

# **HEDGE FUND PORTFOLIO CONSTRUCTION**

Master of Arts in Law and Diplomacy Thesis

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## **Abstract**

Investing in hedge funds requires a diversified and well-constructed portfolio of different hedge fund strategies to ensure that risks at both the individual fund manager level and the systemic level are minimized. The different hedge fund strategies are exposed to different systemic risks, and returns will therefore change with changes in the market environment. These different risk/return profiles provide almost endless possibilities for creating value through active portfolio allocation, where strategies interplay to generate consistent absolute returns.

A prerequisite for a successful allocation is a thorough understanding of the different risk/return drivers in each strategy. Risk in hedge funds comes primarily through exposure to the different underlying security instruments which the funds use to generate returns. A number of hedge fund strategies invest in more than one asset class, thereby diversifying the return generation, but not necessarily reducing the total risk exposure.

An explanation for the risk in some of the hedge fund strategies can be found through regression analysis against other market indicators, while some strategies can only partly be explained by regression analysis. This lack of clearly defined market risk does not indicate that the strategy is risk-free, but merely that the associated risks are non-quantifiable, due to the use of non-linear return methods such as derivatives and leverage.

The optimal portfolio allocation will always be a trade-off among the risks an investor is willing to incur for an anticipated return level. Risks can be measured both as standard deviation and as Value-at-Risk, but a hedge fund portfolio should be constructed with the mean-variance optimization model, as none of the hedge fund strategies can be rejected for normality if the return distribution is considered according to time relevance.

The separation of the hedge fund portfolio into a core and a tactical part would be useful for sophisticated hedge fund investors who have the ability to actively follow market environments, and monitor the risk/return parameters continuously. For the less sophisticated investor, the hedge fund portfolio should be kept at a core level with a long-term investment objective.

Due to opaque investment methods, hedge fund investing requires specialized skills, such as an understanding of complex security instruments, extensive industry knowledge, and analytical ability. An institution or high net worth individual may benefit from an intermediary partner e.g. a fund of hedge funds who possesses the necessary qualifications and skills to filter through the many thousands of hedge funds and understands how the different hedge fund strategies can be optimally combined to generate consistent absolute returns.

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# 1 Introduction

Investing in hedge funds requires a diversified and well-constructed portfolio of different hedge fund strategies to ensure that risks at both the individual fund manager level and systemic level are minimized. The different hedge fund strategies are exposed to different systemic risks, and returns will therefore change with changes in the market environment. These different risk/return parameters provide almost endless possibilities for creating value by active portfolio allocation, where strategies interplay to generate consistent absolute returns.

The purpose of this paper is to identify a practical allocation process for the creation of a hedge fund portfolio. A prerequisite for a successful allocation is a thorough understanding of the different risk/return drivers in each strategy. Section 2 of the paper is therefore an in-depth analysis of the risk and return of the individual strategies. The return numbers analyzed in this paper are derived from hedge fund indices; thus a thorough discussion of the various hedge fund indices is included prior to the examination of the strategies.

In recent years, there has been a lively debate about the relevance of the mean-variance optimizer model for hedge fund portfolio construction, primarily because the mean-variance model assumes normal return distribution. Periodically the return distribution for some hedge funds strategies has differed significantly from a normal distribution. In section 3, the analysis will demonstrate that the extraordinarily higher moments observed in the historical hedge fund return distributions can all be attributed to the period around

1998. In fact, no strategies can be rejected for normality when the hedge fund return distribution is exponentially weighted according to time-relevance. The section concludes with a discussion of core hedge fund portfolio construction.

Section 4 evaluates the impact of adding a complementary hedge fund allocation to a typical Danish pension fund's current portfolio. Also included is a brief discussion of the implementation of such a strategy. The paper concludes with recommendations in section 5.

## **1.1 Market Overview**

Collectively, hedge funds represent a broad array of diverse strategies which seek to generate absolute return under all market conditions. In addition to pursuing absolute return, the majority of hedge fund managers are defined by some common characteristics. First, they often apply leverage to their investments either through borrowing or trading on margin. Secondly, they use short-selling. Thirdly, derivatives may be used for hedging or for leveraged directional positions. Lastly, the fund managers often have significant investments in their own funds<sup>1</sup>.

The first hedge fund, started by Alfred W. Jones in 1949, was a long-short fund<sup>2</sup>. In the beginning, very few people participated in this new field, but some very notable personalities like George Soros, Julian Robertson and Michael Steinhardt established themselves during the period leading up to 1990. Until the late 1990s, the hedge fund

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<sup>1</sup> Jaeger, Lars, *Through the Alpha Smoke Screens: A Guide to Hedge Fund Return Sources*, New York, Institutional Investor Books, 2005, p. 8

<sup>2</sup> Lowenstein, Richard, *When Genius Failed*, Random House, 2000, p.25

industry remained a niche industry, but in the last 10-15 years the industry has grown explosively, and today more than 8,000 funds are in operation. The estimated asset under management for hedge funds varies, with some surveys suggesting numbers as high as \$1.5 trillion<sup>3</sup>.

At first, the majority of investors in hedge funds were private individuals. However, this picture is changing. Morgan Stanley estimates that institutional investors will contribute 60% of hedge fund assets in 2006<sup>4</sup>. Many academic studies have shown that hedge funds offer risk and return characteristics that are different from traditional investments.

Therefore, by including hedge funds in a portfolio, the risk/return characteristics can be optimized. (See Appendix 1 for an overview of some of the academic papers.) This acknowledgement from academics, together with the successful implementation of hedge fund portfolios by some US endowment managers, most notably Yale and Harvard<sup>5</sup>, has proven the value of a sizable hedge fund allocation for both return and diversification purposes.

The first two funds of hedge funds were launched in 1969, and this industry has likewise also experienced rapid growth, with approximately 2,000 funds of funds in operation today<sup>6</sup>. The purpose of a fund of hedge funds can best be explained by comparing them to mutual funds. Funds of hedge funds have the same investment rationale as mutual funds, but instead of investing in bonds or equities, they invest in a selected number of hedge

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<sup>3</sup> Feisst, Melanie, *Hedge funds storm to \$1.5 trillion*, The Daily Telegraph, March 16, 2006

<sup>4</sup> Morgan Stanley, Hedge Fund Seminar Presentation, June 2005, p.20

<sup>5</sup> The annual return for Harvard and Yale were 19.2% and 22.3% respectively for the year ending June 30, 2005.

<sup>6</sup> Morgan Stanley, Hedge Fund Seminar Presentation, June 2005, p.13



funds which they believe are capable of generating the best risk/return trade-off in the future.

Funds of funds can primarily add value in two ways. Firstly, fund of funds managers are often very experienced and have the ability to identify future winning funds in an increasingly complex and crowded hedge fund industry. Secondly, a recent study from EDHEC shows that significant value can be added to a hedge fund portfolio through the systematic implementation of active style allocation decisions, both at the strategic and tactical levels<sup>7</sup>. Currently very few funds of funds make directional allocations based on capital market conditions<sup>8</sup>. This is however likely to change as fund of funds managers realize the value of dynamic allocation in hedge fund portfolios.

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<sup>7</sup> Martellini, Lionel, Mathieu Vaissie and Volker Ziemann, *Investing in Hedge Funds: Adding Value through Active Style Allocation Decisions*, EDHEC Publications, 2005

<sup>8</sup> Nicholas, Joseph G., *Hedge fund of funds investing: an investor's guide*, Princeton, NJ : Bloomberg Press, 2004, p. 83

## 2 Hedge Funds: Risk and Return

### 2.1 Measuring Hedge Fund Performance

A mutual fund which outperforms its benchmark is said to generate an alpha equal to the level of excess return over the benchmark return. Generally, mutual funds invest in relatively defined areas for which appropriate benchmarks exist.

In the hedge fund industry, however, appropriate benchmarks for return comparisons are much less clear. Some hedge fund managers argue that returns should be compared against the risk-free rate given their absolute return objective. Considering that hedge fund investing is far from risk-free, such an argument seems rather weak<sup>9</sup>, and would almost certainly ensure significant positive alpha in a fund. Hedge fund indices, or a selection of peer funds with a similar investment strategy, would provide a more meaningful return comparison.

#### 2.1.1 Performance Biases in Hedge Fund Indices

Most hedge fund indices are constructed by calculating the median performance of a set of managers. The underlying manager database often changes, thereby creating performance biases which impact the reliability of the indices. These biases include the following: survivorship, selection, backfill, reporting, and weighting<sup>10</sup>.

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<sup>9</sup> Jaeger, Lars, *Through the Alpha Smoke Screens: A Guide to Hedge Fund Return Sources*, New York, Institutional Investor Books, 2005, p. 170

<sup>10</sup> Jaeger, Lars, *Through the Alpha Smoke Screens: A Guide to Hedge Fund Return Sources*, New York, Institutional Investor Books, 2005, pp. 172-173, and Lhabitant, François-Serge, *Hedge funds: myths and limits*, Chichester ; New York : Wiley, 2002, pp. 133-136

Survivorship bias occurs when an index includes only surviving funds by removing the historical data from permanently closed funds. The most common cause of fund closure is poor performance. By only including the successful funds, the index will overestimate the performance of all managers in a given strategy. Some data providers attempt to account for this situation by including the return data from closed funds while they were in existence.

Selection bias arises because all hedge fund indices are based on voluntary data submission. Some managers submit data to numerous index providers, while other managers do not submit any data, and are therefore not included in any index. Submitting data to an index is in part marketing, as the managers have an incentive to make investors aware of the fund's existence. There are two types of funds that have no incentive to submit data; closed funds or poorly performing funds.

Backfill bias results from the incubation period between the fund launch and the first data submission. Most new managers prefer to wait until they have an impressive track record before they submit their data to the indices. To avoid backfill data, the indices should only include the data after the fund is added to the database, but most indices include the entire existence period of the fund, thereby adjusting the historical index data.

Reporting bias is a consequence of the time-lag with which funds report. Most indices provide an estimated return before all participating managers have submitted their data, and adjustments can therefore occur once all managers have reported.

Weighting bias is caused by the two ways to weight an index: asset and equal weighted. Asset weighted indices weight the so-called “asset gatherers,” which are the biggest funds in the industry at a pro-rata higher weight than smaller peers. In the hedge fund industry, size often has a negative impact on performance, and the index might therefore not fairly represent the return of the strategy. By contrast, equal weighted indices tend to overweight small funds.

### **2.1.2 Index Providers**

There are numerous hedge fund index providers on the market. Most of them have one or more performance biases, and almost all of them offer an investable version of their indices. These investable indices are in fact funds of hedge funds, as the invested money is allocated to the underlying managers. Some of the main index providers are briefly discussed below.

#### *2.1.2.1 HFR*

Hedge Fund Research (HFR) is arguably the most popular index provider among hedge fund investors. The company has more than 5,000 funds, and funds of funds, in its database. There is no required asset minimum and no required length of track record for inclusion. The indices are equal-weighted and have data dating back to 1990. HFR compensates for survivorship bias by including failed fund’s data for the period of

existence. The company has one main hedge fund index, one main fund of hedge fund index, 26 hedge fund sub-indices, and 4 funds of funds sub-indices. The main hedge fund index however has a company-decided selection bias, as it does not include the managed futures/Commodity Trading Advisor (CTA) strategy,<sup>11</sup> nor does HFR provide a sub-index for managed futures/CTA.

#### *2.1.2.2 Credit Suisse/Tremont*

Credit Suisse/Tremont provides the only asset-weighted hedge fund indices in the industry. The company includes around 400 funds in the indices, which it selects from a database of more than 2,600 funds. Each fund in the database needs a minimum of \$50 million under management, a one-year track record, and current audited financial statements. Funds are selected every quarter. Credit Suisse/Tremont compensate for backfill bias by only including funds' data on a forward basis. The company has one main index, and 13 sub-indices, but does not provide a fund of funds index. The data goes back to 1994.

#### *2.1.2.3 Barclay / GHS*

Barclay / GHS indices have data back to 1997 for most hedge fund strategies. Barclay, however, started as a CTA index, and has data for this strategy back to 1970. The data in the main index is compiled from approximately 2,500 hedge funds, of which about 1,500 are funds of funds. Barclay / GHS offer one main index, one fund of funds index, and 16 sub-indices, which in broad terms represent the same strategies as the Credit Suisse / Tremont indices.

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<sup>11</sup> Lhabitant, François-Serge, *Hedge funds: myths and limits*, Chichester ; New York : Wiley, 2002, pp. 134

#### 2.1.2.4 *Standard & Poor's*

The S&P Hedge Fund Indices are constructed as investable indices, and are more fund of hedge funds than indices. The indices consist of three styles that very broadly represent hedge fund investing: Arbitrage, Event-Driven, and Directional/Tactical. Each style in turn consists of three strategies. The index construction process determines the number of funds required to construct a representative and investable index. Standard & Poor's conclude that a portfolio of 30 to 40 hedge funds represents the risk/return characteristics of broader portfolios of hedge funds<sup>12</sup>.

#### 2.1.2.5 *Morgan Stanley Capital International*

Morgan Stanley Hedge Fund indices were introduced in 2002, with an investable version in 2003. The company offers five so-called process groups, determined by the investment process. The process groups break down to more than 190 different indices, calculated with data from more than 2,500 funds. The classification of the sub-indices is based on investment process, asset classes of the traded instruments, and geographical region<sup>13</sup>. The index construction is somewhat different from most other providers and has still not gained widespread recognition.

### **2.1.3 Selecting Index Providers**

Both HFR and Credit Suisse/Tremont provide market indices which are different from their respective investable indices. Successful funds which have reached their capital limit and are closed to investors remain in the market index, but are removed from the

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<sup>12</sup> Standard and Poor's, *Standard and Poor's Hedge Fund Index*, January 2003, available at <http://www2.standardandpoors.com/servlet/Satellite?pagename=sp/Page/IndicesBrowseMethodologyPg&r=1&l=EN&b=4&s=132&ig=&i=&si=&d=&xcd=HEDGE&f=3>, accessed January 17, 2006

<sup>13</sup> MSCI, *Hedge Fund Index Families*, available at <http://www.msci.com/hfi/index.html>, accessed January 17, 2006

investable index. The investable indices therefore tend to underperform the market indices, as they only include funds still open to capital<sup>14</sup>.

The index bases for HFR and Credit Suisse/Teemont are the broadest in the industry, which make these indices more representative of the strategy performance compared to narrower indices. As discussed above, there are some differences in the index construction of the two companies, and the indices are therefore not fully interchangeable. Some strategies are covered by both companies, while some are only covered by one of them.

In this paper HFR and Credit Suisse/Tremont will both be used as indices for each strategy. In the cases where only one of the main indices covers a strategy, Barclay/GHS will be used as the second index.

#### *1.1.3.1 How to Use the Index Data*

Hedge funds are dynamic and ever-evolving entities, whose managers constantly seek new opportunities within their investment strategies. This fact unfortunately limits the reliability of the data, as the managers might shift investment style. An arbitrage manager in the early 1990s, for instance, was very different in both style and leverage to an arbitrage manager today. In addition, growth in assets and personnel alters the investment approach and the opportunities the manager is pursuing.

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<sup>14</sup> Jaeger, Lars, *Through the Alpha Smoke Screens: A Guide to Hedge Fund Return Sources*, New York, Institutional Investor Books, 2005, pp. 175-176

This paper uses past return data to predict future performance of an individual strategy. Considering the many changes in the hedge fund industry over the years, it is fair to assume that the more recent the data, the more reliable it is for predicting future performance. An economic cycle, however, does not happen over the course of only one year, and to fully understand a strategy's behavior under all market conditions, data for at least six to eight years needs to be considered.

To leverage the recent data over the older data, an exponential weighting of data will be used in the paper. All data is broken down into three-year increments, so that the most recent three-year period is weighted twice as high as the previous and so forth. While this is not in anyway a perfect solution, it partly solves the problem with the trade-off between dynamic styles and consideration of the entire economic cycle.

#### **2.1.4 Peer Groups**

Peer group comparison is another way to measure the performance of an individual fund. Peer group selection is, however, very difficult and requires extensive industry experience, and in-depth knowledge of both the different funds' trading strategies and risk dimensions to ensure comparability. A peer group can constitute a weighted index, or it can be used for comparison one by one to the chosen fund. If a peer group is carefully selected, it can be a very accurate performance indicator for a strategy.



## **2.2 Identification of Risk and Return**

### **2.2.1 Correlation and Regression Analysis to Explain/Forecast Return**

Appendix 2 provides an overview of the main strategies and selected sub-strategies. The classification is divided into six main strategies: Multi-Strategy, Equity, Relative Value, Event Driven, Global Macro, and Managed Futures (CTA).

Risks in hedge funds primarily come through exposure to the different underlying security instruments which the funds use to generate return. A number of hedge fund strategies invest in more than one asset class, thereby diversifying the return generation, but not necessarily reducing the total risk exposure. The best way to identify relationships between hedge fund strategies and market factors is through correlation analysis. Once the correlated factors are identified, the strength of the relationship between a dependent variable (the hedge fund index) and a series of independent variables (correlated market factors) can be tested by regression analysis.

Correlation measures how securities move in relation to each other. It is, however, only a directional indicator which measures how often two securities move in the same direction, but not the amplitude of the moves. Appendix 3 shows the exponentially weighted historical return correlation between individual strategies and some selected market factors.

The two basic types of regression are linear regression and multiple regression. Linear regression uses one independent variable to explain and/or predict the outcome of Y,

while multiple regression uses two or more independent variables to predict the outcome. The general form of each type of regression is:

Linear Regression:  $Y = a + bX + u$

Multiple Regression:  $Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \dots + b_tX_t + u$

Where Y is the dependant variable, X's are the independent variables used to predict Y, a is the intercept, b is the slope, and u is the regression residual. In multiple regression, the separate variables are differentiated by using subscripted numbers.

## **2.2.2 Risk and Return in Each Strategy**

Correlation and regression analysis is the foundation for understanding the risk/return characteristics of hedge fund strategies. One can identify the risk exposure for a given strategy by using regression analysis to determine the strength of the relationship between the strategy and one or more factors representing systemic risk. The results of the regression analysis are found in Appendix 4.

The use of derivatives and the reliance upon risk factors such as liquidity, credit, and volatility creates a non-traditional, non-linear risk exposure which is difficult to measure with traditional methods<sup>15</sup>. Correlation and regression analysis, therefore, only provide limited understanding of the risk exposure for some strategies. By understanding the investment process of these strategies, the risk can be estimated qualitatively.

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<sup>15</sup> Admec, Noel, Lionel Martellini, and Felix Goltz, *Hedge Funds from the Institutional Investor's Perspective*, EDHEC Risk and Asset Management Research Centre, 2005, p.4

The Multi-Strategy managers have been excluded from this examination of basic risk factors. These managers seek to profit from allocating to a number of different strategies and adjusting their allocations based upon perceived opportunities. Therefore, the strategy in itself does not have peculiar risk exposure, but is exposed to the risks of the underlying hedge fund strategies. Each Multi-Strategy fund needs to be examined individually, as the underlying strategies often differ from manager to manager. Many Multi-Strategy managers, however, began as convertible arbitrage managers that diversified into other strategies, and the portfolios therefore tend to have an overweight in arbitrage strategies<sup>16</sup>.

### **2.2.3 Equity Hedged Strategies**

#### *2.2.3.1 Long/Short*

The long/short managers attempt to identify both the most undervalued and the most overvalued companies. They go long the undervalued and short the overvalued companies' equity. The use of short-selling in general serves two main purposes. First, it can represent a bet on an overvalued asset. Second, it can be used to hedge the market risk of the long position. Additionally, it might collect interest on the short amount, provided that the manager has negotiated a good short-rebate with his prime broker<sup>17</sup>.

The advantage of holding both long and short positions is that the portfolio makes money in most market environments, as long as the long position outperforms the short position.

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<sup>16</sup> Credit Suisse – Tremont, *Hedge Fund Index, Multi-Strategy*, available at [http://www.hedgeindex.com/hedgeindex/secure/en/indexdetail.aspx?IndexName=HEDG\\_MULTI](http://www.hedgeindex.com/hedgeindex/secure/en/indexdetail.aspx?IndexName=HEDG_MULTI), accessed March 9<sup>th</sup>, 2006

<sup>17</sup> Lhabitant, François-Serge, *Hedge funds: myths and limits*, Chichester ; New York : Wiley, 2002, p. 79

The HFR Long/Short index is highly correlated to the equity indices, especially the Russell 2000 index family. Incidentally, the highest explanation ratio is found with the Russell 2000 Growth index, which alone can explain 82% of the return over the last six years. This high ratio indicates that the two indices are exposed to the same systemic risk factors. These systemic risk factors include small company, liquidity, and market risks. The company risk is a function of the small – mid- size company space, where the proportional number of company default is higher than for larger companies. The trading volume of smaller companies can also be relatively limited, which in turn means that a sizeable position can have high liquidity risk.

#### *2.2.3.2 Equity Market Neutral*

The strategy seeks to be beta neutral, and only generate return from the relative outperformance of the long versus the short positions, regardless of how the market moves. The neutral position can refer to beta, sector, country, currency, industry, market capitalization, style neutral, or any combination of these factors<sup>18</sup>. Theoretically this should reduce the systemic market risk to an absolute minimum, although liquidity, credit, and company risk for small cap investments remain.

The best explanatory power to the HFR Equity Market Neutral index comes from a blend of the Russell 2000 and the relative outperformance of the Russell 2000 – Russell 1000. The explanation ratio, however, is only 18% over the past three years and 6% over the past six years. This low explanation ratio indicates that the managers have generated

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<sup>18</sup> Jaeger, Lars, *Through the Alpha Smoke Screens: A Guide to Hedge Fund Return Sources*, New York, Institutional Investor Books, 2005, p. 65

returns, either positive or negative, which are uncorrelated to the overall equity market performance.

### 2.2.3.3 *Short-Selling*

Short selling involves the sale of a security not owned by the seller, a technique used to take advantage of an anticipated price decline. The short sellers use all available techniques for shorting securities, including outright securities shorting, uncovered put options, and occasionally futures shorting. A short seller must generally pledge to the lender other securities or cash as collateral for the shorted security in an amount at least equal to the market price of the borrowed securities<sup>19</sup>.

Short sellers average performance as measured by the HFR index has a high negative correlation to the Russell 2000 Growth index. The regression analysis reveals an explanation ratio of over 91% for the past five years' data. Although the explanation ratio is slightly lower over six years, it indicates that the strategy is only profitable when the Russell 2000 Growth index declines. The risk of the strategy is therefore primarily the success factors for the small and mid-cap companies constituting the Russell 2000 growth index, i.e. low default rates and good credit environments, as well as short-specific risk, such as short-squeeze<sup>20</sup> and unlimited position losses.

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<sup>19</sup> HFRI Strategy Definition, *Short Selling*, available at <https://www.hedgefundresearch.com/monthly/index.php?fuse=hfristrats#2897>, accessed January 16, 2006

<sup>20</sup> A short-squeeze is situation in which a lack of supply and an excess demand for a traded stock forces the price upward. If a stock starts to rise rapidly, the trend may continue to escalate because the short sellers will likely want out. For example, say a stock rises 15% in one day, those with short positions may be forced to liquidate and cover their position by purchasing the stock. If enough short sellers buy back the stock, the price is pushed even higher. Short squeezes occur most often in smaller cap stocks with limited liquidity.

## 2.2.4 Relative Value Strategies

The relative value strategy is composed of a number of different arbitrage sub-strategies. All of these strategies almost exclusively depend upon proprietary valuations models, which in turn depend upon historical mean-reversion data for calculations. Because of the high level of leverage normally used in these strategies, the losses can be enormous when the market moves against the historical data and normal predictable rationality. As the founders of LTCM<sup>21</sup> realized, the market will eventually return to the mean-reversed level, but the time lag can be longer than any fund's ability to stay solvent. The two biggest relative value sub-strategies -- convertible arbitrage and fixed income arbitrage -- are discussed in subsequent sections.

### 2.2.4.1 Convertible Arbitrage

The Convertible Arbitrage strategy, as the name implies, is associated with convertible securities. The managers attempt to profit from three different sources: coupon return and short rebate, gamma trading, and mispricing<sup>22</sup>.

A convertible security is a fixed income instrument which can later be converted into a fixed number of shares. Holding a convertible is therefore equivalent to holding a bond position and a call option on the specified amount of underlying stocks. Until maturity, the bond holder will receive a coupon payment and thus will have a stable income source

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<sup>21</sup> LTCM was founded by Salomon Brothers' former fixed income arbitrage team in 1994. Led by John Meriwether the fund returned 42.8%, 40.8%, and 17.1% from 1995 to 1997 respectively and had asset under management of \$6 billion in late 1997. Triggered by the Russian default, LTCM lost 44% in August of 1998 alone. The losses continued in September and LTCM was only rescued from a total meltdown by a syndicate of banks coordinated by the FED on September 23, 1998. LTCM is often referred to as the ultimate collapse of any hedge funds. I can recommend Roger Lowenstein's book "When Genius Failed" for an in-dept description of the fund's collapse.

<sup>22</sup> Jaeger, Lars, *Through the Alpha Smoke Screens: A Guide to Hedge Fund Return Sources*, New York, Institutional Investor Books, 2005, p. 72

from the interest payment of the convertible bond, unless he decides to convert before maturity. The coupon payments, however, are usually low compared to normal bond coupons, and the managers therefore often use leverage. Additionally, a manager can receive an income from shorting the underlying stock and, much like the short selling strategy, receive an immediate income from the sale which can be re-invested. Depending upon the negotiated short rebate, a convertible bond manager can often generate a higher return on the re-investment than the short lending fee.

The option component of a convertible bond causes the bond holder to be long volatility. In technical terms, the long volatility exposure is achieved from being long gamma, where gamma describes the rate of change in delta and delta measures the change in option price per unit of change in the underlying security. A call option has a positive relationship to the price of the underlying: if the underlying rises, so does the premium on the call, provided there are no changes in other variables like implied volatility and time remaining until expiration<sup>23</sup>. Provided the convertible bond manager has delta hedged the position by short-selling the underlying security and employ a consistent re-hedging strategy following price changes in the underlying, the long gamma exposure will increase the value of the total trade with price movements in the underlying. This trading style is known as gamma trading.

A convertible security is a hybrid security which means a simultaneous exposure to different asset classes. Security pricing is therefore more complicated than with a single

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<sup>23</sup> Summa, John, *Getting To Know The "Greeks"*, December 6, 2002, available at <http://www.investopedia.com/articles/optioninvestor/02/120602.asp>, accessed January, 16, 2005

asset class security and opportunities for mispricing can easily arise. Convertible arbitrage managers are experts in pricing all components of the convertible securities. If the manager identifies a convertible security which is significantly underpriced compared to the value of the underlying, there is a mispricing arbitrage opportunity. The manager would then buy the security and hold it until the market adjusts for the mispricing.

HFR's Convertible Arbitrage index correlation to market factors is low, and a regression analysis against the Credit Suisse High Yield index, Goldman Sachs Convertible Bonds Current Yield index, and credit spread between 10 year Treasury bond and BB rated bonds is only 29% over three years, and 9% over six years.

Part of the reason for the low explanation ratio is that convertible arbitrage managers are divided into two different styles: option-based and credit-oriented. These styles are based on the different ways to generate return, but are significantly different in their risk exposure, and tend to perform well under different market environments.

The option-based style, which is to buy the convertible, short the underlying equity, and re-establish the delta hedge frequently tends to do well in volatile environments with big drops in equity prices. The risk for this style, therefore, is mostly falling volatility. By contrast, credit-oriented managers make an assessment of the creditworthiness of the issuer, and invest in convertibles which they believe are currently undervalued. The biggest risk therefore becomes credit risk and widening credit spreads. Due to the option-



component of the convertible, this style does well if the volatility increases and the credit spread remains stable, or if volatility is stable and credit spread narrows.

#### 2.2.4.2 *Fixed Income Arbitrage*

For a number of reasons, there are many relative pricing inefficiencies among related fixed income securities. The ability to identify and capitalize on these pricing inefficiencies is collectively known as fixed income arbitrage. Often the pricing inefficiencies are very small (single-digit basis point), and can only be capitalized upon by employing significant leverage, and by cheap financing through repo loans or very small haircuts.

A normal fixed income arbitrage trade involves both a long and a short position to neutralize interest rate fluctuations. One example of such a trade is on-the-run/off-the-run arbitrage. Newly issued US Treasury bonds typically trade at slightly lower yields than US Treasury bonds of comparable duration. If the spread is sufficiently wide, with attractive financing rates, a position which involves short on-the-run and long off-the-run will make money if held to maturity, or if the yield spread narrows. Often the yield spread narrows once a new treasury issuance occurs, and the on-the-run bonds become off-the-run<sup>24</sup>.

A regression analysis with 1) the JP Morgan Global Government Bond index, 2) the spread between 10- year US Treasury and BBB-rated bonds, and 3) the foreign exchange

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<sup>24</sup> Perold, André F., *Long-Term Capital Management, L.P. (A)*, Harvard Business School, Case 9-200-007, November 1999

rate between the U.S. Dollar and the Euro can model 50% of the return over the past three years. The same factors over six years, however, can only model 7% of the return.

The fixed income arbitrage strategy is often exposed to a combination of liquidity, credit, volatility, and term structure risks, which come from the spread and carry trades. The biggest losses in this strategy occur in a flight-to-quality scenario, where the spreads becomes irrational and unpredictable. The chance of such a scenario's occurrence is low, and therefore almost impossible to model. It is, however, a very significant risk, especially during periods with very low natural spreads.

### **2.2.5 Global Macro**

The Global Macro strategy is one of the oldest and most successful of all hedge fund strategies, but the strategy is in fact a departure from the literal meaning of the term "*hedge fund*," as most of the global macro hedge funds do not hedge their investments. Instead, the managers make very large directional bets that reflect their forecasts of market directions, as influenced by major economic trends and/or particular events<sup>25</sup>. The managers trade interest rates, equity securities, currencies, and commodities and use leverage and derivatives extensively to hold large market exposures and to boost returns.

Global Macro funds performance, as measured by the HFR index, show some correlation to the MSCI EM index and the FX rate movements between the USD and the Euro. However, over the last three years, these factors can only explain 56% of the returns as

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<sup>25</sup> Lhabitant, François-Serge, *Hedge funds: myths and limits*, Chichester ; New York : Wiley, 2002, p. 115

measured by the regression analysis. This explanation ratio drops to 32% over a six-year period.

The Global Macro strategy has somewhat changed its risk profile from large directional bets to a more systematic and hedged investment style. The risks are, however, still relatively difficult to measure, as the investments are very directional, leveraged and the holding period often short. Risks, primarily as leverage, market, and liquidity risk, are very significant, especially during periods where the fund has a large bet on a particular directional move.

#### *2.2.5.1 Emerging Markets*

Investments in emerging markets are often associated with three characteristics: high average return, high volatility, and low correlation to other markets both in the developed and emerging world. Investment opportunities are often limited to the stock and bond markets; hedge fund managers in emerging markets, therefore, face many problems which do not exist in the developed world. The lack of market efficiency and the illiquidity, on the other hand, are exactly the conditions some managers can use to generate superior returns. Investments are generally long investments, as short-selling often is not allowed under local regulations. However, hedging can be accomplished to a lesser degree through OTC swaps, derivatives, or synthetic products. Fixed income investments are often in below investment grade securities, and are either denominated in local currency or one of the major currencies<sup>26</sup>.

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<sup>26</sup> Lhabitant, François-Serge, *Hedge funds: myths and limits*, Chichester; New York: Wiley, 2002, pp. 116-118

The HFR Hedge Fund Emerging Markets index demonstrates a high correlation to the MSCI Emerging Markets index with an 87% explanation ratio over the past five years. The use of complex financial instruments in emerging markets is still relatively limited, as regulatory and market constraints prevent the practical application of these instruments in many of the markets. The high correlation and explanation ratio, therefore, reflects the fact that most investments are long equity investments, and that emerging bonds often behave like equity due to the lower credit quality.

The risks in emerging markets are both country-specific and general. Historically, investors have collectively abandoned emerging markets in case of a flight-to-quality scenario, even if problems are seemingly uncorrelated and most of the funds are therefore somewhat exposed to the same risks (i.e., political, country-specific, liquidity, company, regulatory, and credit risks).

### **2.2.6 CTA/Managed Futures**

Commodity trading advisor (CTA) or managed futures strategy uses the future markets for trades including commodities, interest rates, equity indices, and occasionally currency futures. The individual managers may specialize within a certain range of different futures. The strategy can further be broken down to two main sub-strategies: systematic and discretionary.

Managers who follow a systematic strategy use a proprietary trading model with a particular trading technique, such as trend-following, counter-trend, or spread trading. Systematic managers normally have a well-diversified portfolio across different markets,

where they methodically abandon their losing trades while allowing their winning trades to run.

The discretionary managed futures strategy is very similar to the global macro strategy. The main differences are that discretionary managed futures managers exclusively make bets with futures. The managers make directional long-term positions based on fundamental forecasts and/or short-term bets based on specific information.

The Barclay CTA index shows some correlation to the JPM World Government bond, Natural Gas, Copper, and Gold indices. Over the past three years, these indices can explain 60%, while the same factors over five years can only explain 27% of the return.

Most CTA managers trade a variety of futures, with some funds being specialized in individual sectors such as energy or agriculture. The index return therefore has wide return/risk dispersion among the index contributing funds. The risks in the strategy are highly dependant upon the underlying traded securities performance. The regression shows high correlation for the past three years to commodities which have had a very good run over that period. The results are, however, inconclusive as the prior three year period show very little correlation to the same commodities.

### **2.2.7 Event-Driven Strategies**

Event Driven managers attempt to capitalize on company news events, such as earnings releases, spin-offs, carve-outs, mergers, chapter 11 filings, re-structurings, bankruptcy reorganizations, recapitalizations, and share buybacks. The portfolio of some Event-

Driven managers may shift in majority weighting between Risk Arbitrage and Distressed Securities, while others may take a broader view. Instruments include long and short common and preferred stocks, as well as debt securities and options. Leverage may be used by some managers. Fund managers may hedge against market risk by purchasing S&P put options, put option spreads, use futures or ETF<sup>27</sup>.

The Event Driven strategy's HFR index has significant correlation to the equity and high-yield indices, with an explanatory power of 83% to the Russell 2000 and Credit Suisse High Yield indices over the past six years. Market participants often perceive the release of company news as decisive, which leads to a subsequent relative surge/drop in the prices of the company's securities. The risks are concentrated around the companies mostly in the form of liquidity and small company risk, but the strategy also has significant market risk exposure, which is indicated by the high explanation ratio.

#### *2.2.7.1 Merger Arbitrage*

The Merger Arbitrage strategy seeks to take advantage of the pricing complications and uncertainty surrounding a merger. Most Merger Arbitrage funds hedge against market risk by purchasing S&P put options or put option spreads<sup>28</sup>. Opportunities in this strategy are dependent upon the number of mergers and acquisitions on the market -- the fewer deals, the fewer investment opportunities. In recent years, this strategy has suffered, as too much money has flowed into the strategy, which in turn has lowered the risk premium on the deals.

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<sup>27</sup> HFRI Strategy Definition, *Event Driven*, available at <https://www.hedgefundresearch.com/monthly/index.php?fuse=hfristrats#2888>, accessed January 16, 2006

<sup>28</sup> HFRI Strategy Definition, *Merger Arbitrage / Risk Arbitrage*, available at <https://www.hedgefundresearch.com/monthly/index.php?fuse=hfristrats#2888>, accessed January 16, 2006

Merger Arbitrage as measured by the HFR index shows some correlation to the Russell 2000 Value index and the Russell 2000 – Russell 1000, which is a self-constructed index measuring the relative outperformance of small cap companies over large cap companies. The explanatory power of the regression is 52% over three years and 36% over six years.

Often when a merger or an acquisition is announced, the stock price of the target company trades up to the level of the offer less a risk premium. This risk premium represents the probability that the deal might not materialize either because the offer is not approved by the shareholders or because one of the approving legislative bodies fails to approve the deal. The risk exposure is therefore a combination of market, regulatory, liquidity and company risks.

#### 2.2.7.2 *Distressed Securities*

Distressed Securities strategies invest in, and may sell short, the securities of companies where the security's price has been (or is expected to be) affected by a distressed situation. This may involve reorganizations, bankruptcies, distressed sales, and other corporate restructurings. Depending on the manager's style, investments may be made in bank debt, corporate debt, trade claims, common stock, preferred stock, and warrants<sup>29</sup>.

Depending on the time horizon and the fundamentals, a distressed security may offer great opportunities for long or short investment. The strategies are by nature risky, as managers not only need to deal with the risk of their own mis-valuations, but also with a

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<sup>29</sup> <sup>29</sup> HFRI Strategy Definition, *Distressed Securites*, available at <https://www.hedgefundresearch.com/monthly/index.php?fuse=hfristrats#2558>, accessed January 16, 2006

high probability of default risk in the securities. The good investments, however, can be very attractive and some managers have significant expertise and knowledge in identifying investments with the lowest risk.

HFR's distressed index shows some correlation to the Russell 2000 and Credit Suisse High Yield indices with an explanation ratio of 64% over three years and 52% over six years. The Distressed strategy focuses on company events, much like the Event Driven strategy, but is normally restricted to investments in companies which have been, or are likely to be experiencing financial problems. These companies, if successfully restructured, tend to increase in absolute value, despite market conditions. The main risk factors to consider in the strategy are mostly company specific, and include liquidity, regulatory, and credit risk.

## **2.2.8 Returns Under Different Market Environments**

Different strategies tend to do well under different market environments. These tendencies are related to the risk and return generation characteristics of the individual strategies and therefore are related to the broader market movements. Appendix 5 shows the annual return of all hedge funds strategies since 1994.

By comparing the performance between each hedge fund strategy and the S&P 500 over the entire 12-year period, without considering time relevance, the Long/Short and Distressed strategies are the only strategies which in absolute return have outperformed the S&P. With an exponential weighting of the annual returns according to time



relevance, the Multi-Strategy, Long/Short, Macro, Emerging Markets, Event Driven, and Distressed strategies have all outperformed the S&P 500.

During all three-year periods, including the period 2000-2002, where the S&P 500 was down more than 14% annualized, all hedge fund strategies provided positive returns.

While each individual year saw losses for some strategies, over a five-year investment horizon, hedge funds provide better downside protection than traditional asset classes.

## 3 Hedge Fund Portfolio Construction

### 3.1 Different Portfolio Construction Methods

#### 3.1.1 Stratification

The simplest way to construct a hedge fund portfolio is by mimicking the composition of a broad hedge fund index. This method is known as Stratification and obviously does not add any value over the index in the portfolio construction process. Portfolio managers applying this portfolio construction method can, however, still add value by selecting hedge funds within each strategy which have superior risk/return parameters to the index constituting funds.

#### 3.1.2 Mean-Variance Optimization

Portfolio theory and the diversification benefits first discovered by Markowitz in 1952<sup>30</sup> have been developed to the point that these concepts today form the foundation for most asset allocation strategies. The success of these concepts is not surprising, given that they offer the only “free lunch” available in allocation optimization. The benefits arise from low correlation or low contribution to the volatility of the final portfolio by the selected assets<sup>31</sup>.

In a simple example, the return on a portfolio with only two assets, A and B, would simply be the weighted average:

$$E_P = fE_A + (1 - f)E_B$$

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<sup>30</sup> Markowitz, Harry, “*Portfolio Selection*”, 7(1), *Journal of Finance*, 1952

<sup>31</sup> Admec, Noel, Lionel Martellini, and Felix Goltz, *Hedge Funds from the Institutional Investor’s Perspective*, EDHEC Risk and Asset Management Research Centre, 2005. p.7

where E is the return.

However the formula for the portfolio standard deviation is more complicated and is found by:

$$S_p = \sqrt{f^2 S_A^2 + 2f(1-f)RS_A S_B + (1-f)^2 S_B^2}$$

where R is the correlation between the returns on A and the returns on B, and S is the standard deviation.

Only three dimensions are considered in these formulas: correlation, mean (return) and volatility (standard deviation). The latter two – mean return and volatility -- belong to the return distribution. The exclusive focus on only two dimensions of the return distribution assumes that the return follows a normal distribution, where the first two moments are sufficient statistics to represent the whole distribution<sup>32</sup>. In traditional portfolio construction, the assumption of normality is accepted as valid, and the mean-variance optimizer, which generates an efficient frontier along a range of different risk/return scenarios by using the above formulas, is the normal model used to depict the optimal risk/return distribution, known as the efficient frontier.

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<sup>32</sup> Admec, Noel, Lionel Martellini, and Felix Goltz, *Hedge Funds from the Institutional Investor's Perspective*, EDHEC Risk and Asset Management Research Centre, 2005. p.7

### 3.1.3 Modified Value-at-Risk Optimization

In recent years Value-at-Risk (VaR) has gained more and more recognition as a method for measuring risk. There are three different ways of calculating VaR; only one, known as the Variance-Covariance method, is relevant for portfolio construction.

The VaR method is fairly simple and attempts to quantify the risk of losses, often with a confidence level of 99%. The losses at the determined confidence level are included in the calculations, whereas the remaining 1% probability losses are not included. That in turn means that the VaR is not a maximum loss but a loss barrier that at most will be exceeded by a probability of 1%<sup>33</sup>. If returns are normally distributed, the VaR is defined as:

$$VaR = W(\mu\Delta t - n\sigma\sqrt{\Delta t})$$

Where:  $\mu$  = portfolio historic mean return,  $W$  = current value of the portfolio,  $n$  = number of standard deviation (depending on confidence level),  $\sigma$  = standard deviation, and  $\Delta t$  = time window

This formula is simply a multiple of the confidence level and standard deviation, and would therefore not change the portfolio allocation from the mean – variance scenario.

The VaR has, however, been developed to include scenarios in which returns are not distributed normally and skewness and kurtosis are considered. This expansion of the VaR is known as the Cornish-Fisher expansion. The expansion is defined as:

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<sup>33</sup> Andres Signer and Laurent Favre, *The Difficulties of Measuring the Benefits of Hedge Funds*, The Journal of Alternative Investments, Summer 2002.

$$z_{CF} = z_C + \frac{1}{6}(z_C^2 - 1)S + \frac{1}{24}(z_C^3 - 3z_C)K - \frac{1}{36}(2z_C^3 - 5z_C)S^2$$

where  $z_C$  =critical value for the probability  $(1 - \alpha)$  with a standard normal distribution (-2.33 at 99%),  $S$  = skewness, and  $K$  = excess kurtosis.

By incorporating the Cornish-Fischer expansion in the VaR, one creates the modified VaR, a tool which can measure risk based on all return factors. The modified VaR is defined as:

$$VaR = W(\mu - z_{CF}\sigma)$$

This formula can be applied to constructing a portfolio by identifying the portfolio composition which has the lowest modified VaR for any given return.

## **3.2 Constructing a Core Hedge Fund Portfolio**

The construction of a hedge fund portfolio requires a number of steps which need to be considered during the portfolio construction process. These steps include identification and analysis of data, basic “market” portfolio, optimization, and tactical allocation. An overview of the construction process is found in Appendix 6, and each individual step is further discussed in subsequent sections of the paper.

### **3.2.1 Data Used for Portfolio Construction**

Past data can give some indication of how the strategies will perform in the future in different market environments, and can therefore be useful as guidelines for allocation. It

would, however, be naïve to rely solely upon past data as more than a guideline for practical portfolio construction, as the use of this data would assume that the hedge fund strategies would always revert to the historical means.

The standard deviation and return varies between the HFR and Credit Suisse-Tremont indices, even when measuring the same strategy. As previously discussed, this strategy is a result of the different methods the index provider uses. As no consensus exists on which index is the most reliable for indication of future performance, the data from both providers will be considered throughout the portfolio construction process.

Credit Suisse-Tremont reveals the weighting of the different strategies in its main index on its website<sup>34</sup>. HFR's indices are less useful for this purpose, as HFR has neither a multi-strategy index nor a CTA/Managed Futures index. In this paper, the HFR indices are therefore supplemented by Barclay's CTA and Multi-Strategy indices, in order to form a complete dataset for all the main strategies and thereby have two complete datasets: the Credit Suisse-Tremont Indices and the combined HFR-Barclay Indices.

The Multi-Strategy, Distressed, and Arbitrage strategies are exposed to a "positive" valuation problem caused by the low liquidity of the securities these managers often invest in. When a security is illiquid, the price fluctuations often becomes relatively small,

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<sup>34</sup> Credit Suisse / Tremont Hedge Fund Index, *Constituent Funds*, available at <http://www.hedgeindex.com/hedgeindex/secure/en/constituentsdisplay.aspx?IndexName=HEDG>, accessed March 31, 2006

thereby artificially lowering the standard deviation<sup>35</sup>. Exclusively using the standard deviation for allocation decision is therefore partly wrong, as it does not capture the liquidity risk.

### *3.2.1.1 Hedge Fund Index Return Distribution Analysis*

For a normal distribution, the higher moments, the skewness coefficient (measure of asymmetry) and the kurtosis (thickness of the tails) are zero and three respectively. To identify if skewness and kurtosis are significant enough to reject a normal distribution, skewness – kurtosis tests for normality are run on all indices (see Appendix 7). As with the correlation test in the previous section, the results are exponentially weighted according to time relevance.

The conclusion is that none of the main hedge fund indices can be rejected for normality at the 5% or higher level. This finding is somewhat in contrast to most other studies on the subject. For comparative reasons, the results for all the individual three-year periods, as well as for the entire period from 1997 to 2005, are included (Appendix 7a-e). The period from 1997-1999 in particular shows an asymmetric distribution for almost all strategies, and causes the rejection of normality in an equal weighted test from 1997-2005 (Appendix 7e).

### *3.2.1.2 Correlation Between Hedge Fund Strategies*

An important part of diversification is to invest in strategies which have a low correlation to each other, thereby maximizing the expected return under all market conditions.

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<sup>35</sup> Valuation of illiquid securities is done by estimation. Managers receive estimated quotes from a number of potential counter-parties. Often managers pick the quote which is closest to the previous quote, whereby lowering the standard deviation.

Appendix 8 provides an overview of the correlation between the different hedge fund strategies. As can be seen from the matrix, some strategies such as Event Driven and Distressed are highly correlated, while others, such as CTA and Event Driven, have a low correlation.

### **3.2.2 The Market Portfolio**

The Stratification concept with the weighting of the Credit Suisse-Tremont index is a good first foundation for a general hedge fund portfolio allocation. This index is asset weighted and therefore represents the market's allocation among the different hedge fund strategies. In the hedge fund world, however, where lock-up periods and some strategies' capacity constraints hinder complete free flow of assets, it would be wrong to assume that this market allocation represents the optimal market portfolio. Nevertheless, it is a good approximation and a good starting point for portfolio creation. The market allocation, expected return, and standard deviation using data from both the HFR-Barclay Indices and Credit Suisse-Tremont Indices are found in Appendix 9.

### **3.2.3 Optimization with the Mean-Variance or Modified Value-at-Risk Model?**

The market portfolio can be optimized with either the Mean-Variance or the modified Value-at-Risk optimization model. While mean-variance optimization requires that past return and standard deviation have the same average in the future as in the past, as well as a normal distribution, the modified value-at-risk optimization requires that all four moments of the past return distribution are indicative of the future average. As can be seen in Appendix 10a-b, all four moments change over time, with relatively large percentage changes in skewness and kurtosis.



Using modified Value-at-Risk for practical hedge fund portfolio construction hence becomes difficult, as the prediction of future skewness and kurtosis values is almost impossible considering the big dispersion in the past data. The percentage changes for the first two moments of the return distribution, are smaller and to some extent easier to predict than kurtosis and skewness.

While Value-at-Risk certainly has a function as a measurement for downside risk in a portfolio, its use as a tool for hedge fund portfolio construction is more questionable. The mean-variance optimization is not perfect either, and is exposed to the problem of illiquid security valuation. However, without an existing perfect portfolio construction tool, the mean-variance optimization appears to be the most useful [tool?] for hedge fund portfolio optimization, as the number of unknown factors is fewer and somewhat easier to forecast than the factors required for using the modified Value-at-Risk model.

### **3.2.4 Optimization of the Market Portfolio to Form a Core Portfolio**

As previously discussed, the standard deviation numbers for some of the strategies might be artificially lowered due to illiquidity. The optimization model only works with quantitative input when generating the efficient frontier, and the input numbers would therefore need to be adjusted for this flaw. A solution to this problem is to introduce a maximum allocation to any individual strategy. This maximum is determined as a maximum increase over the market portfolio allocation found in section 3.2.2. Appendix 11 is a matrix of the return and suggested allocation for the optimized portfolios at a

similar risk level to the market portfolios, with a maximum allocation increase of 10%, 25%, and 50% respectively.

Suggestion B in Appendix 11 (25% Max. over Market Portfolio) has an increase in the expected return of 69 basis points over the market portfolio when using the HFR – Barclay dataset. The Credit Suisse – Tremont dataset show the same trend, albeit the expected return increase is slightly lower at 61 basis points. For both datasets, the increase in expected return has been achieved by omitting the Fixed Income Arbitrage and Emerging Markets strategies from the portfolios. The CTA/Managed Futures strategy has been omitted from the HFR – Barclay portfolio, but only reduced in size when optimizing the Credit Suisse – Tremont Portfolio. By contrast, the short –selling strategy is omitted from the Credit Suisse – Tremont portfolio, but slightly increased in the HFR – Barclay portfolio. The allocation increases are almost identical in both portfolios, with raises in the allocations to the Multi-Strategy, Long/Short, Event Driven, and Macro strategies.

### **3.2.5 The Total Risk Exposure for the Core Hedge Fund Portfolio**

An assessment of the risk exposure in the created core portfolio can be found by regression analysis to main factors, in the same way risk exposure was identified for individual strategies in Section 2. The analysis need to be run against the final portfolio, as the combined risk exposure is different from the summation of the risks in each constituting strategy. The regression analysis of the “B” portfolio (HFR-Barclay data) to the Russell 2000 growth is found in Appendix 12.

The regression analysis shows an adjusted R-squared of 77% in the period from 1997 to 2005 to the Russell 2000 growth index. This indicates that the core portfolio is exposed to the risks of the equity market. The return of the core portfolio can hence be expected to vary with the return of the equity market.

### **3.3 Tactical Allocation**

The term “Tactical Portfolio Allocation” refers to active strategies that seek to enhance portfolio performance by opportunistically shifting the asset mix in a portfolio in response to the changing patterns of return and risk<sup>36</sup>. The tactical investments should be less than 40% in total, as any tactical investment can fail due to market mis-timing or misjudgments. Appendix 13a-c provides suggested strategies for tactical allocation in a market environment characterized by low equity volatility, low bond volatility, and low credit spread. These suggestions are based upon strategies which have outperformed in previous years in a similar market environment, and in no way represent an exhaustive tactical analysis. They serve merely to demonstrate some of the factors a proprietary tactical allocation model would normally include. The factors in the example are equal weighted; normally they should be weighted according to the relative conviction in how well the different factors’ historical values represent the current environment.

The bond volatility as measured by the 30-day TNX, and the MOVE index is comparable to the mid-1998 level, where an abrupt upswing in volatility occurred almost overnight in August of 1998. This event was triggered by the unexpected Russian default and the subsequent LTCM crisis. The strategy which made money on this event was the CTA

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<sup>36</sup> Martellini, Lionel and Daphne Sfeir, *Tactical Asset Allocation*, EDHEC Publications, 2003

strategy, as the managers were long bond volatility. The event is considered extraordinary and the suggested tactical allocation therefore does not suggest an increase in the allocation to the CTA space. The Long/Short strategy also had high returns in the periods following mid-1998. This reflects the fact that the equity market was largely unaffected by the increased bond volatility, and the equity market continued to rally until late 2000. The current low bond volatility is likely to increase again, but this factor alone will likely only have a small impact on equity market growth. The suggested distribution of the allocation to this tactical component is therefore exclusively to Long/Short.

The equity volatility shows a comparable range to the August 1994 to December 1995 period. The Long/Short strategy did well during this period, as the primary developed equity markets rallied. The Global Macro strategy also saw significant gains as global macro-economic discrepancies remained high, especially between the developed and emerging markets. The Event Driven and Distressed strategies had good gains in 1995, as companies re-structured. The suggested distribution of the allocation to this tactical component is therefore 1/3 Long/Short, 1/3 Global Macro, and 1/3 distributed equally between the Event Driven and Distressed strategies.

The credit spread environment is at the same level as in the period from December 1995 to March 1997. During this period, the Long/Short, Global Macro, Event Driven, and Distressed strategies all did well. The reasons for the solid return for these strategies are essentially the same as for the period August 1994 to December 1995. In addition, the Emerging Market strategy rallied as investors regained confidence in these markets. The

suggested distribution of the allocation to this tactical component is therefore 1/3 Long/Short, 1/3 distributed equally between Global Macro and Emerging Markets, and 1/3 distributed equally between the Event Driven and Distressed strategies.

### **3.3.1 Combing Core and Tactical Allocation**

Depending on the investor's hedge fund experience and risk tolerance, the core portfolio should constitute between 60-100% of the hedge fund allocation invested according to the long-term performance expectations (5+ years), and independent of market cycles. The remaining 0-40% should be devoted to the tactical allocation invested according to the anticipated short-term (less than two years) market movements.

Based upon the core allocation suggestions found in section 3.2.4 and the tactical allocation conclusions found in section 3.3, the final combined portfolios are calculated. The optimized portfolio "B" (HFR – Barclay dataset) has been selected as the core portfolio<sup>37</sup>. Three final portfolio allocation suggestions are then created; a conservative one with 0% tactical allocation; a moderate one with 20% tactical allocation; and an aggressive one with 40% tactical allocation (Appendix 14).

### **3.3.2 Regional Allocation**

Although global market correlation has increased, the market cycles across the world's three main regions, the US, Europe and Japan, are not fully aligned. This provides an opportunity for geographical diversification which can further optimize a portfolio allocation. Due to the number of hedge funds in the different regions, a suggested

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<sup>37</sup> This decision should be made by the portfolio constructor based on acceptable divergence level from the market portfolio.

allocation between the main regions could be 50% in the US, 35% in Europe and 15% in Japan. This allocation can, however, also be tactical and adjusted according to a manager's belief in regional market outperformance.

## **4 Hedge Fund Portfolio Implementation: Case Study of a Danish Pension Fund**

### **4.1 Adding Hedge Funds to the Current Asset Allocation**

A pension fund has an obligation to meet its liabilities each year, and therefore has a higher need than high net worth individuals for downside risk protection. Traditionally the construction of pension fund portfolios, also known as Asset-Liability portfolios, emphasizes a high bond allocation to ensure stable income from coupon payments.

In recent years, the bond yields have been low and thus pension funds are increasingly seeking investment opportunities in the alternative investment universe for portfolio optimization. The addition of a hedge fund allocation to an existing Asset-Liability portfolio is a complicated exercise which requires in-depth risk analysis, and assessment of the changes in the risk/return parameters. In this section, the addition of a hedge fund allocation to a Danish Pension fund's Asset-Liability portfolio will be analyzed.

#### **4.1.1 Replacing Equity and Bond with Hedge Funds According to the Estimated Risk Increase to These Asset Classes.**

The Danish Pension Fund's current investments are mostly in traditional asset classes. Of the fund's two different investment classes, Class 1 is the more conservative and hence has a higher bond component than the more aggressive Class 2. The pension fund intends to make an initial hedge fund allocation of between 5-10% of its total assets, and to do so, it first needs to consider which part of the current asset allocation will be replaced with the hedge fund allocation.

One possibility is to reduce the current asset allocation equally across all asset classes, a method known as “Equal-Weighted Reduction.” Another method is the so-called “Risk-Weighted Reduction,” with which managers make reductions according to the risk exposure found in section 3.3.3. Seventy-seven percent of the risk can be explained by the equity market, so 77% of the hedge fund portfolio allocation should come from a reduction in the current equity exposure. The remaining 23% could come from either an equal reduction of all other asset classes or exclusively from a reduction in the current bond portfolio, given the size of the current bond portfolio. Appendix 15 provides an overview of the current asset allocation and suggests changes in the asset allocation mix with the introduction of a 5% and 10% hedge fund allocation with equal-weighted and risk-weighted reduction methods.

#### **4.1.2 Portfolio Simulation**

To examine the potential benefits of including a hedge fund portfolios in the asset allocation, it is important to consider both the changes in return as well as the downside protection. The best way to measure this is by running a so-called Monte Carlo simulation, which is a problem-solving technique used to approximate the probability of certain outcomes through multiple trial runs, or simulations, using random variables.

The chosen time period for the simulation is from January 2001 to November 2005, a period characterized by very difficult market conditions in 2001 and 2002, followed by some bull market years. The reason for selecting this period is to place maximum stress on the simulation, thereby obtaining worst-case scenario results for downside risk.



The number of simulations is set to 10,000 run by the “Normal” method. This method takes its random draws from a normal distribution fitted to the actual return time series. The advantage of this method over other simulation methods is that it smoothes out the distribution of returns, thereby limiting the skewness and peaked distributions to a normal fit.

#### *4.1.2.1 Simulation Results*

Five simulations for each investment class are run based on the different allocations found in Appendix 15. The simulation results are found in Appendix 16a-b.

The obtained results show indisputably that both return and risk will be improved significantly with an allocation to hedge funds for both investment classes. Investment class 1 -- which in the first simulation without hedge funds has a mean of 5.30%, a standard deviation of 2.07%, and maximum drawdown of 10.77% -- can in the best simulation scenario (10% hedge funds, risk-weighted allocation), improve the mean to 5.67% with a standard deviation of 1.74% and maximum drawdown of 7.87%.

The first simulation without hedge funds for investment class 2 has a mean of 4.99%, a standard deviation of 2.78%, and maximum drawdown of 18.23%. Again, the best simulation results occur with the 10% hedge funds, risk-weighted allocation which has a mean of 5.37%, a standard deviation of 2.40%, and maximum drawdown of 13.92%.

Both investment classes benefit greatly from a risk-weighted allocation as compared to an equal-weighted allocation. The benefit derives from the reduction in synchronized movements across asset classes and confirms that a risk-weighted allocation is the superior implementation method for risk reduction and return optimization in asset-liability portfolios.

The benefits of adding hedge funds to an asset-liability portfolio is also discussed in a paper by Lionel Martellini and Volker Ziemann, in which they conclude that “*suitably designed hedge fund portfolios can be particularly attractive when the objective of optimizing expected returns is constrained to meeting liabilities. This is due to hedge funds’ benefits in terms of diversification properties, which in turn is related to their appealing behaviors in terms of the impact on tail-distribution and extreme risks of stock and bond portfolios*”<sup>38</sup>.

## **4.2 How to Invest?**

As previously stated, there is significant value in adding a sizeable hedge fund portfolio to the pension fund’s current asset allocation for both return optimization and downside protection purposes. The creation of a good hedge fund portfolio, however, requires specialized knowledge and experience with this type of investment. Given the secrecy surrounding most hedge funds, very meticulous due diligence is required prior to investment in any fund. Appendix 17 provides the author’s suggestions for a due diligence process.

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<sup>38</sup> Martellini, Lionel, and Volker Ziemann, *The Benefits of Hedge Funds in Asset Liability Management*, EDHEC Publications, 2005

The fees in the fund of funds world have come down to more a reasonable level, so that the expertise possessed by fund of funds professionals more often than not offsets the additional cost by their ability to identify superior hedge fund managers. Today, not many institutional investors would attempt to run their own equity investments, but would instead outsource this job to a specialized equity manager. Hedge fund investments could be run in the same way, with a clear mandate to a focused fund of fund manager. Alternatively, investors could establish an in-house team exclusively focused on hedge fund investments. The important thing is to recognize that hedge fund investment is an area which requires specialized skills, such as an understanding of complex security instruments, extensive industry knowledge, and analytical ability due to opaque investment methods.

#### **4.2.1 Optimal Numbers of Managers in a Hedge Fund Portfolio**

Regardless of whether the pension fund establishes an in-house hedge fund team or “outsources” hedge fund investments to a fund of hedge funds, managers needs to consider the number of underlying managers in its hedge fund portfolio.

Theoretically, in the equity world, the optimal number of stocks in a well-diversified portfolio is approximately 20. Adding more stocks would only increase the administrative burden, while risk reduction is marginal as systematic risk cannot be diversified away entirely<sup>39</sup>. Practically speaking, however, the big equity managers often have

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<sup>39</sup> Elton, Edwin J. and Martin J. Gruber, *Modern Portfolio Theory and Investment Analysis*, p.648, 2003

significantly more positions. The reason for this is mostly related to liquidity and the dis-economics of scale rather than portfolio optimization.

Using monthly return data on 455 hedge funds over the period June 1994 – May 2001, Amin and Kat concluded that a portfolio of around 15 funds is optimal for standard deviation reduction, but can reversely also result in lower skewness and increased stock market correlation<sup>40</sup>. Lhabitant and Vicin find in a later paper that the main culprits for the lower skewness in a hedge fund portfolio are the fixed income arbitrage and event-driven strategies, but likewise conclude that the optimal number of managers is 15 to 20. Adding more funds will only fractionally lower the standard deviation<sup>41</sup>. The big funds of hedge funds have the same liquidity and dis-economics of scale problems as the big equity managers. The number of funds in their portfolios is therefore often significantly higher than the theoretical optimal number.

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<sup>40</sup> Amin, G. and H. Kat, *Portfolios of Hedge Funds: What investors really invest in*, Working paper, ISMA, University of Reading, 2002

<sup>41</sup> Lhabitant, Francois-Serge, and Michelle Learned De Piante Vicin, *Finding the Sweet Spot of Hedge Fund Diversification*, EDHED Risk and Asset Management Research Center, April 2004

## 5 Conclusion

An explanation for the risk in some of the hedge fund strategies can be found through regression analysis against other market indicators, while some strategies can only partly be explained by regression analysis. This lack of clearly defined market risk does not indicate that the strategy is risk-free, but merely that the associated risks are non-quantifiable due to the use of non-linear return methods such as derivatives and leverage.

The optimal portfolio allocation will always be a trade-off between the risks an investor is willing to incur and an anticipated return level. Risks can be measured both as standard deviation and as Value-at-Risk, but the construction of a hedge fund portfolio should be done with the mean-variance optimization model, as none of the hedge fund strategies can be rejected for normality if the return distribution is considered according to time relevance.

The separation of the hedge fund portfolio into its core and tactical parts would be useful for sophisticated hedge fund investors who have the ability to actively follow the market environments, and monitor the risk/return parameters continuously. For the less sophisticated investor, the hedge fund portfolio should be kept at a core level with a long-term investment objective.

Hedge fund investment is an area which requires specialized skills, such as an understanding of complex security instruments, extensive industry knowledge, and analytical ability with respect to opaque investment methods. For an institution or high

net worth individual, it is worth considering an intermediary partner, such as a fund of hedge fund manager, who possesses the necessary qualifications and skills to filter through the many thousands of hedge funds, and who understand how different hedge fund strategies can be optimally combined to generate consistent absolute returns.

## **Appendix 1: Academic Papers, Mean – Variance Optimization with Hedge Funds**

Ackermann, Carl, Richard McEnally, and David Ravenscraft, *The Performance of Hedge Funds: Risk, Return and Incentives*, *Journal of Finance* 1999, pp. 833-874

Agarwal, Vikas, and Narayan Y. Naik, On Taking the ‘Alternative’ Route: The Risks, Rewards and Performance Persistence of Hedge Funds, *Journal of Alternative Investments*, Spring 2000, pp. 6-23

Amin, Gaurav S. and Henry M. Kat , *Hedge Fund Performance 1990-2000, Do the ‘Money Machines’ Really Add Value?* , Alternative Investment Research Centre, Working Paper Series, Working Paper #0001, 2002

Edwards, Franklin R. and Mustafa O. Caglayan, *Hedge Fund Performance and Manager Skill*, Columbia University and JP MorganChase Securities Working Paper, May 2001

Fung, William, and David A. Hsieh, *Empirical Characteristics of Dynamic Trading Strategies: The Case of Hedge Funds*, *The Review of Financial Studies*, 1997

Ineichen, Alexander, *In Search of Alpha: Investing in Hedge Funds*, London: UBS Warburg, 2000

Jaeger, Lars, *The New Generation of Risk Management for Hedge Funds and Private Equity Investments*, New York, Institutional Investor Books, 2003, pp. 72-88

Lamm Jr., R. McFall, *Portfolios of Alternative Assets: Why Not 100% Hedge Funds?*, *The Journal of Investing*, Winter 1998, pp.87-97

Liang, Bing, *On the Performance of Hedge Funds*, *Financial Analysts Journal*, July/August 1999, pp. 72-85

Liang, Bing, *Hedge Fund Performance 1990-1999*, *Financial Analyst Journal*, January/February 2001, pp. 11-18

Schneeweis, Thomas, Richard Spurgin, and Vasilios N. Karavas, *Alternative Investments in the Institutional Portfolio*, Alternative Investment Management Association (AIMA), August 2000

Schneeweis, Thomas and Georg Martin, *The Benefits of Hedge Funds: Asset Allocation for the Institutional Investor*, Center for International Securities and Derivatives Markets, University of Massachusetts, Amherst, September 2000

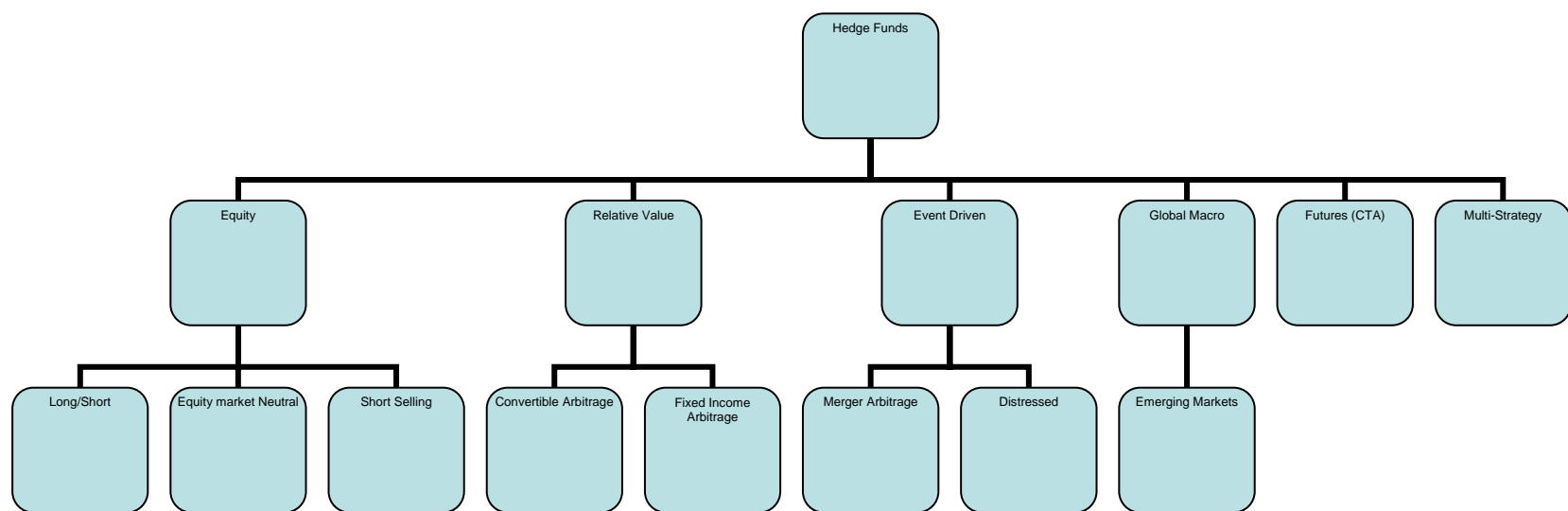
Schneeweis, Thomas et al., *Understanding Hedge Fund Performance: Research Results and Rules of Thumb for the Institutional Investor*, New York, Lehman Brothers Publications, 2001

Swensen, David F., *Pioneering Portfolio Management: An Unconventional Approach to Institutional Investment*, New York: Free Press, 2000

Tremont Partners Inc. / Tass Investment Research, *The Case for Hedge Funds*, The Journal of Alternative Investments, Winter 1999, pp. 71-72



## Appendix 2: Overview of Different Hedge Fund Strategies



*Source: CSFB/Tremont, Hedge Fund Research and Author's own creation*



## Appendix 4: Regression Analysis Hedge Fund Strategies

<b>Long/Short (HFR Index)</b>				
<b>Observation Period Jan2000 - Dec2005</b>	<i>(72 Observations)</i>			
R-squared	<b>0.82</b>			
Adj. R-squared	<b>0.82</b>			
	Coef.	P>t	95% Conf. Interval	
Russell 2000 Growth	0.28104	0.000	0.250	0.312

<b>Global Macro (HFR Index)</b>				
<b>Observation Period Jan2000 - Dec2005</b>	<i>(72 Observations)</i>			
R-squared	<b>0.34</b>			
Adj. R-squared	<b>0.32</b>			
	Coef.	P>t	95% Conf. Interval	
MSCI Emerging Markets	0.112	0.000	0.058	0.165
FX Rate USD-EUR	22.158	0.000	10.628	33.689
<b>Observation Period Jan2003 - Dec2005</b>	<i>(36 Observations)</i>			
R-squared	<b>0.58</b>			
Adj. R-squared	<b>0.56</b>			
	Coef.	P>t	95% Conf. Interval	
MSCI Emerging Markets	0.196	0.000	0.120	0.272
FX Rate USD-EUR	22.632	0.003	8.502	36.761

<b>CTA (Barclay Index)</b>				
<b>Observation Period Jan2000 - Dec2005</b>	<i>(72 Observations)</i>			
R-squared	<b>0.31</b>			
Adj. R-squared	<b>0.27</b>			
	Coef.	P>t	95% Conf. Interval	
JPM World Government Bond	0.371	0.004	0.123	0.618
Natural Gas	0.038	0.003	0.013	0.063
Copper	0.014	0.711	-0.060	0.087
Gold	0.053	0.440	-0.083	0.188
<b>Observation Period Jan2003 - Dec2005</b>	<i>(36 Observations)</i>			
R-squared	<b>0.65</b>			
Adj. R-squared	<b>0.60</b>			
	Coef.	P>t	95% Conf. Interval	
JPM World Government Bond	0.267	0.035	0.020	0.513
Natural Gas	0.040	0.005	0.013	0.067
Copper	0.155	0.000	0.081	0.230
Gold	0.064	0.329	-0.068	0.197

## Appendix 4: Regression Analysis Hedge Fund Strategies

<b>Short-Selling (HFR Index)</b>				
<b>Observation Period Jan2000 - Dec2005</b>	<i>(72 Observations)</i>			
R-squared	<b>0.81</b>			
Adj. R-squared	<b>0.81</b>			
	Coef.	P>t	95% Conf. Interval	
Russell 2000 Growth	0.846	0.000	0.734	0.957
Russell 2000-1000	-0.309	0.006	-0.525	-0.093
<b>Observation Period Jan2001 - Dec2005</b>	<i>(60 Observations)</i>			
R-squared	<b>0.91</b>			
Adj. R-squared	<b>0.91</b>			
	Coef.	P>t	95% Conf. Interval	
Russell 2000 Growth	0.689	0.000	0.630	0.748
Russell 2000-1000	-0.349	0.000	-0.486	-0.211

<b>Event Driven (HFR Index)</b>				
<b>Observation Period Jan2000 - Dec2005</b>	<i>(72 Observations)</i>			
R-squared	<b>0.83</b>			
Adj. R-squared	<b>0.82</b>			
	Coef.	P>t	95% Conf. Interval	
Russell 2000	0.18385	0	0.147407	0.220289
Credit Suisse High Yield	0.32673	0	0.220482	0.432972

<b>Emerging Markets (HFR Index)</b>				
<b>Observation Period Jan2000 - Dec2005</b>	<i>(72 Observations)</i>			
R-squared	<b>0.81</b>			
Adj. R-squared	<b>0.80</b>			
	Coef.	P>t	95% Conf. Interval	
MSCI Emerging Markets	0.463	0.000	0.409	0.516
<b>Observation Period Jan2001 - Dec2005</b>	<i>(60 Observations)</i>			
R-squared	<b>0.87</b>			
Adj. R-squared	<b>0.87</b>			
	Coef.	P>t	95% Conf. Interval	
MSCI Emerging Markets	0.427	0.000	0.383	0.470

**Appendix 4: Regression Analysis Hedge Fund Strategies**

<b>Distressed (HFR Index)</b>				
<b>Observation Period Jan2000 - Dec2005</b>	<i>(72 Observations)</i>			
R-squared	<b>0.52</b>			
Adj. R-squared	<b>0.51</b>			
	Coef.	P>t	95% Conf. Interval	
Russell 2000	0.078	0.002	0.030	0.126
Credit Suisse High Yield	0.324	0.000	0.183	0.465
<b>Observation Period Jan2003 - Dec2005</b>	<i>(36 Observations)</i>			
R-squared	<b>0.64</b>			
Adj. R-squared	<b>0.62</b>			
	Coef.	P>t	95% Conf. Interval	
Russell 2000	0.100	0.002	0.039	0.160
Credit Suisse High Yield	0.469	0.000	0.283	0.655

<b>Merger (HFR Index)</b>				
<b>Observation Period Jan2000 - Dec2005</b>	<i>(72 Observations)</i>			
R-squared	<b>0.36</b>			
Adj. R-squared	<b>0.34</b>			
	Coef.	P>t	95% Conf. Interval	
Russell 2000	0.123	0.000	0.076	0.170
Russell 2000-1000	-0.003	0.925	-0.057	0.052
<b>Observation Period Jan2003 - Dec2005</b>	<i>(36 Observations)</i>			
R-squared	<b>0.53</b>			
Adj. R-squared	<b>0.50</b>			
	Coef.	P>t	95% Conf. Interval	
Russell 2000	0.126	0.006	0.038	0.214
Russell 2000-1000	0.035	0.657	-0.122	0.191

**Appendix 4: Regression Analysis Hedge Fund Strategies**

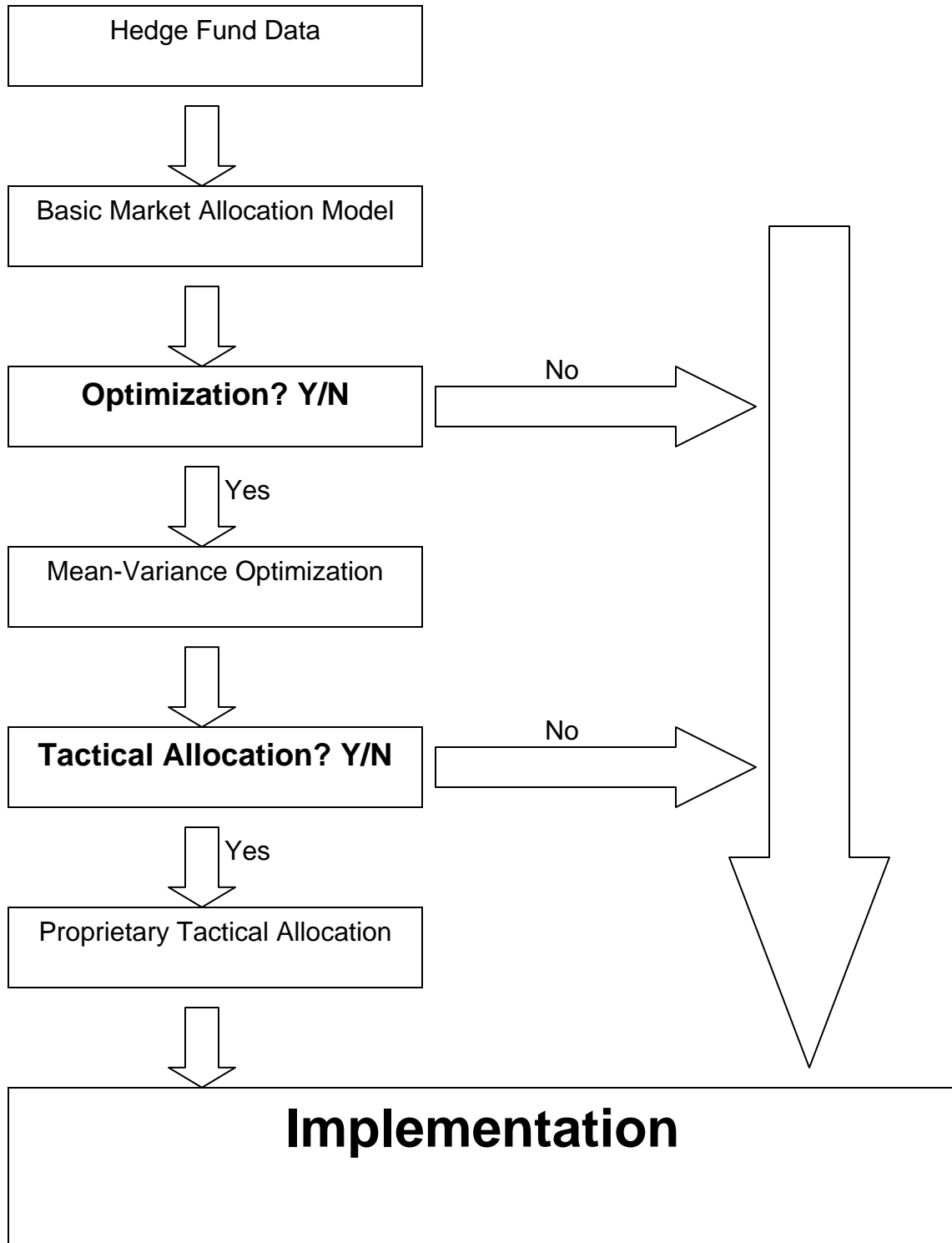
<b>Fixed Income Arbitrage(HFR Index)</b>				
<b>Observation Period Jan2000 - Dec2005</b>	<i>(72 Observations)</i>			
R-squared	<b>0.11</b>			
Adj. R-squared	<b>0.07</b>			
	Coef.	P>t	95% Conf. Interval	
JP Morgan Global Covt. Bond	0.957	0.898	-13.832	15.745
BBB Spread	-1.287	0.270	-3.595	1.021
FX Rate USD-EUR	6.890	0.212	-4.016	17.796
<b>Observation Period Jan2003 - Dec2005</b>	<i>(36 Observations)</i>			
R-squared	<b>0.53</b>			
Adj. R-squared	<b>0.50</b>			
	Coef.	P>t	95% Conf. Interval	
JP Morgan Global Covt. Bond	-1.246	0.827	-12.758	10.265
BBB Spread	-1.498	0.071	-3.132	0.135
FX Rate USD-EUR	9.255	0.055	-0.218	18.728

<b>Convertible Arbitrage(HFR Index)</b>				
<b>Observation Period Jan2000 - Dec2005</b>	<i>(72 Observations)</i>			
R-squared	<b>0.13</b>			
Adj. R-squared	<b>0.09</b>			
	Coef.	P>t	95% Conf. Interval	
Credit Suisse High Yield	12.055	0.075	-1.243	25.353
GS Convertible Bond Current Yield	-1.723	0.273	-4.837	1.391
BB Spread	-1.232	0.441	-4.402	1.938
<b>Observation Period Jan2003 - Dec2005</b>	<i>(36 Observations)</i>			
R-squared	<b>0.36</b>			
Adj. R-squared	<b>0.29</b>			
	Coef.	P>t	95% Conf. Interval	
Credit Suisse High Yield	28.007	0.044	0.742	55.271
GS Convertible Bond Current Yield	-6.731	0.224	-17.779	4.318
BB Spread	-1.445	0.439	-5.198	2.309

## Appendix 5: Hedge Fund Returns

Return	S&P500	T-Bill	Index		FoF		Multi		L/S		Macro		CTA		Eq.Mk.Neu		Short		EM		Event		Distressed		Merger Ab.		FI Ab.		Con. Ab.		
			CSFB	HFR	HFR	Bar	CSFB	Bar	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	Bar	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB
2005	4.91	3.18	7.60	9.36	7.58	6.86	7.53	6.56	9.68	10.69	9.25	7.11	-0.11	2.07	6.14	6.38	16.99	8.52	17.38	21.06	8.94	7.31	11.74	8.43	3.08	6.30	0.63	5.49	-2.55	-1.98	
2004	10.88	1.37	9.64	9.05	6.87	6.65	7.54	6.31	11.57	7.69	8.49	4.64	5.96	3.30	6.50	4.15	-7.71	-3.84	12.47	18.42	14.45	15.02	15.62	18.89	5.46	4.08	6.85	5.99	1.98	1.18	
2003	28.68	1.01	15.46	19.55	11.62	10.44	15.03	11.67	17.30	20.53	17.97	21.44	14.15	8.69	7.06	2.46	-32.60	-21.77	28.74	39.37	20.02	25.33	25.12	29.58	8.99	7.48	7.96	9.36	12.88	9.93	
2002	-22.10	1.61	3.05	-1.44	1.01	1.79	6.31	6.29	-1.60	-4.71	14.67	7.42	18.34	12.36	7.44	0.98	18.15	29.16	7.36	3.70	0.16	-4.30	-0.69	5.28	-3.46	-0.86	5.73	8.77	4.04	9.07	
2001	-11.89	3.43	4.41	4.62	2.80	4.45	5.51	10.51	-3.67	0.40	18.38	6.87	1.92	0.84	9.30	6.71	-3.58	8.99	5.85	10.36	11.49	12.18	20.01	13.28	5.69	2.76	8.03	4.81	14.58	13.37	
2000	-9.10	5.96	4.84	4.98	4.07	10.21	11.17	21.66	2.08	9.09	11.69	1.97	4.25	7.86	14.98	14.56	15.77	34.63	-5.51	-10.71	7.24	6.74	1.94	2.78	14.67	18.02	6.29	4.78	25.65	14.50	
1999	21.04	4.73	23.43	31.29	26.47	26.89	9.37	21.59	47.22	44.22	5.81	17.62	-4.70	-1.19	15.32	7.09	-14.22	-24.40	44.83	55.86	22.26	24.33	22.18	16.94	13.23	14.34	12.10	7.38	16.03	14.41	
1998	28.58	4.87	-0.36	2.62	-5.11	4.13	7.68	9.37	17.19	15.98	-3.63	6.19	20.66	7.01	13.32	8.30	-5.99	-0.54	-37.66	-32.96	-4.87	1.70	-1.68	-4.23	5.59	7.23	-8.16	-10.29	-4.42	7.77	
1997	33.36	5.17	25.92	16.79	16.20	17.67	18.29	17.16	21.46	23.41	37.11	18.82	3.11	10.89	14.82	13.62	0.43	3.86	26.57	16.57	19.97	21.23	20.74	15.40	9.84	16.44	9.35	7.02	14.48	12.72	
1996	22.96	5.12	22.22	21.10	14.39		14.05		17.14	21.75	25.60	9.32	11.98	9.12	16.60	14.20	-5.48	-4.00	34.48	27.14	23.04	24.84	25.54	20.77	13.83	16.61	15.93	11.89	17.87	14.56	
1995	37.58	5.62	21.68	21.50	11.10		11.87		23.03	31.04	30.70	29.32	-7.09	13.64	11.04	16.33	-7.37	-17.14	-16.90	0.69	18.36	25.11	26.13	19.73	11.90	17.86	12.48	6.08	16.55	19.85	
1994	1.32	4.33	-4.35	4.10	-3.48				-8.10	2.61	-5.70	-4.30	11.95	-0.65	-2.02	2.65	14.91	18.53	12.50	3.38	0.75	6.00	0.66	3.84	5.26	8.88	0.33	11.94	-8.06	-3.73	
Annual Avg. Return	12.19	3.87	11.13	11.96	7.79	9.90	10.40	12.35	12.78	15.23	14.19	10.53	6.70	6.16	10.04	8.12	-0.89	2.67	10.84	12.74	11.82	13.79	13.94	12.56	7.84	9.93	6.46	6.10	9.09	9.30	
2003-2005 (Avg)	14.82	1.85	10.90	12.65	8.69	7.98	10.04	8.18	12.85	12.97	11.90	11.06	6.67	4.69	6.57	4.33	-7.77	-5.70	19.53	26.28	14.47	15.89	17.50	18.97	5.84	5.95	5.15	6.95	4.10	3.04	
2000-2002 (Avg)	-14.36	3.67	4.10	2.72	2.63	5.48	7.66	12.82	-1.06	1.59	14.91	5.42	8.17	7.02	10.57	7.42	10.11	24.26	2.57	1.12	6.30	4.88	7.09	7.12	5.63	6.64	6.68	6.12	14.76	12.31	
1997-1999 (Avg)	27.66	4.92	16.33	16.90	12.52	16.23	11.78	16.04	28.62	27.87	13.10	14.21	6.36	5.57	14.49	9.67	-6.59	-7.03	11.25	13.15	12.45	15.75	13.75	9.37	9.56	12.67	4.43	1.37	8.70	11.64	
1994-1996 (Avg)	20.62	5.02	13.18	15.57	7.34				10.69	18.47	16.87	11.44	5.61	7.37	8.54	11.06	0.69	-0.87	10.02	10.40	14.05	18.65	17.44	14.78	10.33	14.45	9.58	9.97	8.79	10.23	
Yearly Average Relative Performance																															
Hedge Fund - S&P500 (Straight12Y)			-1.06	-0.22	-4.39	-2.29	-1.79	0.16	0.59	3.04	2.01	-1.65	-5.48	-6.02	-2.14	-4.07	-13.08	-9.52	-1.34	0.55	-0.37	1.61	1.76	0.37	-4.35	-2.26	-5.72	-6.08	-3.10	-2.88	
Hedge Fund - S&P500 (Expo12Y)			0.82	1.63	-1.65	0.13	1.29	2.31	1.96	3.15	4.06	0.86	-2.18	-3.53	-0.32	-2.83	-11.42	-6.70	4.13	7.62	2.86	3.98	5.08	5.11	-2.56	-1.54	-3.38	-2.95	-1.27	-2.00	

**Appendix 6: Constructing a Hedge Fund Portfolio**





**Appendix 7: Skewness – Kurtosis Tests for Normality (1994-2005 Exponentially Weighted)**

		Return Distribution				Skewness/Kurtosis tests for Normality			
	Strategy	Avg	St Dev	Skew	Kurtosis	Pr(Skew)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
	<b>General Index</b>								
CSFB/Tremont	Hedge Fund Index	0.793	1.593	-0.028	1.162	0.325	0.532	3.64	0.4102
HFR	Fund Weighted	0.851	1.719	-0.254	0.372	0.225	0.701	2.68	0.4206
	<b>Fund of Funds</b>								
HFR	FoF Composite	0.600	1.339	-0.161	1.049	0.159	0.481	4.39	0.2615
Barclay	FoF	0.676	1.191	0.038	1.834	0.115	0.498	7.12	0.1539
	<b>Multi-Strategy</b>								
CSFB/Tremont	Multi-Strategy	0.760	1.004	-0.637	1.201	0.292	0.527	4.72	0.4342
Barclay	Multi-Strategy	0.840	0.843	-0.128	0.529	0.206	0.551	3.40	0.3646
	<b>Long/Short</b>								
CSFB/Tremont	Long/Short Equity	0.873	2.323	0.005	1.279	0.193	0.236	5.92	0.1965
HFR	Equity hedge	0.960	2.216	0.010	0.543	0.273	0.326	4.03	0.2759
	<b>Global Macro</b>								
CSFB/Tremont	Global Macro	1.041	1.933	-0.190	0.746	0.505	0.349	3.53	0.4997
HFR	Macro	0.795	1.785	0.237	1.193	0.454	0.253	3.19	0.2940
	<b>CTA/Managed Futures</b>								
CSFB/Tremont	Managed Futures	0.605	3.585	0.059	-0.006	0.812	0.397	1.40	0.6059
Barclay	CTA	0.465	2.274	0.072	0.113	0.594	0.713	0.58	0.7699
	<b>Equity Market Neutral</b>								
CSFB/Tremont	Equity Mkt Neu.	0.704	0.652	0.453	0.535	0.267	0.348	3.31	0.3328
HFR	Equity Market Neutral	0.508	0.756	-0.176	0.455	0.289	0.474	2.53	0.3305
	<b>Short-Selling</b>								
CSFB/Tremont	Dedicated Short	-0.232	4.651	0.406	0.330	0.498	0.675	2.74	0.6355
HFR	Short Selling	0.228	4.920	-0.086	0.325	0.475	0.507	1.79	0.5672
	<b>Emerging Markets</b>								
CSFB/Tremont	Emerging Markets	1.002	3.175	-0.659	0.825	0.124	0.278	4.96	0.1765
HFR	Emerging Markets	1.238	3.220	-0.542	-0.026	0.218	0.571	4.16	0.1941
	<b>Event Driven</b>								
CSFB/Tremont	Event Driven	0.939	1.274	-1.053	3.652	0.156	0.077	10.24	0.0927
HFR	Event Driven	1.019	1.681	-0.469	1.366	0.451	0.505	3.93	0.5803
	<b>Distressed Securities</b>								
CSFB/Tremont	Distressed	1.098	1.370	-0.529	2.775	0.183	0.439	8.22	0.2900
HFR	Distressed Securities	1.098	1.382	-0.186	1.010	0.354	0.558	4.38	0.5240
	<b>Merger Arbitrage</b>								
CSFB/Tremont	Risk Arbitrage	0.530	1.039	-0.482	1.677	0.404	0.147	4.95	0.2426
HFR	Merger Arbitrage	0.606	0.948	-1.143	2.797	0.046	0.194	9.50	0.0688
	<b>Fixed Income Arbitrage</b>								
CSFB/Tremont	Fixed Income Arbitrage	0.464	0.864	-1.323	2.565	0.039	0.348	11.45	0.0833
HFR	Fixed Income: Arbitrage Index	0.499	0.753	-0.061	3.049	0.245	0.069	8.90	0.1227
	<b>Convertible Arbitrage</b>								
CSFB/Tremont	Convertible Arbitrage	0.612	1.303	-0.850	1.775	0.127	0.199	7.00	0.1369
HFR	Convertible Arbitrage	0.566	1.000	-0.687	1.224	0.151	0.354	4.92	0.2262

**Appendix 7a: Skewness – Kurtosis Tests for Normality (2003-2005 Equal Weighted)**

		Return Distribution				Skewness/Kurtosis tests for Normality			
	Strategy	Avg	St Dev	Skewness	Kurtosis	Pr(Skew)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
	<b>General Index</b>								
CSFB/Tremont	Hedge Fund Index	0.867	0.980	-0.366	-0.244	0.333	0.885	1.01	0.6032
HFR	Fund Weighted	0.998	1.254	-0.413	-0.247	0.276	0.880	1.28	0.5263
	<b>Fund of Funds</b>								
HFR	FoF Composite	0.700	0.978	-0.476	-0.304	0.213	0.804	1.73	0.4220
Barclay	FoF	0.645	0.947	-0.614	-0.042	0.114	0.866	2.72	0.2562
	<b>Multi-Strategy</b>								
CSFB/Tremont	Multi-Strategy	0.800	0.892	-0.324	-0.335	0.389	0.762	0.87	0.6462
Barclay	Multi-Strategy	0.658	0.769	-0.362	-0.004	0.337	0.823	1.02	0.5991
	<b>Long/Short</b>								
CSFB/Tremont	Long/Short Equity	1.020	1.507	-0.405	-0.677	0.285	0.315	2.31	0.3144
HFR	Equity hedge	1.024	1.629	-0.440	-0.552	0.247	0.470	2.00	0.3686
	<b>Global Macro</b>								
CSFB/Tremont	Global Macro	0.941	1.014	0.181	-0.505	0.627	0.532	0.65	0.7219
HFR	Macro	0.872	1.570	0.327	1.885	0.384	0.052	4.57	0.1018
	<b>CTA/Managed Futures</b>								
CSFB/Tremont	Managed Futures	0.589	3.580	0.029	-0.655	0.938	0.341	0.96	0.6193
Barclay	CTA	0.402	2.138	-0.118	0.031	0.750	0.786	0.18	0.9161
	<b>Equity Market Neutral</b>								
CSFB/Tremont	Equity Mkt Neu.	0.533	0.515	0.678	1.335	0.084	0.115	5.29	0.0710
HFR	Equity Market Neutral	0.354	0.521	-0.572	0.658	0.139	0.316	3.46	0.1774
	<b>Short-Selling</b>								
CSFB/Tremont	Dedicated Short	-0.805	3.904	0.288	-0.206	0.442	0.934	0.62	0.7333
HFR	Short Selling	-0.528	2.644	-0.168	-0.384	0.652	0.697	0.36	0.8347
	<b>Emerging Markets</b>								
CSFB/Tremont	Emerging Markets	1.501	1.843	-0.861	0.904	0.033	0.219	5.73	0.0569
HFR	Emerging Markets	1.965	2.211	-0.654	-0.139	0.094	0.982	3.03	0.2198
	<b>Event Driven</b>								
CSFB/Tremont	Event Driven	1.131	0.957	-0.531	1.715	0.167	0.067	5.14	0.0765
HFR	Event Driven	1.229	1.392	-0.175	0.193	0.638	0.627	0.47	0.7904
	<b>Distressed Securities</b>								
CSFB/Tremont	Distressed	1.347	0.854	0.421	-0.321	0.267	0.781	1.39	0.4990
HFR	Distressed Securities	1.442	1.167	0.140	-0.487	0.359	0.556	1.26	0.5333
	<b>Merger Arbitrage</b>								
CSFB/Tremont	Risk Arbitrage	0.475	0.796	-0.201	1.032	0.590	0.181	2.24	0.3268
HFR	Merger Arbitrage	0.486	0.810	-0.702	0.729	0.074	0.284	4.43	0.1093
	<b>Fixed Income Arbitrage</b>								
CSFB/Tremont	Fixed Income Arbitrage	0.418	0.710	-0.706	-0.419	0.073	0.648	3.72	0.1559
HFR	Fixed Income: Arbitrage Index	0.561	0.402	0.663	2.701	0.090	0.018	7.48	0.0238
	<b>Convertible Arbitrage</b>								
CSFB/Tremont	Convertible Arbitrage	0.327	1.222	-0.474	0.708	0.215	0.294	2.85	0.2402
HFR	Convertible Arbitrage	0.246	1.042	-0.541	0.432	0.160	0.443	2.77	0.2506

**Appendix 7b: Skewness – Kurtosis Tests for Normality (2000-2002 Equal Weighted)**

		Return Distribution				Skewness/Kurtosis tests for Normality			
	Strategy	Avg	St Dev	Skewness	Kurtosis	Pr(Skew)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
	<b>General Index</b>								
CSFB/Tremont	Hedge Fund Index	0.351	1.811	0.750	4.115	0.058	0.003	10.01	0.0067
HFR	Fund Weighted	0.244	2.184	0.463	0.137	0.224	0.679	1.76	0.4143
	<b>Fund of Funds</b>								
HFR	FoF Composite	0.226	1.477	0.768	3.131	0.053	0.010	8.74	0.0127
Barclay	FoF	0.449	1.297	1.536	5.191	0.001	0.001	16.51	0.0003
	<b>Multi-Strategy</b>								
CSFB/Tremont	Multi-Strategy	0.619	0.864	-0.390	0.729	0.303	0.284	2.37	0.3052
Barclay	Multi-Strategy	1.001	0.910	0.815	0.783	0.042	0.263	5.24	0.0729
	<b>Long/Short</b>								
CSFB/Tremont	Long/Short Equity	-0.046	3.098	1.198	4.688	0.005	0.002	13.59	0.0011
HFR	Equity hedge	0.161	2.966	1.029	2.135	0.013	0.037	8.87	0.0119
	<b>Global Macro</b>								
CSFB/Tremont	Global Macro	1.181	1.914	-1.096	3.313	0.009	0.008	11.10	0.0039
HFR	Macro	0.453	1.737	0.083	0.437	0.823	0.440	0.67	0.7146
	<b>CTA/Managed Futures</b>								
CSFB/Tremont	Managed Futures	0.708	3.802	0.036	0.069	0.922	0.745	0.11	0.9442
Barclay	CTA	0.590	2.528	0.335	0.107	0.373	0.708	0.98	0.6120
	<b>Equity Market Neutral</b>								
CSFB/Tremont	Equity Mkt Neu.	0.839	0.639	0.380	-0.568	0.314	0.448	1.69	0.4286
HFR	Equity Market Neutral	0.592	1.069	0.497	0.051	0.194	0.764	1.90	0.3867
	<b>Short-Selling</b>								
CSFB/Tremont	Dedicated Short	0.919	5.535	0.071	-0.580	0.849	0.433	0.68	0.7124
HFR	Short Selling	2.165	8.725	-0.367	0.784	0.331	0.262	2.37	0.3059
	<b>Emerging Markets</b>								
CSFB/Tremont	Emerging Markets	0.256	3.456	-0.373	-0.489	0.324	0.553	1.41	0.4940
HFR	Emerging Markets	0.126	3.660	-0.318	-1.061	0.398	0.034	5.11	0.0778
	<b>Event Driven</b>								
CSFB/Tremont	Event Driven	0.510	1.254	-1.093	2.034	0.009	0.043	9.15	0.0103
HFR	Event Driven	0.399	1.987	-0.408	0.359	0.282	0.494	1.74	0.4198
	<b>Distressed Securities</b>								
CSFB/Tremont	Distressed	0.556	1.643	-0.890	2.032	0.028	0.043	7.78	0.0204
HFR	Distressed Securities	0.578	1.498	0.260	-0.242	0.488	0.887	0.52	0.7722
	<b>Merger Arbitrage</b>								
CSFB/Tremont	Risk Arbitrage	0.444	1.214	-0.594	1.760	0.125	0.062	5.55	0.0624
HFR	Merger Arbitrage	0.519	1.068	-1.057	1.608	0.011	0.078	8.21	0.0165
	<b>Fixed Income Arbitrage</b>								
CSFB/Tremont	Fixed Income Arbitrage	0.543	0.753	-1.751	4.806	0.000	0.002	17.56	0.0002
HFR	Fixed Income: Arbitrage Index	0.499	0.934	0.128	0.927	0.731	0.211	1.80	0.4072
	<b>Convertible Arbitrage</b>								
CSFB/Tremont	Convertible Arbitrage	1.137	1.320	-0.812	2.402	0.042	0.026	7.88	0.0195
HFR	Convertible Arbitrage	0.974	0.835	-0.444	0.450	0.243	0.432	2.12	0.3460

**Appendix 7c: Skewness – Kurtosis Tests for Normality (1997-1999 Equal Weighted)**

	Strategy	Return Distribution				Skewness/Kurtosis tests for Normality			
		Avg	St Dev	Skewness	Kurtosis	Pr(Skew)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
	<b>General Index</b>								
CSFB/Tremont	Hedge Fund Index	1.269	3.093	-0.198	1.388	0.596	0.107	3.12	0.2105
HFR	Fund Weighted	1.306	2.801	-0.946	3.678	0.021	0.005	10.62	0.0049
	<b>Fund of Funds</b>								
HFR	FoF Composite	0.958	2.495	-0.622	3.008	0.110	0.012	7.73	0.0210
Barclay	FoF	1.252	1.950	-0.352	2.623	0.350	0.020	5.92	0.0519
	<b>Multi-Strategy</b>								
CSFB/Tremont	Multi-Strategy	0.934	1.349	-2.296	8.812	0.000	0.000	25.09	0.0000
Barclay	Multi-Strategy	1.244	1.007	-1.075	2.151	0.010	0.036	9.21	0.0100
	<b>Long/Short</b>								
CSFB/Tremont	Long/Short Equity	2.158	4.113	-0.474	3.007	0.214	0.012	7.01	0.0300
HFR	Equity hedge	2.084	3.228	-0.152	2.041	0.683	0.042	4.39	0.1111
	<b>Global Macro</b>								
CSFB/Tremont	Global Macro	1.037	4.591	-0.035	0.654	0.926	0.318	1.06	0.5887
HFR	Macro	1.129	2.342	0.571	0.136	0.139	0.679	2.54	0.2806
	<b>CTA/Managed Futures</b>								
CSFB/Tremont	Managed Futures	0.526	3.270	0.406	1.454	0.284	0.097	4.09	0.1292
Barclay	CTA	0.469	2.310	0.310	0.450	0.409	0.431	1.38	0.5009
	<b>Equity Market Neutral</b>								
CSFB/Tremont	Equity Mkt Neu.	1.139	1.077	-0.149	-0.036	0.689	0.859	0.19	0.9084
HFR	Equity Market Neutral	0.775	1.067	0.053	0.732	0.887	0.283	1.24	0.5375
	<b>Short-Selling</b>								
CSFB/Tremont	Dedicated Short	-0.410	6.143	1.635	4.570	0.000	0.002	16.47	0.0003
HFR	Short Selling	-0.504	6.114	0.551	2.505	0.152	0.023	6.58	0.0373
	<b>Emerging Markets</b>								
CSFB/Tremont	Emerging Markets	0.609	6.830	-0.964	3.055	0.019	0.011	9.85	0.0073
HFR	Emerging Markets	0.758	6.441	-0.849	2.732	0.035	0.017	8.63	0.0134
	<b>Event Driven</b>								
CSFB/Tremont	Event Driven	0.964	2.594	-3.581	16.745	0.000	0.000	37.61	0.0000
HFR	Event Driven	1.221	2.370	-2.121	8.638	0.000	0.000	23.79	0.0000
	<b>Distressed Securities</b>								
CSFB/Tremont	Distressed	1.076	2.695	-3.746	18.445	0.000	0.000	39.26	0.0000
HFR	Distressed Securities	0.738	2.141	-2.348	9.725	0.000	0.000	26.12	0.0000
	<b>Merger Arbitrage</b>								
CSFB/Tremont	Risk Arbitrage	0.776	1.793	-1.584	5.191	0.001	0.001	16.84	0.0002
HFR	Merger Arbitrage	1.004	1.405	-3.262	14.517	0.000	0.000	34.71	0.0000
	<b>Fixed Income Arbitrage</b>								
CSFB/Tremont	Fixed Income Arbitrage	0.344	1.688	-2.869	10.013	0.000	0.000	29.63	0.0000
HFR	Fixed Income: Arbitrage Index	0.100	1.737	-2.924	9.190	0.000	0.000	29.36	0.0000
	<b>Convertible Arbitrage</b>								
CSFB/Tremont	Convertible Arbitrage	0.679	1.644	-2.358	5.519	0.000	0.001	22.46	0.0000
HFR	Convertible Arbitrage	0.924	1.081	-1.400	5.542	0.002	0.001	15.96	0.0003

**Appendix 7d: Skewness – Kurtosis Tests for Normality (1994-1996 Equal Weighted)**

	Strategy	Return Distribution				Skewness/Kurtosis tests for Normality			
		Avg	St Dev	Skewness	Kurtosis	Pr(Skew)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
	<b>General Index</b>								
CSFB/Tremont	Hedge Fund Index	1.017	2.620	-0.102	0.145	0.784	0.671	0.26	0.8802
HFR	Fund Weighted	1.201	1.425	-0.463	-0.342	0.224	0.753	1.68	0.4310
	<b>Fund of Funds</b>								
HFR	FoF Composite	0.578	1.368	-0.443	-0.364	0.244	0.723	1.58	0.4534
Barclay	FoF								
	<b>Multi-Strategy</b>								
CSFB/Tremont	Multi-Strategy	0.667	1.775	-0.814	0.150	0.050	0.670	4.20	0.1223
Barclay	Multi-Strategy								
	<b>Long/Short</b>								
CSFB/Tremont	Long/Short Equity	0.807	2.178	-0.524	-0.162	0.172	0.990	2.00	0.3679
HFR	Equity hedge	1.396	1.883	-0.144	-0.070	0.698	0.899	0.17	0.9202
	<b>Global Macro</b>								
CSFB/Tremont	Global Macro	1.299	4.044	0.158	0.671	0.671	0.310	1.28	0.5266
HFR	Macro	0.875	2.575	-0.534	0.796	0.165	0.257	3.48	0.1757
	<b>CTA/Managed Futures</b>								
CSFB/Tremont	Managed Futures	0.480	3.389	-0.308	1.955	0.413	0.048	4.63	0.0989
Barclay	CTA								
	<b>Equity Market Neutral</b>								
CSFB/Tremont	Equity Mkt Neu.	0.668	0.955	0.146	-0.318	0.695	0.786	0.23	0.8925
HFR	Equity Market Neutral	0.868	0.755	-0.154	-0.116	0.680	0.953	0.17	0.9168
	<b>Short-Selling</b>								
CSFB/Tremont	Dedicated Short	0.099	4.113	0.233	-0.214	0.533	0.924	0.41	0.8163
HFR	Short Selling	-0.016	5.531	0.412	-0.200	0.277	0.942	1.26	0.5328
	<b>Emerging Markets</b>								
CSFB/Tremont	Emerging Markets	0.777	5.397	0.424	0.995	0.264	0.191	3.20	0.2018
HFR	Emerging Markets	0.828	3.098	0.070	-0.495	0.851	0.545	0.41	0.8148
	<b>Event Driven</b>								
CSFB/Tremont	Event Driven	1.078	1.252	-0.015	-0.572	0.967	0.444	0.61	0.7373
HFR	Event Driven	1.419	1.386	0.233	0.237	0.533	0.589	0.71	0.7014
	<b>Distressed Securities</b>								
CSFB/Tremont	Distressed	1.318	1.761	-0.255	-0.828	0.496	0.165	2.58	0.2757
HFR	Distressed Securities	1.142	1.118	-0.258	0.558	0.490	0.368	1.37	0.5048
	<b>Merger Arbitrage</b>								
CSFB/Tremont	Risk Arbitrage	0.821	0.774	-0.077	-0.528	0.835	0.501	0.51	0.7746
HFR	Merger Arbitrage	1.128	0.660	-0.777	0.647	0.051	0.322	4.78	0.0917
	<b>Fixed Income Arbitrage</b>								
CSFB/Tremont	Fixed Income Arbitrage	0.753	0.886	-1.452	2.583	0.001	0.021	12.51	0.0019
HFR	Fixed Income: Arbitrage Index	0.796	0.872	-0.886	2.041	0.029	0.042	7.77	0.0206
	<b>Convertible Arbitrage</b>								
CSFB/Tremont	Convertible Arbitrage	0.658	1.199	-0.993	0.308	0.016	0.531	5.83	0.0543
HFR	Convertible Arbitrage	0.784	1.164	-1.404	2.022	0.002	0.043	11.31	0.0035

**Appendix 7e: Skewness – Kurtosis Tests for Normality (1994-2005 Equal Weighted)**

						Skewness/Kurtosis tests for Normality			
	Strategy	Avg	St Dev	Skewness	Kurtosis	Pr(Skew)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
	<b>General Index</b>								
CSFB/Tremont	Hedge Fund Index	0.876	2.274	0.117	2.291	0.555	0.001	9.94	0.0069
HFR	Fund Weighted	1.125	1.968	-0.609	2.907	0.001	0.000	22.57	0.0000
	<b>Fund of Funds</b>								
HFR	FoF Composite	0.803	1.601	-0.256	4.291	0.142	0.000	21.61	0.0000
Barclay	FoF	0.008	0.015	0.365	3.454	0.161	0.001	11.52	0.0031
	<b>Multi-Strategy</b>								
CSFB/Tremont	Multi-Strategy	0.757	1.255	-1.243	3.393	0.000	0.000	31.73	0.0000
Barclay	Multi-Strategy	0.968	0.924	-0.103	0.687	0.999	0.706	0.14	0.9314
	<b>Long/Short</b>								
CSFB/Tremont	Long/Short Equity	0.985	2.971	0.229	3.899	0.251	0.000	16.16	0.0003
HFR	Equity hedge	1.360	2.537	0.179	1.422	0.302	0.005	8.19	0.0166
	<b>Global Macro</b>								
CSFB/Tremont	Global Macro	1.114	3.214	0.030	2.791	0.879	0.000	11.56	0.0031
HFR	Macro	1.250	2.381	0.355	0.620	0.044	0.109	6.34	0.0419
	<b>CTA/Managed Futures</b>								
CSFB/Tremont	Managed Futures	0.576	3.480	0.039	0.404	0.844	0.286	1.19	0.5508
Barclay	CTA	0.487	2.310	2.054	8.894	0.420	0.622	0.91	0.6349
	<b>Equity Market Neutral</b>								
CSFB/Tremont	Equity Mkt Neu.	0.795	0.851	0.340	0.380	0.092	0.309	3.95	0.1389
HFR	Equity Market Neutral	0.737	0.900	0.182	0.406	0.295	0.240	2.51	0.2850
	<b>Short-Selling</b>								
CSFB/Tremont	Dedicated Short	-0.049	5.002	0.837	2.082	0.000	0.002	19.34	0.0001
HFR	Short Selling	0.322	6.039	0.141	1.647	0.415	0.002	9.07	0.0107
	<b>Emerging Markets</b>								
CSFB/Tremont	Emerging Markets	0.786	4.744	-0.660	4.639	0.002	0.000	24.16	0.0000
HFR	Emerging Markets	1.312	4.212	-0.845	4.155	0.000	0.000	33.17	0.0000
	<b>Event Driven</b>								
CSFB/Tremont	Event Driven	0.921	1.643	-3.432	24.206	0.000	0.000		0.0000
HFR	Event Driven	1.153	1.884	-1.302	4.763	0.000	0.000	47.53	0.0000
	<b>Distressed Securities</b>								
CSFB/Tremont	Distressed	1.074	1.865	-2.887	18.697	0.000	0.000		0.0000
HFR	Distressed Securities	1.196	1.731	-0.643	5.752	0.001	0.000	33.32	0.0000
	<b>Merger Arbitrage</b>								
CSFB/Tremont	Risk Arbitrage	0.629	1.216	-1.257	6.496	0.000	0.000	40.53	0.0000
HFR	Merger Arbitrage	0.816	1.227	-2.585	11.282	0.000	0.000		0.0000
	<b>Fixed Income Arbitrage</b>								
CSFB/Tremont	Fixed Income Arbitrage	0.515	1.084	-3.097	16.408	0.000	0.000		0.0000
HFR	Fixed Income: Arbitrage Index	0.672	1.214	-1.719	10.796	0.000	0.000	73.47	0.0000
	<b>Convertible Arbitrage</b>								
CSFB/Tremont	Convertible Arbitrage	0.700	1.374	-1.320	3.012	0.000	0.000	32.67	0.0000
HFR	Convertible Arbitrage	0.799	1.022	-1.107	1.959	0.000	0.001	31.16	0.0000

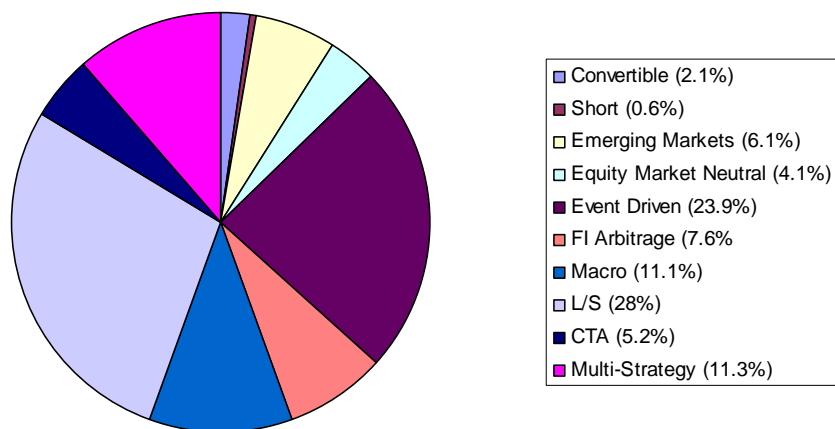
## Appendix 8: Correlation between Hedge Fund Strategies

### Historical Return Correlation Between Hedge Funds Strategies 1994-2005 (12Y Exponentially Weighted)

Strategy	Index			FoF		Multi		L/S		Macro		CTA		Eq.Mk.Neu		Short		EM		Event		Distressed		Merger Ab		FI Ab.		Con. Ab.		
	CSFB	HFR	Bar	HFR	Bar	CSFB	Bar	CSFB	HFR	CSFB	HFR	CSFB	Bar	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	
<b>General Index</b>																														
CSFB/Tremont		0.86	0.87	0.94	0.93	0.61	0.73	0.91	0.81	0.73	0.79	0.33	0.38	0.23	0.47	-0.58	-0.63	0.74	0.74	0.78	0.79	0.66	0.71	0.60	0.58	0.35	0.44	0.48	0.49	
HFR		0.86	0.99	0.92	0.91	0.59	0.77	0.91	0.97	0.47	0.70	0.16	0.23	0.32	0.43	-0.78	-0.83	0.83	0.87	0.80	0.90	0.69	0.74	0.71	0.71	0.18	0.31	0.44	0.49	
Barclay		0.87	0.99	0.87	0.93	0.60	0.79	0.84	0.91	0.44	0.64	0.14	0.22	0.32	0.44	-0.70	-0.75	0.79	0.82	0.74	0.83	0.62	0.67	0.70	0.69	0.15	0.30	0.43	0.45	
<b>Fund of Funds</b>																														
HFR	FoF Composite	0.94	0.92	0.87	0.99	0.64	0.81	0.91	0.88	0.61	0.76	0.25	0.32	0.31	0.46	-0.63	-0.66	0.80	0.83	0.79	0.82	0.67	0.73	0.62	0.66	0.28	0.37	0.51	0.54	
Barclay	FoF	0.93	0.91	0.93	0.99	0.65	0.83	0.85	0.82	0.54	0.67	0.22	0.29	0.30	0.48	-0.57	-0.59	0.74	0.75	0.75	0.77	0.61	0.67	0.63	0.64	0.25	0.36	0.49	0.51	
<b>Multi-Strategy</b>																														
CSFB/Tremont	Multi-Strategy	0.61	0.59	0.60	0.64	0.65	0.76	0.54	0.56	0.37	0.40	0.12	0.18	0.32	0.30	-0.36	-0.32	0.43	0.46	0.60	0.59	0.52	0.54	0.45	0.49	0.31	0.39	0.61	0.57	
Barclay	Multi-Strategy	0.73	0.77	0.79	0.81	0.83	0.76	0.65	0.67	0.37	0.52	0.17	0.26	0.39	0.40	-0.53	-0.45	0.53	0.58	0.72	0.71	0.63	0.62	0.63	0.70	0.35	0.36	0.72	0.71	
<b>Long/Short</b>																														
CSFB/Tremont	Long/Short Equity	0.91	0.91	0.84	0.91	0.85	0.54	0.65	0.91	0.50	0.69	0.22	0.28	0.26	0.49	-0.67	-0.76	0.73	0.74	0.72	0.79	0.58	0.66	0.66	0.63	0.19	0.30	0.37	0.42	
HFR	Equity hedge	0.81	0.97	0.91	0.88	0.82	0.56	0.67	0.91	0.40	0.64	0.13	0.20	0.29	0.45	-0.76	-0.85	0.75	0.78	0.73	0.85	0.59	0.66	0.70	0.70	0.09	0.23	0.37	0.41	
<b>Global Macro</b>																														
CSFB/Tremont	Global Macro	0.73	0.47	0.44	0.61	0.54	0.37	0.37	0.50	0.40	0.72	0.40	0.44	0.07	0.31	-0.22	-0.24	0.50	0.46	0.47	0.43	0.47	0.45	0.31	0.27	0.42	0.47	0.28	0.28	
HFR	Macro	0.79	0.70	0.64	0.76	0.67	0.40	0.52	0.69	0.64	0.72	0.55	0.68	0.23	0.33	-0.46	-0.50	0.64	0.63	0.50	0.58	0.47	0.51	0.46	0.41	0.30	0.39	0.31	0.35	
<b>CTA/Managed Futures</b>																														
CSFB/Tremont	Managed Futures	0.33	0.16	0.14	0.25	0.22	0.12	0.17	0.22	0.13	0.40	0.55	0.93	-0.01	0.24	-0.11	-0.08	0.11	0.09	0.07	0.09	0.08	0.04	0.06	0.12	0.09	0.23	0.03	0.02	
Barclay	CTA	0.38	0.23	0.22	0.32	0.29	0.18	0.26	0.28	0.20	0.44	0.68	0.93	0.06	0.24	-0.14	-0.13	0.18	0.16	0.08	0.13	0.09	0.08	0.15	0.18	0.13	0.24	0.10	0.09	
<b>Equity Market Neutral</b>																														
CSFB/Tremont	Equity Mkt Neu.	0.23	0.32	0.32	0.31	0.30	0.32	0.39	0.26	0.29	0.07	0.23	-0.01	0.06	0.16	-0.18	-0.17	0.29	0.30	0.21	0.29	0.20	0.24	0.26	0.27	0.15	0.24	0.33	0.30	
HFR	Equity Market Neutral	0.47	0.43	0.44	0.46	0.48	0.30	0.40	0.49	0.45	0.31	0.33	0.24	0.24	0.16	-0.22	-0.21	0.30	0.29	0.39	0.36	0.30	0.26	0.38	0.45	0.10	0.17	0.27	0.22	
<b>Short-Selling</b>																														
CSFB/Tremont	Dedicated Short	-0.58	-0.78	-0.70	-0.63	-0.57	-0.36	-0.53	-0.67	-0.76	-0.22	-0.46	-0.11	-0.14	-0.18	-0.22	0.86	-0.55	-0.60	-0.63	-0.74	-0.61	-0.65	-0.57	-0.54	-0.08	-0.07	-0.32	-0.39	
HFR	Short Selling	-0.63	-0.83	-0.75	-0.66	-0.59	-0.32	-0.45	-0.76	-0.85	-0.24	-0.50	-0.08	-0.13	-0.17	-0.21	0.86	-0.62	-0.65	-0.56	-0.74	-0.51	-0.59	-0.58	-0.51	-0.02	-0.12	-0.20	-0.27	
<b>Emerging Markets</b>																														
CSFB/Tremont	Emerging Markets	0.74	0.83	0.79	0.80	0.74	0.43	0.53	0.73	0.75	0.50	0.64	0.11	0.18	0.29	0.30	-0.55	-0.62	0.94	0.63	0.70	0.55	0.59	0.54	0.51	0.10	0.30	0.26	0.32	
HFR	Emerging Markets	0.74	0.87	0.82	0.83	0.75	0.46	0.58	0.74	0.78	0.46	0.63	0.09	0.16	0.30	0.29	-0.60	-0.65	0.94	0.68	0.75	0.62	0.64	0.57	0.55	0.14	0.27	0.31	0.38	
<b>Event Driven</b>																														
CSFB/Tremont	Event Driven	0.78	0.80	0.74	0.79	0.75	0.60	0.72	0.72	0.73	0.47	0.50	0.07	0.08	0.21	0.39	-0.63	-0.56	0.63	0.68	0.90	0.91	0.85	0.69	0.71	0.35	0.31	0.59	0.61	
HFR	Event Driven	0.79	0.90	0.83	0.82	0.77	0.59	0.71	0.79	0.85	0.43	0.58	0.09	0.13	0.29	0.36	-0.74	-0.74	0.70	0.75	0.90	0.81	0.83	0.77	0.76	0.27	0.31	0.50	0.52	
<b>Distressed Securities</b>																														
CSFB/Tremont	Distressed	0.66	0.69	0.62	0.67	0.61	0.52	0.63	0.58	0.59	0.47	0.47	0.08	0.09	0.20	0.30	-0.61	-0.51	0.55	0.62	0.91	0.81	0.85	0.56	0.55	0.37	0.25	0.56	0.62	
HFR	Distressed Securities	0.71	0.74	0.67	0.73	0.67	0.54	0.62	0.66	0.66	0.45	0.51	0.04	0.08	0.24	0.26	-0.65	-0.59	0.59	0.64	0.85	0.83	0.85	0.61	0.51	0.44	0.34	0.58	0.61	
<b>Merger Arbitrage</b>																														
CSFB/Tremont	Risk Arbitrage	0.60	0.71	0.70	0.62	0.63	0.45	0.63	0.66	0.70	0.31	0.46	0.06	0.15	0.26	0.38	-0.57	-0.58	0.54	0.57	0.69	0.77	0.56	0.61	0.80	0.11	0.24	0.38	0.36	
HFR	Merger Arbitrage	0.58	0.71	0.69	0.66	0.64	0.49	0.70	0.63	0.70	0.27	0.41	0.12	0.18	0.27	0.45	-0.54	-0.51	0.51	0.55	0.71	0.76	0.55	0.51	0.80	0.08	0.20	0.43	0.41	
<b>Fixed Income Arbitrage</b>																														
CSFB/Tremont	Fixed Income Arbitrage	0.35	0.18	0.15	0.28	0.25	0.31	0.35	0.19	0.09	0.42	0.30	0.09	0.13	0.15	0.10	-0.08	-0.02	0.10	0.14	0.35	0.27	0.37	0.44	0.11	0.08	0.52	0.41	0.34	
HFR	Fixed Income: Arbitrage Index	0.44	0.31	0.30	0.37	0.36	0.39	0.36	0.30	0.23	0.47	0.39	0.23	0.24	0.24	0.17	-0.07	-0.12	0.30	0.27	0.31	0.31	0.25	0.34	0.24	0.20	0.52	0.39	0.34	
<b>Convertible Arbitrage</b>																														
CSFB/Tremont	Convertible Arbitrage	0.48	0.44	0.43	0.51	0.49	0.61	0.72	0.37	0.37	0.28	0.31	0.03	0.10	0.33	0.27	-0.32	-0.20	0.26	0.31	0.59	0.50	0.56	0.58	0.38	0.43	0.41	0.39	0.90	
HFR	Convertible Arbitrage	0.49	0.49	0.45	0.54	0.51	0.57	0.71	0.42	0.41	0.28	0.35	0.02	0.09	0.30	0.22	-0.39	-0.27	0.32	0.38	0.61	0.52	0.62	0.61	0.36	0.41	0.34	0.34	0.90	

## Appendix 9: Market Hedge Fund Portfolio Allocation

**Credit Suisse / Tremont Index Allocation**

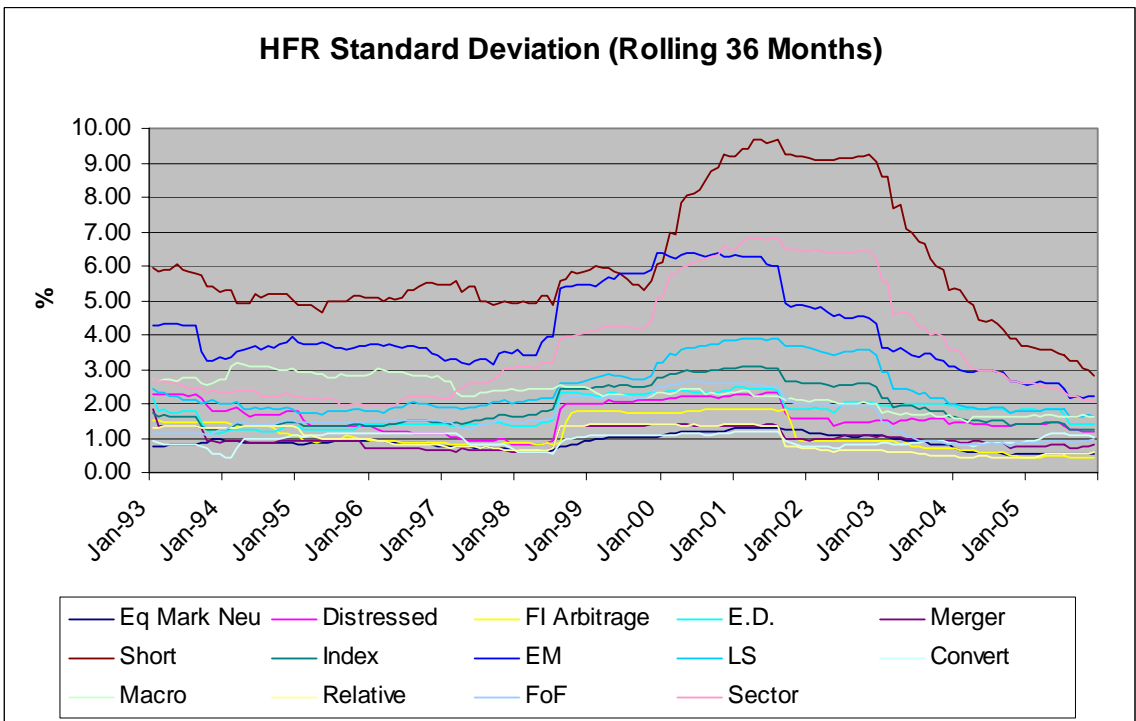
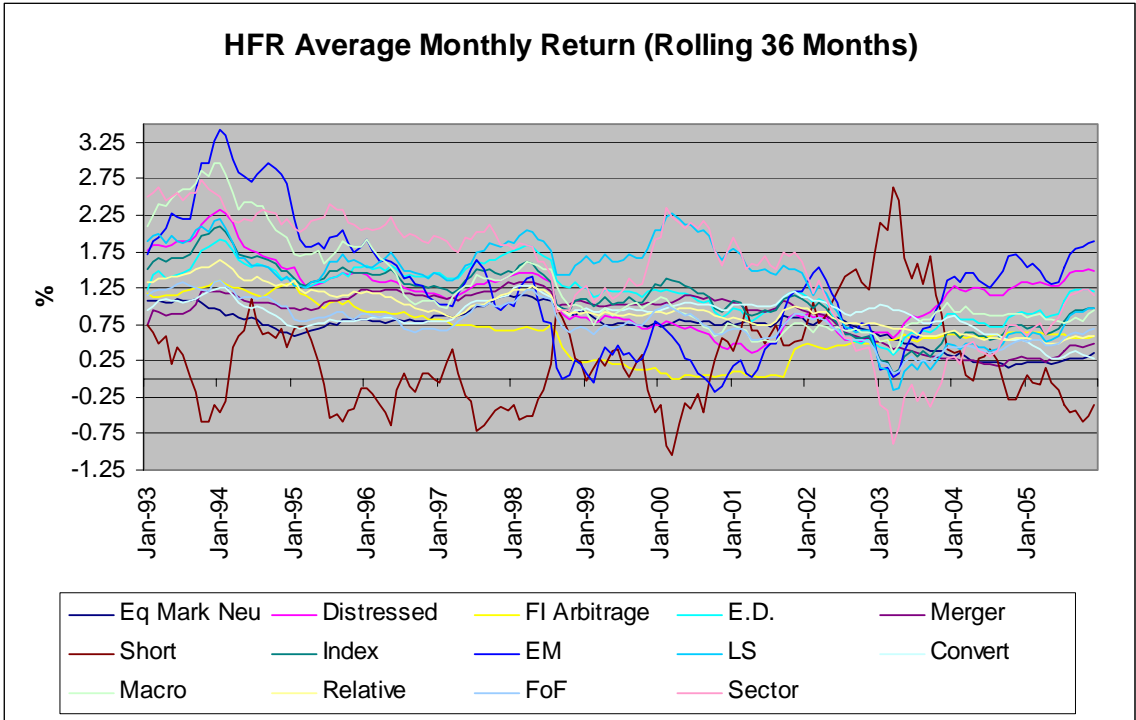


<b>HFR - Barclay Indices</b>				
<b>Risk/Return Analysis</b>				
<b>Risk Table</b>	<b>Month</b>	<b>Quarter</b>	<b>Annualized</b>	
<b>Compound ROR</b>	0.90%	2.72%	11.35%	
<b>Standard Deviation</b>	1.77%	3.55%	6.13%	
<b>Semi Deviation</b>	1.75%	3.34%	6.07%	
<b>Gain Deviation</b>	1.28%	2.77%	4.44%	
<b>Loss Deviation</b>	1.14%	1.89%	3.94%	
<b>Down Dev.(0%)</b>	0.83%	1.19%	2.87%	
<b>Sharpe(4.25%)</b>	0.32	0.47	1.11	
<b>Sortino(0%)</b>	1.09	2.30	3.77	

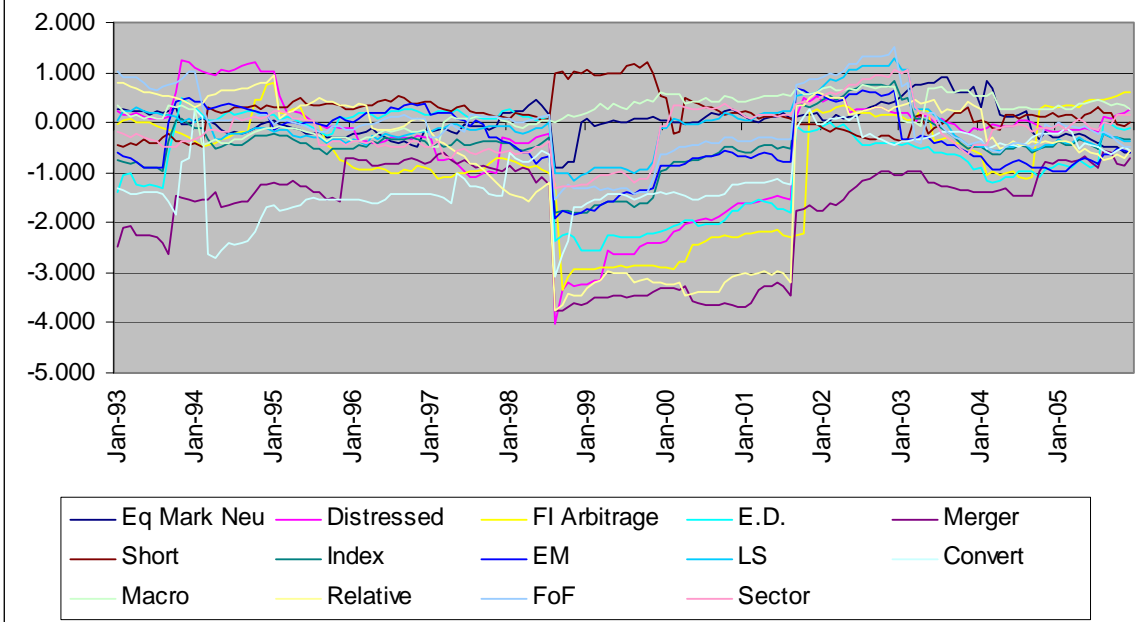
<b>Credit Suisse / Tremont Indices</b>				
<b>Risk/Return Analysis</b>				
<b>Risk Table</b>	<b>Month</b>	<b>Quarter</b>	<b>Annualized</b>	
<b>Compound ROR</b>	0.87%	2.64%	10.99%	
<b>Standard Deviation</b>	1.81%	3.45%	6.29%	
<b>Semi Deviation</b>	1.79%	2.99%	6.19%	
<b>Gain Deviation</b>	1.36%	2.92%	4.71%	
<b>Loss Deviation</b>	1.41%	3.53%	4.87%	
<b>Down Dev.(0%)</b>	0.91%	1.30%	3.15%	
<b>Sharpe(4.25%)</b>	0.30	0.46	1.03	
<b>Sortino(0%)</b>	0.96	2.03	3.33	



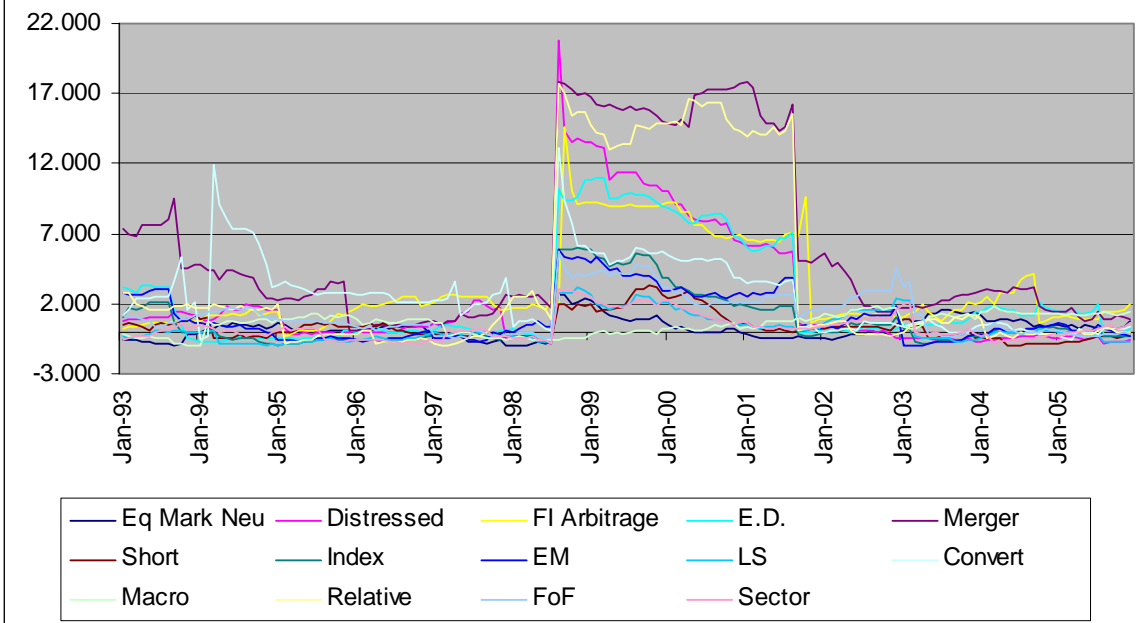
**Appendix 10a: HFR Return Distribution (Rolling 36 Months)**



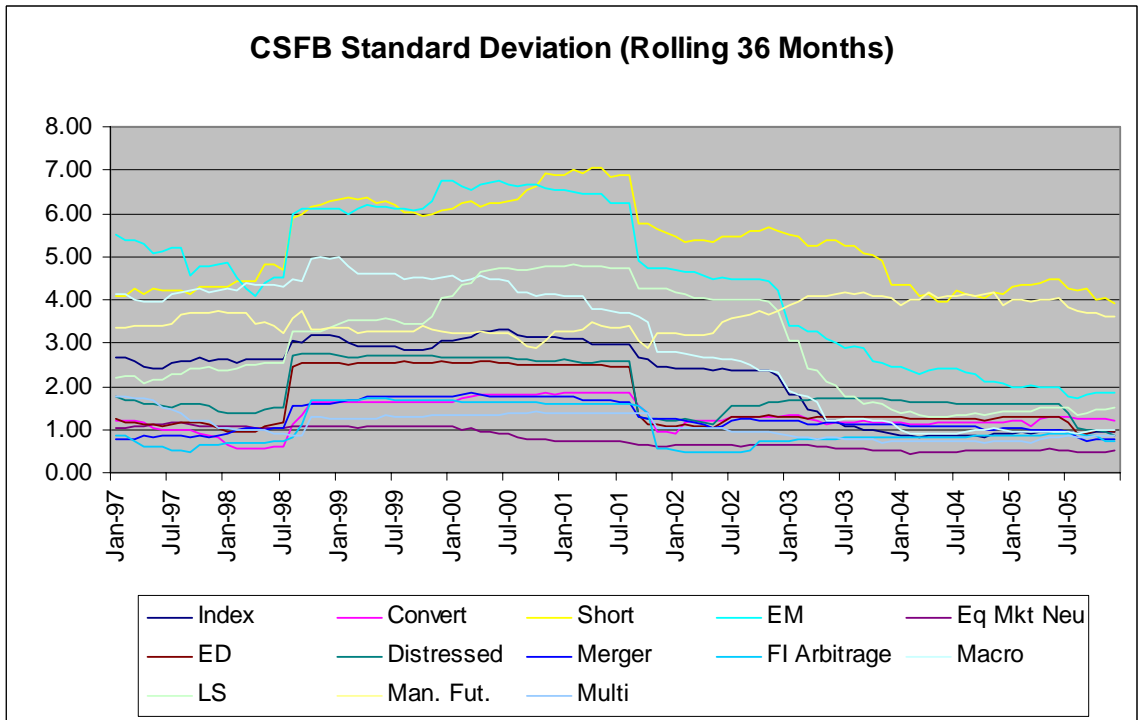
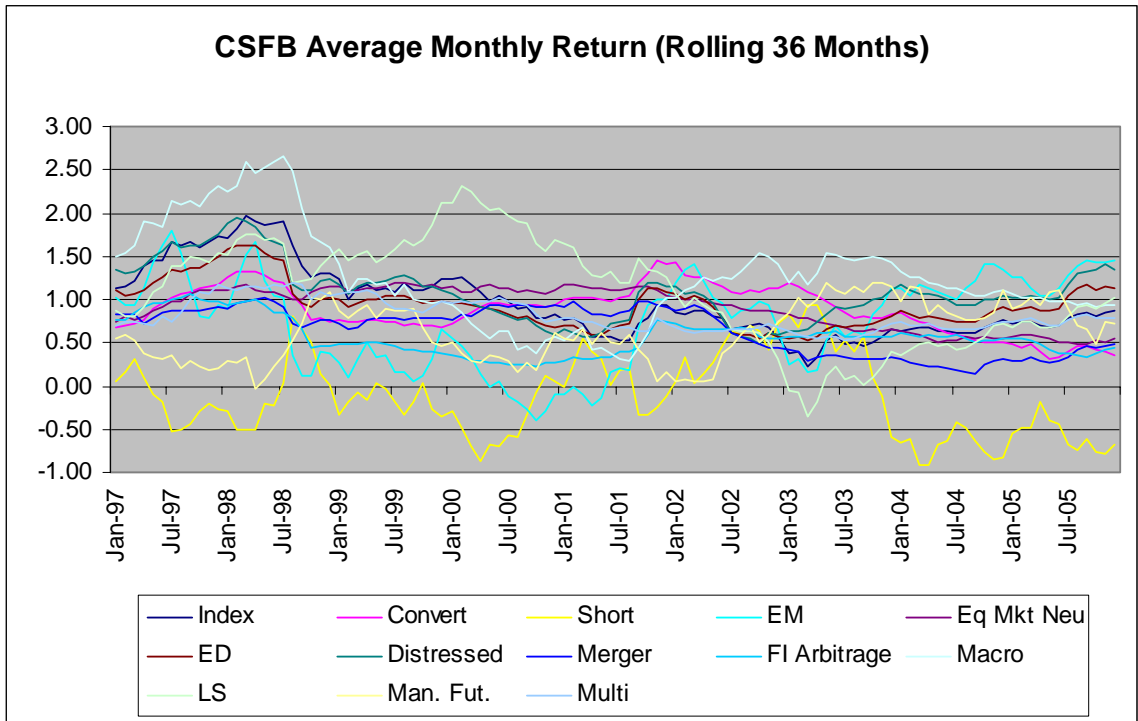
### HFR Skewness (Rolling 36 Months)

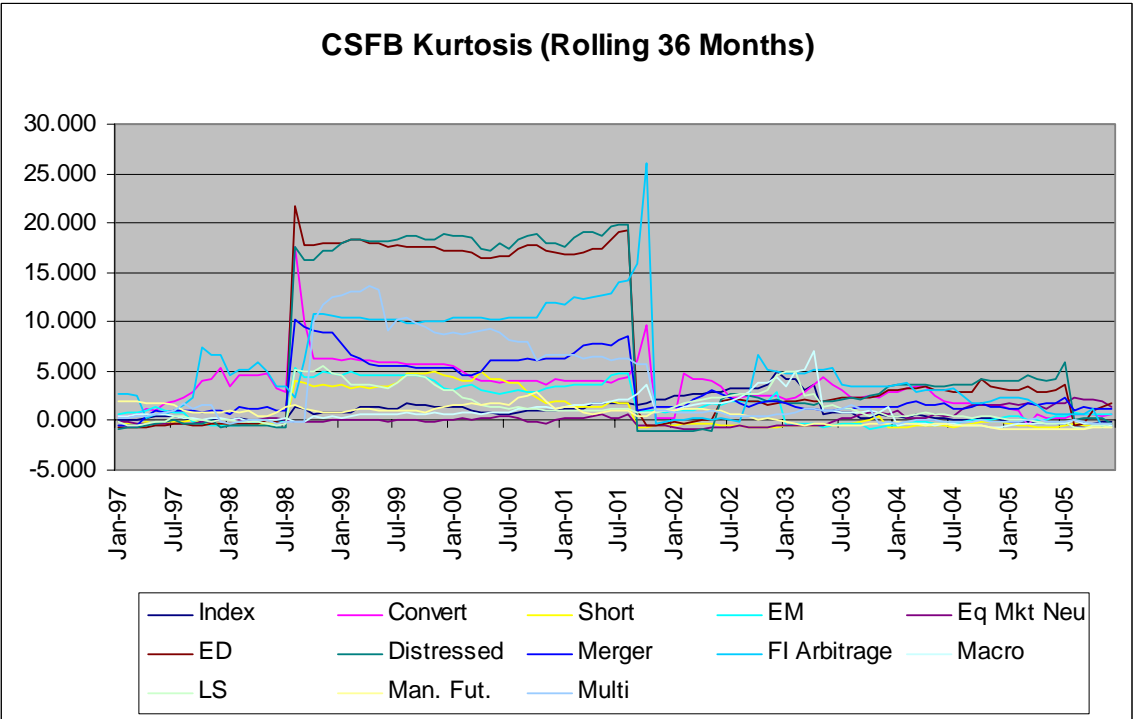
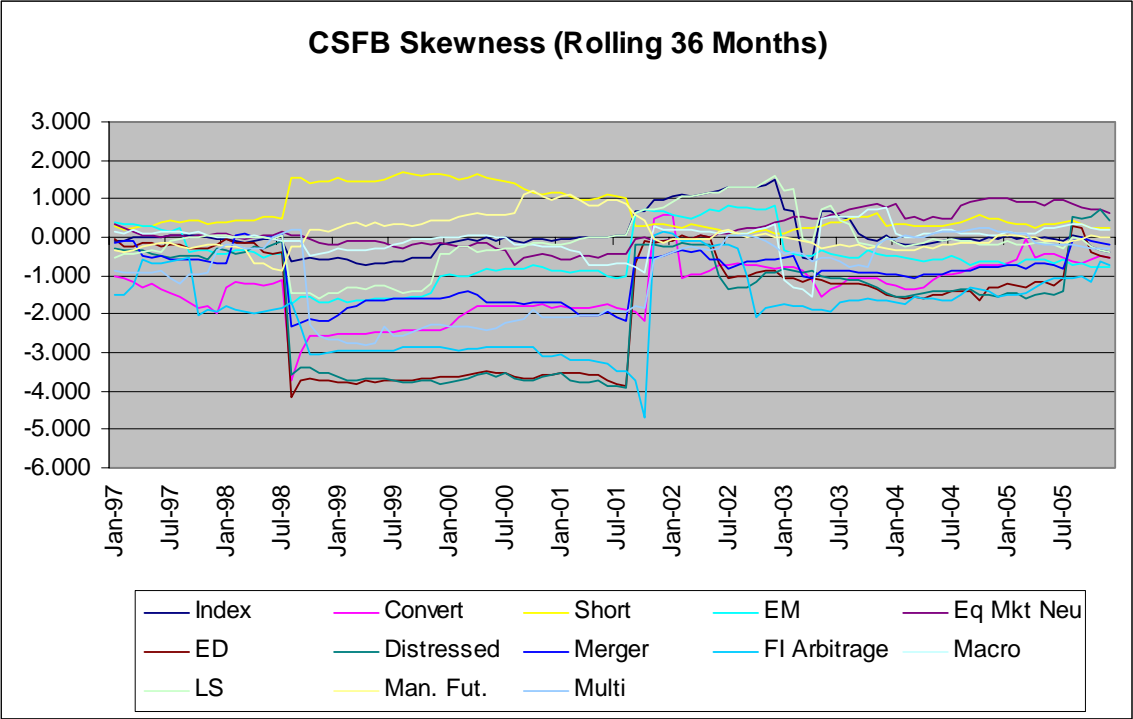


### HFR Kurtosis (Rolling 36 Months)



**Appendix 10b: CSFB Return Distribution (Rolling 36 Months)**





## Appendix 11: Optimized Hedge Fund Portfolios

<b>Optimized Market Portfolio (HFR - Barclay Data)</b>				
	Market	Suggestion A	Suggestion B	Suggestion C
<b>Maximum Allocation Over Market Portfolio</b>		<b>10.00%</b>	<b>25.00%</b>	<b>50.00%</b>
Annualized Return	11.35%	11.62%	12.04%	12.23%
Standard Deviation	6.13%	6.14%	6.14%	6.14%
Barclay CTA Index[5.200%]	5.20%	5.23%	0.00%	0.00%
Barclay Multi Strategy Index[11.300%]	11.30%	12.43%	14.13%	16.95%
HFR Convertible Arbitrage Index[2.100%]	2.10%	2.31%	2.63%	3.15%
HFR Emerging Markets (Total)[6.100%]	6.10%	5.47%	0.00%	0.00%
HFR Equity Hedge Index[28.000%]	28.00%	30.80%	34.55%	31.78%
HFR Equity Market Neutral Index[4.100%]	4.10%	4.51%	4.20%	0.00%
HFR Event-Driven Index[23.900%]	23.90%	26.29%	29.88%	35.85%
HFR Fixed Income: Arbitrage Index[7.600%]	7.60%	0.00%	0.00%	0.00%
HFR Macro Index[11.100%]	11.10%	12.21%	13.88%	11.37%
HFR Short Selling Index[0.600%]	0.60%	0.75%	0.75%	0.90%

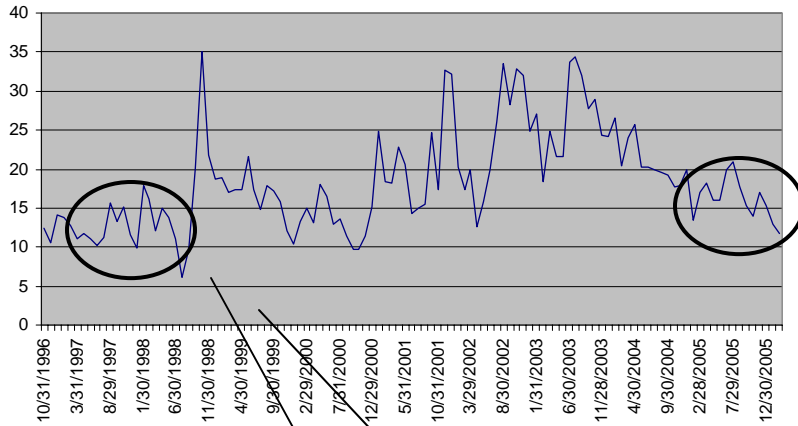
<b>Optimized Market Portfolio (Credit Suisse - Tremont Data)</b>				
	Market	Suggestion A	Suggestion B	Suggestion C
<b>Maximum Allocation Over Market Portfolio</b>		<b>10.00%</b>	<b>25.00%</b>	<b>50.00%</b>
Annualized Return	10.99%	11.24%	11.60%	11.75%
Standard Deviation	6.29%	6.28%	6.28%	6.26%
Credit Suisse - Tremont HFI Managed Futures[5.200%]	5.20%	5.72%	2.50%	0.00%
Credit Suisse - Tremont HFI Multi-Strategy[11.300%]	11.30%	12.43%	14.13%	16.95%
Credit Suisse - Tremont HFI Convertible Arbitrage[2.100%]	2.10%	2.30%	2.63%	0.00%
Credit Suisse - Tremont HFI Emerging Markets[6.100%]	6.10%	3.24%	0.00%	0.00%
Credit Suisse - Tremont HFI Long-Short Equity[28.000%]	28.00%	30.80%	31.87%	30.35%
Credit Suisse - Tremont HFI Equity Market Neutral[4.100%]	4.10%	4.51%	5.13%	6.15%
Credit Suisse - Tremont HFI Event Driven[23.900%]	23.90%	26.29%	29.88%	29.90%
Credit Suisse - Tremont HFI Fixed Income Arbitrage[7.600%]	7.60%	2.50%	0.00%	0.00%
Credit Suisse - Tremont HFI Global Macro[11.100%]	11.10%	12.21%	13.88%	16.65%
Credit Suisse - Tremont HFI Dedicated Short Bias[0.600%]	0.60%	0.00%	0.00%	0.00%

**Appendix 12: Regression Analysis of the Core Portfolio**

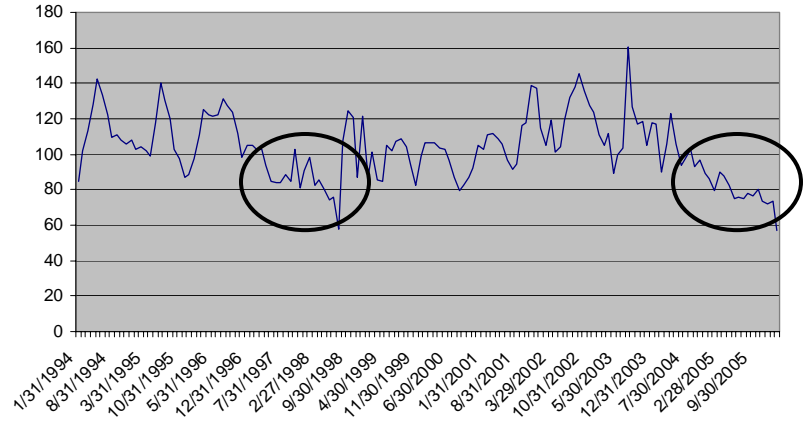
Source	SS	df	MS	Number of obs = 108	
				F( 1, 106) = 351.49	
Model	0.028134753	1	.028134753	Prob > F = 0.0000	
Residual	0.008484646	106	.000080044	R-squared = 0.7683	
				Adj R-squared = 0.7661	
Total	0.036619399	107	.000342237	Root MSE = .00895	
core	Coef.		P>t	[95% Conf. Interval]	
russell2000g	0.2088421		0	.1867572	.230927
_cons	0.0082573		0	.0065449	.0099698

## Appendix 13a: Similar Historical Market Conditions (Treasury Bond Volatility)

10Y T-Note 30 Day Volatility

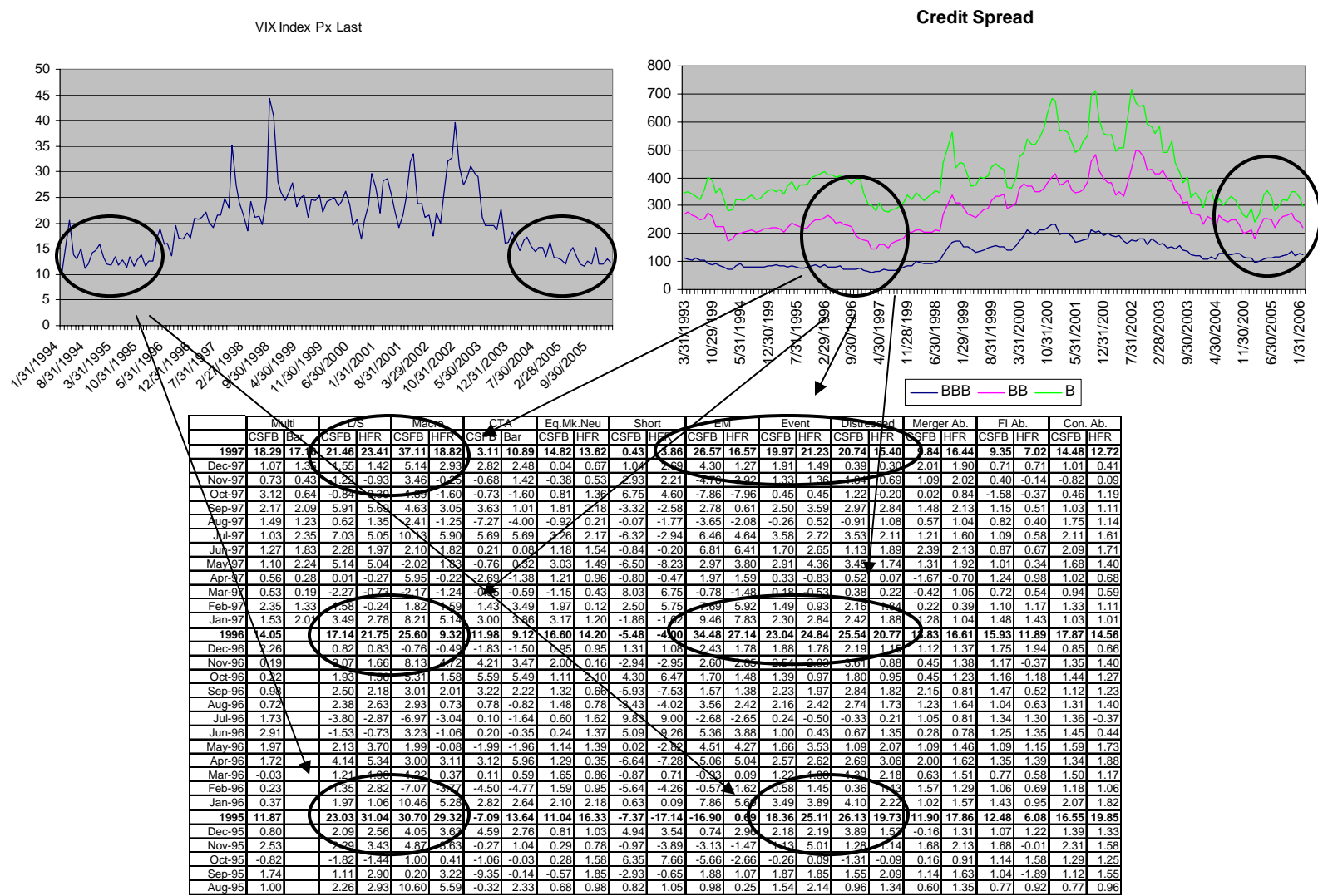


MOVE Index



	Multi		L/S		Macro		CTA		Eq.Mk.Neu		Short		EM		Event		Distressed		Merger Ab.		FI Ab.		Con. Ab.	
	CSFB	Bar	CSFB	HFR	CSFB	HFR	CSFB	Bar	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR	CSFB	HFR
<b>1999</b>	<b>9.37</b>	<b>21.59</b>	<b>47.22</b>	<b>44.22</b>	<b>5.81</b>	<b>17.62</b>	<b>-4.70</b>	<b>-1.19</b>	<b>15.32</b>	<b>7.09</b>	<b>-14.22</b>	<b>-24.40</b>	<b>44.83</b>	<b>55.86</b>	<b>22.26</b>	<b>24.33</b>	<b>22.18</b>	<b>16.94</b>	<b>13.23</b>	<b>14.34</b>	<b>12.10</b>	<b>7.38</b>	<b>16.03</b>	<b>14.41</b>
Dec-96	2.51	2.05	13.07	10.88	9.24	6.82	2.35	0.22	0.96	2.39	-6.60	-14.60	15.34	14.80	3.09	3.39	1.90	2.62	0.47	0.46	0.97	0.31	0.90	1.08
Nov-96	2.71	1.93	8.31	6.76	4.40	3.83	-0.52	1.96	1.56	1.05	-6.48	-11.68	9.29	7.90	2.04	3.38	1.55	1.14	0.52	2.23	0.78	1.07	1.30	0.99
Oct-96	0.09	0.97	4.39	2.93	2.44	-0.75	-4.82	-4.21	0.82	0.44	1.85	-3.17	3.66	3.13	0.35	0.42	-0.30	-0.15	1.75	0.69	0.91	0.25	0.70	0.33
Sep-96	0.04	1.26	0.60	0.35	-3.18	1.08	1.81	0.05	0.22	0.85	1.74	3.18	-0.65	-1.89	1.04	1.62	1.73	-1.00	2.16	1.25	0.74	0.25	1.39	0.66
Aug-96	0.90	1.00	-0.27	0.04	-2.85	-0.55	-0.32	-0.32	1.11	0.70	4.32	4.38	-2.66	-1.45	0.11	-0.78	0.19	0.37	0.80	0.52	-0.41	-0.34	0.23	0.42
Jul-96	1.04	1.26	1.54	0.61	-1.81	0.46	-0.72	-0.52	1.66	1.91	-0.02	-0.16	-1.55	-0.99	1.32	0.81	1.96	0.68	0.16	1.38	0.49	0.65	1.09	1.05
Jun-96	2.05	2.06	4.65	3.80	3.02	2.16	2.76	1.55	1.92	2.02	-2.36	-1.69	4.90	9.34	2.93	2.93	2.49	1.93	1.22	1.61	0.75	1.32	0.81	1.09
May-96	0.38	0.97	0.82	1.22	-0.05	0.90	-2.93	1.43	1.44	0.17	0.43	-0.20	-1.23	0.47	2.17	2.00	2.43	1.91	2.47	2.04	0.88	-0.03	1.89	1.40
Apr-96	0.29	2.92	3.29	5.25	1.79	3.88	2.67	1.81	2.02	-0.65	-3.75	-2.49	6.49	7.45	3.07	5.13	3.14	5.06	3.39	1.31	1.63	0.11	2.14	2.66
Mar-96	0.22	1.14	3.76	4.05	-2.00	1.07	1.07	-1.22	1.35	-0.76	-1.77	-0.04	7.43	8.86	2.39	2.06	2.89	2.20	2.56	1.05	1.34	1.31	1.04	1.53
Feb-96	1.26	1.01	-3.14	-2.41	-1.60	-1.24	-0.54	2.62	0.61	-1.33	5.59	6.97	1.17	1.54	-0.05	-0.48	0.07	-0.27	-1.37	0.25	1.52	1.09	1.22	0.25
Jan-96	1.63	1.89	-0.97	-0.98	-2.88	0.81	-0.14	1.50	0.69	0.15	-7.18	-5.90	-2.92	-2.32	1.88	1.65	2.22	1.40	-1.51	0.71	1.90	1.17	2.27	2.11
<b>1998</b>	<b>7.68</b>	<b>9.37</b>	<b>17.19</b>	<b>15.98</b>	<b>-3.63</b>	<b>6.19</b>	<b>20.66</b>	<b>7.01</b>	<b>13.32</b>	<b>8.30</b>	<b>-5.99</b>	<b>-0.54</b>	<b>-37.66</b>	<b>-32.96</b>	<b>-4.87</b>	<b>1.70</b>	<b>-1.68</b>	<b>-4.23</b>	<b>5.59</b>	<b>7.23</b>	<b>-8.16</b>	<b>-10.29</b>	<b>-4.42</b>	<b>7.77</b>
Dec-98	1.32	1.35	6.56	5.27	2.34	2.44	2.80	2.12	1.24	3.59	-5.75	-5.48	-3.84	-2.76	1.70	2.73	1.55	0.15	1.55	1.94	1.73	0.15	0.35	1.60
Nov-98	1.95	2.84	3.74	3.84	-1.08	1.98	-1.80	-0.93	2.10	0.85	-7.12	-4.84	4.68	5.14	2.77	2.43	3.17	1.70	2.04	2.33	1.55	-1.42	2.06	3.33
Oct-98	-4.76	-0.70	1.74	2.47	-11.55	-1.83	1.21	-0.75	2.48	-0.61	-8.69	-8.97	1.68	2.16	0.66	1.25	0.89	-0.75	2.41	2.14	-6.96	-6.09	-4.68	-0.48
Sep-98	0.57	-0.06	3.47	3.16	-5.12	-0.50	6.87	3.16	0.95	0.81	-4.98	-4.18	-7.40	-4.98	-2.96	-0.62	-1.43	-3.57	-0.65	1.74	-3.74	-6.45	-3.23	-1.07
Aug-98	1.15	-2.08	-11.43	-7.65	-4.84	-3.70	9.95	5.92	-0.85	-1.67	22.71	19.40	-23.03	-21.02	-11.77	-8.90	-12.45	-8.50	-6.15	-5.69	-1.46	-1.18	-4.64	-3.19
Jul-98	0.70	0.54	0.61	-0.67	1.80	0.23	-1.12	-0.29	-0.10	-0.27	2.72	3.04	0.08	-0.30	0.04	-0.57	0.39	-0.40	-0.37	-0.57	0.48	1.69	0.52	0.49
Jun-98	0.24	0.10	3.40	0.50	3.28	0.57	0.91	0.36	0.47	1.69	-2.34	1.16	-4.68	-6.01	-0.79	0.31	0.31	0.13	-0.53	0.50	-1.08	-1.31	-0.37	0.22
May-98	1.22	0.38	-1.69	-1.27	3.37	0.08	3.25	0.76	1.31	0.48	10.89	8.16	-9.78	-9.32	-1.20	-1.19	-1.41	0.28	0.23	-0.60	-0.21	0.19	0.65	0.40
Apr-98	1.81	1.28	1.14	1.39	1.57	-0.13	-4.03	-3.39	0.29	0.66	0.86	-2.25	-0.18	-0.55	0.73	0.31	0.51	1.55	1.64	1.59	-0.01	1.03	1.27	1.35
Mar-98	1.56	1.64	5.03	4.54	10.16	5.05	1.06	0.54	1.97	1.26	-2.42	0.06	3.63	2.94	2.48	2.93	1.27	2.17	2.38	1.05	1.61	1.34	1.42	1.58
Feb-98	1.54	2.17	5.64	4.09	0.21	1.90	-0.28	-0.99	1.85	0.76	-6.89	-4.98	2.00	3.96	2.56	3.36	2.80	2.35	3.81	1.89	0.81	1.28	1.63	1.52
Jan-98	0.30	1.63	-0.93	-0.16	-2.18	0.20	0.87	0.58	0.91	0.54	-1.05	1.33	-5.90	-5.43	1.73	0.25	3.76	1.10	-0.54	0.96	-0.84	0.39	0.84	1.91

## Appendix 13b: Similar Historical Market Conditions (Equity Volatility and Credit Spread)





**Appendix 13c: Tactical Hedge Fund Allocation**

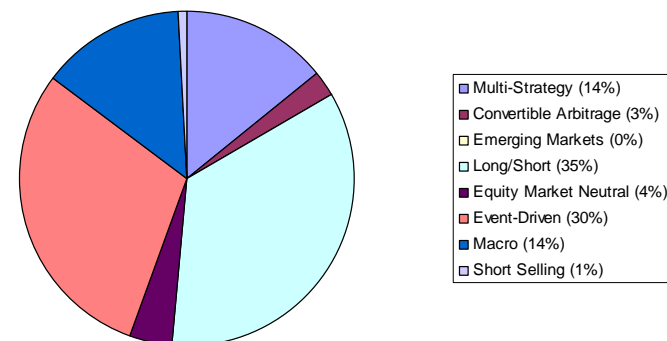
Tactical Weight	Factor	Current Range	Comparison Period	Outperforming Strategies	Suggested Distribution	Allocation
33%	Bond Volatility	10-15%	Jan 98 - Jul 98	Long/Short	100%	33.3%
				CTA (Only very short-term)	0%	0.0%
33%	Equity Volatility	11-15%	Aug 94 - Dec 95	Long/Short	33%	11.1%
				Global Macro	33%	11.1%
				Event Driven	33%	11.1%
33%	Credit Spread (BB)	200-250bp	Dec 95 - Mar 97	Long/Short	33%	11.1%
				Global Macro	17%	5.6%
				Emerging Markets	17%	5.6%
				Event Driven	33%	11.1%

<b>Total Tactical Allocation</b>	
Long/Short	55.6%
Global Macro	16.7%
Emerging Markets	5.6%
Event Driven	22.2%
<b>Total</b>	<b>100.0%</b>

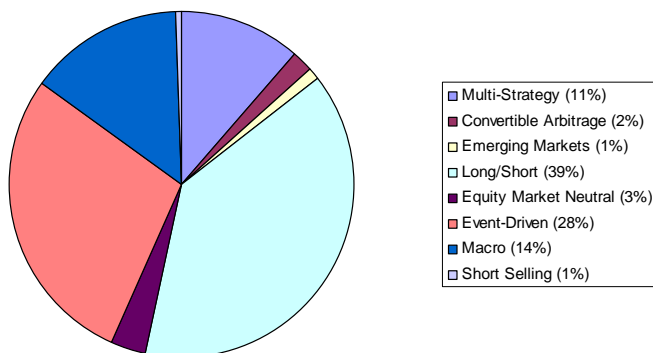
## Appendix 14: Core - Tactical Hedge Fund Allocation

Core - Tactical Hedge Fund Portfolio			
	Conservative (Core)	Moderate (20%)	Aggressive (40%)
Annualized Return	12.04%		
Standard Deviation	6.14%		
CTA/Managed Futures	0.00%	0.00%	0.00%
Multi-Strategy	14.13%	11.30%	8.48%
Convertible Arbitrage	2.63%	2.10%	1.58%
Emerging Markets	0.00%	1.11%	2.22%
Long/Short	34.55%	38.75%	42.95%
Equity Market Neutral	4.20%	3.36%	2.52%
Event-Driven	29.88%	28.34%	26.81%
Fixed Income Arbitrage	0.00%	0.00%	0.00%
Macro	13.88%	14.43%	14.99%
Short Selling	0.75%	0.60%	0.45%

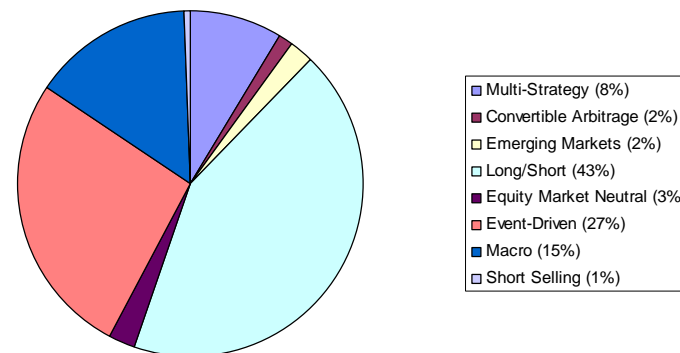
Conservative (Core)



Moderate (20% Tactical)



Aggressive (40% Tactical)



## Appendix 15: Asset Allocation of a Danish Pension Fund with and without hedge funds

	Current (No HF)		Equal-Weighted Distribution				Risk-Weighted Distribution				Benchmark
			5% HF		10% HF		5% HF		10% HF		
	Class1	Class2	Class1	Class2	Class1	Class2	Class1	Class2	Class1	Class2	
<b>Long-dated Bonds Total</b>	<b>58.5%</b>	<b>48.5%</b>	<b>55.6%</b>	<b>46.1%</b>	<b>52.7%</b>	<b>43.7%</b>	<b>57.4%</b>	<b>47.4%</b>	<b>56.2%</b>	<b>46.2%</b>	
Danish	43.9%	36.4%	41.7%	34.6%	39.5%	32.7%	43.0%	35.5%	42.2%	34.7%	JPM Danish
Euroland	14.6%	12.1%	13.9%	11.5%	13.2%	10.9%	14.3%	11.8%	14.1%	11.6%	JPM Euro
<b>High-Yield Bonds Total</b>	<b>6.5%</b>	<b>6.5%</b>	<b>6.2%</b>	<b>6.2%</b>	<b>5.9%</b>	<b>5.9%</b>	<b>6.5%</b>	<b>6.5%</b>	<b>6.5%</b>	<b>6.5%</b>	
HY Bonds	3.9%	3.9%	3.7%	3.7%	3.5%	3.5%	3.9%	3.9%	3.9%	3.9%	CSHY
EM Bonds	2.6%	2.6%	2.5%	2.5%	2.3%	2.3%	2.6%	2.6%	2.6%	2.6%	JPM EMBI
<b>Stocks Total</b>	<b>23.0%</b>	<b>32.0%</b>	<b>21.9%</b>	<b>30.4%</b>	<b>20.7%</b>	<b>28.8%</b>	<b>19.2%</b>	<b>28.2%</b>	<b>15.3%</b>	<b>24.3%</b>	
Danish	3.5%	4.8%	3.3%	4.6%	3.1%	4.3%	2.9%	4.2%	2.3%	3.6%	KBX
<i>Europe Total</i>	6.9%	9.6%	6.6%	9.1%	6.2%	8.6%	5.7%	8.4%	4.6%	7.3%	
European Small Cap	1.0%	1.4%	1.0%	1.4%	0.9%	1.3%	0.9%	1.3%	0.7%	1.1%	MSCI Europe Small
European Large Cap	5.9%	8.2%	5.6%	7.8%	5.3%	7.3%	4.9%	7.2%	3.9%	6.2%	MSCI Europe
<i>US Total</i>	9.2%	12.8%	8.7%	12.2%	8.3%	11.5%	7.7%	11.3%	6.1%	9.7%	
US Small Cap	1.4%	1.9%	1.3%	1.8%	1.2%	1.7%	1.1%	1.7%	0.9%	1.5%	Russell2000
US Large Cap	7.8%	10.9%	7.4%	10.3%	7.0%	9.8%	6.5%	9.6%	5.2%	8.3%	S&P 500
<i>Japan Total</i>	2.3%	3.2%	2.2%	3.0%	2.1%	2.9%	1.9%	2.8%	1.5%	2.4%	
Japan Small Cap	0.3%	0.5%	0.3%	0.5%	0.3%	0.4%	0.3%	0.4%	0.2%	0.4%	Russell/Nomura
Japan Large Cap	2.0%	2.7%	1.9%	2.6%	1.8%	2.4%	1.6%	2.4%	1.3%	2.1%	MSCI Japan
Emerging Markets	1.2%	1.6%	1.1%	1.5%	1.0%	1.4%	1.0%	1.4%	0.8%	1.2%	MSCI Emerging Market Free
<b>Private Equity Total</b>	<b>2.0%</b>	<b>3.0%</b>	<b>1.9%</b>	<b>2.9%</b>	<b>1.8%</b>	<b>2.7%</b>	<b>2.0%</b>	<b>3.0%</b>	<b>2.0%</b>	<b>3.0%</b>	EVCA
<b>Real Estate Total</b>	<b>10.0%</b>	<b>10.0%</b>	<b>9.5%</b>	<b>9.5%</b>	<b>9.0%</b>	<b>9.0%</b>	<b>10.0%</b>	<b>10.0%</b>	<b>10.0%</b>	<b>10.0%</b>	IPD (Index Denmark)
<b>Hedge Funds Total</b>	<b>0%</b>	<b>0%</b>	<b>5%</b>	<b>5%</b>	<b>10%</b>	<b>10%</b>	<b>5%</b>	<b>5%</b>	<b>10%</b>	<b>10%</b>	HFR Index
<b>Total</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	

## Appendix 16a: Portfolio Simulation, Class 1

Class 1: No Hedge Funds								
All Portfolio Statistics	Annualized Return	Annualized Standard Deviation	Annualized Sharpe (RF)	Annualized Semi Deviation	Average Gain Deviation	Average Loss Deviation	Annualized Sortino (0%)	Maximum Drawdown
Number Simulations	10,000	10,000	10,000	10,000	10,000	9,999	10,000	10,000
Mean	5.30%	3.45%	0.951	3.53%	2.35%	1.78%	3.623	2.72%
Median	5.28%	3.44%	0.937	3.50%	2.33%	1.74%	3.162	2.48%
Standard Deviation	2.07%	0.42%	0.597	0.55%	0.38%	0.49%	2.385	1.19%
Maximum	12.96%	5.21%	4.019	5.92%	4.24%	4.90%	37.642	10.77%
Minimum	(1.74%)	1.97%	(1.207)	1.59%	1.24%	0.40%	(0.686)	0.44%
5th Percentile	1.94%	2.79%	0.001	2.67%	1.75%	1.03%	0.911	1.24%
1st Percentile	0.59%	2.55%	(0.394)	2.36%	1.53%	0.80%	0.263	0.87%
Class 1: 5% Hedge Funds, Equal-Weight								
All Portfolio Statistics	Annualized Return	Annualized Standard Deviation	Annualized Sharpe (RF)	Annualized Semi Deviation	Average Gain Deviation	Average Loss Deviation	Annualized Sortino (0%)	Maximum Drawdown
Number Simulations	10,000	10,000	10,000	10,000	10,000	9,999	10,000	10,000
Mean	5.44%	3.46%	0.987	3.54%	2.36%	1.77%	3.739	2.69%
Median	5.42%	3.45%	0.973	3.50%	2.34%	1.74%	3.263	2.46%
Standard Deviation	2.08%	0.42%	0.597	0.55%	0.38%	0.49%	2.452	1.17%
Maximum	13.25%	5.19%	4.049	5.93%	4.28%	4.72%	42.065	10.64%
Minimum	(1.62%)	1.97%	(1.142)	1.60%	1.25%	0.32%	(0.633)	0.45%
5th Percentile	2.06%	2.80%	0.034	2.68%	1.76%	1.03%	0.967	1.23%
1st Percentile	0.70%	2.56%	(0.358)	2.38%	1.55%	0.80%	0.310	0.86%
Class 1: 10% Hedge Funds, Equal-Weight								
All Portfolio Statistics	Annualized Return	Annualized Standard Deviation	Annualized Sharpe (RF)	Annualized Semi Deviation	Average Gain Deviation	Average Loss Deviation	Annualized Sortino (0%)	Maximum Drawdown
Number Simulations	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Mean	5.55%	3.46%	1.018	3.53%	2.36%	1.77%	3.854	2.65%
Median	5.53%	3.45%	1.007	3.49%	2.35%	1.73%	3.358	2.42%
Standard Deviation	2.08%	0.42%	0.598	0.55%	0.38%	0.50%	2.518	1.16%
Maximum	13.47%	5.15%	4.066	5.88%	4.33%	4.71%	47.005	10.45%
Minimum	(1.50%)	1.96%	(1.080)	1.61%	1.27%	0.36%	(0.578)	0.43%
5th Percentile	2.17%	2.79%	0.065	2.67%	1.76%	1.01%	1.025	1.21%
1st Percentile	0.80%	2.56%	(0.330)	2.38%	1.56%	0.78%	0.356	0.86%
Class 1: 5% Hedge Funds, Risk-Weight								
All Portfolio Statistics	Annualized Return	Annualized Standard Deviation	Annualized Sharpe (RF)	Annualized Semi Deviation	Average Gain Deviation	Average Loss Deviation	Annualized Sortino (0%)	Maximum Drawdown
Number Simulations	10,000	10,000	10,000	10,000	10,000	9,999	10,000	10,000
Mean	5.49%	3.15%	1.097	3.22%	2.18%	1.59%	4.354	2.28%
Median	5.46%	3.14%	1.081	3.19%	2.17%	1.55%	3.780	2.08%
Standard Deviation	1.90%	0.38%	0.600	0.51%	0.35%	0.46%	2.776	0.99%
Maximum	12.53%	4.71%	3.996	5.51%	3.90%	4.65%	44.354	8.72%
Minimum	(1.09%)	1.82%	(1.070)	1.55%	1.14%	0.18%	(0.465)	0.35%
5th Percentile	2.44%	2.54%	0.152	2.43%	1.64%	0.90%	1.294	1.03%
1st Percentile	1.20%	2.33%	(0.234)	2.16%	1.46%	0.66%	0.576	0.73%
Class 1: 10% Hedge Funds, Risk-Weight								
All Portfolio Statistics	Annualized Return	Annualized Standard Deviation	Annualized Sharpe (RF)	Annualized Semi Deviation	Average Gain Deviation	Average Loss Deviation	Annualized Sortino (0%)	Maximum Drawdown
Number Simulations	10,000	10,000	10,000	10,000	10,000	9,999	10,000	10,000
Mean	5.67%	2.88%	1.260	2.94%	2.03%	1.42%	5.281	1.90%
Median	5.64%	2.87%	1.238	2.91%	2.02%	1.38%	4.553	1.74%
Standard Deviation	1.74%	0.35%	0.606	0.46%	0.31%	0.43%	3.308	0.83%
Maximum	12.32%	4.24%	4.022	5.29%	3.57%	4.49%	51.129	7.87%
Minimum	(0.45%)	1.71%	(0.911)	1.43%	1.03%	0.07%	(0.213)	0.26%
5th Percentile	2.85%	2.33%	0.301	2.22%	1.53%	0.77%	1.738	0.85%
1st Percentile	1.71%	2.12%	(0.089)	1.98%	1.35%	0.56%	0.978	0.61%

**Appendix 16b: Portfolio Simulation, Class 2**

<b>Class 2: No Hedge Funds</b>								
All Portfolio Statistics	Annualized Return	Annualized Standard Deviation	Annualized Sharpe (RF)	Annualized Semi Deviation	Average Gain Deviation	Average Loss Deviation	Annualized Sortino (0%)	Maximum Drawdown
Number Simulations	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Mean	4.99%	4.64%	0.648	4.74%	3.04%	2.50%	2.270	4.49%
Median	4.96%	4.62%	0.643	4.69%	3.01%	2.46%	1.968	4.09%
Standard Deviation	2.78%	0.56%	0.591	0.74%	0.53%	0.63%	2.539	1.99%
Maximum	16.37%	6.89%	3.856	7.60%	5.79%	5.60%	190.811	18.23%
Minimum	(4.57%)	2.72%	(1.608)	2.30%	1.43%	0.28%	(1.276)	0.12%
5th Percentile	0.48%	3.75%	(0.310)	3.60%	2.20%	1.53%	0.155	2.03%
1st Percentile	(1.41%)	3.41%	(0.707)	3.18%	1.90%	1.23%	(0.403)	1.48%
<b>Class 2: 5% Hedge Funds, Equal-Weight</b>								
All Portfolio Statistics	Annualized Return	Annualized Standard Deviation	Annualized Sharpe (RF)	Annualized Semi Deviation	Average Gain Deviation	Average Loss Deviation	Annualized Sortino (0%)	Maximum Drawdown
Number Simulations	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Mean	5.15%	4.62%	0.686	4.72%	3.03%	2.47%	2.385	4.39%
Median	5.13%	4.60%	0.681	4.67%	3.01%	2.43%	2.068	4.00%
Standard Deviation	2.77%	0.56%	0.592	0.74%	0.53%	0.63%	3.163	1.94%
Maximum	16.59%	6.83%	3.869	7.78%	5.75%	5.74%	266.003	17.82%
Minimum	(4.37%)	2.69%	(1.551)	2.30%	1.45%	0.20%	(1.227)	0.09%
5th Percentile	0.67%	3.73%	(0.269)	3.59%	2.20%	1.51%	0.222	1.99%
1st Percentile	(1.21%)	3.40%	(0.678)	3.17%	1.92%	1.21%	(0.344)	1.47%
<b>Class 2: 10% Hedge Funds, Equal-Weight</b>								
All Portfolio Statistics	Annualized Return	Annualized Standard Deviation	Annualized Sharpe (RF)	Annualized Semi Deviation	Average Gain Deviation	Average Loss Deviation	Annualized Sortino (0%)	Maximum Drawdown
Number Simulations	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Mean	5.26%	4.55%	0.720	4.64%	2.99%	2.43%	2.514	4.23%
Median	5.23%	4.53%	0.715	4.59%	2.97%	2.39%	2.168	3.86%
Standard Deviation	2.73%	0.55%	0.592	0.72%	0.52%	0.62%	4.669	1.88%
Maximum	16.58%	6.68%	3.876	7.66%	5.65%	5.66%	433.316	17.28%
Minimum	(4.09%)	2.62%	(1.492)	2.28%	1.45%	0.08%	(1.169)	0.05%
5th Percentile	0.84%	3.67%	(0.236)	3.52%	2.18%	1.47%	0.282	1.92%
1st Percentile	(1.03%)	3.35%	(0.629)	3.12%	1.89%	1.18%	(0.297)	1.41%
<b>Class 2: 5% Hedge Funds, Risk-Weight</b>								
All Portfolio Statistics	Annualized Return	Annualized Standard Deviation	Annualized Sharpe (RF)	Annualized Semi Deviation	Average Gain Deviation	Average Loss Deviation	Annualized Sortino (0%)	Maximum Drawdown
Number Simulations	10,000	10,000	10,000	10,000	10,000	9,999	10,000	10,000
Mean	5.17%	4.31%	0.737	4.40%	2.85%	2.29%	2.600	3.94%
Median	5.16%	4.30%	0.732	4.36%	2.83%	2.26%	2.272	3.59%
Standard Deviation	2.59%	0.52%	0.592	0.69%	0.49%	0.59%	2.284	1.74%
Maximum	15.72%	6.40%	3.922	7.33%	5.36%	5.32%	136.486	16.15%
Minimum	(3.67%)	2.49%	(1.456)	2.12%	1.44%	0.46%	(1.115)	0.16%
5th Percentile	0.99%	3.48%	(0.217)	3.34%	2.08%	1.39%	0.350	1.79%
1st Percentile	(0.75%)	3.16%	(0.617)	2.96%	1.82%	1.11%	(0.247)	1.31%
<b>Class 2: 10% Hedge Funds, Risk-Weight</b>								
All Portfolio Statistics	Annualized Return	Annualized Standard Deviation	Annualized Sharpe (RF)	Annualized Semi Deviation	Average Gain Deviation	Average Loss Deviation	Annualized Sortino (0%)	Maximum Drawdown
Number Simulations	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Mean	5.37%	3.99%	0.844	4.07%	2.67%	2.09%	3.024	3.41%
Median	5.35%	3.97%	0.832	4.03%	2.65%	2.05%	2.644	3.10%
Standard Deviation	2.40%	0.48%	0.594	0.64%	0.45%	0.56%	2.255	1.50%
Maximum	15.05%	5.91%	3.985	6.82%	4.95%	4.94%	96.298	13.92%
Minimum	(2.73%)	2.27%	(1.279)	1.96%	1.36%	0.44%	(0.911)	0.22%
5th Percentile	1.48%	3.22%	(0.112)	3.09%	1.96%	1.25%	0.581	1.55%
1st Percentile	(0.11%)	2.93%	(0.514)	2.74%	1.72%	0.96%	(0.042)	1.12%

## **Appendix 17: Due Diligence Process**

The due diligence process is extremely important in the creation of a hedge fund portfolio. Hedge funds are not required to disclose any information, and most funds have a lock-up period, which may impose a penalty on early withdrawal from a fund before the lock-up period expires. Investing with managers who turn out to be fraudulent or incapable of delivering the anticipated return can therefore be very costly, as firing a manager is much more complex than divesting from a bad equity investment.

Quantitative and qualitative analysis is equally important in the due diligence process. The quantitative analysis is often the first part of the selection process and can give indication of the past return generation of a manager relative to the risk taken. In the hedge fund world however, past performance is even less indicative of future results than other assets classes, as some managers change investment style or sector/market focus. The qualitative analysis follows, once a potential manager has been identified, and is often the last step before an initial investment is made. Both quantitative and qualitative analysis is described in further details below.

### **1 Quantitative analysis**

#### **1.1 Filtering through more than 8,000 funds**

No one knows for sure how many hedge funds exist worldwide. Most industry experts believe the number of funds is above 8,000, but as registration is not mandatory in some countries, an exact number is impossible to obtain.

Investors can subscribe to various databases which provide data and contacts addresses for hedge funds who have agreed to have their performance numbers published. Most of these databases have a search function where funds can be identified according to performance, volatility, style, location, etc.

There are, however, many funds who do not submit data or details to these databases. These funds in general fall into two categories: new funds which are currently working on establishing a track record or funds with an impressive track record that do not need to “advertise” to attract investors. The latter fund type, which is often soft-closed to new money, can only be found via industry relations.

#### **1.2 Return Distribution, Drawdown, Ratios**

The average return and standard deviation can give a quick overview of the risk/return relationship in the fund, but are not always sufficient to understand the managers’ efficiency. For that reason, different ratios have been developed to help quantify the relative risk/return relationship in a fund (see appendix).

The most commonly used ratio is the Sharpe ratio, which measures return relative to the risk-free rate and standard deviation. Due to its use of standard deviation, the Sharpe ratio is only useful for normal distributed returns, as standard deviation increases with a

skewed return. A positive skew is of interest to most investors, but would in fact lower the Sharpe ratio.

The Sortino ratio somewhat compensates for this flaw in the Sharpe ratio. Instead of using standard deviation in the denominator, the Sortino ratio uses downside semi-standard deviation. By doing so, only the harmful downside volatility is measured, hence the ratio does not penalize a fund for upside volatility.

The Treynor ratio replaces standard deviation with beta in the denominator, which theoretically measure return over systemic risk. As previously discussed in section 3, the market indices in the hedge fund industry are probably not exhaustive enough to qualify as a systemic risk measurement. Therefore beta in an individual fund would need to be identified with regression analysis of the individual fund, making this ratio almost useless for hedge fund comparison.

Drawdown is the peak to valley percentage decline during a specific period, which is normally determined from the time a retrenchment begins to when the low is reached. This can indicate how well the fund in the past has protected its downside risk.

The Sterling and Calmar ratios are almost exclusively applied in a hedge fund context and are very similar ratios. They both use compounded annual return, usually over 3 years, in the nominator and maximum drawdown in the denominator. The difference is that the Sterling denominator is an average drawdown over the past three years, whereas the Calmar denominator is the absolute value drawdown. Equal for both ratios is that a higher ratio indicates more return for the same risk or the same return for less risk.

## **2 Qualitative analysis**

While much of the qualitative analysis is common sense and often depends on the comfort level and previous relationships with manager, there are some minimum requirements which should be a part of any due diligence process.

### **2.1 Organization**

Hedge funds are often small organizations with only 10-15 people, where each individual's contribution is essential. A fund which compensates and appreciates its employees fairly is likely to have a low staff turnover, which can hopefully ensure consistent performance.

All legal material should be firmly analyzed to ensure full knowledge of the terms of subscription prior to the investment. Often the main content of the subscription documents is summarized in a colorful presentation, which is presented to prospective investors during the initial phase of the investment process. As the content of such a presentation is up to the discretion of the manager, and who may leave out vital parts of the subscription material, a full review of the entire material is required.

Pending litigation or regulatory investigations against the fund or any employee should be taken seriously and could cause a re-valuation of the investment. In addition, the latest

statement from a recognized auditor should be viewed, to ensure that performance numbers are accurate and reliable.

## **2.2 Assets**

In the hedge fund world, big is not necessarily better. Often continuous and rapid expansion dilutes performance. The managers need to have an idea about how much money they can handle both in the short and long term, and a plan for how they intend to ensure that the money is put to work, if an investment in the fund is made.

The employees of the fund should preferably have significant investments in their own fund, to ensure that their interest in the fund's performance is aligned with the external investors.

## **2.3 Portfolio Construction**

When constructing a hedge fund portfolio it is essential to know the sector and geographic exposure of the entire portfolio, which requires an in-depth understanding of the risk exposure each individual manager has in the portfolio. To do that, understanding of the fund's portfolio construction is important for identification of risks associated with a particular fund. Many managers use a top-down approach, while others use a bottom-up approach to generate investment ideas for the portfolio. Both approaches can work, depending on the field and specialization of the manager.

Some hedge fund managers are reluctant to reveal their positions, but funds with more than \$100 million in investments are required to file a 13-f quarterly with the SEC for all their equity related holdings. *"The 13-f regulation also applies to foreign hedge funds insofar they use any means or instrumentality of United States interstate commerce in the course of their business, or exercise investment discretion over \$100 million or more in Section 13(f) securities"*<sup>42</sup>.

## **2.4 Risk Management**

Hedge funds are not risk-free, but a hedge fund can, in contrast to many other investment types, manage risk through use of derivatives, etc. Detailed examination of a fund's risk management should be a part of a good due diligence process, which also includes stop-loss strategy, trading authority, and fund liquidity.

## **2.5 Fee and Fund structures**

Fee structures in hedge funds are often very complex, and are different from fund to fund. Most funds however charge both a management fee as well as an incentive fee. The management fee is charged regardless of performance, while the incentive fee is a percentage of the net profit, and often, but not always, subject to a high watermark. The high watermark ensures that the manager does not get paid large sums for poor

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<sup>42</sup> U.S. Securities and Exchange Commission, Division of Investment Management, *Frequently Asked Questions About Form 13F*, May 2005, Available at <http://www.sec.gov/divisions/investment/13ffaq.htm> (accessed February 26, 2006)



performance, i.e. if the manager loses money over a period, he must get the fund's net assets above the previous high before receiving a performance bonus.

Often a manager offers more than one share class for investment. The difference among the share classes is often determined by the length of the lock-up period the investor is willing to accept. The general rule is that the longer the lock-up, the lower the fees. In addition, some managers offer share classes which differs with regard to the investments e.g. a core fund and a fund with double leverage.

### **3 Post-Investment due diligence**

After an investment is made, methodical and continuous reviews of managers in the portfolio should take place on a regular basis to determine the ongoing risk exposure of the fund, and to monitor the manager for style drift and/or investment beyond his area of expertise. While not always recommendable, it should be accepted that managers occasionally invest outside their core competencies if a special occasion has arisen, which the manager may be able to generate reward from.

Most managers provide investors with weekly performance update and more exhaustive monthly updates, which often break performance numbers down to sectors and regions. Even in months where the manager has performed well, these updates should be meticulous considered and compared to the prior month to understand what drove the good performance.

## **Exhibit 1 to Appendix 16: Ratio Formulas**

**Sharpe Ratio:** 
$$\frac{\overline{r_p} - r_f}{\sigma_p}$$

Where:  $\overline{r_p}$  = Expected portfolio return,  $r_f$  = Risk free rate,  $\sigma_p$  = Portfolio standard deviation

**Sortino Ratio:** 
$$\frac{\overline{r_p} - r_f}{\sigma_{down}}$$

Where:  $\overline{r_p}$  = Expected portfolio return,  $r_f$  = Risk free rate,  $\sigma_{down}$  = Downside semi-standard deviation

**Treynor Ratio:** 
$$\frac{\overline{r_p} - r_f}{\beta_p}$$

Where:  $\overline{r_p}$  = Expected portfolio return,  $r_f$  = Risk free rate,  $\beta_{down}$  = Beta of the portfolio

**Calmar Ratio:** 
$$\frac{CAR}{MaxDraw}$$

Where:  $CAR$  = Compounded Annual Return,  $MaxDraw$  = Maximum Drawdown (absolute value)

**Sterling Ratio:** 
$$\frac{CAR}{AvgMaxDraw - 10\%}$$

Where:  $CAR$  = Compounded Annual Return,  $AvgMaxDraw$  = Average Maximum Drawdown

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