such situations, as:

(1) One arm of the business is sold off as an IPO, to another company or as a management buyout. Will the holders of the convertible bonds be compensated for this type of event by, for example, an adjustment to the conversion ratio?

(2) The issuer is taken over. Here the problem may be that the value placed on the convertible bonds of the target in the takeover may be lower than the hedge fund manager paid for the convertible bonds of the target, and, as usually happens in such cases, the price of the target's shares rises. This is a double whammy for the manager, a loss on the convertible loan stock and a loss on the short position in the underlying securities as their price rises.

If these issues are not dealt with in the convertible's legal documentation, then these risks need to be managed, not an easy task.

5.3.2.17 *Trading opportunities for convertible arbitrage funds*

In the U.S.A., yields on convertible bonds are, in general, higher than on comparable bonds in Europe or Japan, as, in the U.S.A., the credit rating of issuers is generally speaking lower than in Europe and Japan.

More of the activity in the U.S. convertible bond market is around picking up the higher yield while hedging the other risks. In other words, the principal risk and, perhaps, some other risks are hedged, and the manager picks up the stream of excess income. By contrast, in Europe and Japan, where credit quality is higher, and therefore the stream of excess income lower, more of the activity is around trading opportunities involving the bonds.

Trading opportunities can arise from a number of different sources. Here

we will look at some of the main trading opportunities involving convertibles:

(1) The price of the equity underlying the convertible falls more than the price of the convertible. If this happens, the loss on the long position in the convertible is more than compensated for by the gain on the short position in the equity, and a convertible arbitrage manager may decide to take a profit.

(2) Reductions in credit spreads between the convertible and the corresponding government bond give rise to a profit on the convertible, and, again, a hedge fund manager may decide to take a profit.

(3) Improvements in the credit quality of convertible bonds also provide money making opportunities for the hedge fund manager.

(4) Falls in interest rates give rise to similar opportunities to those in (2).

(5) Changes in implied or expected volatility can also be a source of profit. Recall that a convertible loan stock can be viewed as a combination of a bond and an embedded call option. As volatility increases, the value of a call option increases. So, a rise in implied or expected volatility will push up the price of the convertible, giving rise to a profit opportunity for the hedge fund manager.

(6) Changes in liquidity can also be a major source of profit. In the first half of 2001, there was significant buying of convertible loans stocks in the U.S.A. Prices rose on the back of this buying spree, and existing convertible bondholders saw the prices of their holdings rise.

5.3.2.18 *What can go wrong?*

Apart from widespread credit defaults, probably the worst combination of events for a convertible arbitrage hedge fund manager is:

(1) a rise in interest rates;
(2) a widening of credit spreads (a 'flight to quality');
(3) a rise in equity prices; and
(4) a fall in expected volatility.

In the U.S.A., in the first three quarters of 1999, stock price volatility fell, interest rates rose and share prices went up.

5.3.3 *Merger arbitrage*

In order to discuss merger arbitrage, let us define two terms. We shall refer to a company that is being taken over by another company as the 'target', and the company doing the taking over as the 'offeror'.

Typically, when a takeover is announced, the price of the target's shares rises from its price before the announcement to a price just under the price that will be paid by the offeror on successful completion of the takeover. A numerical example is given in Section 5.3.3.1.

Merger arbitrage hedge fund managers seek to profit from the difference between the share price of a target just after the announcement and its price when, and if, the takeover is successful. The term 'merger arbitrage' is sometimes called 'risk arbitrage'. The concept can be widened to include the capture of the profit from other corporate activities, like a demerger (spin off) or a recapitalisation.

The way in which the profit in a merger or arbitrage is 'locked in' (the profit will only be locked in if the deal actually goes ahead, hence the inverted commas) depends on the nature of the consideration for the target.

If the consideration is cash, then the hedge fund manager can lock in the profit by buying the target's shares at the discount to the takeover price, and by exchanging the shares for the takeover price when, and if, the deal closes.

If the consideration is shares of the offeror rather than cash, then the hedge fund manager will buy the target's shares and sell the offeror's shares short. This ensures that, if the price of the offeror's shares rises, losses on the short position will be compensated for by gains on the exchange of shares. If the price of the offeror's shares falls, then the gain on the short sale will compensate for the loss on the exchange when the deal closes.

5.3.3.1 *Risk/reward trade-off*

In merger arbitrage, the profit (the difference between the announced takeover price and the current price of the share) that the hedge fund manager is trying to capture is of the order of €1 or less per share. If the takeover or merger fails to go through, the price of the target's shares can fall significantly. The ratio of the possible loss if a deal did not go through to the expected profit could be of the order of 20 to one.

Example. A U.S. company agrees to be acquired by a German company, for cash of $32.75 per share on a certain date in the future. Prior to the announcement, the U.S. company was trading at $21.50. On the day of the announcement, the share price of the U.S. company jumps to $32.25. The profit that the hedge fund is trying to capture is just $0.50 ($32.75−$32.25). The return to the hedge fund manager is 1.55% (0.5/32.25). If the number of days from announcement until the deal closes is 40, the annualised return is about 14%. If the deal fails to go ahead, the hedge fund manager will face a loss of about $10.75 ($31.25−$21.50) or more. The potential loss is over 20 times the profit potential.

The manager's returns can also be hit if the deal is delayed and takes longer to close. Doubling the number of days from announcement to close from 40 to 80 will halve the percentage return to the hedge fund manager. If the deal is subject to due diligence, and it is decided that, on reviewing the numbers, the price to be paid is cut by $1 per share, the hedge fund manager will suffer a loss.

Among the high profile deals that have fallen apart, causing big losses for merger arbitrageurs, in the last five years, are: the General Electric take-over of Honeywell; and the failed merger of British Telecommunications and MCI. The failure of the General Electric bid for Honeywell is estimated to have cost merger arbitrage funds between $750m and $1bn. (Source: The *Financial Times*, quoting Andrew Whittaker, head of arbitrage research at Lehman Brothers.)

5.3.3.2 *Risks in the strategy*

The risks in the strategy are very high compared with the profit, and investors in merger arbitrage funds need to be confident about the manager's risk management skills. This category of hedge fund produces a lot of outliers on the downside. It is a form of jump risk.

Investors need to understand how the manager selects deals and how he diversifies his portfolio.

On deal selection, you should be looking for sounds from the manager like:

(1) We avoid deals that are subject to a large combination of the following: financing; regulatory approval; approval of competition watchdogs; due diligence; long time delay from announcement to close; and the earnings performance for the target being in line with analysts' consensus expectations.

(2) We avoid deals which are agreements in principle and ones where the announcement is merely a letter of intent.

(3) We make a thorough analysis of what could cause the deal to break.

(4) We look at the tax aspects of the deal, especially cash deals. (The problem with cash deals, especially where the offeror and the target are located in two different tax jurisdictions, is that the consideration may be treated as a dividend distribution by the offeror, and therefore subject to withholding tax, part of which cannot be reclaimed. When the profit on a deal is less than 2%, a 10% withholding tax just leads to massive losses.)

(5) We look at the general economic and interest rate environments, to see how they could affect financing of a deal, how they might affect deals subject to earnings performance thresholds for the target.

(6) We look at commodity prices, especially where the deals are in industries where profitability is driven by commodity prices.

(7) We look at the risk that an offeror becomes a target during a merger or takeover of another company. This may cause the deal to break with serious losses, as the price of the original offeror's shares rises (as it becomes a target itself), hitting the manager's short position in the deal, and the price of the original target collapses, hitting his corresponding long position.

(8) We like targets that are performing strongly, deals where there is a

good strategic rationale behind the merger, and offerors with strong balance sheets.

(9) We like deals which are likely to prove robust in bear markets.

(10) We try to avoid deals in highly regulated industries, where approval of the deal might require clearance from competition regulators and industry regulators.

(11) We look for offerors where there is a plentiful supply of stock which can be borrowed.

In the area of portfolio diversification, you would need to look at maximum position sizes that are defined in terms of the risk/reward ratio, as well as monetary limits. There should be a reasonable spread of deals in the portfolio by industry and type of consideration (cash or stock).

5.4 Key Questions for Prospective Hedge Fund Managers

Here are some key questions to ask your prospective hedge fund manager:

(1) Ask the manager to go through the various risks which he faces in managing the portfolio. See how many of the above risks he identifies. Be delighted if he surprises you by pointing out other risks not identified under the various headings.

(2) Ask the manager how he manages the risks which he has identified.

(3) Ask to see the systems which he has in place to measure and monitor these risks.

(4) Ask to see the manager's file of the legal documentation associated with convertible bonds or merger arbitrage deals in the portfolio, and ask him to take you through particularly unusual features of a few bonds or deals.

(5) Ask the manager how he pulls the various risks together to get a portfolio view of risk.

(6) Ask your manager to take you through the performance of the fund for a number of extreme market events, both good and bad. Watch out for excessive leverage on the deals which went well. They could have failed, and what would have been the result then.

(7) Ask the manager who is 'minding' the portfolio while he is talking to you.

(8) Ask the manager where he gets his information, and judge whether it is timely, in the light of the risks which he is taking.

5.5 Qualitative Factors in Choosing a Hedge Fund

There are many fine examples of due diligence questionnaires around — see, for example, the Alternative Investment Management Association's hedge fund due diligence questionnaire. Here, we wish to focus on a series of points which you need to consider carefully after you have done your due diligence.

5.5.1   *Key personnel*

Make sure that all the key personnel are 'tied in' to the hedge fund, and cannot up and leave too readily. This is particularly important where the hedge fund is operated by a large, traditionally long-only investment management company. The real asset here is intellectual capital of the manager, not in the institution's brand or infrastructure. If the manager is good and he leaves, follow the manager, not the institution. The infrastructure can be recreated.

The answers to all of the questions asked of the key personnel in the due diligence questionnaire should be independently verified. If the manager says that he got a first class honours degree in mathematics from Cambridge University, then phone the University and check. It is no use finding out, when it is too late, that this was not the case. Mistakes can occur when due diligence questionnaires are completed by more junior staff. Check out every inconsistency between the due diligence questionnaire and your enquiries with the hedge fund manager.

References should be taken for all key personnel, from such people as auditors, existing customers of the hedge fund, regulators, fellow hedge fund asset allocators and prime brokers. A comparison of the skills and experience of the personnel, with the range of investment activities that the manager may carry out on behalf of investors, should be made to assess the fit of investment strategy and experience. The prospectus for any public fund offered by the manager is a good source of such information.

5.5.2   *Managers investing in the fund*

Sometimes key personnel have investments in the hedge fund itself, as opposed to owning shares in the hedge fund investment management organisation. Traditionally, this was viewed as a positive feature, especially if the hedge fund has long lockup periods and deals in illiquid assets. (A lockup period is a minimum period of time in which an investor must remain in a hedge fund. It can take the form of a minimum period of notice to redeem an investment in the fund, or that an investor must remain in the fund for a minimum period of time from the date of entry.)

5.5.2.1   *The theory*

The theory goes that, if the hedge fund manager has a substantial part of his wealth invested in the hedge fund, he would not 'go wild' and pump up the volatility of the fund just to gain performance fees. The theory goes on that, if he does pump up the volatility and something goes wrong, at least you will both share the pain together. Unfortunately, sharing pain with fellow patients does not cure the underlying illness. So, the theory assumes that the manager will mind your money in the same way as he minds his own. However, it raises the question whether the manager has the same, or a bigger, or a smaller appetite for risk compared with the investor. This issue is rarely explored.

5.5.2.2 *Problems with the theory*

A manager who has made a good return in the first few months of a year may be satisfied with that return for the year, and exit the market for the rest of the year. In this case, the fund may be in cash for the rest of the year following the few months of good return. Credit events aside, cash rises in value every day with increasing interest. Rises in value trigger performance fees. Who would invest in a cash fund with fees of 2% in terms of annual management charge and 20% of performance above the previous high?

Also, a manager may decide that, after a large drawdown (continuous period of negative returns), he will reduce the risk of the fund and the risk to his own investment in it, and 'sit tight' for a few months. Resetting the risk to a lower level makes it very difficult to regain past losses which occurred at higher risk levels. This may not be in the interests of the investors in the hedge fund.

Finally, in view of the magnitude of leverage in some hedge funds, a manager may decide to trade for his own account ahead of large orders for his clients, although this is outlawed by the Central Bank of Ireland, in its *Handbook for Investment Firms*, and by many other regulators, but it is tempting, and difficult to prove that there was any wrongdoing.

So, for these reasons, it is best not to have the manager 'emotionally involved' in the fund, by having some of his own money invested in it.

5.5.2.3 *Other approaches to the problem*

At the root of this problem is the level of risk that the hedge fund manager could take and long lockup periods. The problem can be managed better by investing in hedge funds:
(1)   with no lockup periods;
(2)   which invest in liquid assets;
(3)   which maintain a constant level of forecast risk — risk cannot be determined with absolute certainty in advance, it can only be forecast in advance; and
(4)   where there is daily monitoring of the risk of the fund.

5.5.3   *Fees*

Sometimes it is tempting to focus almost exclusively on fees, because they are often the easiest aspects of a hedge fund to understand, while failing to understand the investment strategy and its inherent risks. The issue is the returns delivered after deducting fees and the risk taken in generating those returns.

It is vital to ask if there are any other fees, like brokerage fees, where the hedge fund manager gets a fee for every trade executed. Ask for numerical examples of how fees would be calculated for various performance scenarios, including periods of negative returns, and for various numbers of trades in different markets/sectors/geographic areas.

5.5.4 *Infrastructure and organisation*

It is very important that the hedge fund manager has a good infrastructure, so that he can concentrate on generating returns rather than on dealing with routine settlement headaches. Check the staffing levels, and find who is responsible for what roles. Look at the qualifications and experience of the staff employed by the hedge fund manager.

In this regard, look for a proper board of management with non-executive directors at the head of the hedge fund investment management company. This provides some comfort on the operational oversight of the firm.

5.5.4.1 *Regulatory supervision*

Look for hedge funds which are supervised by regulators with highly respected reputations, like the Central Bank of Ireland in Ireland or the Securities & Exchange Commission (SEC) or the Commodity Futures Trading Commission (CFTC) in the U.S.A. It is a positive message if a hedge fund manager submits to regulatory scrutiny. The regulators mentioned above carry out police checks on all the hedge fund principals before granting an authorisation. This adds a degree of comfort, and provides a check that one would not normally be able to make.

Hedge funds which are regulated by, for example, the CFTC in the U.S.A., are required to prepare a very detailed disclosure document for clients, covering such issues as: the background of the principals of the firm; investment philosophy and method; potential benefits for investors; trading programs; management and incentive fees; litigation (civil, administrative and criminal) against the firm or its principals; principal risk factors; and summary performance information. Performance information must be prepared to specified standards. In addition, all staff involved in trading must pass an appropriate examination covering regulatory and market trading topics. Ethics training is also a requirement of this regulatory environment.

5.5.4.2 *Information technology*

Information technology infrastructure is very important. The last thing that you want to find is that your manager gets increasingly bogged down in paperwork as funds under management grow. Visit the offices of the hedge fund manager and examine the IT infrastructure, consider inputs to and outputs from systems, the reports produced, the degree of rekeying of data, and the extent to, and frequency with, which the outputs of different systems have to be reconciled. Look for high levels of automation, low to no rekeying of information, and an integrated system which avoids reconciliations. Examine the valuation system and any system-based risk management tools. Find out how frequently data are backed up, and where the back up is stored.

Ask to see the firm's business interruption plan, find out when it was last

tested, and what the tests showed. Look for evidence of a standby hot site ready to recommence trading in a matter of hours.

5.5.5 *Lockup periods*

A lockup period is a minimum period of time for which an investor must remain in a hedge fund. It can take the form of a minimum period of notice to redeem an investment in the fund, or a requirement that an investor must remain in the fund for a minimum period of time from the date of entry.

Lockup periods may be indicative of investment in illiquid securities (like private equity) or of high levels of leverage that cannot be unwound quickly without severe market consequences, or a crude way to solve the problem of a mis-match between the investment time horizon of a hedge fund and its investors, or simply a desire on the part of the manager to hold on to investors' money for a minimum period of time. Ask the hedge fund manager why there is a lockup period at all, and how its length was determined. (One hedge fund which I know of has a five-year lockup period, and thereafter investors must give one year's notice of intention to exit. I asked the manager why there was such a long notice and lockup period. He told me that the hedge fund was leveraged 17 times, so that, if a group of investors representing \$100m in capital wished to liquidate their holdings, this would necessitate the unwinding of \$1.7bn of positions in the market. That takes time if you wish to avoid market impact.)

5.5.6 *Transparency*

It is a good idea to clarify in advance the frequency and content of the investment and risk reports which you will get from your manager. Daily is ideal, so that you can integrate the risk of the hedge fund manager's positions into those of your own portfolio, and assess the degree of risk which he is taking. However, for short sell and long/short equity hedge fund managers, transparency poses a problem, since, if their short positions were known, one could easily take advantage of them. However, some compromise solution can usually be reached with the hedge fund manager's prime broker, providing some comfort on risk levels, without revealing individual positions.

6. STATISTICAL ANALYSIS OF HEDGE FUND PERFORMANCE DATA

6.1 *Introduction*

An analysis of the past returns from a hedge fund is best conducted in the light of discussions with the manager regarding his investment strategy and the risks which he takes in achieving that strategy. A better picture of the past returns of a hedge fund is obtained if both graphical and numerical techniques are used in the analysis of past performance data.

In the graphical analysis, we get some idea of the symmetry of the distribution of returns, the thickness of the tails on both sides, and the shape of the distribution of returns relative to the normal or some other distribution. Numerical techniques allow us to test hypotheses about the data, and reduce the chances of us making erroneous conclusions about the data.

Put simply, you need to 'play' with the data in different ways to get a thorough understanding of it. In hedge fund analysis, it is important not to rely on any one graphic or statistical measure of the data, but rather draw your conclusions from a synthesis of the entire analysis. For those interested in further statistical analysis of hedge funds, data box plots and QQ plots might be considered. In addition, for a more mathematical examination of the tails of a distribution of hedge fund returns, the mean excess function is a useful tool. We do not consider QQ plots or mean excess functions any further in this section.

6.2   *Number of Observations of Past Performance Data*

Some hedge funds have traded for a relatively short period of time. This means that there may only be six observations of monthly performance available, and investors may be concerned about the validity of any conclusion made from a sample of six. However, in six months there are approximately 120 trading days, and that is a much larger sample from which to work.

If a hedge fund manager is managing risk on a daily basis, then he must be marking his portfolio to market each trading day. So, it is important to ask your hedge fund manager for daily data, for three reasons:

(1)   it gives you more observations of past performance with which to analyse the hedge fund;

(2)   it gives you some comfort that the portfolio is being marked to market each day; and

(3)   the time it takes to get the information may be an indication of the quality of the manager's IT systems.

If a hedge fund maintains a constant level of forecast risk over a trading week, rather than a trading day, then ask the hedge fund manager for weekly rather than daily data. (All of the days of the week are not equal in terms of their trading characteristics. Some hedge fund managers recognise this in the risk management process, and maintain a constant level of risk from one trading week to another rather than from one trading day to another.)

Even if you have obtained 1,000 observations of daily data, this may not be enough from which to draw any conclusions. To understand this point, consider two hedge fund managers, one called 'FewButLarge' and the other called 'ManyButSmall'. Both managers have returned 20% p.a. over the last four years.

FewButLarge did five deals in the last four years, which gave him his 20% p.a. returns. When he does a trade he does a big trade, and when he is not doing a big trade he has no exposure to the market. ManyButSmall does, on average, about three trades per trading day. Roughly speaking, all of the trades are the same size. So, in the last 1,000 trading days (about four years), ManyButSmall has done about 3,000 trades of equal size.

Which manager's data are more reliable in terms of making forecasts of risk and return for the future? ManyButSmall's data are more reliable, because we have 3,000 roughly equal size trading observations from which to examine his distribution of returns and make some assessment of his risk. For FewButLarge, we really have only five observations. Maybe he is a great trader, but maybe he was just lucky. With just five observations, it is impossible to make any reliable estimates of return or risk. Put simply, make sure that you understand how many trades the data represent, and the distribution of the size of trades.

6.3   The Data

Make sure that you are clear as to what data you have got from your hedge fund manager. Are they valued using bid, mid or offer prices in the market? At what time on each valuation day are they valued, and does this time vary from day to day? What is the source of the valuation data? Can a random sample of the data be checked with an independent third party, like an institutional client of the hedge fund manager? These questions are important for correlation analysis, because you will find that the S&P 500 index is not 100% correlated with itself if one series of data uses the value of the index ten minutes after the opening and the other uses the value of the index ten minutes before the close.

6.4   Analysis of Past Performance Data
6.4.1   Graphical analysis

Start by drawing an empirical cumulative distribution function of the data. The empirical cumulative distribution function is preferable to a histogram, as the latter calls for the data to be grouped, which can introduce some distortion into a picture.

For completeness, Figure 6.1 shows a histogram of the daily return data for a long/short equity hedge fund.

We can identify a number of outliers on the upside and the downside of the histogram.

6.4.1.1   Empirical cumulative distribution function

The empirical cumulative distribution function of the data can be sketched as follows:

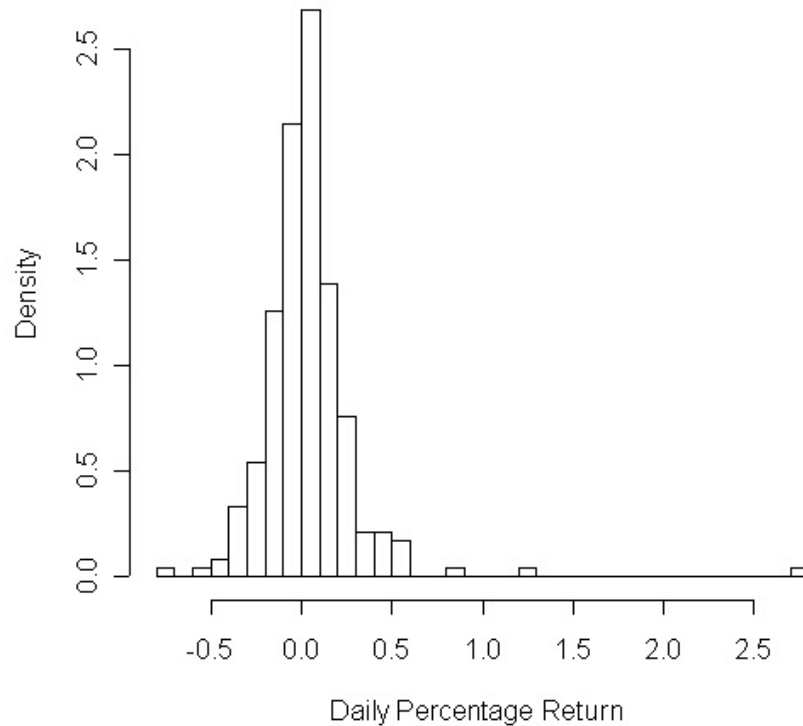(1)   Rank the observations from the lowest to the highest.

Figure 6.1.   Daily percentage return for long/short equity hedge fund

(2)   For each ordered value of the data, calculate the number of ordered
       data values less than or equal to that value. Call this number i_j.
(3)   For each ordered value of the data, calculate the proportion of ordered
       (in ascending order) values less than or equal to that value. Call this
       proportion i_j/n, where n is the total number of observations. For future
       reference, we denote the empirical cumulative distribution function by
       $F_n(x)$; $F_n(x) = i_j/n$.
(4)   Plot the values i_j/n against their corresponding ordered value $X_{(j)}$,
       where $X_{(j)}$ is the jth ordered value of the sample. The general co-ordinate
       of a point on the plot is $(X_{(j)}, F_n(X_{(j)})) = (X_{(j)}, i_j/n)$.

Figure 6.2 plots the empirical cumulative distribution function for the
daily return data for the long/short equity hedge fund shown in Figure 6.1.
There are 238 observations in this sample.
   You can see, from Figure 6.2, that the empirical cumulative distribution
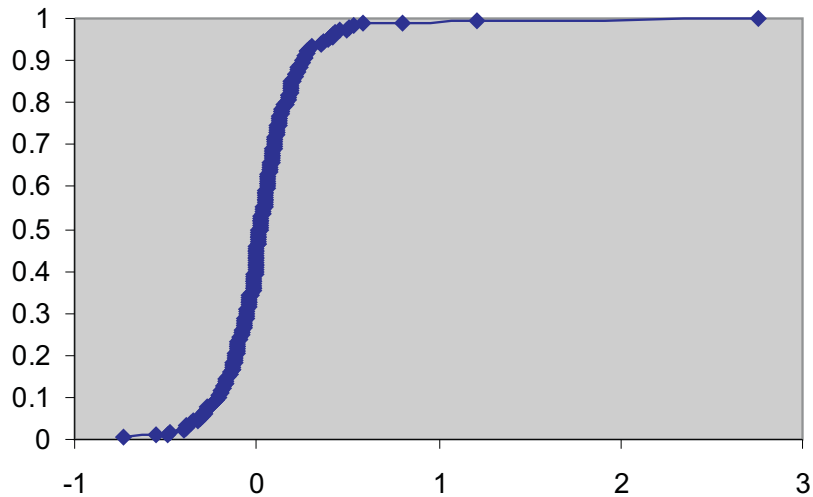
Figure 6.2. Empirical cumulative distribution function for the daily returns of a long/short equity hedge fund

function quickly shows up the lack of symmetry in the underlying distribution, the presence of outliers, the central location of the distribution, and its spread about that central location.

From the empirical cumulative distribution function, we can pick the median return, the return above which 50% of the data items lie and below which 50% of the data items lie. For the long/short equity fund, the median return is +0.19% per day.

The outliers on the upside are obvious, but there appears to be at least one outlier on the downside also. This data set shows three very large positive returns — the upper right section of the graph has a long flat portion which is almost parallel to the horizontal axis. This indicates that the distribution has positive skewness. (Skewness is the degree of asymmetry in a distribution. If the frequency curve (smoothed frequency polygon) of a distribution has a longer tail to the right of the central maximum than to the left, it is said to be skewed to the right or have positive skewness. If the smoothed frequency polygon has a longer tail to the left of the central maximum than to the right, it is said to be skewed to the left or have negative skewness. There are other definitions of skewness, like considerably more extreme values in one direction than the other.) If there were a long flat portion of the graph in the lower left section of the graph, this would indicate negative skewness.

In the statistical analysis of merger arbitrage hedge funds, where there are

Table 6.1.   Interpretation of 'high value observations against low value
observations' plots

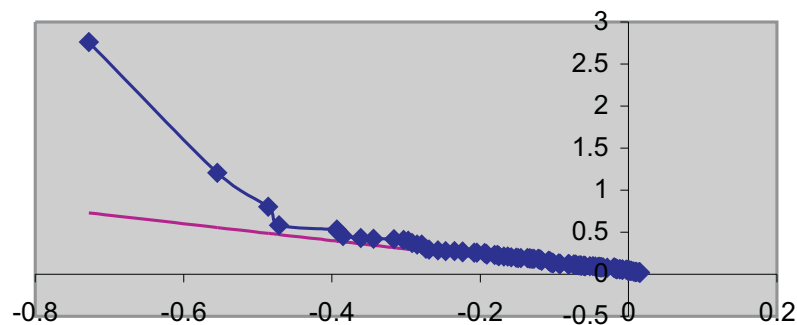| Approximate slope of plot (M)	Interpretation
$M = -1$	Symmetric
$M < -1$	Positive skewness
$M > -1$	Negative skewness

Figure 6.3.   'High value observations against low value observations' plot
for the long/short equity hedge fund in Figure 6.1

several years of data, you will tend to find negative skew in the distribution of
returns. There are a limited number of outliers on the upside in such strategies.
As we saw, downside outliers are in the nature of merger arbitrage strategies.

6.4.1.2   *High-values v low-values plot*

A further assessment of symmetry in the daily returns can be obtained by
plotting the upper half of the ordered observations against the lower half of
the ordered observations. The data points (x, y) for the graph are as
follows:
(1)   (smallest value in data set, highest value in data set);
(2)   (second smallest value in data set, second highest value in data set); and
(3)   etc.

The plot is interpreted by looking at the slope of the line and comparing
it to that of a line with a slope of -1.

Table 6.1 shows how the plots can be interpreted. The slope of the points
in the scatter diagram will always be negative, because of the way in which
the plot is constructed.

Figure 6.3 plots the 'high value observations against low value
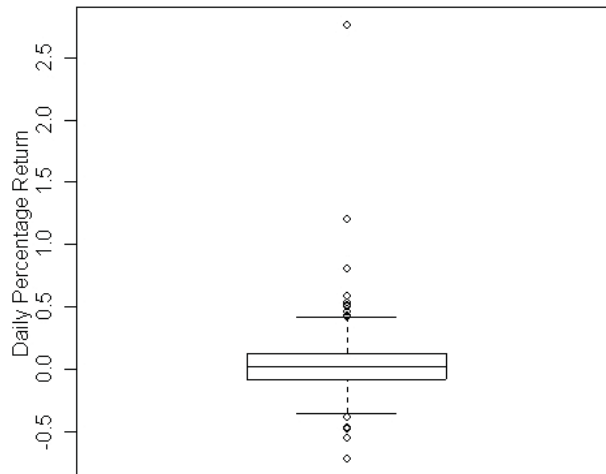observations' for the long/short equity hedge fund data of Figure 6.1. The

Figure 6.4.   Daily return for long/short equity hedge fund

slope of the line is less than -1, indicating positive skewness. The lower line on the graph is the $y = x$ line, but it may not appear to be so to the eye, as the scale on the two axes is different.

6.4.1.3   *Box plot*

A box diagram for the long/short equity hedge fund manager is plotted in Figure 6.4.

The mid-line of the box is the median, and the distance between the upper and lower lines is the inter-quartile range. The other two horizontal lines, positioned one above and one below the box, are drawn 1.5 inter-quartile ranges above and below the median. The outliers are easily spotted on this chart. There appear to be more outliers on the downside than the empirical cumulative distribution function suggests.

6.4.1.4   *Assessing the thickness of the tails*

It is important to get some feel for the thickness of the upper and lower tails of the distribution of returns. Investors are particularly interested in the upper tail of the distribution, positive returns, but are also concerned about the thickness of the lower tail of the distribution.

Interpretation of tail thickness must be based on an understanding of the risks that the manager is taking. For example, in merger arbitrage the risks are many times the rewards (see Section 5), and, when things go wrong for a manager on a deal, the losses are quite large in relation to the profit that
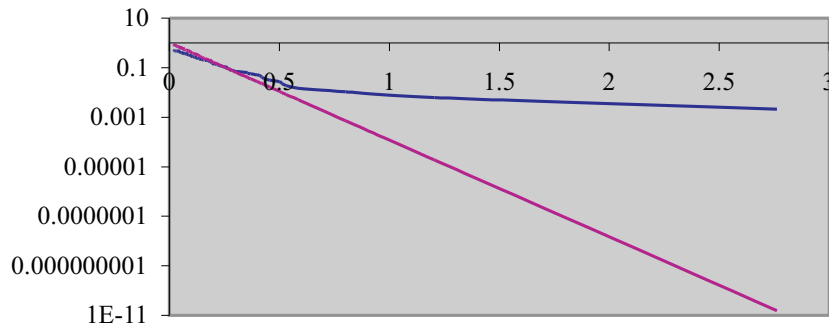
Figure 6.5.   Upper tail thickness comparison

might have emerged if the deal were successful. So, an examination of the lower tail of the distribution is very important for such funds.

In assessing 'tail thickness', the exponential and the negative exponential distributions are very easy to work with from a mathematical point of view. We use the negative exponential as a benchmark against which to assess the thickness of the upper tail of the distribution and the exponential for the lower tail.

For the negative exponential distribution, the cumulative distribution function $F(x)$ is given by the equation $F(x) = 1 - e^{-x/\lambda}$, and therefore $\ln(1 - F(x)) = -x/\lambda$. To get some idea of the relative thickness of the upper tail of a distribution, plot a graph of x against $(1 - F_n(x))$ on semi-log graph paper for the upper half of the ranked data. For the purpose of the plot, redefine $F_n(x)$ as $F_n(x) = (i_j - 0.5)/n$ (recommended in *Graphical Analysis*, by Ralph B. D'Agostino, in Goodness-of-fit techniques (*Statistics, textbooks and monographs*, **68**)). The parameter λ can be estimated by using any value for which the model is supposed to hold. Alternatively, we could find the maximum likelihood estimator of the parameter.

Figure 6.5 shows the plot to analyse the thickness of the upper tail of the long/short equity hedge fund of Figure 6.1. The curved line in Figure 6.5 is the plot of the data, and the straight line is what the plot ought to look like if the distribution had a tail like that of a negative exponential distribution. The straight line is based on just one value of λ, rather than on the maximum likelihood estimator. If the plot were a straight line, we might be able to conclude that the upper tail of the distribution can be modelled by the negative exponential distribution.

In judging points that do not lie on the line, it is horizontal, not vertical, distance from the line that is relevant. If the plot bends inwards (bends towards the *y*-axis rather than the *x*-axis) and away from the straight line, the tail of the distribution may be lighter than that of the negative exponential distribution. If, on the other hand, the plot bends outwards
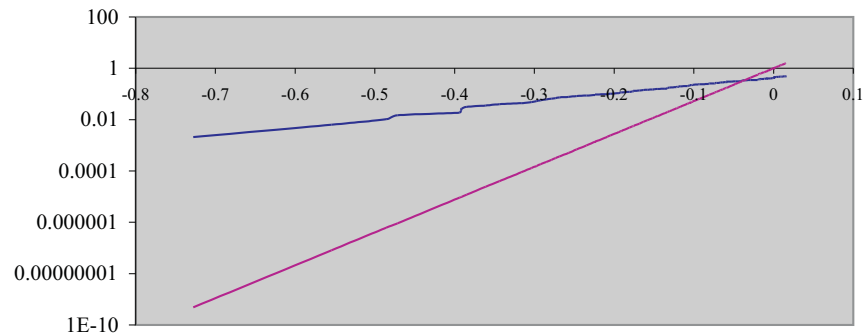
Figure 6.6.   Lower tail thickness comparison

(bends towards the *x*-axis rather than the *y*-axis), the tail of the distribution may be heavier than that of the negative exponential. Different values of λ give different straight lines, but it is usually clear that the data either bend away from the lines towards the *x*-axis or the *y*-axis.

We conclude that the distribution of daily returns for the long/short equity hedge fund manager has a thicker tail on the upside than that of a corresponding negative exponential distribution. We would need to talk to the manager to see if there are any systematic reasons for this feature, or is it just his risk trades that went well. The mirror image of high-risk trades that went well are high-risk trades that failed. The lower tail of the distribution can be examined in a similar way, again using semi-log paper.

Figure 6.6 shows the plot of the lower tail of the daily return data for the long/short equity hedge fund. The steep straight line in Figure 6.6 represents what the plot would be like if the lower tail of the data followed an exponential distribution based on one estimate of λ. The data plot bends upward towards the *x*-axis and indicates greater tail thickness compared with the exponential distribution.

We conclude that the distribution of returns of the long/short equity hedge fund manager has a thicker tail on the downside than that of a corresponding exponential distribution.
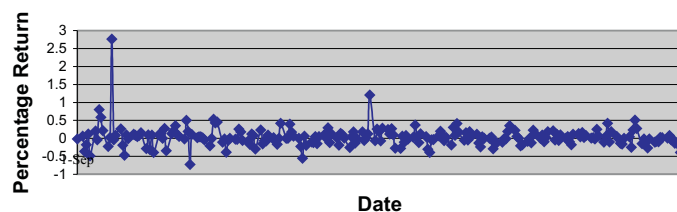

Figure 6.7.   Distribution of daily returns in time

As a compliment to the graphical assessment of tail thickness relative to the negative exponential distribution, the numerical analysis assesses tail thickness relative to the normal distribution using the kurtosis measure.

6.4.1.5   *Distribution of returns in time*

Figure 6.7 shows the distribution in time of the returns of the long/short equity hedge fund of Figure 6.1. For anonymity reasons, the start date shown for the fund was chosen at random, and subsequent dates are not shown. This analysis is important in considering the stability of the correlation coefficient between a hedge fund and any existing portfolio that an investor may be looking to diversify. The spikes of positive and negative returns can easily be identified, and we can examine how the fund behaved during extreme market events.

6.4.2   *Numerical analysis*

Start by calculating the total return over all the continuous observation periods which you have at your disposal. Annualise it if the total time period covered by the observations is longer than a year.

6.4.2.1   *Mean*

The numerical analysis of past performance data can begin by calculating the mean return for the hedge fund. Again, in hedge funds with jump risk, like the hedge fund manager who invested in cash and wrote put and call options to generate extra return, care must be taken to ensure that it is reasonably representative of the central tendency of returns.

For the long/short equity fund manager in Figure 6.1, the mean return is approximately +0.37% per day.

The mean return should be compared with that available on other similar investments over the same time period.

Compare the mean with the median found from the graphical analysis. If the mean exceeds the median, the distribution is said to have positive skewness, and if the mean is less than the median, it is said to have negative skewness. A further test for skewness will be discussed below.

The median return for the long/short equity fund manager in Figure 6.1 is approximately +0.19% per day.

As a descriptive statistic, the mean is of limited value if a distribution has more than three quarters of its observations above or below the 'average'. So, it is important to measure the degree of skewness before relying on the mean as a descriptive statistic for a distribution. In a highly skewed distribution, the median is a much more descriptive statistic than the mean. Trends in the mean and the median over time should also be examined.

In the case of the long/short equity hedge fund in Figure 6.1, almost 79% of the observations are below the average, indicating a very highly skewed

distribution of returns. So, the mean is not a very useful measure of central tendency.

6.4.2.2   *Standard deviation*

Before measuring the standard deviation of return, we need to understand the background to the observations of return that we have collected. If the portfolio valuations on which the returns are calculated are in any way subjectively determined by the manager or an associate, then little value can be placed on the standard deviation as a measure of variability. This could arise where a hedge fund uses highly illiquid esoteric options, where the daily mark-to-market value is determined by the manager. The values of such highly illiquid esoteric options could easily be smoothed to reduce the variance of published returns.

Likewise, it is important to know if a hedge fund manager has entered into any derivative or other transactions that swap the return in the best and worst months for the return on another asset, like cash. In this case, the return observations are smoothed, and it would be misleading to draw any inference from the calculated standard deviation. (In the 30 years to the end of 2000, over 50% of the annual variance in the S&P 500 index came from the best and the worst months in each calendar year.)

Again, as part of the interview with prospective managers, you need to find out if the manager follows any practice like reducing the exposure of the portfolio to risk for the remainder of a year after a 'good' month or 'good' months. If this is the case, then the standard deviation is not based on as many observations as might at first appear.

Standard deviation is not a relative measure, so it must be compared with that of similar funds for the same time period. To get an idea of relative size, one might compare it to that of a traditional balanced fund over the same time period. Trends in the standard deviation over time should also be examined.

6.4.2.3   *Co-efficient of variation and Sharpe ratio*

The co-efficient of variation is defined as the standard deviation divided by the mean (assuming the mean is not zero). For a sample, the co-efficient of variation is estimated as the ratio of the sample standard deviation to the sample mean. This statistic is useful in comparing different hedge funds. The Sharpe ratio is another statistic that is useful in comparing hedge fund managers, provided that the standard deviation is a reasonable measure of the risk.

6.4.2.4   *Ranking of returns*

Ranking the observations in descending order, and dividing them into sub-groups by reference to:
(1) the number of standard deviations from the mean; and
(2) quartiles or deciles;

are useful exercises. After ranking the data in descending order, it is often useful to check how much of the total return for the observation period spanned by the data has been achieved in just one day, two days, three days, four days, etc.

For the long/short equity hedge fund in Figure 6.1, the total return for the 238 days was 9.1%. Ranking the data in descending order shows that almost 4% of this return was achieved in just two of the 238 days, and over half of the return in just three of the 238 days. This may indicate a significant variation in the level of risk taken by the fund from day to day, and would warrant a discussion with the manager on his volatility management strategy.

Features like this will also be picked up by the kurtosis measure. This feature in the return pattern ties in with the positive skewness of the distribution of observations which we found earlier. Use the ranked returns to calculate the number of observation periods with positive return ('winning' months) and the number with negative returns ('losing' months). Calculate the average return in winning months and the average return in losing months. Compare these two figures, and consider them in the context of the hedge fund manager's strategy and the risks which he takes. Is it a case of when it goes wrong (losing time periods) it goes badly wrong, like in merger arbitrage, or are the average returns in winning and losing time periods the same? If the percentage of winning months is low, their average value is high, and the average value of losing months is very low, you should check if the manager is out of the market for long periods of time.

Look at the return in the worst observation period, and ask yourself: "Is that consistent with the manager's strategy and risk management policy?" The analysis by quartiles or deciles should quickly show up outliers.

6.4.2.5 *Maximum drawdown*

Examine the data in date order, and find the longest number of successive days/weeks/months for which the value of the fund fell, referred to as a drawdown. Count the number of these observation periods and the cumulative negative return during the maximum drawdown period. Then count the number of observation periods until the fund had recovered to its value before the drawdown. Remember that a 9% fall in value requires an upward move from that point of about 11% to return to the original value from which the fund fell.

Maximum drawdown is a statistic that needs to be examined with considerable care. It has a number of features that need to be borne in mind:

(1) it uses only two data points from the entire price series of a hedge fund's performance, so it is not a very efficient statistic;
(2) when using the statistic to compare two funds, it must be borne in mind that the maximum drawdown is a function of the track record length; and

(3) when using the statistic to compare two funds, it must be borne in mind that maximum drawdown is a function of volatility.

6.4.2.6 *Skewness*

When examining the distribution of returns of a hedge fund, it is great to find a normal distribution, as such a distribution of returns minimises the probability of surprises. Obviously, finding a hedge fund with positive skewness would be even better, but we should have to be convinced that there were strong investment reasons why the fund has a positive skew. If a distribution follows the pattern and shape of the normal curve, then the mean and the standard deviation are sufficient to describe the distribution; but, if this is not the case, we need to have some idea of the extent of departure from the symmetry. Skewness is a measure of the lack of symmetry of a distribution.

Non-normality has serious consequences for the accuracy of probability statements regarding Type I (a Type I error is made when we reject a hypothesis when it should be accepted) and Type II (a Type II error is made when we accept a hypothesis when it should be rejected) errors, when one is testing means and variances. This is especially so when the number of observations is small. Attempts to decrease one type of error are generally accompanied by an increase in the other type of error. In practice, one type of error may be more serious than the other, so a compromise is reached in favour of minimising the more serious error. A measure of skewness is given by the formula:

$$3 * (\text{Mean} - \text{Median}) / (\text{Standard deviation}).$$

(This statistic is referred to as Pearson's second coefficient of skewness.)

The skewness of the normal distribution is zero, as the mean is equal to the median. The lognormal distribution has positive skewness.

For the long/short equity fund in Figure 6.1, this measure of skewness gives a value of $+0.2$, confirming the positive skewness which we found in our graphical analysis.

Pearson's second coefficient of skewness is not much use in inferential work concerning skewness. We use another index of skewness, based on the third moment of a distribution about its mean.

For a distribution, this index of skewness is equal to:

$$(1/N) * \sum z_i^3$$

where $z_i = (X_i - \mu) / \sigma$, with the usual meaning of μ and σ.

The estimate of this index of skewness, derived from a sample of observations, is given by the formula:

$$[n/\{(n-1)(n-2)\}] * \sum z_i^3$$

where n is the number of observations, μ is replaced by the sample mean, and σ by the sample standard deviation.

For $n > 150$, the sampling distribution of this index is approximately normal, with mean zero and standard error $\sqrt{(6/n)}$. For smaller values of n, a more accurate standard error can be calculated by multiplying the above standard error by the expression:

$$(1 - 3n^{-1} + 6n^{-2} - 15n^{-3} + \ldots).$$

In the case of the long/short equity hedge fund manager in Figure 6.1, the sample estimate of this index of skewness is $+4.34$. The standard error is $\sqrt{(6/238)} = 0.158777$. Clearly, the z statistic is highly significant.

We could argue that the very high level of positive skewness of this manager is a very good feature, as it points to a significant proportion of the surprises being on the upside. In the absence of some systematic factor in the hedge fund strategy that points to large positive returns and very low negative returns, it would be unwise to conclude that this is the case.

Looking at the data for this long/short equity fund, we found that over half the return for the 238 trading days was accounted for by three days' returns. It is not surprising that the skew is highly positive. Large positive returns may be just the mirror image of high risk strategies that have, so far, paid off. We would need to have discussions with the manager on this topic.

In merger arbitrage, we find that the return distribution is negatively skewed because of the nature of the strategy — small upside with high risk on each deal.

6.4.2.7 *Kurtosis*

We defined a 'surprise' as a daily/monthly/quarterly return which is very large relative to the usual periodic returns that we have come to expect from the manager. Very large returns in a period may be welcomed by investors, but they *may* be indicative of the potential for very large negative returns, which are not so welcomed by investors. The word may is used, because a large positive return could have been achieved within tight risk control parameters set by the hedge fund manager in consultation with the investor.

Kurtosis is a measure of the 'thickness' of the tails of a probability distribution relative to that of the normal distribution with the same standard deviation. Thick tails contain surprises for hedge fund investors. We need to examine the kurtosis of a manager's return distribution, because it can give us some information about the potential for 'surprises' in the daily/monthly/quarterly returns from a manager. Hedge fund managers whose funds exhibit high kurtosis are more likely than those with low kurtosis to have surprises in store for investors.
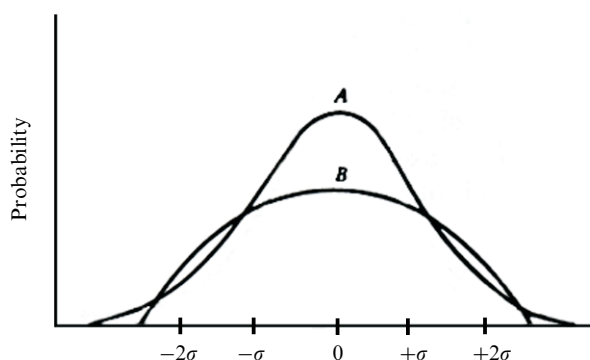
Figure 6.8. Probability density functions

In the context of hedge funds, another way to interpret kurtosis is as a measure of how well a hedge fund manager is controlling the overall risk in the hedge fund. High kurtosis may be indicative of widely fluctuating levels of underlying risk in the fund. If the underlying level of risk in the hedge fund fluctuates widely, then so too does the potential for surprises.

Measures of kurtosis are relative ones, and the usual distribution with which comparisons are made is the normal distribution. From a statistical point of view, kurtosis is often described as a measure of the flatness or peakedness of a distribution. However, this is not fully correct. Kurtosis indicates the extent to which the probability density of observations differs from the probability density of the normal distribution. In Figures 6.8 and 6.9 the normal distribution is marked A. The normal distribution is neither very flat nor very peaked.

6.4.2.8 *Platykurtic distributions*
Figure 6.8 shows a platykurtic distribution, marked B. Compared with the normal distribution, a platykurtic distribution has less probability distributed in the tails, less probability distributed around the mean, and more probability distributed in the regions between the mean and the two tails.

6.4.2.9 *Leptokurtic distributions*
In Figure 6.9 the leptokurtic distribution is marked C. Compared with the normal distribution, leptokurtic distributions have more probability distributed in the tails, more around the mean, but less probability in the regions between the tails and the mean.

From the point of view of the hedge fund investor, a leptokurtic distribution of returns has more probability distributed in the tails, from where surprises come.

All skewed distributions are leptokurtic. The converse is not true. Some
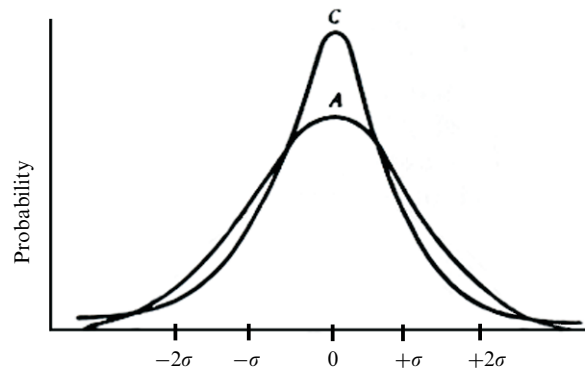
Figure 6.9.   Probability density functions

leptokurtic distributions are symmetric, and so it is not true to say that all leptokurtic distributions are skewed.

The distribution of equity returns tends to be slightly leptokurtic. Phillip Coggan, writing in the *Financial Times* in the early part of 2001, quoted Bart Dowling, of Merrill Lynch, as saying that there have been four large daily movements in the S&P 500 index in the last year. If the distribution of daily moves were normal, each move should only have occurred once every 120 years.

6.4.2.10   *Measures of kurtosis*

One measure of kurtosis is the fourth moment about the mean, adjusted to be a dimensionless quantity by dividing it by the standard deviation raised to the power of four. This measure is called the moment coefficient of kurtosis, and is defined mathematically as:

$$\kappa = \left\{ (1/N) * \sum z_i^4 \right\} / \left\{ (1/N) * \sum z_i^2 \right\}^2.$$

For the normal distribution, the moment coefficient of kurtosis is equal to three. Most people in the hedge fund industry define kurtosis as $(\kappa - 3)$, which is negative for platykurtic distributions, positive for leptokurtic distributions, and, by definition, zero for the normal distribution. The $(\kappa - 3)$ definition of kurtosis is also referred to as excess kurtosis.

Another measure of kurtosis, the percentile coefficient of kurtosis, is based on percentiles and quartiles, and is defined mathematically as:

$$\kappa = Q/(P_{90} - P_{10})$$

where $Q = \frac{1}{2}(Q_3 - Q_1)$, or perhaps better known as the semi-quartile range. For the normal distribution, κ has a value of 0.263.

The index of excess kurtosis for a population of hedge fund returns is:

$$(1/N) \sum z_i^4 - 3.$$

The index is zero for the normal distribution, positive for leptokurtic distributions and negative for platykurtic distributions.

The estimate of the index of kurtosis derived from a sample of observations is given by the formula:

$$[n(n+1)/\{(n-1)(n-2)(n-3)\}] * \sum z_i^4 - 3[(n-1)^2/\{(n-2)(n-3)\}]$$

where n is the number of observations, and μ is replaced by the sample mean and σ by the sample standard deviation.

For $n > 1,000$, the sampling distribution of this index is approximately normal, with mean zero and standard error $\sqrt{(24/n)}$. For smaller values of n, a more accurate standard error can be calculated by multiplying the above standard error by the expression:

$$(1 - (15/2) * n^{-1} + (271/8) * n^{-2} - (2,319/16) * n^{-3} + \ldots).$$

In the case of the long/short equity hedge fund manager in Figure 6.1, the sample estimate of this index of excess kurtosis is in excess of $+40.6$. The standard error, using the above adjustment on account of the small sample size, is: $0.9691 * \sqrt{(24/238)} = 0.3077$.

Clearly, the z statistic is significant, and we would conclude that the distribution of returns is not normal. We conclude that the distribution is leptokurtic, and therefore that it has more probability density around the mean and in the tails of the distribution than a normal distribution. Kurtosis of this magnitude and significance is indicative of big surprises. One interpretation of high kurtosis is that the risk in the hedge fund portfolio varies significantly from one time period to another. Further discussions would need to take place with this manager, in order to find the reasons why so much of the total return over the period took place in just three of the 238 days. This feature of the data is a significant contributor to the high kurtosis.

6.4.3 *Correlation analysis*

If the hedge fund is being selected to reduce the risk of an existing portfolio, then an examination of the hedge fund and the existing portfolio data, along the lines of Section 4, should also be conducted.

6.5   *Conclusion*

In order to assess the past performance of a hedge fund, you need to understand the investment strategy and the risks taken by the hedge fund manager. The past performance data must undergo a thorough analysis, so that one gets to grips with almost every feature of the data. For this reason, both graphical and numerical techniques are necessary. The interpretation of the results must be made in the light of the investment strategy followed and the risks taken by the hedge fund manager.

6.6   *Long/Short Equity Hedge Fund Manager — Conclusions*

With regard to the long/short equity hedge fund manager of Figure 6.1, we conclude that the upper and lower tails of the distribution are thicker than the corresponding tails of a negative exponential and exponential distribution respectively. This tail thickness is also confirmed by the kurtosis measure, which is very high. This would suggest that investors may be in for surprises.

Further discussion with the manager is needed to ascertain the reasons for the daily returns in the outlier category on both the upside and the downside. The distribution has a strong positive skew, so it is worth discussing the upside outliers with the manager, to see if there are any systematic factors at work in the strategy, which ought to consistently deliver this distribution shape. In pursuing this issue with the manager, we would need to be attuned to the risks being taken, and consider the extent to which these positive outliers would have been negative outliers if the trades had 'gone wrong'.

More than half of the return for the period was achieved in just three days. The risks taken on those days would need to be carefully scrutinised in further discussions with the manager.

7.   VOLATILITY MANAGEMENT STRATEGY

7.1   *Introduction*

When selecting a traditional pension scheme manager, the trustees and their advisors spend time with each prospective manager to gain a clear understanding of his investment objective, investment policy and fee structure. In Section 5 we looked at the investment objectives and policies of different types of hedge funds, and we found that the risks faced by these hedge funds are somewhat different to those found in traditional long-only funds. We looked at some questions which investors might ask prospective hedge fund managers, in order to get a handle on their risk management process in qualitative terms.

7.2   *Volatility Management Strategy*

The Bank of International Settlements moved, some years ago, to develop a common standard for risk measurement, so that shareholders, regulators

and other stakeholders in the investment world had a handle on the level of risk being taken by banks. The standard allows comparability of risk, despite differences in underlying assets and trading activities.

Investment banks and investment managers use value-at-risk (VaR) as a common standard in measuring risk across different activities. To measure VaR, one needs to define a specified probability level and a time horizon. Let us say that these are defined to be 97.5% (two standard deviations) and one day respectively. A VaR measure for a portfolio would tell you that the manager is 97.5% confident that an adverse change in the value of the portfolio over one day will not exceed a calculated amount. Put another way, there is only a 2.5% chance that an adverse change in the value of the portfolio will exceed the calculated amount. VaR is a good means of measuring risk when the returns on the underlying assets are normally distributed, but not such a good means of measuring it when the underlying assets are complex option positions. However, at least there is now a standard for risk measurement and for comparing risk across different parts of an organisation and across organisations.

Understanding and being comfortable with a hedge fund manager's volatility management strategy is probably the most important issue for hedge fund investors to consider, prior to investing in a hedge fund. The words risk and volatility are used interchangeably in this section.

7.2.1 *Implications of fee structure for volatility*

The fee structure in hedge funds is different from traditional long-only funds, and this, too, has potential implications for the level of risk which hedge fund managers may take. If the hedge fund manager increases the level of risk, he increases the probability of his earning larger performance fees. Investors ought to be concerned if the risk level is increased purely for this reason, without regard to the potential downside.

7.2.2 *Minimising 'surprises'*

Variations in the level of risk taken by a hedge fund manager can give rise to changes in the size and frequency of 'surprises'. A 'surprise' can be defined as a large return, be it positive or negative, which appears unlikely, given the standard deviation of past returns and assuming that returns are normally distributed. Investors certainly do not want negative surprises, and, while positive surprises may be initially welcomed, they raise the question of the level of risk involved in delivering the positive surprise. Surprises give rise to larger than expected drawdowns.

Suppose that a fund has a reliable standard deviation equal to, say, 14% (one where the past observations reflect what can happen in a fund, unlike the fund selling out-of-the-money call and put options on the S&P 500 which had not had one of its options exercised against it). Suppose, further, that the returns from the fund were normally distributed, with a mean of 13% p.a.,

then it would be surprising (less than 1% chance), although not impossible, to observe a return for a month that was less than −19.5%.

In a given observation period, if a hedge fund manager varies the level of risk, he varies the chances of a surprise. So, investors need to understand the volatility management strategy of the hedge fund manager.

7.2.3 *Average risk measures are not enough*

In getting to grips with risk in quantitative terms, a figure like the average level of risk is not a definitive guide to the risks which you are taking. You need to find out the maximum level of risk. To see why this is the case, consider a hedge fund with an average level of risk of 14% (as measured by standard deviation of return). This is about the long-term level of risk of the S&P 500 index. To achieve this level of risk, the manager could vary his forecast risk in managing the portfolio between, say, 5% and 23% (let us say that the average level of risk is 14%, it is not a linear combination of maximum and minimum levels of risk). Consider now what happens if there is an adverse move against the fund when the forecast risk level is at 23%. The losses are proportional to a risk level of 23%, not the average of 14%. If the average risk of a hedge fund is 14% and the maximum risk is 23%, then it is very difficult for the hedge fund to recover from losses arising when the risk level is 23% by running an average risk of 14%.

Suppose that a manager with an expected return of 13% p.a. varies his forecast risk from 5% to 23% (as measured by standard deviation of return). If the fund is operating at a steady 5% risk for one year, and the manager's returns are normal, then there is only a 1% chance that the return of the fund will be less than 1.5% for the year. By contrast, if the fund operates at a steady 23% risk for the month, the chances of a return of less than 1.5% are over 30%; in other words, 30 times higher than when the risk level is 5%.

The minimum risk level is also important. If the fund can adopt the minimum risk level for long periods of time, perhaps because it just made a packet on some position and does not want to lose any of its gains, then you have to ask whether you would be better off in a cash fund where there are no performance fees. Credit default aside, cash rises in value daily because of interest income, and each new high represents a performance fee.

So, while an explanation of investment objectives and investment policy is generally adequate in getting to grips with traditional long-only funds, with hedge funds you need to find out the manager's risk management policy or, as we shall call it here, the manager's 'volatility strategy'.

Some hedge fund managers have an intuitive feel for the level of risk in their portfolio. This is especially true of hedge fund managers who have had several years' experience as successful fund managers. This has a number of powerful advantages over system-based risk management programmes. Chief

among these advantages is the ability of such a hedge fund manager to identify jumps in market risk following certain events. For example, after the tragic events of 11 September 2001 in the U.S.A., equity markets remained closed for the balance of the week in which the events occurred. A system-based risk management programme would not be able to forecast the inevitably higher level of risk that would apply when the U.S. equity markets reopened. By contrast, this would be perfectly obvious to a hedge fund manager with an intuitive feel for risk.

7.3   *Changes in a Hedge Fund's Volatility*

The volatility of a hedge fund can change in three main ways:

(1) by the manager varying the degree of leverage (Leverage means to increase the economic exposure of the fund to a particular asset or assets. Doing so increases the risk of the hedge fund's portfolio also. Hedge funds can leverage their portfolios using derivatives, repurchase agreements, short positions or simply by borrowing.);

(2) by the volatility of the underlying hedge fund positions changing; and

(3) by the correlation matrix between the constituent assets of the portfolio changing.

The degree of leverage is usually within the control of the hedge fund manager. The volatility of the underlying hedge fund position is not within the control of the hedge fund manager. However, in certain types of hedge fund, it can be reduced somewhat using diversification, in the same way that a portfolio of equities can be diversified by investing in several different equities, the returns of which are uncorrelated. If the correlation matrix changes, positions that were previously believed to offset each other in the risk management strategy may now move in the same direction, with negative consequences for risk and return.

To understand the concept, we shall look at two simple examples. Example 1 illustrates how a traditional long-only manager can simply increase the volatility of the portfolio by changing the underlying investment portfolio within his mandate. Example 2 illustrates how a hedge fund manager can change the volatility of his portfolio, using both leverage and a change of underlying assets.

7.3.1   *Example 1*

Suppose that we have a traditional long-only manager whose stated investment strategy is to invest in U.S. equities. Let us say that the manager holds a portfolio of equities which mirrors the performance of the S&P 500 index. Suddenly, the prospects for technology stocks become very bright, and the manager switches his entire portfolio to mirror the performance of the NASDAQ 100 index.

The manager continues to be within his mandate, U.S. equities, but the risk level has risen from about 20% p.a. for the S&P 500 to 57% for the NASDAQ 100 index. (The figures of 20% and 57% represent, respectively, the average volatility of the S&P 500 and NASDAQ 100 indices during 2000. A mean return of 14% p.a. is assumed in this example.) As a result of this change of volatility profile, the investor has moved from a one in 100 chance of a return of −32.5% p.a. to a one in 5 chance of a return of −32.5% p.a.

7.3.2 *Example 2*

Now, suppose that we have a long/short equity hedge fund manager who confines his activities to U.S. equities. Let us say that the hedge fund manager is bullish on all U.S. equities, and holds a portfolio which mirrors the performance of the S&P 500 index. Suddenly, the prospects for technology stocks become very bright, and the manager switches his entire portfolio to mirror the performance of the NASDAQ 100 index and leverages the portfolio. The level of leverage is such that his economic exposure to the NASDAQ 100 is twice the value of his assets.

The manager continues to be within his mandate, U.S. equities, but the risk level has risen from about 20% p.a. for the S&P 500 to 114% for a 2× leveraged position in the NASDAQ 100 index. (The figures of 20% and 57% represent, respectively, the average volatility of the S&P 500 and NASDAQ 100 indices during 2000. A mean return of 14% p.a. is assumed in this example.) As a result of this change of volatility profile, the investor has moved from a one in 100 chance of a return of −32.5% p.a. to about a one in three chance of a return of −32.5% p.a.

7.3.3 *Volatility forecasting*

Volatility forecasting is a very mathematically intensive exercise. Ideally, a hedge fund manager should forecast the level of portfolio risk in advance of putting on a new trade for the portfolio. If this were not being done, it would be important to find out how the hedge fund manager keeps track of the risk in his portfolio.

For example, when the U.S. equity markets opened after the tragic events of 11 September 2001, one might have expected the risk of the markets to be higher then it had been before 11 September 2001. A hedge fund manager with positions in the U.S. equity markets would need to examine the impact that this increase in volatility would have on his portfolio.

In this context, absolute risk is the issue, not risk relative to some concept of 'the benchmark' or 'the market'. The reason for this is that the risk relative to the benchmark/market could be zero. However, that is meaningless if we do not know the risk of the benchmark/market, and remember that market risk varies all the time.

The level of risk that actually unfolds in the future may be different from

that forecast by the manager. There are at least two possible explanations for this phenomenon:
(1) the event may be unlikely in view of the information available beforehand; or
(2) the forecast may not have made the best possible use of the information available beforehand.

A review of actual risk versus forecast risk is a useful exercise in assessing the hedge fund manager risk control strategy. Explanations should be sought for frequent deviations between actual and forecast risk. A graph of actual risk versus forecast risk is a useful assessment tool.

If a hedge fund manager decides to forecast risk, and uses parameters like estimates of asset variance, correlations between assets, etc., in the model, to optimise the selection of trades which the hedge fund will put on, then it is important to realise that any errors in the parameters will be magnified by the optimiser. Some traditional fund managers found this out to their cost, when they used certain proprietary estimates of risk and correlation from a well-known vendor to optimise the tracking error of their portfolio relative to a benchmark.

Data quality is vital in forecasting risk and in optimising trade selection. To be reliable, the data must be obtained from highly liquid markets. For example, using share prices from days for which a stock did not trade to estimate the share's volatility and its correlation with other shares is a case of 'rubbish in' equals 'rubbish out'. In addition, the more dimensions that a mathematical optimiser has, the greater the room for error. Mathematical optimisers are, in this respect, only suitable as a means of picking the optimum set of trades where the number of assets to be analysed is relatively small. Small in this context would be six or less.

7.3.4 *Examining the results*

Once you have discussed the manager's volatility strategy, you can then perform a relatively simple statistical test to see if there is a gap between the stated volatility policy and the outcome observed. Again, it is important to realise that the test will reveal nothing of value if the hedge fund takes jump risk and if we have not observed any jumps in the data.

In order to perform the statistical test, it is first necessary to determine the time interval, if any, over which the hedge fund manager aims to keep the volatility of the portfolio constant. For example, one manager might have daily volatility targets while another might have weekly volatility targets. (This is not unusual, as different days of the week exhibit different volatility characteristics. Meeting daily volatility targets may make an investment strategy less profitable and more risky compared with meeting weekly volatility targets.)

Examine the kurtosis of the distribution of returns for this time interval. If it is high (excess kurtosis > 1) and statistically significant, this may be

indicative of significant variation in the volatility of the hedge fund. If the kurtosis is low, be sure that you are confident that it is low. Do not let hedge fund managers with short track records and low kurtosis off the hook, just because you do not have enough observations to do a reliable test of the statistical significance of the kurtosis measure.

High levels of excess kurtosis would warrant a further discussion of the issue of volatility strategy with the manager. Ask for more detailed examples of how volatility strategy was handled in periods where the returns were relatively large and positive and periods where the returns were relatively large and negative.

7.4   *Risk Monitoring by Institutional Investors in Hedge Funds*

As a monitoring tool, institutional investors in hedge funds might consider asking for the forecast level of risk being taken by the hedge fund to be supplied to them on a daily basis.

7.5   *The Benefits of a Constant Level of Risk*

Risk and return are inextricably linked. The higher the level of risk, the higher the expected return. When it comes to hedge funds, focus on the risk, the returns are a by-product of the level of risk taken. If the level of forecast risk is constant, there ought to be fewer surprises. If the investors in a hedge fund are monitoring forecast risk each day and comparing it with actual risk, it is more difficult for a hedge fund manager to increase volatility as a way of increasing his chances of gaining a performance fee. Finally, attention by a hedge fund manager to a constant level of forecast risk will reduce the chances of forecast risk moving higher and the fund being 'hit', just when risk is very high.

A hedge fund manager can keep the forecast risk of his portfolio constant by reducing leverage in his portfolio when the risk of the underlying assets rises, and raising leverage when the risk of the underlying assets falls. A constant level of risk, monitored daily by investors in a hedge fund, makes it difficult for a hedge fund manager to pump up volatility to increase the chances of performance fees.

8.   FUNDS OF HEDGE FUNDS

8.1   *Introduction*

A fund of hedge funds consists of several individual hedge funds, selected, monitored and usually managed (managed, in this context, means that the manager of the pool of hedge funds allocates money to individual hedge fund managers, administers the pool, monitors the pool and can add or remove hedge fund managers from the pool) by an individual or a corporate body. An investor can get exposure to all the hedge fund managers in the fund of

hedge funds by making a payment to the fund vehicle (usually a limited liability company) which is operated by the manager.

A recent article in the *Financial Times* ('Hedge Funds', by Robert Budden; 'Clipped funds pay compelling returns') said:

> "Advisors recommend first-time investors buy into funds of funds as this will normally give investors exposure to a wide range of strategies. It also means that the underlying hedge funds are continuously monitored by an experienced fund manager."

On the face of it, this represents reasonable advice. The investor is not investing in one fund, so he is getting diversification by hedge fund strategy. An experienced hedge fund manager has picked the hedge funds on a professional basis, and continually monitors them on behalf of the investors in the fund of hedge funds. Other arguments in favour of investing in a fund of hedge funds, as opposed to a single hedge fund, include:

(1) widening the exposure from just one manager to a pool of managers; and

(2) a pool of hedge funds is sometimes billed as having greater liquidity than a single hedge fund.

Here are some questions which might arise in the minds of potential investors in a fund of funds:

(1) Just how well diversified is the fund of hedge funds?

(2) What experience does the fund of hedge funds manager have in putting together such funds, and how has he performed in this regard in the past?

(3) What were the selection criteria used to choose the hedge funds included in the fund of hedge funds?

(4) Has the fund of hedge funds manager examined the past performance data for each of the constituent hedge funds in a manner similar to that used in earlier sections of this paper?

(5) How is the risk of the individual hedge funds measured, monitored and aggregated to the fund of hedge funds level by the fund of hedge funds manager?

(6) What reliability can be placed on the past performance figures quoted for the fund?

(7) What are the performance figures when allowance is made for fees charged by the fund of hedge funds manager and the fees of the individual hedge fund managers in the fund of hedge funds?

(8) How much does the fund of hedge funds manager charge for his services?

(9) How much does each of the individual hedge fund managers charge?

(10) How are the two levels of charges integrated, and what is the total charge?

(11) How does the fund of hedge funds generate returns?

Throughout the remainder of this document, we will refer to a fund of hedge funds simply as a pool.

8.2   *Just how Well Diversified is the Pool?*

Do not assume that the pool is diversified just because there are 20 different managers in the pool. The risk of a portfolio is not reduced by simply increasing the number of assets in a portfolio. Rather, it is reduced by increasing the number of assets in the portfolio whose returns are uncorrelated.

We saw earlier that, when a new portfolio is formed by adding a new asset to an existing portfolio, the expected return on the new portfolio is a linear combination of the expected returns on the new asset and the existing portfolio. However, calculation of the expected risk of the new portfolio is not so simple. One simple relationship will help you to decide whether the addition of a new manager to your portfolio will reduce the risk of the combined portfolio.

If the variance of the new asset exceeds the product of the variance of the existing portfolio and the coefficient of correlation between the two assets, then adding the new asset will reduce the variance of the combined portfolio. The proportion of the new asset to add can be determined using differential calculus.

Armed with this relationship, you can quickly decide if the addition of a new manager will improve the portfolio's expected return and lower the risk of the portfolio. Correlation stress testing can also be carried out.

A relatively simple computer program can be used to find the portfolio with the top ten hedge funds in terms of return for the lowest risk, from a list of hedge funds and the associated data.

The program can also be adjusted to allow for other selection criteria, like:
(1)   a restriction that no more than a certain number of hedge funds can come from some particular hedge fund investing style;
(2)   a ceiling on the number of unregulated hedge funds to be included; and
(3)   not including hedge funds where the variance most likely underestimates the risk.

8.3   *Experience of the Fund of Hedge Funds Manager*

The experience of the fund of hedge funds manager in putting together a pool is a critical issue for investors in funds of hedge funds. Ask the manager of the pool for performance data on other pools managed by him or his associates.

It is also a good idea to ask for a prospectus and data on any principal protected pools operated by the manager of the offered pool. Principal protection tends to be dynamically hedged, even if it is insured by an insurance company. If there is a prospectus or offering document for such a pool, it usually gives some useful information on the hedge funds in the pool.

Details of the dynamic hedging operation and a comparison of the principal protection pool and a pool without such protection often reveals interesting information about the risk in pools operated by the manager. Information, like the cost of the principal protection, is useful in assessing the degree of risk in the pool. Selection criteria for the addition and removal of hedge funds from the pool and other issues that you may need to consider are often discussed in more detail in the offer documents for principal protected pools.

Ask for performance details and a list of pools in which the manager of the offered pool acts as an advisor or co-ordinator of advisors. Performance data for pools of a different class than the offered pool should also be sought.

Ask for details of proprietary trading by the pool manager or his associates. Proprietary trading should be widely defined for this purpose. Include in the definition of 'proprietary trading', pooled funds in which the manager of the offered pool has a significant beneficial interest. If there are differences in leverage, costs or trading method between a pool manager's proprietary trading results and those of other pools offered by him, then seek explanations. Key issues to look out for in relation to a pool are the risk management skills of the pool manager, the net of all fees' returns to investors in the pool and the frequency of entry and exit of individual hedge fund managers from the pool.

8.4 *What are the Selection Criteria?*

In answering this question, you may be able to further your knowledge and understanding of the selection of hedge fund managers in the creation of a portfolio. Keep the principles from earlier in mind. The reliability of any assessment of future return or risk of a hedge fund is set by the 'number of observations' which you have of past performance.

8.5 *Due Diligence carried out by the Fund of Hedge Funds Manager*

If the pool manager has not applied the elementary analysis techniques of earlier sections of this paper, and has not satisfied you that he has used equivalent or better techniques, then this is a warning light.

8.6 *Aggregating the Risks in a Pool*

This is an extremely complex task, but it must start with the information that each hedge fund manager in the pool sends to the pool manager. It would be prudent to ask the pool manager for the risk and other information which he has requested from each of the hedge fund managers. The frequency of reporting of this information is another critical issue. Getting a handle on the information pack and the frequency with which it is provided should help you to decide whether you have confidence in the pool manager. The prospectus for some funds of hedge funds may specifically state that no attempt is made to aggregate risk across the hedge funds in the pool!

Where a hedge fund in the pool invests in illiquid assets, you need to look at how the assets are valued, the source of prices and the frequency of valuation. Risk information based on 'smoothed' prices does not give a true reflection of the risks involved. Look out for hedge funds in the pool with long lockup periods. Ask why the lockup period is so long. Investigate the contribution that gearing and underlying market risk make to the overall risk of the constituent hedge funds.

Institutional investors may be better off selecting a few hedge funds to invest in, where they understand the risks of the individual funds, and can aggregate the risk across the funds and integrate it with their existing portfolio.

8.7 *Reliability of Past Performance Figures quoted for a Pool*

When a new pool is being put together, one could start with a database of hedge funds, run a complex program to select, say ten, hedge funds for inclusion in the pool, and set the selection criteria to develop a fund with any reasonable set of investment characteristics.

Put another way, suppose that you wish to create a fund consisting of, say ten, ordinary shares of publicly quoted companies which have a five-year track record, as follows:
(1)   the average annualised return of the fund is 20%; and
(2)   the annualised standard deviation of return of the fund is 10%.

If you have access to a good database of share price movements spanning the last five years, and you have a computer program, it would not be too long before you would be able to come up with a portfolio that meets the track record criteria. Unlike the past performance of an individual hedge fund, the past performance of a pool of hedge funds can be manufactured easily to meet almost any desired investor appetite, ranging from low risk and low return to high risk and high return. In looking at the 'simulated' performance figures for a new pool, it is not unusual to find that there have been no losing months and that the Sharpe ratio of the fund is some superb number like three.

So, it is important to ask the pool manager how the portfolio was constructed. Then, reflect on his answer and keep the points above in mind. As a general rule, ask the pool manager if he has received independent confirmation of the monthly performance figures quoted to him by the constituent hedge fund managers. Independent confirmation can usually be got from an institutional client of the hedge fund manager, where the institution is not in anyway related to the hedge fund manager.

It is also important to ask the pool manager if he has investigated the investment performance of all of the funds, including proprietary funds, managed by each of the hedge fund managers in the pool. This should give you some idea of the spread of each constituent manager's investment skills.

The methods used by the hedge fund managers in the pool to calculate their net asset values and performance fees should have been properly investigated by the manager.

8.7.1 *Biases in hedge fund databases*

Hedge fund databases contain significant biases. These can be summarised as follows:

(1) There is no requirement for a hedge fund manager to report his performance to a database. So, having traded from inception for a period and having good results, a manager may decide to put his performance figures into a database. The bias here is that only those managers who survived an initial period from start up find themselves in the database. If you are looking at the returns of hedge funds quoted in databases, be aware that the since inception returns for funds tend to be biased upwards. On the other hand, it is important to realise, too, that a number of top performing hedge funds do not include themselves in databases, because they have reached their capacity limit or because of regulatory restrictions on advertising.

(2) Hedge funds that are in a database do not have to stay in it. If you are a hedge fund manager, and you see your performance figures declining, you may not wish to advertise it to the whole hedge fund community and to potential investors in the next fund which you intend to set up. The simple thing to do is to take your fund out of the database. So, if you are looking at the returns of hedge funds quoted in a database, be aware that there may be a survivorship bias — only those who perform well stay in the database. Again, it is important to note that some hedge funds with good performance are withdrawn from databases, because they have reached capacity in terms of assets under management, or because of regulatory restrictions on advertising. Other reasons for withdrawal from a database include merger and a change of name.

(3) Some databases have particular compilation rules that need to be understood, so that you can be aware of any bias in the figures which you are viewing. For example, does the database exclude the performance of funds which went out of business during the periods for which data are available? If this is the case, then any performance figures are biased upwards.

(4) Where hedge fund indices are used to look at particular hedge fund strategies, check how the indices are compiled. Are the returns shown the arithmetic average of the constituent funds of the index, or are they weighted averages? (Weighted average returns are usually prepared by weighting the returns of each hedge fund in the index by assets under management. As usual, a thorough review of the database is always much more revealing than summary statistics.) In addition, remember

that indices, by their very nature, tend to have lower volatility than any of their constituent hedge funds.

(5) Another question to ask is: "Are all the hedge funds in the database open for new business?" If they are not, then you should confine your search to those which are open for new business, and compare the results of this search with similar results for the whole database. You may find a trend there, like the funds closed to new business perform worse than those open for new business.

(6) The biases pointed out here also affect estimates of volatility, too. In general, the biases identified will tend to underestimate volatility.

(7) When you search one of the large databases, be aware that you can introduce further bias to your sample by selecting only those hedge funds which meet certain criteria.

(8) Suppose that a particular set of hedge funds has a very low standard deviation and high returns. Ask the key questions: "Is this jump risk? Have we had a sufficient number of extreme market events that illustrate the true performance of such funds?"

8.8 *Performance Net of All Fees*

While a fund of hedge funds is sometimes used for diversification or risk reduction in a portfolio, it is useful to review the fund from a performance perspective. Where the pool has operated for a few years, it is useful to see if the net of all fees performance is any better than investing in a balanced fund, when risk, return and kurtosis are taken into account.

The average fund of hedge funds levies an annual management charge of 1.4% and an incentive fee of 10% for the pool manager. These charges are in addition to the charges levied by the constituent hedge fund managers.

A recent study by Amin & Kat (2001) shows that funds of hedge funds typically do not deliver superior returns, because of their double charging structure, annual management fees and performance fees for the constituent hedge funds and for the pool manager.

8.9 *Charges*
8.9.1 *Pool manager charges*

Pool managers usually charge an annual management fee and a fee related to the performance of the pool. Performance fees for the pool manager may not kick in until a certain threshold rate of return is reached. Ask for details of any threshold and of the frequency with which performance fees are earned, e.g. monthly or quarterly.

A key issue to focus on is the way in which the pool manager's performance fees vary with the performance of the constituent hedge fund managers. The pool manager may also receive rebates of fees charged by some, but not all, of the constituent hedge fund managers, and this may influence allocation strategy. This issue needs to be studied closely.

Some hedge fund practitioners in the U.S.A. rather cynically refer to a fund of hedge funds as a fund of fees. As an investor, you must be sure as to which of the two funds you intend to invest in.

8.9.2 *Charges of the individual hedge fund managers*

To answer this question, we need to look at the annual management charge of each manager and his performance fees and any associated threshold for such fees. It is vital to ask if there are any other fees, like brokerage fees, where the hedge fund manager gets a fee for every trade executed. Diligence in the search for fees at this level is very important. Ask for numerical examples of how fees would be calculated for various performance scenarios, including periods of negative returns, and for various numbers of trades in different markets/sectors/geographic area.

8.9.3 *Integration of the two levels of charges*

Suppose that, in one month, half of the hedge fund managers in the pool deliver positive returns, after allowing for performance fees, and the other half negative returns, so that the total return to the investor is zero. Depending on the rules of the pool, it is possible, in the circumstances described above, for the managers who deliver positive returns to earn performance fees, despite the fact that the investor gets no return for the month.

It is important to examine how the two levels of fees interact and combine to produce the total fee for the pool. Ask for numerical examples based on both negative and positive pool performance, with varying distributions of performance across the constituent hedge funds.

8.10 *Protected Pools*

In a protected pool, the investors are offered a capital or an income guarantee. This makes them attractive to risk adverse investors, as such pools offer the potential gains from a diversified portfolio of hedge funds with some limit on downside risk. From the point of view of a manager making an allocation to hedge funds, protected pools limit 'career risk', provided that the guarantor performs if he is called upon so to do. Protected pool products are often structured as fixed-income securities, which allows them to fit into the regulatory framework of many institutions and the existing settlement systems.

It would be a mistake to assume that such vehicles are the Holy Grail of hedge fund investing. As well as the fees charged by the individual hedge funds that make up the pool and by the pool manager, the guarantor will require a premium for underwriting the risk, and to be reimbursed for his costs of assessment and monitoring of the constituent managers. Net of performance fees for such funds reflect these extra costs, and remember that lower risk is generally associated with lower returns.

Protected pool hedge fund products certainly make the initial sale easier,

but may give rise to difficult after sales service issues, when the net of fees performance does not live up to stellar performance expectations. The allocating manager's career ought to survive, but the client service manager will probably have a tougher time with these products.

In recent times, some structured products have been developed which offer a single hedge fund manager with principal protection. Where the hedge fund manager has good risk management systems in place, the insurance costs for such products may be more reasonable than for a multi-manager pool, and therefore give better net of fees returns.

8.11   *How Does the Fund of Hedge Funds Generate Returns?*

Typically, the marketing would suggest that returns are generated by a mixture of strategy allocation and manager selection within strategies. Suppose that the pool manager felt that corporate merger and acquisition activity was going to fall significantly. The pool manager might decide to reduce the pool's exposure to these types of strategies, and increase its exposure to, say, short sellers. Once this decision is made, the problem becomes one of selecting short selling hedge funds.

On the face of it, this sounds like a sensible way to generate returns. It also sounds like a good way of attributing performance. It is very similar to the way that a typical balanced fund manager generates returns by asset allocation and, within asset classes, stock selection.

However, there is one difference which investors need to look carefully at before accepting the theory. Balanced fund managers can switch between the main asset classes with relative ease and at relatively low cost. In fact, they can do so with great speed and at very low costs if they use stock index futures and bond futures. This is where the analogy with funds of hedge funds breaks down. Many funds have long lockup periods, and tactical strategy allocation may not be a reality. So, ask the pool manager, who suggests this approach to generating returns, for a list showing the lockup period for each of the hedge funds in the pool, and assess for yourself if the strategy will work.

Pool managers usually can fire or add new managers to the pool without any consultation with the pool investors. So, make sure that you are happy with the manager's selection and monitoring criteria and skills. Firing a 'losing' manager seems to make good sense on the face of it. However, from the pool investor's point of view, the issues are not quite as clear cut. If the 'losing' manager were to turn around his poor performance, there would be no performance fees payable while he claws his way back to his previous 'high water mark'. However, if a new manager is added to the pool and the losing manager is removed, any performance generated by the new manager is subject to performance fees immediately. The new manager added to the pool does not have to make up the losses of the losing manager, who was removed from the pool before he starts to earn performance fees. Frequent

firing of losing managers seems like a good idea, but it may be expensive for the pool investors.

8.12 *Traps for the Unwary*

The fund of hedge funds' industry has a supply side as well as a demand side. We will now focus on the implications of the supply side for investors.

Suppose that you are a hedge fund manager, and that your performance has been less than stellar in recent times. You have taken down your risk level, and are just plodding along, giving a return close to what investors could get on deposits. You have managed to hold most of the clients, at least for the moment, so you are getting the management fees, but the performance fees are nothing like they used to be in the old days. One way to get more money into a hedge fund like this would be to package it up in a fund of hedge funds with a number of other hedge funds with more stellar performances. The ailing fund then gets its share of new business from sales of the fund of hedge funds, and so the management charge can grow. Some investors may query the presence of this poor performing hedge fund in the pool, but it will usually be justified on the basis that it represents diversification within the pool. After all, diversification is what investors are looking for in a fund of hedge funds. This is yet another reason to review each hedge fund manager in the pool, and to monitor the new ones added to the pool over time.

8.13 *Closed-End Funds of Hedge Funds*

Many funds of hedge funds are structured as closed-end funds, which are quoted on stock exchanges. Investors can simply purchase such funds through their stockbrokers and so settlement is very easy. These closed-end funds of hedge funds' shares often trade at a premium to their net asset value. However, this premium may disappear, and, perhaps, become a discount to net asset value very quickly, especially if investor sentiment changes. Even if you buy a fund of hedge funds at a discount to its net asset value, be aware that the discount could widen as well as narrow. This is a further layer of volatility which investors must beware of when investing in closed-end funds of funds which are quoted on stock exchanges. Open-ended funds do not suffer from this disadvantage, as the price must equal the net asset value of the fund.

In addition, this access route to funds of hedge funds suffers from the further disadvantage of stockbroker commission, possibly stamp duty and custody fees.

Funds of funds which are open-ended in structure and have a high degree of liquidity in their underlying assets do not suffer from this type of discount to net asset value problem.

8.14 *Customised Pools for Institutional Investors*

For the institutional investor, investing in an existing fund of hedge funds may pose some difficulties:

(1) high fees with poor transparency of fees;
(2) a general lack of transparency — it sometimes does not go beyond the names and allocations to the constituent hedge fund managers; a major problem for institutional investors that need to manage the various risks across all their investments; and
(3) lack of liquidity.

Institutional investors, who feel they must have a fund of hedge funds, sometimes consider a customised fund of hedge funds. The investment vehicle is usually structured as a limited liability entity. With this approach, the institution can have a much greater influence on the information flows from the constituent hedge fund managers, which is so vital for risk management purposes. Greater and more frequent access to the trades and positions of the constituent hedge fund managers will help the institution to aggregate its stock specific risk, currency risk, credit risk, market risk, sector and geographic exposures, and strategy exposures.

Further, institutional investors can tailor their customised pool to meet the correlation, return and risk characteristics to their specification. Greater control can also be exercised over the selection of managers, especially if the institution wishes to confine itself to regulated entities in domiciles with a strong regulatory history. The fees charged by the constituent managers of the pool and the frequency at which liquidations are allowed may also be negotiated. The customisation approach should also allow the institution to avoid hidden fees tucked away in many funds of hedge funds. The downside, however, is the substantial costs and set-up fees involved, but these could be viewed as an investment in new skills for a new market environment.

8.15 *Conclusion*

Some institutional investors may find existing funds of hedge funds unattractive. The main reasons for this are:

(1) the lack of transparency;
(2) the difficulties in aggregating the risk in a fund of hedge funds;
(3) the consequent difficulties in integrating the various risks in the fund of hedge funds with the portfolio of an institutional investor;
(4) the relatively poor after-fees performance of such funds; and
(5) in some cases, lack of liquidity of many funds of hedge funds.

As an alternative to an existing fund of funds investment, institutional investors may prefer to create their own portfolio of hedge funds. This approach allows them to decide the key parameters of such a fund, including

the risk, the correlation to the existing portfolio and the expected return. The portfolio could be a tailor-made fund of hedge funds, or the institutional investor may invest directly in a number of hedge funds.

REFERENCES

AMIN, G.S. & KAT, H.M. (2001). *Hedge fund performance 1990-2000, do the 'money machines' really add value?* University of Reading ISMA Centre.

CREREND, W.J. (1998). *Fundamentals of hedge fund investing: a professional investor's guide*. McGraw Hill.

EMBRECHTS, P., KLUPPELBERG, C. & MIKOSCH, T. (2001). *Modelling extremal events for insurance & finance*. Springer.

FACULTY & INSTITUTE OF ACTUARIES (2001). Hedge funds for pension funds. By the Applications of Institutional Investments Working Party. Paper presented to the Investment Conference.

HILL, B.M. (1975). A simple approach to inference about the tail of a distribution. *Annals of Statistics*, **3**, 1163-1173.

MARDIA, K.V. (1980). Tests of univariate and multivariate normality. *Handbook of Statistics, Vol. 1*, Krishnaniah, P.R. (editor), North Holland Publishing Company.

MERRILL LYNCH INVESTMENT MANAGERS (2000). *Hedge funds*.