Understanding Hedge Fund Performance:

Research Results and Rules of Thumb for the Institutional Investor

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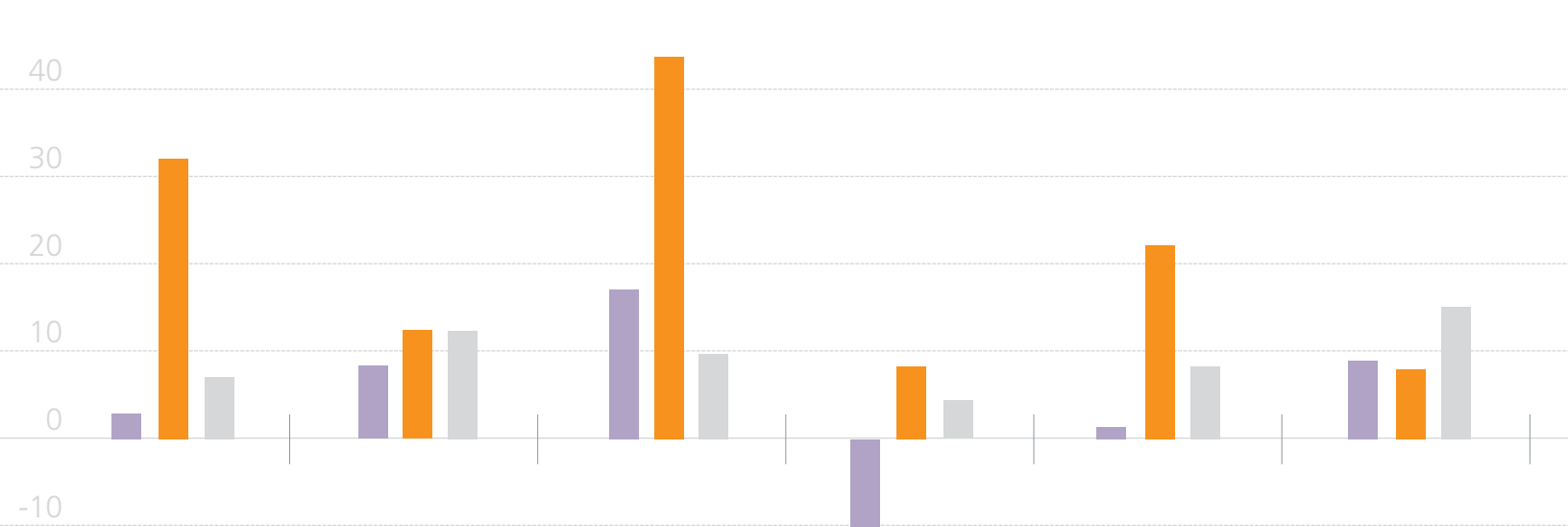**Hossein Kazemi** Associate Professor of Finance
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Abstract

During the past decade hedge fund investments offered investors increased returns while reducing risk through diversification. Recent advances in understanding the factors that drive hedge fund returns indicate the benefits of macro factor analysis (e.g., market factor-based models of return estimation) as well as micro factor analysis (e.g., fund based characteristics). Results presented in this article differ from other recent research by focusing on the performance of particular hedge fund strategies and individual funds, as opposed to the performance characteristics of the hedge fund industry as a whole. Results that are based solely on broad-based hedge fund indices are shown to overestimate or underestimate the impact of certain factors on fund performance. This paper presents evidence on how fund-based performance issues, such as incentive fees, may affect performance. The paper also focuses on how macro return drivers can be used to determine style consistency among funds as well as to understand hedge fund performance in differing market environments.

In short, results show that:

1. There is no universal hedge fund index that can adequately represent the hedge fund world. Existing composite indices differ widely in composition and performance.

2. Alpha is very sensitive to the choice of model. Using a risk-adjusted approach that captures the fundamental return variability, such as peer index or multi-factor model, may be superior to other approaches such as absolute return or S&P 500 beta.

3. Hedge fund classifications when disaggregated into sub indices offer different views of the impact of certain micro/macro factors than when universe returns are used.

4. There is some evidence of micro effects (lockups etc.). However, the impact of certain micro effects such as survivor bias, fees, offshore vs. onshore, may be difficult to model.

5. Depending on the hedge fund strategy considered, a single factor or a multi-factor model of return estimation may be appropriate. As important, one must consider the changing sensitivity of various fund strategies to these factors over time that may capture changes in fund strategy.

The results show the importance of a more detailed understanding of hedge funds and alternative asset markets in which they operate than is commonly presented in published literature.
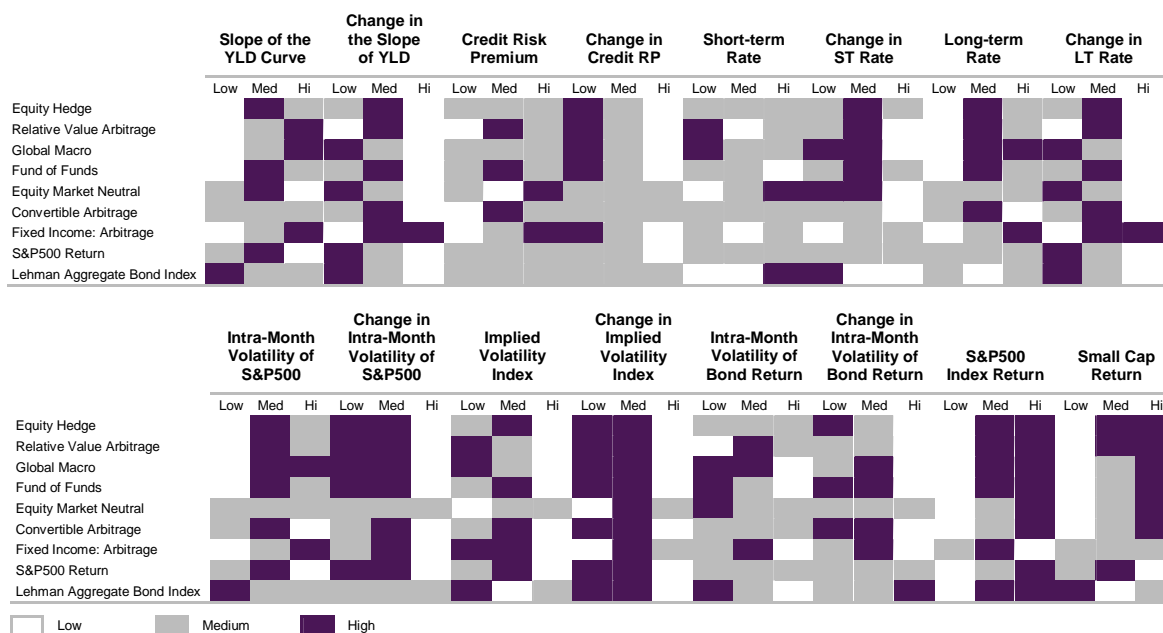
Moreover, the results of this study provide a number of simple rules of thumb for investors contemplating investment or currently invested in hedge funds:

1. Use style-pure subindices, in contrast to universe-based return, to provide more accurate estimates of future returns.

2.   Use indices which track the underlying risk or return patterns of the hedge fund strategy to obtain alpha (outperformance) estimates.

3.   Use due diligence processes to reduce potential survivor bias impacts on 'historical estimates of return' (e.g., size, relative performance comparisons).

4.   When suitable, use investments with lockups to increase potential rates of return.

5.   When suitable, use illiquid investments to increase potential rates of return.

6.   Use multi-factor return models to better capture expected hedge fund benefits.

7.   Use disaggregated data to capture unique impacts of micro factors on fund performance.

8.   Forecasts of economic variables can be used to make allocations across hedge fund strategies. The market environments which tend to be more or less favorable to each of the strategies are summarized in Exhibit 15.

Exhibit 15

Single Factor Performance Characteristics

First grid factor columns (each with Low / Med / Hi): Slope of the YLD Curve, Change in the Slope of YLD, Credit Risk Premium, Change in Credit RP, Short-term Rate, Change in ST Rate, Long-term Rate, Change in LT Rate

Rows: Equity Hedge, Relative Value Arbitrage, Global Macro, Fund of Funds, Equity Market Neutral, Convertible Arbitrage, Fixed Income: Arbitrage, S&P500 Return, Lehman Aggregate Bond Index

Second grid factor columns (each with Low / Med / Hi): Intra-Month Volatility of S&P500, Change in Intra-Month Volatility of S&P500, Implied Volatility Index, Change in Implied Volatility Index, Intra-Month Volatility of Bond Return, Change in Intra-Month Volatility of Bond Return, S&P500 Index Return, Small Cap Return

Rows: Equity Hedge, Relative Value Arbitrage, Global Macro, Fund of Funds, Equity Market Neutral, Convertible Arbitrage, Fixed Income: Arbitrage, S&P500 Return, Lehman Aggregate Bond Index

Legend: Low (white), Medium (gray), High (purple)

Note: The above tables indicate the relative performance of each hedge fund strategy during indicated levels of performance or magnitude of the underlying factors. This analysis is best explained with an example. Suppose we are interested in the performance sensitivity of Equity Hedge to S&P500 returns. The analysis consists of sorting all historical monthly S&P500 returns in the data time window from low to high and dividing those returns into three groups, Low, Medium, High. Equity Hedge returns for the *corresponding* months are noted, and an average of Equity Hedge performance for each of these groups is taken. These averages are then compared with the historical performance of that strategy to indicate the relative performance of that strategy during periods of different SP500 movements.

Introduction

During the past decade hedge fund investments[1] have been shown to offer investors additional means of increasing return while reducing risk through asset diversification. Research has also shown that the sources of the expected return differ for various hedge fund strategies, and that certain hedge fund strategies provide unique return opportunities not generally available through long only traditional stock and bond investment [Fung and Hsieh, 1997a; Schneeweis and Pescatore, 1999].[2] In fact, it is due to the different return opportunities and return drivers for certain hedge funds that risk diversification (relative to traditional stock and bond investments) exists. Research has further shown that traditional means of style-based performance analysis and asset allocation frameworks (e.g., mean/variance return/risk optimization) can be used to determine the appropriate allocation to hedge funds [Schneeweis and Pescatore, 1999].[3]

In this paper we concentrate on understanding both overall economic (e.g., macro) factors as well as fund (micro) elements driving fund performance. Results show that the returns of some hedge fund strategies are driven by the same market forces (market return, credit spreads, yield curve, market volatility) as traditional stock and bond investments and thus may be regarded primarily as return enhancers. In contrast, other hedge fund strategies are little affected by variables that drive traditional stock and bond investments and thus may be regarded primarily as return diversifiers. Moreover, specific fund characteristics such as fund age, fund size etc. also affect fund performance. Thus results show that both macro and micro factors are of importance in hedge fund selection and performance.

Given the empirical results presented in this paper, certain rules of thumb may be used by institutional investors to govern their investment philosophy. These include:

1. Use style-pure subindices, in contrast to universe-based return, to provide more accurate estimates of future returns.

2. Use indices which track the underlying risk or return patterns of the hedge fund strategy to obtain alpha (outperformance) estimates.

3. Use due diligence processes to reduce potential survivor bias impacts on 'historical estimates of return' (e.g., size, relative performance comparisons).

4. When suitable, use investments with lockups to increase potential rates of return.

5. When suitable, use illiquid investments to increase potential rates of return.

6. Use multi-factor return models to better capture expected hedge fund benefits.

7. Use disaggregated data to capture unique impacts of micro factors on fund performance.

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1 *Generally regarded as limited partnership entities in which the investment vehicles or underlying investment strategies use cash, futures and options markets as well as long and short positions in order to obtain investment return.*

2 *The alternative investment universe consists of investments outside of publicly traded debt, equity, and real estate. It includes investments ranging from hedge funds and managed futures to venture capital, private placements, LBO funds, to natural resource partnerships and commodity investment.*

3 *The lack of normality in certain hedge fund strategies may make the application of strict mean variance optimization problematic; however, research [Kazemi and Schneeweis, 2001] has also shown that these effects may be minimal or can be integrated directly into the optimization process through various constraints (e.g., value-at-risk restrictions etc.).*

8.   Forecasts of economic variables can be used to make allocations across hedge fund strategies. The market environments which tend to be more or less favorable to each of the strategies are summarized in Exhibit 15.

General Description of Hedge Funds

While many definitions for hedge funds exist, they are basically loosely regulated private pools of investment capital that can invest in both cash and derivative markets on a levered basis for the benefits of their investors.

Hedge funds may be considered an asset class if they provide return and risk characteristics not easily obtained from investment in other asset classes. For instance, equity investments are driven by common factors such as corporate earnings, while bonds are driven by common factors such as interest rates. These factors may also drive the returns of certain hedge fund strategies such as distressed and hedge equity, however, Fung and Hsieh [1997a] and Schneeweis and Spurgin [1998] have shown that traditional and modern alternatives are also driven by additional factors, such as location factors (market factors) and trading factors (option – like payoffs). Schneeweis and Spurgin [1999] have also included factors which capture liquidity premiums and arbitrage potentials, as well as momentum factors.[4]

Hedge funds have been described as skill-based investment strategies. This is due primarily to the fact than many hedge fund managers do not explicitly attempt to track a particular index. As a result, managers have greater flexibility in trading style and execution and offer a greater probability of obtaining returns due to the unique skill or strategy of the trader. As a result, hedge funds have also been described as *absolute return* strategies, as these managers attempt to maximize long-term returns independently of a traditional stock and bond index. In short, they emphasize *absolute return*, and not returns relative to a predetermined index.

It is important to realize, however, that the fact that hedge funds do not emphasize benchmark tracking *does not mean* that the return from a hedge fund is based solely on manager skill. Hedge fund managers who manage a particular investment strategy or focus on a particular investment opportunity can be said to track that investment strategy or risk/return opportunity. Research indicates that hedge funds returns within a particular investment strategy are driven largely by market factors (such as changes in credit spreads or market volatility [Fung and Hsieh, 1997a; Schneeweis, Kazemi and Spurgin, 2001]) specific to that strategy. One can therefore think of hedge fund returns as a combination of manager skill in processing information and the underlying return from passive investment in the strategy itself.[5]

Hedge Fund Investment Universe

Hedge funds may be considered an asset class if they provide return and risk characteristics not easily obtained from investment in other asset classes. Academic research has shown that each of the various hedge fund strategies has common factors driving the returns in each group, but that different factors may drive the returns across different hedge fund strategies.

Within the hedge fund universe there are numerous possible subclassifications. For our purposes, the various hedge fund strategies have been grouped as follows.

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[4]   *Recent research [Schneeweis, Kazemi and Spurgin 2001] studies factor exposures that are related to price effects, and the exposures that are due to changes in volatility.*

[5]   *See Schneeweis and Kazemi [2001] for various approaches to creating passive indices that are optimized to track historical hedge fund returns and strategies.*

Relative Value: Balanced, or hedged, long and short positions with subindices such as *long/short equity or equity market neutral* (long undervalued equities or short overvalued equities, usually on an equal dollar basis); *convertible hedging* (long convertible bonds or preferred, short underlying common); *bond hedging* (yield curve arbitrage or long/short debt positions).

Event Driven: (Corporate transactions and special situations) subindices including *deal arbitrage* (long/short equity securities of companies involved in corporate transactions; *bankruptcy/distressed* (long undervalued securities of companies usually in financial distress or operating under Chapter 11). *Multi-strategy* includes deal funds dealing in both deal arbitrage and bankruptcy.

Equity Hedge Funds: Long and short securities with varying degrees of exposure and leverage such as *domestic long equity* (long undervalued U.S. equities; short selling is used sparingly); *domestic opportunistic equity* or *hedged equity* (long and short U.S. equity with ability to be net short overall) and *global international* (primarily long undervalued equities with the ability to use short selling opportunistically).

Global Asset Allocators: Opportunistically long and short multiple financial and/or non-financial assets. Sub-indices include *systematic* (long or short markets based on trend-following or other quantitative analysis) and *discretionary* (long or short markets based on qualitative / fundamental analysis, often with technical input). Investment strategies that focus only on futures or options on futures are also often classified as managed futures.

Benefits of Hedge Funds

Previous research sponsored by Lehman Brothers [2000][6] focused on allocating between hedge funds and traditional assets, providing guidance on 1) stand-alone risk/return properties of hedge fund styles, 2) portfolio consequences of including hedge funds and 3) strategic portfolio construction with hedge funds.

This research showed that:

- Traditional methods of risk assessment, style analysis and asset allocation can be used for hedge funds as for stocks and bonds.
- Certain hedge fund asset strategies (e.g., equity market neutral) may be regarded as risk reducers and diversifiers for traditional stock and bond portfolios due to those hedge funds' sensitivity to different market factors.
- Certain hedge fund asset strategies (e.g., domestic long) may be regarded primarily as return enhancers of traditional stock and bond portfolios due to those hedge funds' sensitivity to the same market factors as traditional stock and bond investments.
- Asset allocation analysis indicates the unique benefit of certain hedge fund strategies (e.g., equity market neutral) in diversifying stock and bond portfolios, especially in economic scenarios in which traditional assets (e.g., stocks and/or bonds) perform poorly.
- Hedge fund indices reflect the performance of actual multi-manager portfolios.

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[6] *To receive a copy of Schneeweis and Martin, The Benefits of Hedge Funds: Asset Allocation for the Institutional Investor contact Joseph Pescatore, Vice President, Lehman Brothers Inc., 745 Seventh Avenue, New York, NY, jpescato@lehman.com or Heidi Fitzpatrick, Lehman Brothers Europe, 1 Broadgate, London, UK, hfitzpat@lehman.com .*

- Traditional methods of portfolio creation and analysis indicate the importance of hedge funds in obtaining optimal portfolio return and risk performance.

Performance Issues in Hedge Fund Investment

Basic Return Factors

While hedge fund investment has increased dramatically in the last decade, stocks and bonds remain the primary form of individual and institutional investment. One of the principal reasons for the increase in hedge funds is that within a particular asset class (e.g. stocks), securities tend to move together especially in periods of extreme market movements and that traditional mutual funds fail to outperform comparable passive indices [Bodie, Kane, and Marcus, 2000; Schneeweis et. al., 2000]. In contrast, academic and practitioner research on hedge funds has shown that many hedge fund strategies provide diversification benefits relative to traditional stock and bond investments and, in addition, have shown to outperform passive indices [Kazemi and Schneeweis, 2001]. See Exhibit 1 for a summary of research on understanding hedge fund performance and Appendix I for a listing of data sources and time periods used in Exhibits shown in this study.

In addition to the underlying return and diversification benefits of traditional and hedge fund investments, within the past decade, a number of empirical studies have directly assessed the source of return (e.g., return drivers) of traditional and alternative investments. For instance, for traditional stock and bond investments, a common set of factors have been used to explain returns [Fama and French, 1996]. Similarly, academic research [Fung and Hsieh, 1997a; Schneeweis and Spurgin, 1998; Schneeweis and Pescatore, 1999; Agarwal and Naik, 2000b] indicates that for hedge funds, as for traditional stock and bond mutual funds, a common set of return drivers based on the trading strategy factors (e.g., option like payoffs) and location factors (e.g., payoffs from buy and hold policy) help to explain returns of each strategy. It has also been shown that, as for traditional "long bias" stock and bond investments, the returns of some "long bias" equity-based and fixed-income-based hedge fund strategies are impacted primarily by changes in the risk and return of the underlying stock and bond markets and should be regarded less as portfolio return diversifiers than as portfolio return enhancers. Other hedge fund strategies that attempt to be less affected by the direction of the underlying stock and bond markets (e.g., equity market neutral or bond arbitrage) may be regarded more as diversifiers for traditional stock and bond portfolios.

Certain location and strategy factors are consistent with the return of the underlying strategy. While these factors are helpful in a wide range of performance issues, they may not directly represent the underlying trading process. In fact, the use of option-like payoffs may simply capture the impact of increasing and decreasing prices on strategies capable of capturing those direct price effects or the option payoff exposure of those strategies which focus on changes in volatility. Recent academic research has also focused on direct replication of the underlying strategies. These approaches use both location factors and trendfollowing momentum models as well as volatility factors to capture the implicit option payoff. In these studies, after consideration for market factors, changes in volatility and momentum factors, option like payoff variables generally have little to add as explanatory variables (Schneeweis and Spurgin, 2001).

Exhibit 1

Authors	Subject	Data, Model and Tested Hypotheses	Results and Supporting Hypotheses
Asness, Krail, Liew [JPM, forthcoming]	Stale Prices	CSFB/Tremont, 1994-2000; Regression on Lagged S&P returns	Non-synchronous return data lead to understated estimates of exposure; after adjusting for increased market exposure a broad universe of hedge funds does not add value
AMR (Ackermann, McEnally, Ravenscraft) [JF, 1999]	Sources of Hedge Fund Performance (e.g., size, fees, etc)	MAR and HFR, 1990-1995, restrict funds to at least 24 of data	Hedge fund size and incentive fees are critical determinants of superior risk-adjusted performance
Agarwal and Naik (WP, 2000)	Sources of hedge fund return	586 funds following ten strategies, 1990-1998 measured on trading factors (option like payoffs), location factors (underlying returns, spread etc.), and leverage factor	Non-Directional strategies Load on trading strategy factors and directional strategies load on location factors
Agarwal and Naik [JAI, 2000)	Performance Persistence of Hedge Funds	HFR 1994-1998; style factors and persistence	Reasonable Degree of Persistence attributable to loser persistence
Brown and Goetzmann [JOB, 1999]	Offshore Funds: Survival and Performance	Bernheim Offshore	Differences in survivor bias, and return history
Brown and Goetzmann [Yale WP, 2001]	Style creation	Multiple sources	Factor based style groupings
Fung and Hsieh [RFS, 2001]	Option theory (e.g., lookback option) to explain trendfollowing return behavior	CTA DATA	Lookback options explain historical return for trendfollowing hedge funds (CTAs)
Fung & Hsieh [RFS, 1997]	Return Characteristics of Hedge Funds	TASS data	Non-Directional strategies Load on trading strategy factors and directional strategies load on location factors
Fung and Hsieh [WP, 2000]	Broad Based versus Style Specific Indices	Comparisons of Hedge Fund Indices	Broad Based Indices reflect current 'bets' among hedge fund managers, but for diversification use equal weighted indices
Fung and Hsieh (JEF, 2000c)	Market Impact of Hedge Funds	Multiple sources	Little Evidence that Hedge funds systematically cause market prices to deviate from fundamentals
Fung and Hsieh (FAJ, 2000d)	Benchmark Issues	Various Indices	Index Universe is 'momentum bet" and Individual Index is style bet
Goetzmann, Ingersoll, and Ross [NBER, 1998]	Fee Performance Impacts		Impact of High Water marks on Performance
Liang (JFQA, 2000)	Characteristics of Alternative Hedge Fund Data Bases	TASS and HFR Data Bases	Differences in survivor bias, and return history
Liang (FAJ, 2000)	Hedge fund historical performance	HFR, 1990-1997. Returns a function of incentive fees, management fee, assets, lockup, and age factors	Each of the listed factors as well as onshore versus offshore affects performance

Exhibit 1 (cont'd)

Authors	Subject	Data, Model and Tested Hypotheses	Results and Supporting Hypotheses
Liang (FAJ, 2001)	Return Performance Survivorship Bias Fee Impacts	TASS Data base, 1407 Live, 609 dead funds, 1990-	Superior Risk Adjusted Performance for hedge funds; Annual Survivor Bias – 2.43%; Fund Fee Changes are performance Related
Mitchell, and Pulvino [JF, 2001]	Return Factors and Performance of self-generated hedge fund style (merger arbitrage)		Merger arbitrage loads on factors similar to that described in Fung and Hsieh
McCarthy and Spurgin [JAI, 1998]	Tracking error of various hedge fund Indices	MAR, HFR, EACM	Relative tracking error of various styles
Schneeweis [JAI, 1998]	Test the impact of absolute and risk adjusted return persistence	MAR, 1990-1997	For market neutral and Event little relationship between return persistence relationships and risk adjusted performance relationships
Schneeweis and Spurgin [JAI, 1998]	Sharpe style based factors on hedge fund returns	Various Data bases, 1990-2001	Market factors (Long volatility and short volatility) explain hedge fund index returns
Schneeweis and Spurgin [Lake etc., 1999]	Sharpe style based factors on hedge fund returns	Various Data bases, 1990-2001	Market factors (Long volatility and short volatility) explain hedge fund index returns
Spurgin [JAI, 1999]	Passive benchmark replication	Zurich CTA indices	Passive benchmarks can be created which tracks active strategy

Some studies directly replicate the underlying strategy [Mitchell and Pulvino, 2000]. These studies support the use of market factors and option-like payoff variables (e.g., put options) to describe hedge fund strategies. Fung and Hsieh [2000a] find a relationship between option-based payoff strategies and various hedge fund strategies (primarily trendfollowing based systems), while other studies [Schneeweis and Spurgin 2001] show that while trading strategy based factors (option payoff) may be correlated with the returns of nondirectional hedge fund strategies, certain hedge fund strategies (e.g., CTA trendfollowing) may be better described as designed to be a market timing model based on making money in up/down momentum markets with low market volatility [Schneeweis and Spurgin, 2001]. In short, each hedge fund strategy is designed to directly trade certain financial instruments in a pre-designed manner. For instance, a particular hedge fund strategy may be designed to capture returns in markets which are 1) delta neutral/long gamma; 2) low volatility/high trend; 3) low volatility /high market convergence, 4) decreasing credit spreads and 5) market factor driven.

In this analysis we concentrate on using variables that are fundamentally associated with the underlying holdings of the strategy and the strategy itself. One reason for concentrating on the underlying factors used in trading strategies is that investors may consider allocation to various strategies as economic factors directly driving hedge fund returns warrant and even consider allocations to new strategies based on new economic conditions driving hedge fund returns.

Additional Issues in Hedge Fund Performance Analysis

While many hedge fund strategies have been shown to provide unique return as well as risk-reduction opportunities, it is important to note that as for traditional assets, concern still exist as to:

- Performance Persistence
- Benchmark Determination
- Alpha Determination
- Index Alternatives
- Stale Price Bias
- Fund Structure
- Fees/Lockup
- Foreign/Domestic
- Asset Base

Performance Persistence

Investment choices are often based on past performance. The usefulness of historical hedge fund data is a topic of controversy. As is true for stock and bond analysis [Bodie, Kane and Marcus, 2000], hedge funds with similar investment styles generate similar returns and that there is little evidence of superior individual manager skill within a particular style group [Brown et al., 1999].[7] Research has also shown that the volatility of returns (that is "risk") is more persistent through time than the level of returns. This research [Schneeweis, 1998] shows that the best forecast of future returns is one that is consistent with prior volatility, not one that is consistent with prior returns.[8]

Simple measures of return persistence, such as comparing last month's return to this month's return, may not provide suitable insight into the ability to use historical performance as a means of determining relative future performance. Results using historical data are impacted by a wide variety of methodological issues such as survivor bias and backfill bias. Moreover, rebalancing a hedge fund portfolio is constrained by a number of issues including lockups, manager search, and replacement and reinvestment assumptions. Because portfolios cannot be efficiently rebalanced on a monthly basis, performance persistence studies may require a longer *ex post* holding period than used in studies of traditional stock and bond markets.

The usefulness of return forecasts diminishes the longer the *ex post* holding period. Various practical investment reasons may form the basis for the reduction in performance persistence benefits as the holding period increases. For instance, hedge fund managers may have taken a large position in particular security which provides them with higher relative return for a short time period, however, if one has a longer holding period, their ability to replicate the purchase of the superior asset during the investment period relative to other hedge fund managers may decrease.

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[7] *To the degree that superior return persistence is shown, the result is due primarily to consistency among poor in contrast to superior performers.*

[8] *The ability of historical data to classify managers into similar trading strategies is still an open question. Fung and Hsieh [1997] and others have used various factor analytic programs to group managers; Martin[2001] uses cluster analysis. . In contrast, various fund management companies place managers into relevant groups based on direct evaluation. Future research is required to see which of the relevant methods provides the least bias.*

In Exhibit 2a, for top and bottom portfolios (twelve funds) based on the ranked previous months return, the differential performance of 'post' selection performance persistence (one month returns and average six month returns) is provided. The difference in absolute performance between the two portfolios decreases as the investment period increase. A one-month historical return selection period may be too small in terms of providing an accurate forecast of future return. In addition, using simple one-month investment periods for hedge funds that employ lockups may not be applicable. In Exhibit 2b, we also show the impact of using a six-month selection period for ranking and three month and six-month post investment periods. As shown in Exhibit 2b, the longer the investment period the lower the relative return difference between the top and bottom portfolios. These results show the difficulty in determining best of breed portfolios using simple historical ranked return classification systems.

Exhibit 2a: Performance Persistence

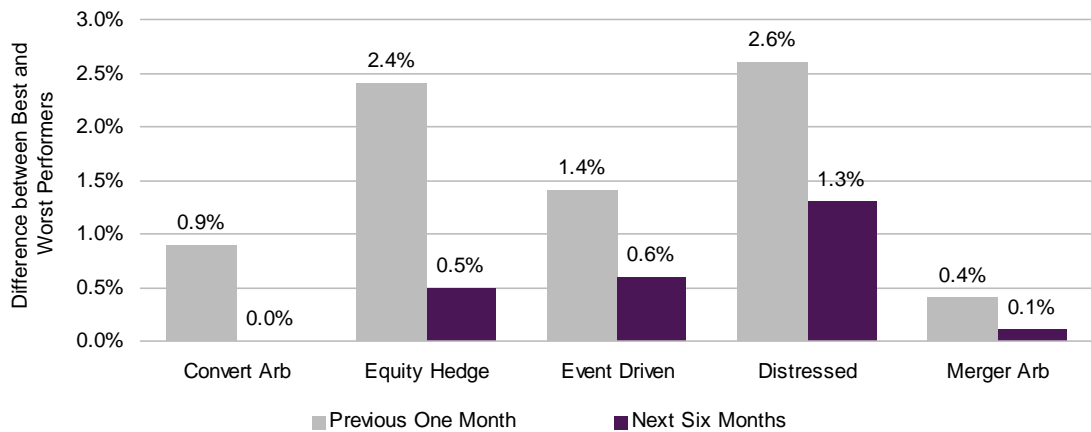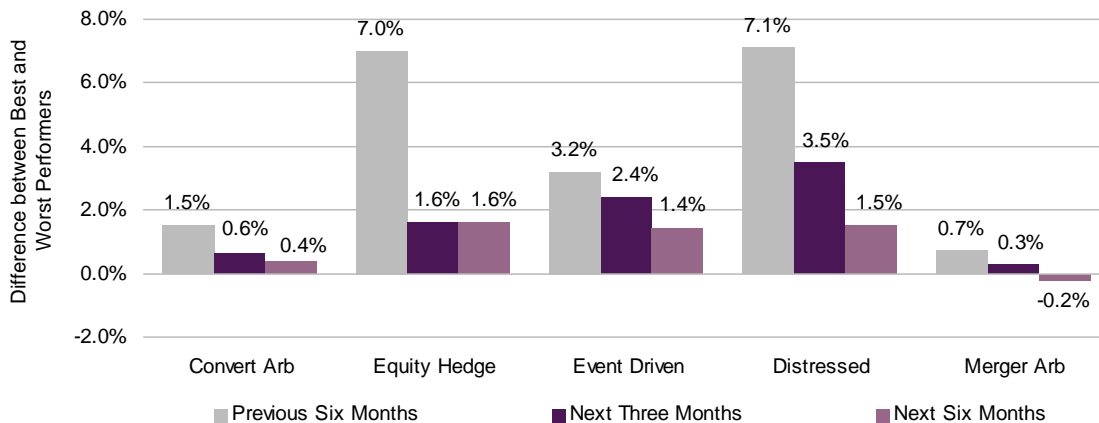**Difference between Best and Worst Performers over 6-Month Intervals and Subsequent Performance: 1998-2000**

Exhibit 2b: Performance Persistence

Difference between Best and Worst Performers over 6-Month Intervals and Subsequent Performance: 1998-2000

Benchmark Determination

Many performance indices can be used as benchmarks for hedge fund performance. An appropriate benchmark will reflect the particular style of an investment manager and will serve as a surrogate for the manager in studies of risk and return performance and asset allocation. A wide range of academic studies have used both single factor and multi-factor models in describing market factors and option-like payoffs in describing the source of hedge funds returns [Fund and Hsieh 1997a; Schneeweis and Pescatore, 1999).

Recently, research has also focused on developing passive indices (e.g., tracking portfolios) which are either based on active managers who trade similar to the strategy in question and/or on individual security holdings within a particular strategy designed to minimize the return differential between the hedge fund strategy and the passive index [Schneeweis and Kazemi, 2001]. In most cases, evidence does exist for abnormal returns based on a variety of alternative return forecast models, however, investors should be cautioned that abnormal return based on stated model assumptions does not mean markets are inefficient. The reference benchmark may not offer a complete tracking portfolio for the hedge fund such that the abnormal returns are simply due to additional unmeasured risks.

In the area of benchmark determination and hedge fund performance, several issues of direct interest including alpha determination, index determination, and survivor bias are discussed in the following sections.

Alpha Determination

Hedge funds have often been promoted as 'Absolute Return' vehicles. Absolute return vehicles are investments, which have no direct benchmark or for which returns are expected to be positive even when equity markets perform poorly (i.e. the beta with respect to S&P 500 = 0). Estimates of excess return however, must be made relative to a representative benchmark. Problems in alpha determination have been discussed widely in the literature [Schneeweis, 1998], however, as shown in Exhibit 3, differences in the cited benchmark can result in large differences in reported 'Alpha'. The relevant alpha determination formulae are given below.

Exhibit 3: Alpha Determination

Alternative Measures of Alpha
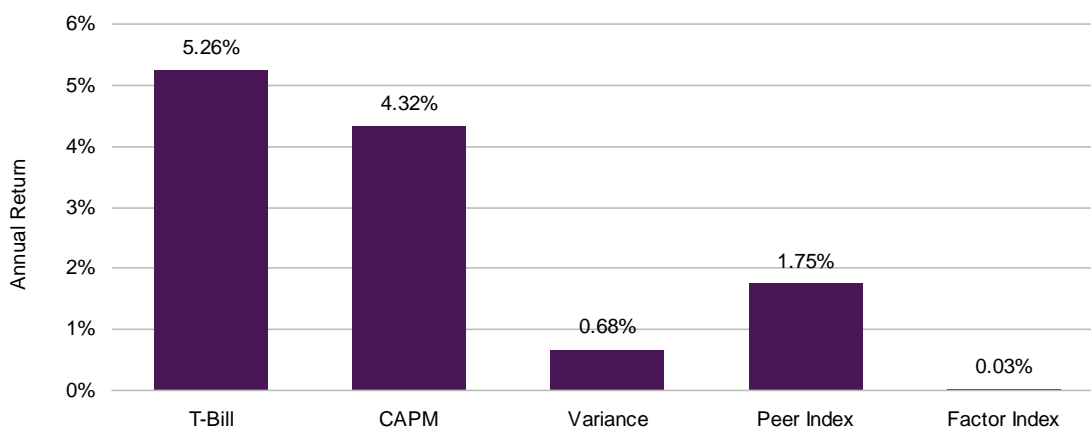
Zurich Fund of Funds: Alpha Determination		Alpha (R_i-Expected Return)
Benchmark	**Model (R_i-Expected Return)**	
T-Bill	R_i-R_f	5.26%
CAPM	R_i-(R_f+($R_{S\&P}$-R_f)B_i)	4.32%
Historical Variance	R_i-(R_i from Sharpe Ratio = .66)	0.68%
Peer Index	R_i - Peer Active	1.75%
Factor Index	(R_i-R_f)-(b_o+ b_i(S_r-R_f)+b_i(B_R-R_f)+$b_i C_{CP}$+$b_i C_{TP}$+$b_i C_{BV}$+$b_i C_{SV}$+$b_i C_{VIX}$)[9]	0.03%

The lack of a clear hedge fund benchmark, however, is not indicative of an inability to determine a comparable return for a hedge fund strategy. Hedge fund strategies within a particular style often trade similar assets with similar methodologies and are sensitive to similar market factors. Two principal means of establishing comparable portfolios include using a single or multi factor based methodology or using optimization to create tracking portfolios with similar risk and return characteristics; more recently cluster analysis has been used by Martin [2001]. It is beyond the scope of this paper to cover all issues relative to benchmark tracking and return forecasting for hedge funds. However, later sections of this paper discuss both single and multi-factor models of return estimation. Passive indices that track underlying hedge fund returns are explored in Kazemi and Schneeweis [2001]. In that analysis, passive indices which track the return of the hedge fund strategy are created both from factors which underlie the strategy as well as financial instruments which are used in the strategy. In these cases, active hedge fund management gave evidence of positive alpha relative to cited tracking portfolios.

Index Determination

Previous studies on the performance of hedge funds were often based on the use of various existing active manager based hedge fund indices and subindices. Each hedge fund index has its own unique methodology [Schneeweis Partners, 2001]. Previous research has analyzed both the actual tracking error between various hedge fund indices [McCarthy and Spurgin, 1998] as well as various weighting (e.g., value versus equal), survivor bias, selection bias etc. effects in the use of various hedge fund indices [Fung and Hsieh, 2001]. As shown in Exhibit 4c, the actual historical returns for various well-known hedge fund indices vary widely over the past five years. In addition, while the correlation between similar strategy based hedge fund indices generally remain high (e.g., above .80) in certain cases the correlations fall below .20 (i.e., See Appendix VI -Equity Market Neutral). Various reasons may exist for low correlations between 'similar strategy' indices. Some indices impose size and age restrictions while other indices, which are value weighted, may result in a particular index taking on the return characteristics of the best performing hedge fund in a particular time period.

The use of indices themselves as surrogates for hedge fund performance is based on the simple assumption that the indices themselves reflect the actual return process inherent in the funds used by investors for actual investment. The problem of using existing indices, which attempt to track a universe of hedge funds, has recently been addressed in academic research [Fund and Hsieh, 2000d]. Fung and Hsieh point out that value-weighted indices reflect the weights of popular bets by investors since the asset value of the various funds change due to asset purchases as well as price. The ability of an investor to track such an index is problematic as well as based on a market

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[9] *The C in front of C_{CP}, C_{TP}, C_{BV}, C_{SV}, and C_{VIX} stands for change (i.e., Change in Credit Premia, Change in Term Premia, Change in intermonth Bond Volatility, Change in intermonth Stock Volatility, and Change in VIX).*

momentum strategy. Equal weighted indices may better reflect potential diversification of hedge funds and funds designed to track such indices; however, the cost of rebalancing may make these indices likewise difficult to create in an investable form.

In brief, while overall market indices may provide an indication of current market return (on an equal weighted or value weighted basis), the concept of a single all encompassing hedge fund index, reflecting some natural market based equilibrium assumption as to the proper holdings of hedge funds, in not appropriate. In fact, the best one may wish to do, is to create ones' own overall hedge fund index which optimizes ones' risk/return profile from existing style pure funds or indices.

In addition to theoretical concerns over the representation of various hedge fund index construction techniques, empirical or data based implications of using various hedge fund indices in determining the return/risk benefits of hedge funds are also of concern.

First, efficient frontier estimation and return/risk benefits are extremely sensitive to return estimation. As shown in Exhibit 4a, the differential historical index returns among various index providers may have implications on suggested weighting of hedge funds for optimizing existing equity, bond, or equity/bond portfolios.[10]

Second, the historical returns for any index may not reflect the expected returns for the current index. Both equity and hedge fund indices change composition over time. For instance, today's equity (S&P 100 or S&P 500) or hedge fund index may not reflect the composition of the same index in past years. As a result, comparing a hedge fund with either equity or hedge fund index on a historical basis may not reflect its relative return with today's index. As shown in Exhibit 4b, if one simply takes today's S&P 100 or Hedge Fund Research (HFR) composition (weightings), use those weightings relative to the sector returns of each index, and backfill the returns historically, the performance of today's index over past years would differ from the historical data in indices most often used in performance comparisons.

Simply put, the existence of alpha or performance relative to an historical index is no indication of its performance relative to that index into the future. Note the problem of using historical data as an indicator of current index return is of greater concern for value indices than equal weight indices in that it is weighted to the best recent performing funds or funds.

Even if one decides to use historical index data, the question arises as to which index to use. While the underlying indices may differ as to reported average returns (Exhibit 4c), what is of greater concern for investors, is whether the underlying indices similarly reflect the actual relative sensitivity of hedge funds to various market conditions such that each index provides information on the true diversification benefits of the underlying hedge fund strategies. Moreover, the sensitivity of various hedge fund indices to these economic factors may change over time, such that the changing styles and changing assets under management (if asset weighted) in an index may make historical results conditional at best (Exhibit 4e).

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[10] *It is important to note that use of historical returns in optimization modeling may not reflect expected risk and return relationships. If factor based regression models are used to forecast expected rates of return, then the consistency of various index models to factor sensitivities is the issue of concern.*

Exhibit 4a

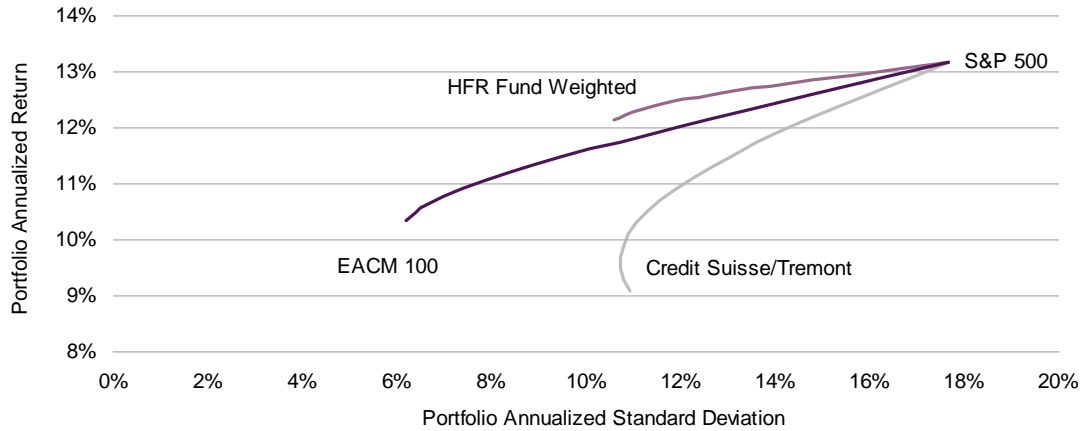**Risk and Return of S&P 500 and Hedge Fund Indices: 1/1998-12/2000**

Exhibit 4b

Differential Return Between Historical Index Returns and Synthetic Returns (e.g., Current Index Weighting or Listing with Historical Index Returns (1996-2000)
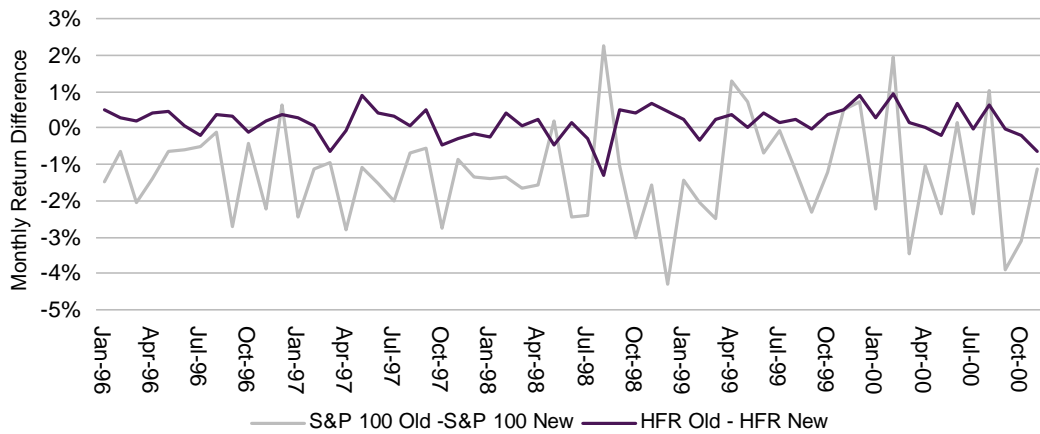
Exhibit 4c

Yearly Return	HFR Composite	HFR Fund of Funds	EACM 100	CSFB Tremont	S&P 500	Lehman Gov/Corp
1996	21.1	14.4	17.1	22.2	14.0	5.1
1997	16.6	16.2	14.6	25.9	16.2	1.0
1998	2.6	-5.1	1.6	-.4	24.8	14.9
1999	31.3	26.5	23.5	23.4	25.3	-5.8
2000	6.7	5.5	8.0	14.3	-12.9	1.9
Performance Analysis						
Annualized Return	15.2	11.0	12.7	16.7	12.5	3.2
Standard Deviation	9.0	7.9	5.4	10.6	14.3	5.7
Sharpe Ratio	1.07	.68	1.32	1.04	.48	-.42
Correlation with S&P 500	.75	.62	.59	.46	1.00	.11
Correlation with Lehman Bond	-.10	-.25	-.17	-.19	.11	1.00

Yearly Return	CSFB Convertible Arbitrage	EACM Convertible Arbitrage	HFR Convertible Arbitrage	CSFB Long/Short Equity	EACM Equity Hedge	HFR Equity Hedge
1996	17.9	13.6	14.6	17.1	22.1	21.8
1997	14.5	11.7	12.7	21.5	18.3	23.4
1998	-4.4	2.6	7.7	17.2	6.0	16.0
1999	-16.0	16.1	14.4	47.2	58.8	44.2
2000	25.6	7.0	14.3	2.1	2.4	9.6
Performance Analysis						
Annualized Return	13.5	10.1	12.7	20.2	20.0	22.5
Standard Deviation	5.1	4.2	3.3	14.1	13.9	11.3
Sharpe Ratio	1.5	1.1	2.1	1.0	1.0	1.5
Correlation with S&P 500	.10	.29	.41	.68	.65	.70
Correlation with Lehman Bond	-.40	-.44	-.34	.00	-.08	.02

Yearly Return	CSFB Fixed Income Arbitrage	EACM Bond Hedge	HFR Fixed Income Arbitrage	CSFB Event Driven	EACM Event Driven	HFR Event Driven
1996	15.9	16.0	11.9	23.0	15.6	24.8
1997	9.4	7.0	7.0	20.0	13.7	21.2
1998	-8.2	-17.1	-10.3	-4.9	3.1	1.7
1999	12.1	8.7	7.4	22.3	16.3	24.3
2000	6.3	-2.9	3.9	7.2	13.6	7.3
Performance Analysis						
Annualized Return	6.8	1.7	3.7	13.0	12.4	15.5
Standard Deviation	4.7	6.0	5.2	7.3	5.2	7.2
Sharpe Ratio	.2	-.7	-.4	1.0	1.3	1.4
Correlation with S&P 500	.00	.11	-.10	.65	.55	.67
Correlation with Lehman Bond	-.40	-.48	-.35	-.27	-.31	-.14

Yearly Return	CSFB Equity Mkt Neutral	EACM Long/Short Equity	HFR Equity Mkt Neutral	EACM Systematic	CSFB Managed Futures
1996	16.6	12.8	14.2	16.6	12.0
1997	14.8	9.4	13.6	11.1	3.1
1998	13.3	3.0	8.3	18.7	20.7
1999	15.3	2.5	7.1	-6.0	-4.7
2000	15.0	4.0	14.9	-7.6	-15.9
	.0	.0	.0	.0	.0
Performance Analysis					
Annualized Return	15.0	6.2	11.6	5.9	2.2
Standard Deviation	3.1	3.0	4.0	14.2	14.7
Sharpe Ratio	3.0	.2	1.5	.0	-.2
Correlation with S&P 500	.58	.06	.30	.03	.03
Correlation with Lehman Bond	-.06	.19	.14	.28	.34

Exhibit 4d

Hedge Fund Correlations with Macro Factors (1998-2000)

	S&P 500	Lehman Bond	Change in Credit Spread	Change in VIX (Volatility)
CSFB-Tremont Hedge Fund	.44	-.07	-.21	.01
HFRI Fund Weighted Composite	.70	-.13	-.51	.11
EACM 100	.50	-.15	-.31	.09
CSFB-Tremont Convertible Arb.	.10	-.21	-.02	-.52
HFRI Convertible Arbitrage	.42	-.24	-.33	-.24
EACM Convertble Hedge	.29	-.45	-.16	-.15
CSFB-Tremont Equity Mkt Neutral	.64	-.20	-.57	-.07
HFRI Equity Market Neutral	.31	.17	-.20	-.32
EACM L/S Equity	.03	.07	.16	-.25
CSFB-Tremont Event Driven	.59	-.35	-.56	-.03
HFRI Event Driven Index	.64	-.22	-.55	.09
EACM Event	.52	-.29	-.59	-.06
CSFB-Tremont Global Macro	.11	.05	.16	-.19
HFRI Macro Index	.38	.02	-.14	.21
EACM Global Asset Allocators	.27	.26	-.09	.02
CSFB-Tremont Long-Short	.61	-.02	-.45	.21
HFRI Equity Hedge	.68	-.01	-.45	.16
EACM Equity Hedge	.59	-.08	-.40	.23
HFRI Distressed	.53	-.29	-.45	-.01
EACM Bankruptcy	.50	-.34	-.56	.07
HFRI Merger Arbitrage	.49	-.22	-.70	-.16
EACM Merger Arbitrage	.54	-.20	-.69	-.11

Exhibit 4e

Style Asset Proportions

	Missing	Asian Equity Hedge	Dedicated Short Sheller	European Equity Hedge	Event Driven	Fixed Income	Global Equity Hedge	Global Macro	Relative Value (Non-Directional)	Emerging Markets	US Equity Hedge	Currency	Managed Futures	Fund of Funds
Jan-91	14%	0%	2%	0%	9%	6%	12%	18%	4%	2%	20%	2%	2%	9%
Apr-91	14%	0%	1%	0%	8%	5%	11%	19%	4%	3%	19%	2%	2%	10%
Jul-91	13%	0%	1%	0%	8%	5%	12%	24%	4%	3%	16%	3%	2%	9%
Oct-91	13%	0%	1%	0%	8%	4%	13%	23%	4%	4%	15%	2%	2%	10%
Jan-92	12%	0%	1%	0%	8%	4%	11%	22%	3%	5%	19%	2%	2%	10%
Apr-92	12%	0%	1%	0%	7%	3%	13%	22%	3%	7%	17%	2%	2%	10%
Jul-92	11%	0%	1%	0%	7%	3%	12%	22%	6%	7%	15%	2%	2%	10%
Oct-92	10%	0%	1%	0%	6%	3%	13%	24%	6%	7%	14%	2%	3%	10%
Jan-93	9%	1%	1%	1%	6%	3%	14%	24%	6%	7%	14%	2%	3%	11%
Apr-93	9%	1%	0%	1%	6%	3%	13%	24%	6%	7%	13%	2%	3%	11%
Jul-93	8%	1%	0%	1%	6%	2%	12%	26%	6%	7%	12%	2%	3%	12%
Oct-93	8%	2%	0%	1%	6%	2%	11%	27%	6%	9%	11%	2%	3%	13%
Jan-94	7%	2%	1%	1%	5%	3%	10%	24%	5%	13%	11%	2%	3%	12%
Apr-94	8%	2%	1%	1%	6%	3%	10%	22%	5%	13%	11%	2%	3%	13%
Jul-94	7%	2%	1%	1%	5%	2%	9%	18%	6%	13%	11%	2%	4%	20%
Oct-94	6%	2%	1%	1%	5%	2%	8%	17%	6%	15%	11%	2%	4%	20%
Jan-95	6%	2%	1%	1%	5%	1%	8%	17%	7%	13%	12%	2%	3%	21%
Apr-95	6%	1%	1%	1%	6%	2%	8%	17%	8%	13%	12%	2%	4%	20%
Jul-95	5%	1%	1%	1%	6%	2%	7%	25%	7%	12%	11%	2%	2%	17%
Oct-95	4%	1%	1%	1%	7%	1%	7%	25%	8%	11%	12%	2%	1%	17%
Jan-96	3%	1%	1%	1%	8%	1%	7%	27%	8%	11%	12%	1%	1%	16%
Apr-96	2%	2%	1%	1%	9%	1%	7%	23%	9%	11%	13%	2%	1%	17%
Jul-96	2%	2%	1%	1%	10%	1%	9%	20%	10%	12%	14%	2%	1%	17%
Oct-96	1%	2%	1%	1%	10%	1%	8%	19%	11%	11%	16%	1%	1%	16%
Jan-97	1%	2%	1%	1%	10%	1%	9%	19%	11%	11%	15%	2%	1%	16%
Apr-97	1%	2%	1%	1%	10%	1%	9%	19%	12%	13%	14%	3%	1%	15%
Jul-97	1%	2%	0%	1%	10%	1%	8%	18%	12%	14%	13%	3%	1%	15%
Oct-97	0%	2%	0%	2%	9%	1%	8%	18%	13%	12%	14%	3%	1%	16%
Jan-98	0%	2%	0%	2%	12%	1%	8%	18%	15%	9%	13%	3%	1%	16%
Apr-98	0%	2%	0%	2%	13%	1%	10%	18%	14%	9%	14%	2%	0%	13%
Jul-98	0%	1%	0%	2%	12%	1%	11%	21%	16%	6%	14%	3%	0%	11%
Oct-98	0%	1%	1%	2%	12%	1%	12%	19%	17%	5%	15%	2%	1%	11%
Jan-99	0%	1%	1%	2%	12%	1%	12%	15%	15%	4%	17%	2%	1%	15%
Apr-99	1%	1%	1%	3%	13%	1%	11%	13%	16%	5%	18%	2%	1%	15%
Jul-99	1%	1%	1%	3%	12%	1%	11%	10%	16%	5%	22%	2%	1%	13%
Oct-99	1%	2%	1%	3%	13%	1%	12%	9%	17%	4%	22%	1%	1%	13%
Jan-00	1%	2%	0%	4%	12%	1%	13%	7%	16%	5%	24%	1%	0%	12%
Apr-00	1%	2%	0%	5%	12%	1%	13%	6%	17%	4%	26%	1%	0%	12%
Jul-00	1%	2%	0%	5%	13%	1%	13%	3%	19%	4%	25%	1%	0%	11%
Oct-00	1%	2%	0%	5%	13%	1%	14%	3%	19%	3%	24%	1%	0%	13%

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Survivor Bias

Survivor bias is often raised as a major concern for investors in hedge funds. Survivor bias results when managers with poor track records exit the business, while managers with good records remain. If survivor bias is large, then the historical record of the average surviving manager is higher than the average return of all managers over the test period. Since a diversified portfolio would have likely consisted of funds that were destined to fail as well as funds destined to succeed, studying only survivors results in overestimation of historical return. Brown et al. [1999] and others [Fung and Hsieh, 1998] have estimated this bias to be in the range of at least 1.5%-3% per year. (For an example of a typical relative return pattern of nonsurviving funds relative to surviving funds in the months before dissolution see Appendix II).

Results in Exhibit 5, support this previous research with differential return dependent on strategy but ranging between 3.9% for Currency and .2% for Global Macro. It is also important to realize that most previous studies of survivor bias did not take into consideration the market factors driving fund survival. In fact, given the changing nature of the number and style of funds studied, the impact of survivor bias must take into market conditions and the unique style under consideration.

For instance, in Exhibit 5, survivor bias (for the data set under consideration) differs by strategy. Survivor bias is minor for event but is higher for hedge equity and is considerable for currency funds. More importantly, for the largest sample of hedge funds; that is, equity hedge or relative value, survival bias is in the previously reported range of 1.5 to 2%. However the timing of this survivor bias may be concentrated in certain periods (e.g., following the August 1998 hedge fund crisis). Thus the levels of survivor bias impact exhibited in past data may over or underestimate future bias depending on economic conditions and strategy. This is as expected. For investors, the problem of survivor bias may be overestimated if one assumes that current conditions do not evoke a market factor driving increased probability of funds being driven out of business (e.g., high water marks and recent fund performance issues).

Survivor bias may be reduced through superior due diligence or simply by focusing on funds that have reduced risk of bias. For instance, one explanation for the proliferation of funds-of-funds is that managers of these funds may be able to avoid managers destined to fail, thereby mitigating the survivor bias problem. Investors may be willing to bear an additional layer of management fees in order to reduce exposure to these funds. As a result, once one screens on basic selection criterion, survivor bias may be reduced significantly. While not studied in depth in this analysis, results in Exhibit 5 also show that the asset size of nonsurvivors in 1998 (period before testing) indicates differences in average size of those event driven managers which survive and those which fail to survive. If other strategies follow similar size impacts on survival potential, simple prescreening on size or style may reduce the impact of survivor bias on expected returns.

Exhibit 5: Survival Bias

**Survivor Versus Non-Survivor Performance
Average Annual Return, January 1998 to June 2000**

Strategy	Survivors Return	Non-Survivors Return	All Funds Return	Difference (Survivors-All)
Relative Value	11.7	-3.7	9.3	2.4
Global Macro	13.5	8.5	13.3	0.2
Global Hedge Equity	25.7	5.5	22.8	2.9
Event	13.9	1.2	12.6	1.3
US Equity	32.2	7.4	29.7	2.4
Currency	5.6	-3.3	1.8	3.8
Equity Hedge Funds, Average Assets of Survivors and Non-Survivors, 1998-2000				
Survivor	$74.8m			
Non-Survivor	$32.6m			

Stale Price Bias

In traditional markets, lack of security trading may lead to what is call stale price bias. For securities with stale prices, measured correlation may be lower than expected and depending on the time period chosen measured standard deviation may be higher or lower than would exist if actual prices existed.

Even in traditional markets, prices are often computed using benchmark lattice, appraisal values, etc. such that reported prices do not reflect current market prices. In fact, for CTA or many liquid hedge fund strategies, prices reflect market-traded prices to a greater extent than that in many traditional asset portfolios.

Moreover, research on stale price effects in hedge funds, which use traditional academic research methodologies, may fail to represent or reflect the actual existence of stale prices. Many hedge funds do not contain equity issues such that evidence of a correlation with lagged equity returns is not necessarily indicative of stale prices. Moreover, unlike tests of stale prices in traditional markets, most research in hedge funds used monthly data.[11] It is unlikely that monthly data would capture stale price effects over lengthy time period especially since for many hedge fund strategies the underlying holdings are relatively liquid compared to many traditional assets (e.g., real estate) or compared to traditional alternatives such as private equity for which appraisal values are used.

In Exhibit 6, the correlation between various hedge fund indices and lagged values of the S&P 500 are used to indicate a possible existence of stale 'equity' prices in certain hedge fund data. As expected there is little evidence except in some technology based hedge funds of any delayed

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[11]   *For research on the correspondence between daily and monthly returns see Martin et. al., (1997) which indicates that use of monthly data and intermonth data are mathematically consistent.*

price effects.[12] Future research in this area may well concentrate on the use of daily data and on those hedge fund strategies in which model-based or otherwise non-market based prices form a major portion of the asset strategy.

Exhibit 6: Stale Prices

Correlation with S&P 500: Contemporaneous and Lagged Correlation, 1994-2000

Strategy	Contemporaneous	Lag One Month	Lag Two Months
CSFB-Tremont Convertible Arbitrage	.13	-.11	-.11
HFRI Convertible Arbitrage	.39	-.02	-.07
EACM Convertible Hedge	.19	-.04	.00
HFRI Distressed	.51	-.13	-.17
EACM Bankruptcy	.51	.04	-.18
CSFB-Tremont Event Driven	.60	-.12	-.13
HFRI Event Driven Index	.62	-.01	-.16
EACM Event	.54	.03	-.18
CSFB-Tremont Long-Short	.62	-.02	-.16
HFRI Equity Hedge	.62	.00	-.13
EACM Equity Hedge	.57	-.01	-.18
CSFB-Tremont Equity Market Neutral	.48	.01	.09
HFRI Equity Market Neutral	.33	-.01	-.26
EACM L/S Equity	.03	-.07	-.16
HFRI Merger Arbitrage	.46	.09	-.13
EACM Merger Arbitrage	.49	.05	-.17

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[12] *Note additional research not reported here on normality of hedge funds, indicates that using daily data most hedge funds report distributions that are more nearly normal. One of the reasons for hedge fund reporting skewed distributions may be due in part to the use of monthly data which results fewer observations distorted sample statistics. Of course, the distribution properties of returns will vary with the hedge fund style being examined.*

Fund Factors (Onshore/Offshore, Performance Fees, Lock up, Age, Size)

In addition to market factors affecting a broad range of investment vehicles, individual fund factors likewise may affect expected performance. Academic and practitioner research has tested various fund specific factors such as onshore/offshore, age, and size on manager performance. This research has supported 1) young funds outperform old funds [Cross-Border 2001] on a total return basis or at least old does not outperform young [Liang, 2000], 2) large outperforms small [Liang, 2000] and 3) offshore and onshore may have some impact on performance, 4) fund of funds may provide closer approximation to return estimation than indices [Fung and Hsieh, 2000].

Unfortunately, as in any tests of fund effects one has the problem of disaggregating effects over a large number of funds each with different strategies, starting periods, etc. In fact, while it is not the purpose of this paper to conduct a detailed analysis of each of the above effects, the following indicates that simple relationships between hedge fund return and each of the aforementioned fund factors must be analyzed more closely before final conclusions can be made.

Performance Fees and Lockup Impacts

As shown in Exhibit 7, for the largest sector of hedge funds (equity hedge), there is little evidence of impact of performance fees and a small effect of lockup affecting overall performance. What is of greater impact is whether the funds are growth, value, or small in strategy. Since the small funds in this sample outperform the value funds for this period of analysis and since the US equity hedge funds concentrating on small firms have higher incentive fees than the average of the value based hedge funds one cannot easily determine if the effect is style concentration or performance fees. In any event, the differential return between the value, growth, and small fund hedge equity samples for funds with 20% incentive and those with less than 20% are so small that no conclusion can be made from this data as to the effect of fees on performance. However, it is important to note that previous results on survivor bias do indicate that after periods of severe drawdown (1998) fees may have an impact on increased fund dissolution, as funds (with high water marks) decide to cease operations rather than work only under a long-term percentage agreement. Thus performance fee may have less an impact on immediate strategy except in cases of extreme market moves.

Exhibit 7

Hedged Equity Styles With Low (10%) and High (20%) Incentive Fees

Style	Incentive Fee (%)	Monthly Return	Standard Deviation	Information Ratio
Value	10	1.63%	4.4%	0.37
Value	20	1.70%	3.9%	0.44
Growth	10	1.74%	8.3%	0.21
Growth	20	1.63%	4.4%	0.37
Small Cap.	20	1.78%	3.3%	0.54

In contrast to performance fees, there is some evidence of an impact of lockup on performance. As noted in Exhibit 8, for the U.S. opportunity hedge fund set, funds with quarterly lockups have higher return than similar strategy funds with monthly lockups. However, care must be taken in consideration of such an effect, as the risk-adjusted returns are similar for all subgroups within the U.S. opportunity set.

Exhibit 8

Hedged Equity Styles With Monthly and Quarterly Lockup Periods

Style	Lockup	Monthly Return	Standard Deviation	Information Ratio
Value	Monthly	1.70%	4.6%	0.37
Value	Quarterly	1.86%	5.0%	0.37
Growth	Monthly	1.63%	5.6%	0.29
Growth	Quarterly	1.69%	4.4%	0.38
Small Cap.	Monthly	1.69%	3.1%	0.54
Small Cap.	Quarterly	1.83%	4.9%	0.37

Foreign/Domestic

While generally similar, foreign and domestic funds may differ both in composition and in structure. Different reasons exist for small differences in holdings including participants in the funds as well as issues regarding liquidity. Despite these differences, as shown in Exhibit 9, there is little direct evidence of major return differences in various hedge fund subindices differing by US/Offshore registration of the funds.

Exhibit 9: Onshore/Offshore

Information Ratios: Onshore and Offshore HFR Indices (1994-2000)
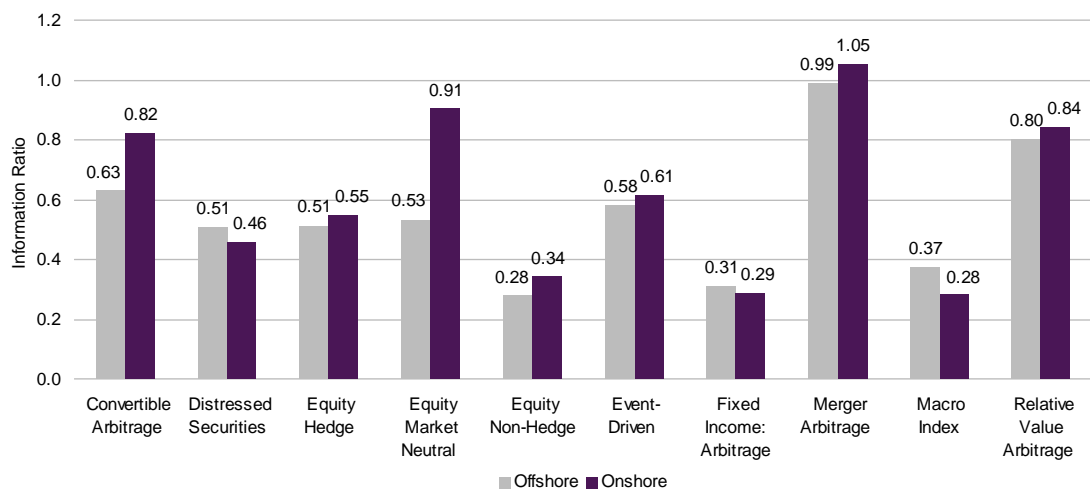
Fund of Funds

Fund of funds may differ from overall hedge fund performance due to various issues including a less direct impact of survivor bias since hedge funds which dissolve are included in the returns of the fund of funds (there still is some survivor bias in that fund of funds may themselves remove themselves from data sets due to poor performance etc.). Fund of funds may therefore provide a more accurate prediction of future fund returns than that provided for by more generic indices. As shown in Exhibit 4c, the return for fund of funds indices does underperform that of the more general indices.

More importantly, fund of funds (FOF) must themselves be presented in a more style pure format. As shown in Exhibit 10a and 10b, a number of FOF given as FOF diversified by category differ greatly not only in their correlation with standard indices but by their sensitivity to general economic factors. Those with the lowest correlation to indices, however, also have created difference in sensitivity to general economic factors. Investors must use factors in order to test 'style drift' of generic FOF.

Exhibit 10a

Correlation of Diversified Fund of Funds with EACM 100 and HFR Fund of Funds Index
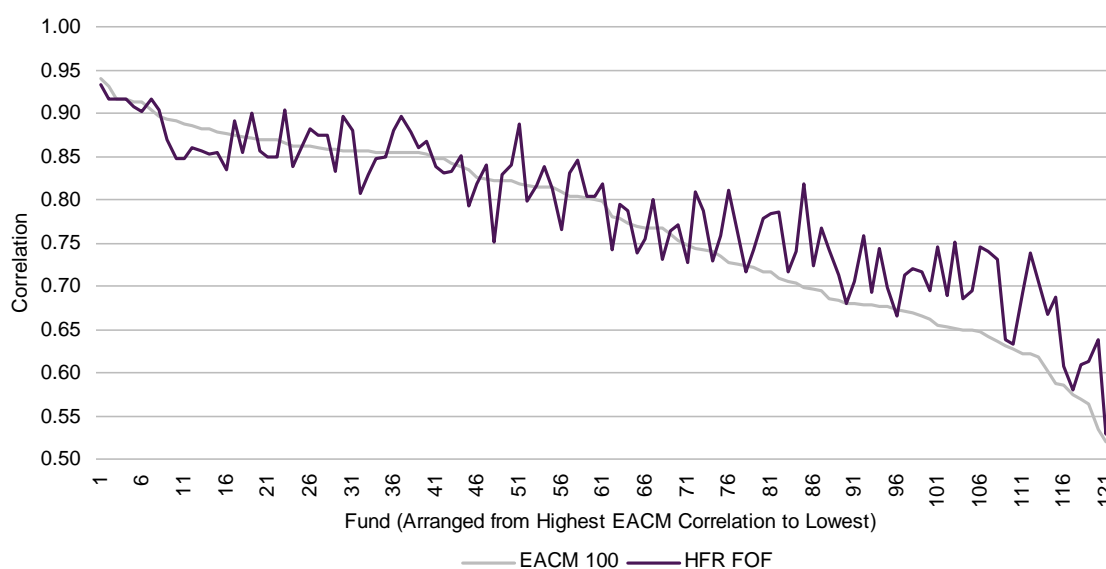
Exhibit 10b

Diversified Fund of Fund Correlations with Hedge Fund, FOF Indices and Market Factors Ranked from Highest to Lowest Correlation with EACM 100 Index (1998-2000)

Portfolio	EACM100	HFR Fund of Funds	HFR Composite	CSFB Composite	S&P 500	Lehman Bond	Change in Credit Spread	Change in VIX
1	.88	.87	.87	.84	.50	-.11	-.32	-.33
2	.82	.83	.80	.78	.47	-.16	-.32	-.27
3	.72	.75	.71	.69	.43	-.13	-.29	-.29
4	.55	.60	.55	.55	.29	-.14	-.21	-.19

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Exhibit 10c

Correlation (12 months Previous to Date):
FOF Starting in Year 1991 with FOF Starting in Following Year

Date	1993 Apr	1994 Apr	1995 Feb	1996 Mar	1997 Feb	1998 Feb	1999 Feb	2000 Mar	FOF 91-FOF'Year'
1991	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
1992	0.82	0.97	0.86	0.89	0.94	0.95	0.91	0.93	0.07
1993		0.87	0.69	0.78	0.94	0.93	0.84	0.84	0.16
1994			0.81	0.92	0.96	0.96	0.95	0.88	0.12
1995				0.65	0.85	0.89	0.86	0.94	0.06
1996					0.67	0.91	0.93	0.96	0.04
1997						0.74	0.96	0.93	0.07
1998							0.81	0.99	0.01
1999								0.84	0.00
Correlation Difference	0.18	0.13	0.19	0.35	0.33	0.26	0.19	0.16	
FOF 91-FOF New Year	1993 Apr	1994 Apr	1995 Feb	1996 Mar	1997 Feb	1998 Feb	1999 Feb	2000 Mar	

Correlations of FOF Starting in 1991 with FOF in Year of Inception and in Year 2000
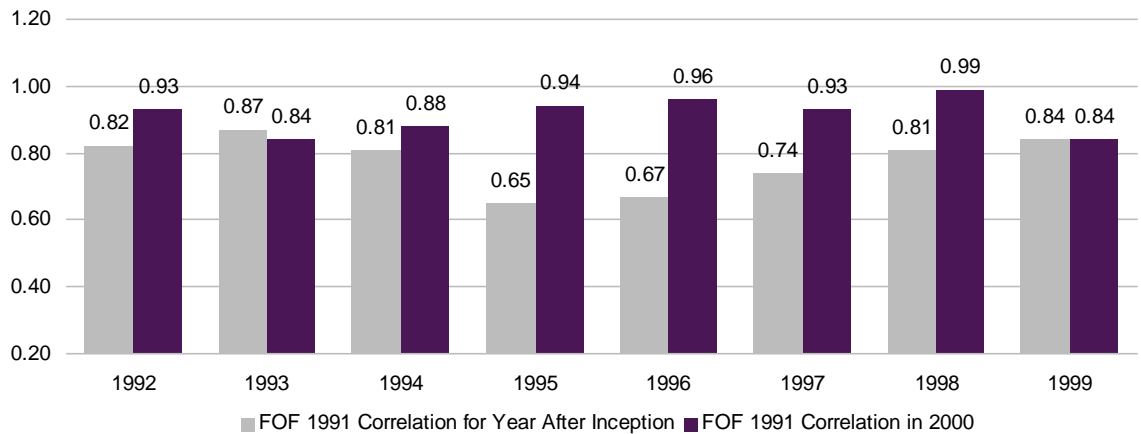
Exhibit 10d

Factor Correlations: Fund of Funds (1998-8/2000)

Fund of Funds Strategy	S&P 500	Lehman Bond	Change in Credit Spread	Change in VIX (Volatility)
Diversified	.37	-.08	-.22	-.21
Event	.40	-.17	-.27	-.32
Hedge Equity	.36	-.13	-.27	-.23
Macro	.26	-.05	-.21	-.15
Relative Value	.29	-.09	-.23	-.16

Exhibit 10e

Differential 24 Month Correlations (FOF-Avg. Fund Weighted) 1992-2000
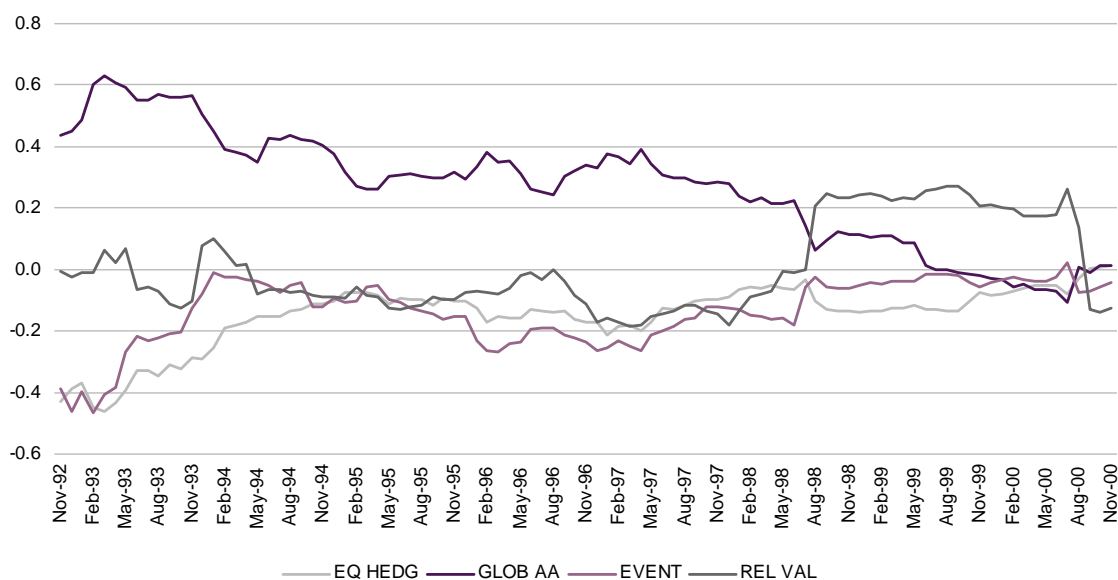
As a result, the use of FOF, which change over time in response to rebalancing, may not fit well into strict asset allocation modeling. For instance, as shown in Exhibit 10c, the correlation of new funds of funds (US diversified fund of funds) starting in years 1992 onward, have a lower correlation with FOF starting in 1991 in the initial year of the new fund, however, as years progress the correlations increase. This indicates that new FOF are constructed differently than old funds. This is expected. New fund of funds can be more flexible in fund selection. As time passes, however, older funds of funds can redistribute cash or funds such that they resemble the new fund construction. However, the results also indicate that simple averaging across fund of funds without taking the year of origination into account may not be appropriate.

Moreover, the changing strategy emphasis in FOF is shown in Exhibit 10d, in that the differential correlation of FOF with certain dominant hedge fund strategies (e.g., Global Macro and Hedge Equity) in comparison to the average fund weighted index is given. Note that over time the correlations of hedge equity rise and global macro fall indicating an increase in FOF use of hedge equity and a decrease in the use of Global Macro. These results emphasize that FOF may be market timing and are less useful in asset allocation strategies since the factor sensitivity and composition change in contrast to more style pure hedge fund indices or strategies (See Exhibit 10e).

Effect of Fund Size

Results are also presented on the potential impact of size on fund return, risk, and risk adjusted performance. In Exhibit 11, the correlation of fund size as of January 1996 is correlated with fund return, risk, and risk adjusted return over the next four years. (These results are shown for representative purposes, other size and return periods showed similar results). Results show that, overall, larger funds tend to underperform smaller funds on a pure return basis, but have lower risk. These results are consistent with previous research, which hypothesizes that small funds may take riskier positions for a wide range of agency issues. Similar results are generally shown when correlation of fund size with returns, risk, and risk adjusted return is studied.

Exhibit 11: Size Effects

Correlation of Size in January, 1996 with Subsequent Performance Measures

	Average Return	Standard Deviation	Information Ratio
All Funds	-0.07	-0.03	-0.03
Hedged Equity Value	-0.14	-0.25	0.19
Hedged Equity Growth	-0.07	-0.24	0.28
Merger Arbitrage	0.19	0.52	-0.19
Market Neutral	-0.33	-0.31	-0.01

However, as indicated previously, disaggregating the data into sub-strategies results in some differences. For instance, for risk arbitrage funds, small funds had lower returns, lower risk and higher risk adjusted returns. In contrast, large hedged equity funds showed lower returns and lower risk, and higher risk adjusted returns. These results indicate asset size effects are complex, and strategy-dependent, and thus simple rules of thumb, like 'larger funds have better risk-adjusted performance," may be inadequate.

Age-Vintage Effects

Investors should be clear about whether they are trying to engage in manager selection or style selection, and choose the appropriate allocation strategy. Investors should be sensitive that, because of 'vintage effects' it may be difficult to compare the performance of funds with different lengths of track record.

LEHMAN BROTHERS

When comparing hedge fund returns, investors often resort to performance statistics like annualized returns, volatility and Sharpe ratio, however, these statistics hide the time dimension behind the performance.[13] Funds, which start in different market environments, can have substantially different track records. These differences in starting points lead to 'vintage effects'. In Exhibit 12, we compute average twelve month moving average information ratio for all funds within a style that start in the same month.[14]

Exhibit 12: Vintage Year Effects

Twelve Monthly Rolling Average of Information Ratio for Selected HFR Indices: 1996-2000
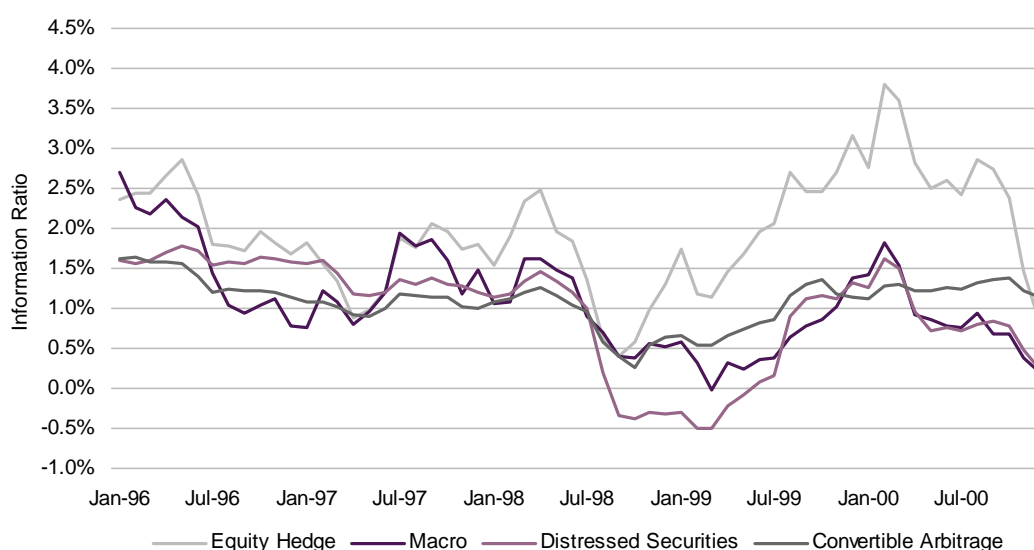
The cyclical variation in the information ratios is indicative of potential problems in comparing funds, which performed over different market environments.

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[13] *This section relies primarily on the TASS Data Base. The basis for using the TASS Data Base is its wide coverage, most thorough data on 'dead' funds, and complete data from 1991-2000. We have made substantial amount of improvements to the data set through style classification of unclassified funds, elimination of erroneous or inappropriate data, and linking of funds by management company.*

[14] *All current hedge fund research focuses on funds rather than the management company. Recent research in the mutual fund area shows that management companies matter in the opening and closing of funds. Our preliminary results indicate that there is information in the performance of other (unassociated) funds within a management company for the performance of a specific fund. The implication is that investors should consider the track record of other funds within the management complex when identifying potential candidates.*

Hedge Fund Return Determination

Single Factor Performance

In addition to micro (fund) based factors affect fund performance, macro (market) based factors also have an impact on fund strategy performance. Once these factors and their associated risk premiums are identified, then the expected long-term return from a portfolio can be calculated using its exposure to the factors. In the classical CAPM framework, the expected return on an asset is related to the beta of the asset with respect to market portfolio. For instance, an asset with the beta of 2 is expected to have a risk premium that is twice as high as the market portfolio's risk premium.

Results in Exhibit 13 shows the performance of a number of hedge fund strategies over the past 10 years (2/1990–2000) relative to the S&P 500. Issues in beta based returns forecasts are discussed further in Appendix III. Results reflect the use of both equity market (beta) and volatility factors in explaining overall return relationships. In Appendix IV, other examples of cross-sectional return forecast methods are offered. Results show that a single factor (i.e., the equity market portfolio) may not be able to properly measure the riskiness of certain hedge fund strategies. For this reason a multifactor model for measuring the risk premium of various asset classes may be preferred.

Exhibit 13: Single Factor Return Relationships for Traditional Benchmarks and HFR Hedge Fund Indexes

Index	Market Model Beta	Market Model R-Square	Market Model Return	Historical Return	Historical Alpha	Historical Volatility	Sharpe Ratio	Volatility Model Return
Lehman Corporate Bond	0.15	0.19	6.5%	8.3%	1.7%	4.7%	0.73	8.7%
Russell 2000	0.91	0.47	15.1%	13.8%	-1.3%	18.3%	0.49	19.9%
Convertible Arbitrage Index	0.09	0.12	5.9%	11.4%	5.6%	3.4%	1.92	7.7%
Distressed Securities Index	0.19	0.15	7.0%	14.6%	7.7%	6.6%	1.48	10.3%
Emerging Markets (Total)	0.67	0.32	12.5%	15.3%	2.8%	16.4%	0.63	18.4%
Emerging Markets: Asia Index	0.49	0.22	10.4%	10.1%	-0.3%	14.5%	0.36	16.8%
Equity Hedge Index	0.41	0.37	9.5%	21.2%	11.7%	9.3%	1.75	12.5%
Equity Market Neutral Index	0.05	0.05	5.5%	11.0%	5.5%	3.3%	1.87	7.6%
Equity Non-Hedge Index	0.78	0.56	13.7%	19.2%	5.5%	14.4%	0.99	16.7%
Event-Driven Index	0.27	0.35	8.0%	16.1%	8.1%	6.4%	1.75	10.1%
Fixed Income (Total)	0.11	0.17	6.1%	10.9%	4.8%	3.7%	1.62	7.9%
Fixed Income: Arbitrage Index	-0.03	0.01	4.6%	8.7%	4.1%	4.9%	0.78	8.9%
Fixed Income: High Yield Index	0.21	0.17	7.2%	9.9%	2.6%	6.9%	0.72	10.6%
Fund of Funds Index	0.19	0.17	7.0%	11.5%	4.5%	6.3%	1.05	10.0%
Fund Weighted Composite Index	0.35	0.45	8.9%	16.4%	7.5%	7.3%	1.58	10.9%
Macro Index	0.29	0.19	8.2%	17.9%	9.7%	9.3%	1.41	12.5%
Market Timing Index	0.32	0.42	8.5%	14.8%	6.2%	6.9%	1.43	10.5%
Merger Arbitrage Index	0.11	0.16	6.1%	13.2%	7.0%	3.9%	2.15	8.0%
Relative Value Arbitrage Index	0.10	0.12	6.0%	13.4%	7.4%	4.0%	2.12	8.2%
Sector (Total)	0.50	0.24	10.6%	23.9%	13.4%	14.2%	1.34	16.5%
Statistical Arbitrage Index	0.14	0.27	6.5%	11.1%	4.6%	3.8%	1.66	8.0%
Short Selling Index	-1.11	0.44	-7.5%	3.0%	10.6%	23.0%	-0.08	23.8%

Multi-Factor Performance

While previous research has shown that macro economic factors are related to hedge fund return performance, a wide variety of multi-factor models are available to model forecasted return relationships. However, these market factors are dependent on the strategies used to model the return to risk relationship.

While both single and multi-factor models of return estimation provide a statistical basis for measured return relationships, more complex non-linear models may provide additional explanatory power in various economic conditions. In this study we present the performance of 6 common hedge fund strategies under various economic conditions. We use HFR indices to measure the performance of these strategies. They are: equity hedge, relative value arbitrage, global macro, equity market neutral, convertible arbitrage and fixed income arbitrage. Also, we study the performance of HFR's fund of fund index as well. The study covers 1990-2000 time period.

Economic conditions are described in terms of the values of 9 financial and macro economic factors. Previous studies have shown that exposures to these factors can explain close to 60% of cross-sectional differences in average rates of return on different strategies. Further, some of these factors have been shown to be useful in predicting the performance of traditional asset classes. The factors are:

Slope of the yield curve: This is measured by the difference between the yield to maturity of the 30-year Treasury and the 3-month T-Bill.

Long-term yield: This is measured by the yield on the 30-year Treasury.

T-Bill Rate: This is represented by the yield on the 3-month Treasury.

Credit Risk Premium: This is measured by the difference between the yield on the BAA bond and the yield on AAA bonds. Moody's calculates the average yields.

Intra-month standard deviation of S&P 500 index: This is obtained by calculating the intra-month standard deviation of the daily total rate of return on S&P 500 index.

S&P 500 total return: The monthly rate of return on S&P 500 index.

Small cap return: This is represented by the monthly rate of return on Russell 2000 index.

Implied volatility index: CBOE's Implied Volatility Index for options on S&P 100 index.

Intra-month volatility of bond returns: This is obtained by calculating the intra-month standard deviation of the daily total rate of Lehman Brothers Aggregate Bond index.

Results in Exhibits 14a and 14b shown that, relative to simple single index models, the explanatory power of certain hedge fund strategies that are not equity dependent improve as one adds additional factors capturing volatility impacts as well as potential arbitrage (term premia) or credit risk effects. Detailed regression results are presented in Appendix IV. Another important factor is the consistency of these relationships over time. In Exhibit 14c–14e, twenty-four month rolling correlations of four principal hedge fund strategies (relative value, event, global macro and hedge equity) with the tested market factors are shown.

Note that the correlation of hedge equity with the S&P 500 remains fairly constant over this time period while the correlations of hedge equity with other market factors changes over time. In contrast, for other hedge fund strategies the factor relationships with other hedge fund strategies vary over time. One reason is that the relative value and event substrategies include a wider range of strategies or that certain hedge fund strategies change their strategy emphasis. For example, in Exhibit 14f the moving correlations of the FOF with the tested market factors are shown. As discussed previously, the increased emphasis of today's FOF on equity strategies is reflected in the increased correlation of FOF with the S&P 500.

Exhibit 14a

	S&P 500	Change in Credit Spread	Change in Term Premia	Change in VIX	R-Square (Adj)	Single-Factor SP500 R-Sqr
Traditional Asset Benchmarks						
Lehman Govt Bond	0.06	0.00	-0.006	0.03	0.07	0.09
Lehman High Yield	0.19	-0.08	0.016	-0.23	0.39	0.24
Lehman Investment Grade	0.12	-0.01	-0.020	-0.02	0.23	0.20
S&P500	1.00	0.00	0.000	0.00	1.00	1.00
Russell 2000	0.84	-0.11	0.031	-0.29	0.51	0.48
MSCI Ex-US	0.66	0.03	0.023	-0.22	0.32	0.33
Hedge Fund Research Indices						
Convertible Arbitrage	0.07	0.00	0.011	-0.10	0.19	0.14
Distressed Securities	0.13	-0.08	0.021	-0.22	0.36	0.16
Emerging Markets (Total)	0.58	-0.12	0.038	-0.42	0.40	0.32
Emerging Markets: Asia	0.43	-0.07	0.029	-0.30	0.25	0.21
Equity Hedge	0.38	-0.07	0.013	-0.13	0.41	0.38
Equity Market Neutral	0.07	-0.01	0.002	0.04	0.04	0.05
Equity Non-Hedge	0.70	-0.10	0.018	-0.31	0.62	0.57
Event-Driven	0.22	-0.07	0.020	-0.22	0.53	0.37
Fixed Income (Total)	0.09	-0.04	0.007	-0.08	0.27	0.17
Fixed Income: Arbitrage	-0.05	-0.03	0.007	-0.08	0.02	0.01
Fixed Income: High Yield	0.14	-0.08	0.016	-0.26	0.38	0.19
Fund of Funds	0.15	-0.03	0.006	-0.13	0.20	0.17
Fund Weighted Composite	0.31	-0.06	0.016	-0.19	0.54	0.46
Macro	0.23	-0.04	-0.003	-0.20	0.22	0.20
Market Timing	0.31	0.01	0.006	-0.08	0.41	0.40
Merger Arbitrage	0.09	-0.02	0.008	-0.11	0.22	0.18
Relative Value Arbitrage	0.08	-0.01	0.013	-0.11	0.19	0.12
Sector (Total)	0.46	-0.08	0.031	-0.23	0.28	0.24
Short Selling	-1.03	0.15	-0.007	0.21	0.45	0.44
Statistical Arbitrage	0.15	-0.01	-0.006	0.05	0.27	0.27

Exhibit 14b

Differential Rsq (Multi-factor-Single factor)
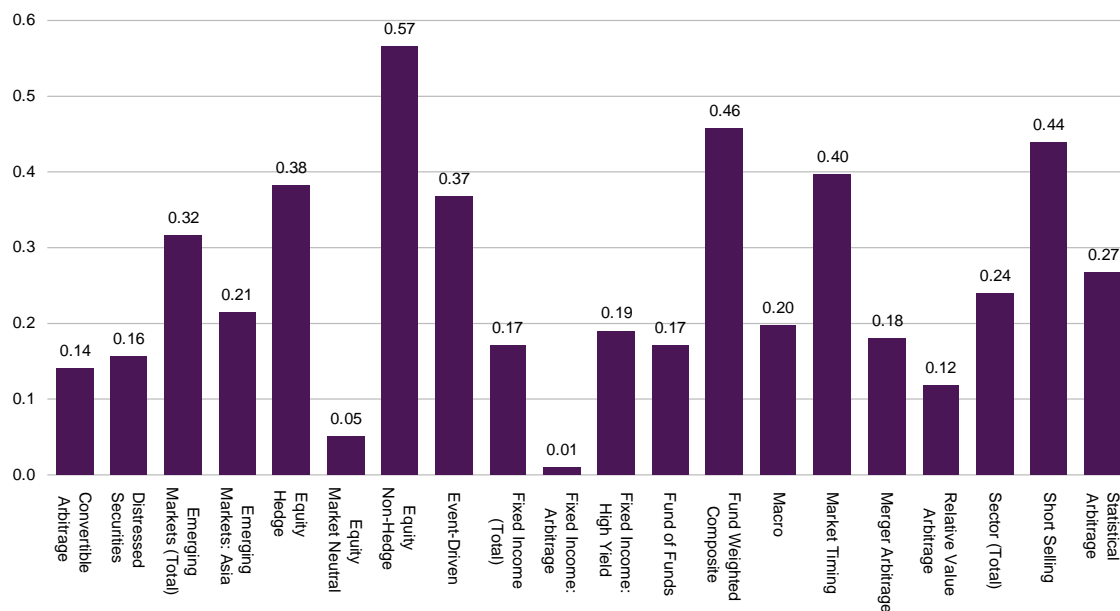
Exhibit 14c

Correlation of Hedge Equity with Market Factors (24 Month Rolling Correlation): 1993-2000
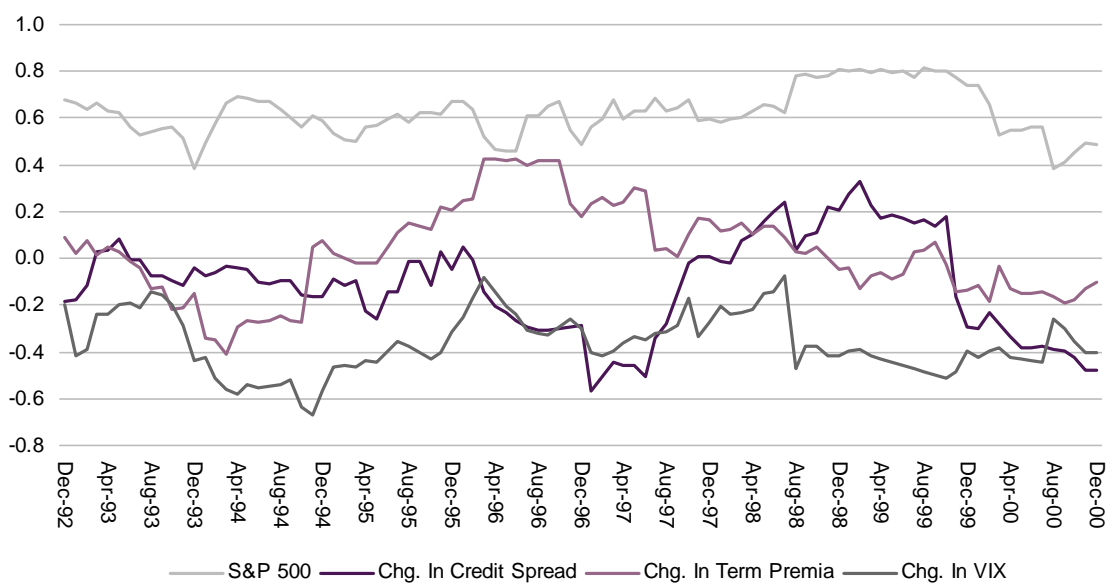
Exhibit 14d

Correlation of Event Driven with Market Factors (24 Month Rolling Correlation): 1993-2000

Legend: S&P 500 — Chg. In Credit Spread — Change in Term Premia — Chg. In VIX
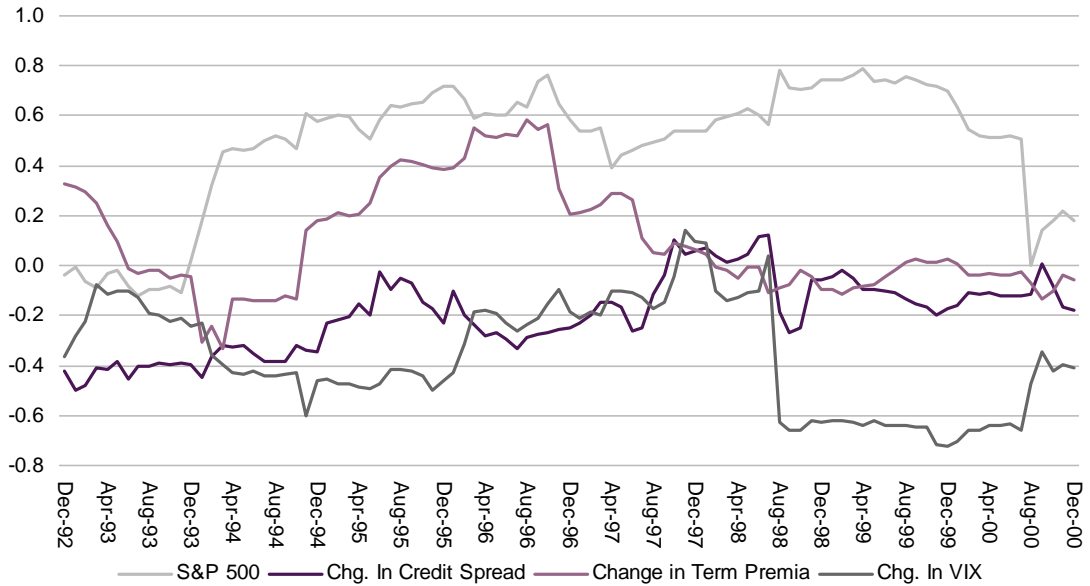
Exhibit 14e

Correlation of Relative Value with Market Factors (24 Month Rolling Correlation): 1993-2000

Legend: S&P 500 — Chg. In Credit Spread — Chg. In Term Premia — Change in VIX
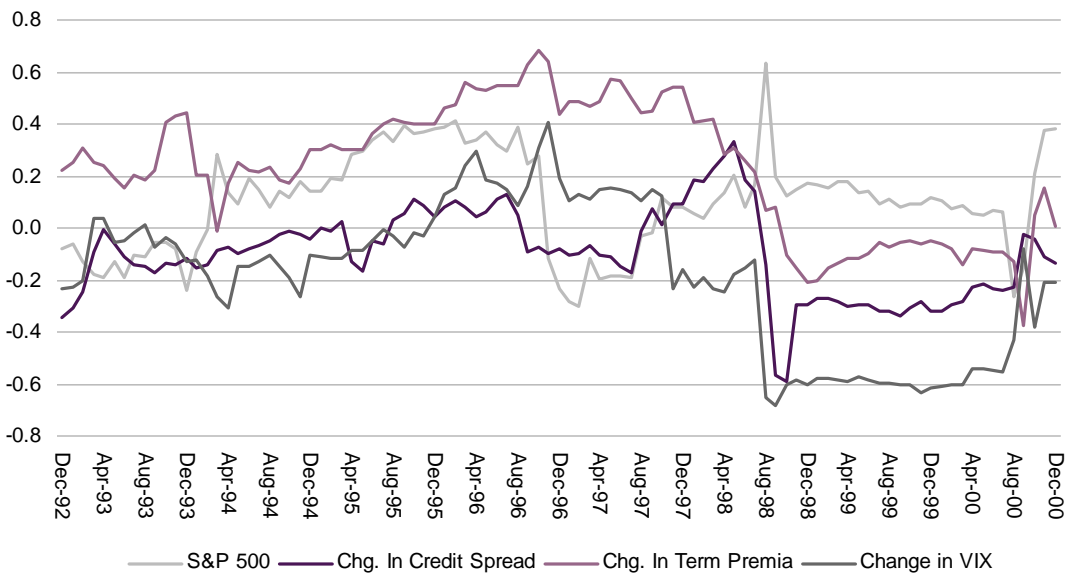
Exhibit 14f

Correlation of Fund of Funds with Market Factors (24 Month Rolling Correlation): 1993-2000
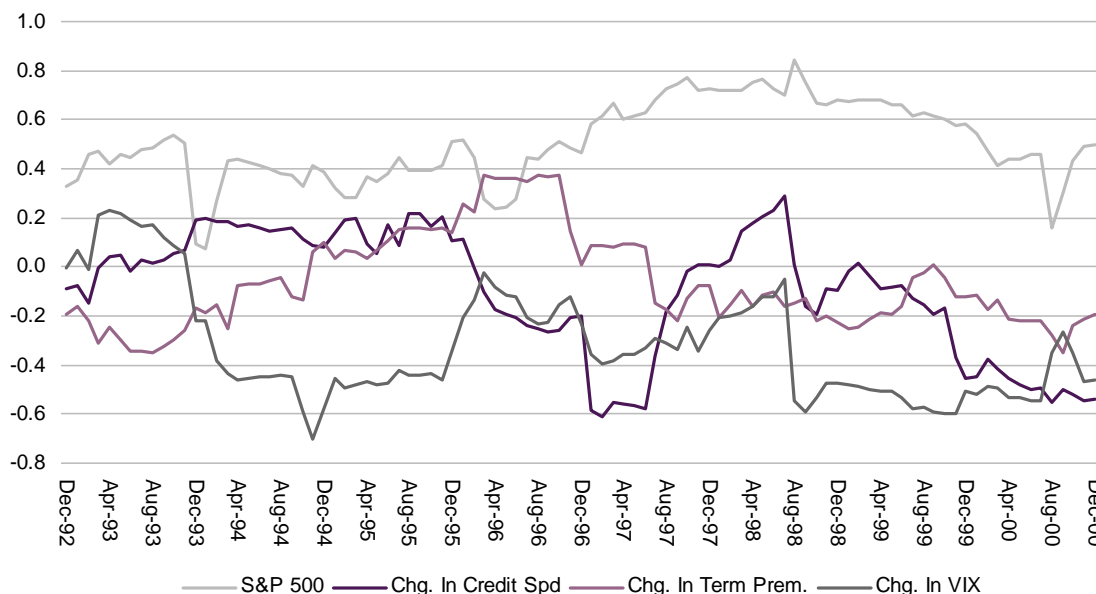
Factor Sensitivities of Hedge Fund Styles

In this section, the performance of the various principal hedge fund strategies under both levels and changes in the above factors. See Appendix V for actual numerical results for a larger set of hedge fund strategies.

Equity Hedge

This strategy has substantial exposure to equity markets and therefore performs well when equity markets are performing well. Generally speaking, a moderately upward sloping yield curve is an indication of a growing economy with low inflation rate. Also, when credit risk premium is declining the risk premium on equity declines as well and thus this strategy performs well. Finally, declining volatility is also associated with smaller equity risk premium and higher return on this strategy.

This strategy performs above its historical average when

- The yield curve is moderately upward sloping and there no are substantial increases or decreases in its slope.

- Credit risk premium is declining.

- There are no substantial increases or decreases in the short-term rate.

- The long-term rate is at a moderate level and is not increasing.

- The intra-month volatility of S&P 500 and the implied volatility index are at a moderate levels and are not increasing.

- The intra-month volatility of bond returns is declining.
- The returns on large cap and small cap stocks are high.

This strategy performs substantially below its historical average when

- The yield curve is downward sloping or there are substantial increases in its slope.
- Credit risk premium is increasing.
- The short-term rate is increasing or decreasing by a substantial amount.
- The long-term yield is very low and is increasing.
- The intra-month volatility of S&P 500 and the implied volatility index are high or are increasing.
- The intra-month volatility of bond returns is increasing.
- The returns on large cap and small cap stocks are negative.

Relative Value Arbitrage

The return on this strategy has some of the characteristics of the Equity Hedge strategy except that it is less sensitive so some of the factors (e.g., equity return and bond return volatilities)

This strategy performs above its historical average when

- The yield curve is moderately upward sloping and there are no substantial increases or decreases in its slope.
- Credit risk premium is moderate and is declining.
- The short-term rate is low and is not changing.
- The long-term rate is at a moderate level and is not changing.
- The intra-month volatility of S&P 500 and the implied volatility index are moderate or low and are not increasing.
- The intra-month volatility of bond returns is at a moderate level.
- The returns on large cap and small cap stocks are high.

This strategy performs substantially below its historical average when

- The yield curve is downward sloping and there are substantial changes in its slope.
- Credit risk premium is very low and is increasing.
- The short-term rate is increasing.
- The long-term yield is low or is changing by a large amount.
- The intra-month volatility of S&P 500 and the implied volatility are high or are increasing.
- The returns on large cap and small cap stocks are negative.

Global Macro

This strategy has had some similarities to Equity Hedge strategy except that it has also exhibited higher exposure to the bond market as well as systematic trading of forward, futures and option contracts. For example, it performs very poorly (well) when the slope of the yield curve is increasing (decreasing). Its exposure to bond market also can be seen from its poor performance when the volatility of bond returns is high.

This strategy performs above its historical average when

- The yield curve is upward sloping and is declining.

- Credit risk premium is declining.

- The short-term rate is at a low level and is not increasing.

- The long-term rate is at moderate or high levels and is not increasing.

- The intra-month volatility of S&P 500 and the implied volatility index are low and are not increasing.

- The intra-month volatility of bond returns is low to moderate and is not changing.

- The returns on large cap and small cap stocks are high.

This strategy performs substantially below its historical average when

- The yield curve is downward sloping or there are substantial increases its slope.

- Credit risk premium is increasing.

- The short-term rate is increasing.

- The long-term yield is very low or is increasing by a large amount.

- The intra-month volatility of S&P 500 and the implied volatility index are high or are increasing.

- The intra-month volatility of bond returns is high or is increasing.

- The returns on large cap and small cap stocks are negative.

Equity Market Neutral

The strategy seems to perform above average when economic conditions are in a state of equilibrium and therefore are not changing substantially. It performs specially well when there is an upward sloping yield curve with declining long-term yields. Also, it is an attractive investment when market volatility is at a moderate level.

This strategy performs above its historical average when

- The yield curve is moderately upward sloping and its slope is declining.

- Credit risk premium is high.

- The short-term rate is at a high level or is not increasing.

- The long-term rate is declining.

- The implied volatility index is at a moderate level and is not changing.

- The intra-month volatility of bond returns is low.
- The returns on large cap and small cap stocks are high.

This strategy performs substantially below its historical average when

- The yield curve is highly upward sloping or there is a substantial increase in its slope.
- Credit risk premium is moderate.
- The short-term rate is low and is increasing by a substantial amount.
- The long-term yield is increasing by a large amount.
- The intra-month volatility of S&P 500 is high, the implied volatility index is low, or the implied volatility is decreasing.
- The returns on large cap and small cap stocks are negative.

Convertible Arbitrage

This strategy is attractive specially when the yield curve is moderately upward sloping and there are no substantial changes in the yield curve. Also, it performs well when market volatility is at a moderate level.

This strategy performs above its historical average when

- The slope of the yield curve is not changing.
- Credit risk premium is moderate.
- The long-term rate is not high and is not changing.
- The intra-month volatility of S&P 500 and the implied volatility index are at moderate levels and are not increasing.
- The intra-month volatility of bond returns is not increasing.
- The returns on large cap and small cap stocks are high.

This strategy performs substantially below its historical average when

- The slope of the yield curve is increasing.
- Credit risk premium is very low.
- The short-term rate is increasing.
- The long-term yield is high or is increasing by a large amount.
- The intra-month volatility of S&P 500 and the implied volatility index are high and are increasing.
- The intra-month volatility of bond returns is increasing.
- The returns on large cap and small cap stocks are negative.

Fixed Income Arbitrage

This strategy performs well when the yield curve is highly upward sloping. The reason is that during periods of high long-term rates, this strategy will be long the long end of the term structure and short the short end of the market. However, the strategy performs equally well when the slope of the yield curve is increasing. This indicates that during such economic conditions the strategy is short the long maturity bonds and long the short maturity bonds. Further, the strategy performs well when the credit risk premium is high or when it is decreasing, indicating that the strategy is long low credit fixed income instruments.

This strategy performs above its historical average when

- The yield curve is upward sloping and the slope is increasing.

- Credit risk premium is high and is declining.

- The long-term rate is high or is not decreasing.

- The intra-month volatility of S&P 500 and the implied volatility index are not high are not changing.

- The intra-month volatility of bond returns is at a moderate level and is not changing.

- The returns on large cap stocks are moderate.

This strategy performs substantially below its historical average when

- The yield curve is downward sloping or the slope is decreasing.

- Credit risk premium is low and is increasing.

- The short-term rate is at a moderate level and is decreasing.

- The long-term yield is low or is declining.

- The intra-month volatility of S&P 500 and the implied volatility index are high and are increasing.

- The intra-month volatility of bond returns is high or is increasing.

- The returns on large cap stocks are high.

For each of the above strategies the returns for variable for high, median, and low returns are given in Appendix V. For purposes of presentation, the Appendix shows the performance of various strategies under 3 different economic conditions: low, medium and high values of the slope of the yield curve. For example, low values of the slope of the yield curve range between –0.63% and 1.05%. Under this condition the macro strategy performed rather poorly. On an annual basis it earned 6.6% *below* its annualized mean, 17.69%. On the other hand, the convertible arbitrage performed rather well since it earned 0.77% above its annualized mean of 11.5%. Further, when slope of the yield curve is low, equity hedge strategy is relatively more volatile (2.48% above its overall annual standard deviation of 9.46%), while global macro is relatively less volatile (1.33% below its overall annual standard deviation of 9.21%). Finally, we notice that only when the slope of the term structure is close to the middle (range 1.06% to 2.19%), the equity hedge earns above its overall average. Exhibit 15 provides a summary of the above results.

Rules of Thumb

The empirical results presented in this paper may provide the basis for certain rules of thumb that may be used by institutional investors to govern their investment philosophy. These rules of thumb include:

1. Use style-pure subindices, in contrast to universe-based return, to provide more accurate   estimates of future returns.

2. Use indices which track the underlying risk or return patterns of the hedge fund strategy to obtain alpha (outperformance) estimates.

3. Use due diligence processes to reduce potential survivor bias impacts on 'historical estimates of return' (e.g., size, relative performance comparisons).

4. When suitable, use investments with lockups to increase potential rates of return.

5. When suitable, use illiquid investments to increase potential rates of return.

6. Use multi-factor return models to capture expected hedge fund benefits.

7. Use disaggregated data to capture unique impacts of micro factors on fund performance.

8. Forecasts of economic variables can be used to make allocations across hedge fund strategies. The market environments which are more or less favorable to each of the strategies are summarized in Exhibit 15. Note, for example, that the relative factor performance characteristics of fund of funds is very similar to Equity Hedge.

Exhibit 15

Single Factor Performance Characteristics

Note: The above tables indicate the relative performance of each hedge fund strategy during indicated levels of performance or magnitude of the underlying factors. This analysis is best explained with an example. Suppose we are interested in the performance sensitivity of Equity Hedge to S&P500 returns. The analysis consists of sorting all historical monthly S&P500 returns in the data time window from low to high and dividing those returns into three groups, Low, Medium, High. Equity Hedge returns for the *corresponding* months are noted, and an average of Equity Hedge performance for each of these groups is taken. These averages are then compared with the historical performance of that strategy to indicate the relative performance of that strategy during periods of different SP500 movements.

Summary

Recent advances in determining factors driving hedge fund return have both indicated the benefits of market factor based models of return estimation as well as the importance of certain micro (e.g., fund based) characteristics driving fund return. This paper researches both micro and macro factors affecting hedge fund return.

Some simple results are presented. Investors must realize that 1) there is no universal hedge fund index and those that represent themselves as such differ widely in composition and performance, 2) alpha based measures of return are sensitive to the expected modeling approach, however, the use of a common approach for traditional and alternatives (peer index, variance based or multi-factor are superior to simple beta approaches), 3) general hedge fund classifications must be disaggregated before analytical work should be done, 4) some evidence of micro effects exist (lockups etc.) however, the impacts of survivor bias, fees, offshore and onshore, may be more difficult to model (e.g., subject to macro events and high water mark impacts) than is commonly presented and 5) that both single and multi-factor models can be used in a variety of hedge fund return analyses (e.g. sensitivity and stability).

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Appendix I: Source of Data and Time Frame for Exhibits 1-14 and Appendices I-IV

Exhibits

Exhibit 1: Selected Bibliography

Exhibit 2: PerTrac source on multiple data bases used to create common data set with funds that have 3 year age and asset restrictions (1998-11/1999)

Exhibit 3: Zurich FOF Universe and traditional and alternative Indices (1998-2000)

Exhibit 4: Various hedge funds and traditional indices (1996-2000)

Exhibit 5: TASS (1996-5/2000)

Exhibit 6: Various hedge fund indices (1994-2000)

Exhibit 7: Zurich Hedge Fund Universe Data (1997-2000)

Exhibit 8: Zurich Hedge Fund Universe Data (1997-2000)

Exhibit 9: HFR Indices (1994-2000)

Exhibit 10: Zurich Hedge Fund Universe Data Fund of Funds Data (various time periods)

Exhibit 11-12: TASS and Zurich data

Exhibits 13-14: HFR indices and Bloomberg

Appendices: Source of Data

Appendix II: TASS Data

Appendix III: HFR Indices

Appendix IV: HFR Indices and Bloomberg

Appendices V-VII: As indicated therein

Appendix II: Survivor Bias: US Equity Time Pattern Profile

The traditional pattern of differential return between survivor funds and non-survivor funds in the months before dissolution is shown in the following exhibit (US Equity). The return differential is based on average ranked return differential in the month –12 to –7. Note that in general hedge funds performed which relatively poorly in the months -12 to –7 also performed poorly just prior to dissolution. However, as indicated in the final grouping, for a set of funds that dissolved but performed relatively well in months –12 to –7 before dissolution also performed well in the months just prior to dissolution. In short, result show that survivor bias may also include funds, which ceased reporting despite having relatively higher strategy performance. Results shown in this exhibit are for the largest of hedge fund strategies (e.g., US equity) but results reflect patterns for other hedge fund strategies.

Average Differential Return (Survivor Average-Non-Survivor Returns) for Portfolios 1-5 (Approximately 10 firms per group) based on Ranked Residual Average (12 Months to 7 Months before Non-reporting)
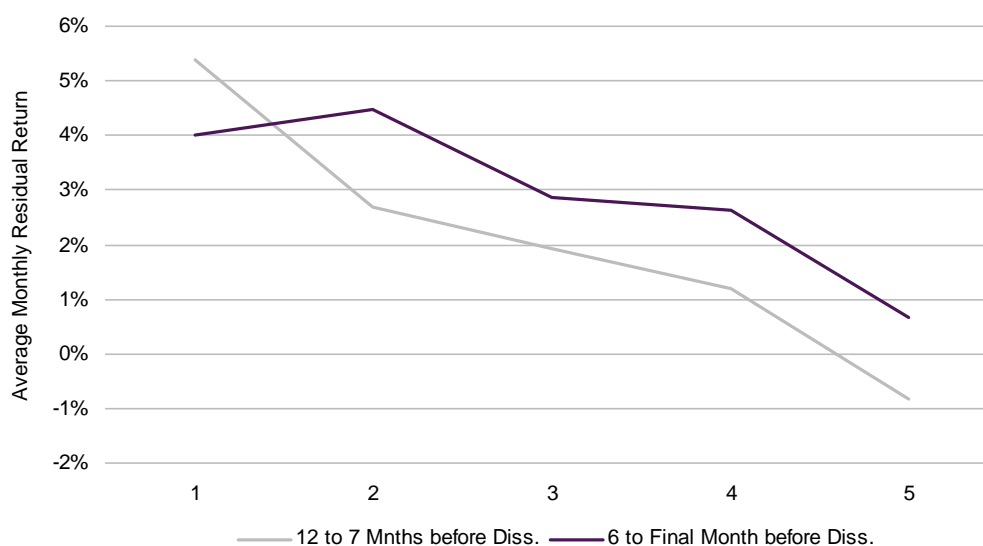
Appendix III: Forecasting Hedge Fund Performance

In an associated paper to this study, CAPM and multi-factor have been developed to provide us with more robust estimates of the risk premiums. The risk premiums obtained from these models are then used as inputs in optimizations model for the purpose of *strategic asset allocation*. In fact, this is the approach recommended by *Black and Litterman* when the investor has no strong view about the future performance of different asset classes. For tactical asset allocation a forecasting model has also been created based on the multi-factor model. For this research see Kazemi and Schneeweis [2001].

For example, a cross-sectional regression can be used to ascertain the relationship between average returns and single or multi-factor sensitivities. As shown for simple single factor models, return relationships can be determined relative to beta or standard deviation.

	Beta	R-Square
Return = a + bi x (S&P 500)	0.09	0.55
Return = a + bi x (S&P 500) – Excludes HF Short Sellers	0.12	0.40
Return = a + bi x (Standard Deviation)	0.01	0.00
Return = a + bi x (Standard Deviation) – Excludes HF Short Sellers	0.53	0.29

Note that in the above regressions, the impact of including hedge fund strategies which have low beta (and low return) in a beta based regression model in comparison to a standard deviation based regression model. As in classical CAPM tests, beta based regression models may be superior to regression models based on total risk. However, exclusion of short sellers from the regression permits the use of standard deviation as a predictor variable in this simple regression framework.

Hedge Fund Return Versus Betas (1990-2000 – S&P 500)
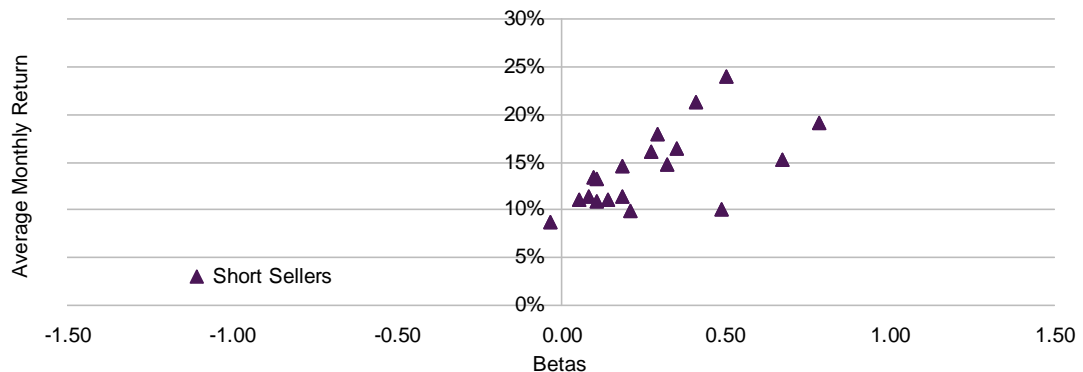
Hedge Fund Return Versus Standard Deviation (1990-2000 – S&P 500)
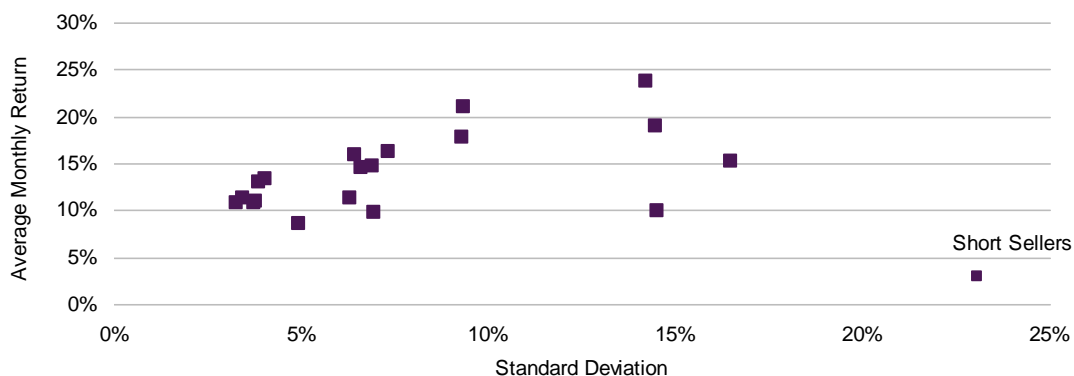
Hedge Fund Return Versus Betas (1990-2000 – S&P 500): Excludes Short Seller Hedge Funds
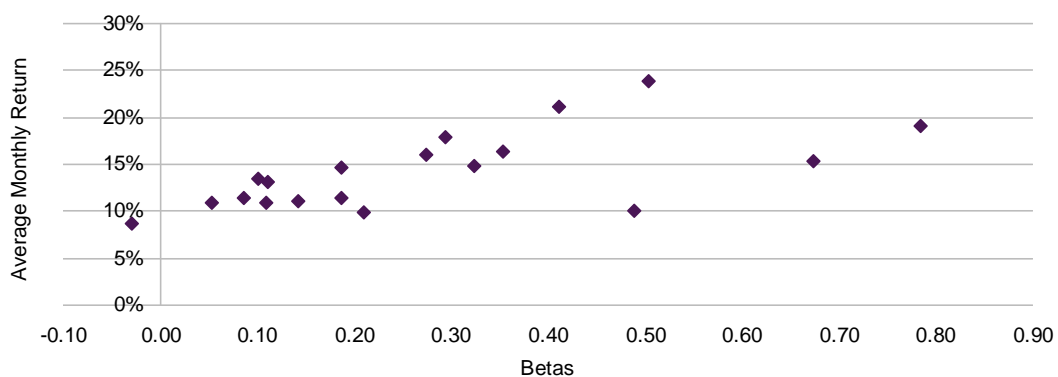
Hedge Fund Return Versus Standard Deviation (1990-2000 – S&P 500): Excludes Short Seller Hedge Funds
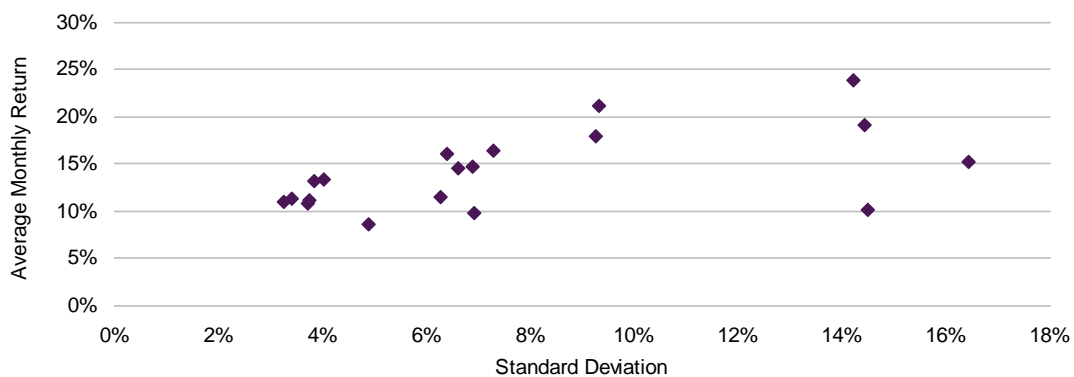
Appendix IV: Detailed Multi-Factor Regression Results

	R-Square	Intercept (%)	S&P 500	Change in Credit Spread	Change in Term Premium	Change in VIX
CorpHi	0.41	0.53**	0.1900**	-0.0820**	0.0155*	-0.0023**
CorpInv	0.25	0.52**	0.1191**	-0.0087	-0.0197**	-0.0002
FR2000	0.52	0.04	0.8423**	-0.1098*	0.0311	-0.0029*
USGov Itermediate (IM)	0.10	0.52**	0.0617**	-0.0039	-0.0059	0.0003
Convertible Arbitrage	0.21	0.87**	0.0691**	0.0017	0.0107*	-0.0010**
Distressed Securities	0.38	1.05**	0.1342**	-0.0826**	0.0211**	-0.0022**
Emerging Markets (Total)	0.42	0.52	0.5779**	-0.1173*	0.0382*	-0.0042**
Emerging Markets: Asia	0.28	0.29	0.4255**	-0.0680	0.0292	-0.0030*
Equity Hedge	0.43	1.27**	0.3762**	-0.0717**	0.0126	-0.0013*
Equity Market Neutral	0.07	0.83**	0.0659**	-0.0076	0.0017	0.0004
Equity Non-Hedge	0.63	0.67**	0.6996**	-0.1027**	0.0184	-0.0031
Event-Driven	0.55	1.05**	0.2215**	-0.0651**	0.0197**	-0.0022**
Fixed Income (Total)	0.30	0.80**	0.0872**	-0.0399**	0.0068	-0.0008*
Fixed Income: Arbitrage	0.05	0.79**	-0.0478	-0.0284	0.0067	-0.0008
Fixed Income: High Yield	0.40	0.65**	0.1390**	-0.0820**	0.0159*	-0.0026**
Fund of Funds	0.23	0.76**	0.1525**	-0.0346	0.0061	-0.0013*
Fund Weighted Composite	0.56	0.96**	0.3093**	-0.0583**	0.0160*	-0.0019**
Macro	0.24	1.19**	0.2267**	-0.0445	-0.0032	-0.0020*
Market Timing	0.43	0.82**	0.3099**	0.0111	0.0064	-0.0008
Merger Arbitrage	0.25	0.99**	0.0867**	-0.0190	0.0082	-0.0011**
Relative Value Arbitrage	0.22	1.02**	0.0805**	-0.0143	0.0128*	-0.0011**
Sector (Total)	0.30	1.39**	0.4606**	-0.0839*	0.0310*	-0.0023*
Short Selling	0.47	1.63**	-1.0251**	0.1546*	-0.0071	0.0021
Statistical Arbitrage	0.29	0.72**	0.1489**	-0.0093	-0.0065	0.0005

*	*Significant with 90% Confidence.*
**	*Significant with 99% Confidence.*

Appendix V: Single Factor Relationships

Changes in Yield Curve	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	-0.63%	-0.09%	-0.09%	0.11%	0%	0.94%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	-3.02%	0.10%	2.29%	-0.63%	1%	0.64%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	-2.53%	0.39%	1.64%	-0.54%	1%	0.07%	13.40%	3.98%
HFRI Macro Index	3.28%	-0.93%	0.56%	-0.15%	-4%	1.06%	17.69%	9.21%
HFRI Fund of Funds Index	-2.62%	0.55%	2.62%	-1.32%	0%	0.62%	11.22%	6.22%
HFRI Equity Market Neutral Index	-1.77%	-0.10%	2.41%	-0.32%	-1%	0.34%	11.05%	3.37%
HFRI Convertible Arbitrage Index	-1.99%	0.76%	1.96%	-0.67%	0%	-0.27%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	-4.69%	-1.53%	3.44%	-1.21%	1%	1.81%	8.80%	4.86%
S&P500 Return	10.82%	0.24%	0.34%	-0.50%	-11%	-0.15%	13.99%	14.29%
Lehman Aggregate Bond Index	6.02%	-0.47%	0.28%	-0.33%	-6%	-0.01%	7.93%	3.79%

Credit Risk Premium	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	0.53%	0.66%	0.66%	0.82%	1%	1.38%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	-0.72%	1.18%	0.82%	-1.57%	0%	0.39%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	-2.90%	0.60%	2.91%	-1.19%	0%	0.26%	13.40%	3.98%
HFRI Macro Index	0.38%	-0.51%	-3.01%	0.06%	3%	0.55%	17.69%	9.21%
HFRI Fund of Funds Index	-1.23%	1.64%	2.36%	-0.61%	-1%	-1.33%	11.22%	6.22%
HFRI Equity Market Neutral Index	0.43%	-0.05%	-1.28%	-0.21%	2%	0.26%	11.05%	3.37%
HFRI Convertible Arbitrage Index	-1.62%	0.82%	1.41%	-1.00%	0%	-0.04%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	-1.82%	-1.86%	-1.39%	-0.06%	3%	1.35%	8.80%	4.86%
S&P500 Return	3.73%	0.16%	-1.26%	-1.97%	-2%	1.82%	13.99%	14.29%
Lehman Aggregate Bond Index	-0.45%	0.08%	0.63%	-0.06%	0%	0.06%	7.93%	3.79%

Slope of the Yield Curve	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	-0.63%	1.05%	1.06%	2.19%	2%	4.64%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	-3.53%	2.48%	4.65%	-0.52%	-1%	-2.60%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	-1.89%	0.42%	0.27%	-1.23%	2%	0.58%	13.40%	3.98%
HFRI Macro Index	-6.60%	-1.33%	-2.06%	-0.44%	9%	1.22%	17.69%	9.21%
HFRI Fund of Funds Index	-5.03%	1.41%	4.03%	-0.67%	1%	-1.21%	11.22%	6.22%
HFRI Equity Market Neutral Index	-0.71%	0.52%	2.96%	-0.51%	-2%	-0.20%	11.05%	3.37%
HFRI Convertible Arbitrage Index	0.77%	0.64%	-0.33%	-0.48%	0%	-0.19%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	-5.89%	1.30%	0.54%	-1.75%	5%	-0.52%	8.80%	4.86%
S&P500 Return	-3.55%	3.05%	8.40%	-0.01%	-5%	-3.90%	13.99%	14.29%
Lehman Aggregate Bond Index	2.08%	-0.23%	-1.07%	-0.08%	-1%	0.30%	7.93%	3.79%

Change in Credit Risk

	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	-0.25%	-0.02%	-0.02%	0.02%	0%	0.20%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	7.98%	0.11%	-1.08%	-1.89%	-7%	1.22%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	3.16%	-0.32%	-0.20%	-0.26%	-3%	0.43%	13.40%	3.98%
HFRI Macro Index	4.98%	0.83%	0.11%	-1.00%	-5%	0.05%	17.69%	9.21%
HFRI Fund of Funds Index	4.89%	0.01%	-1.73%	-1.36%	-3%	1.01%	11.22%	6.22%
HFRI Equity Market Neutral Index	-0.41%	0.16%	0.97%	-0.25%	-1%	0.13%	11.05%	3.37%
HFRI Convertible Arbitrage Index	0.65%	-0.57%	-0.34%	0.07%	0%	0.50%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	5.44%	-1.51%	-0.45%	-0.71%	-5%	1.37%	8.80%	4.86%
S&P500 Return	3.72%	-1.70%	4.42%	-2.47%	-8%	3.46%	13.99%	14.29%
Lehman Aggregate Bond Index	-0.76%	0.14%	0.11%	0.01%	1%	-0.08%	7.93%	3.79%

T-Bill

	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	2.74%	4.75%	4.77%	5.35%	5%	8.04%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	0.27%	-1.99%	0.32%	0.66%	-1%	1.22%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	2.24%	0.49%	-2.35%	0.46%	0%	-1.20%	13.40%	3.98%
HFRI Macro Index	4.43%	0.68%	-2.61%	-0.40%	-2%	-0.25%	17.69%	9.21%
HFRI Fund of Funds Index	0.68%	-0.88%	1.38%	1.51%	-2%	-0.83%	11.22%	6.22%
HFRI Equity Market Neutral Index	-2.71%	0.24%	0.06%	-0.26%	3%	-0.11%	11.05%	3.37%
HFRI Convertible Arbitrage Index	0.62%	0.24%	-0.03%	-0.43%	-1%	0.23%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	0.67%	1.81%	-1.69%	-1.93%	1%	-0.55%	8.80%	4.86%
S&P500 Return	0.01%	-2.04%	3.44%	1.41%	-3%	0.65%	13.99%	14.29%
Lehman Aggregate Bond Index	-2.48%	0.32%	-1.31%	-0.30%	4%	-0.22%	7.93%	3.79%

Change in T-Bill Rate

	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	-0.90%	-0.06%	-0.06%	0.04%	0%	0.57%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	-1.19%	0.67%	3.88%	-0.38%	-3%	-0.21%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	-0.57%	0.88%	3.04%	-0.33%	-2%	-0.82%	13.40%	3.98%
HFRI Macro Index	3.85%	0.60%	4.77%	0.10%	-9%	-1.09%	17.69%	9.21%
HFRI Fund of Funds Index	-1.00%	0.84%	2.27%	-0.76%	-1%	-0.10%	11.22%	6.22%
HFRI Equity Market Neutral Index	1.97%	0.09%	1.38%	-0.26%	-3%	0.01%	11.05%	3.37%
HFRI Convertible Arbitrage Index	0.54%	0.08%	1.03%	-0.19%	-2%	0.13%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	-2.29%	0.76%	1.58%	0.28%	1%	-1.22%	8.80%	4.86%
S&P500 Return	-4.32%	2.98%	4.43%	-1.64%	0%	-1.62%	13.99%	14.29%
Lehman Aggregate Bond Index	6.92%	-0.91%	-1.57%	-0.21%	-5%	0.20%	7.93%	3.79%

Long-Term Yield	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	4.98%	6.16%	6.24%	7.39%	7%	8.99%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	-3.99%	1.76%	5.51%	-0.58%	-2%	-1.48%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	-2.26%	0.50%	2.58%	-1.02%	0%	0.31%	13.40%	3.98%
HFRI Macro Index	-7.19%	-1.24%	3.70%	1.21%	3%	-0.30%	17.69%	9.21%
HFRI Fund of Funds Index	-5.64%	1.18%	6.58%	0.13%	-1%	-2.19%	11.22%	6.22%
HFRI Equity Market Neutral Index	-0.50%	0.81%	1.37%	-0.50%	-1%	-0.43%	11.05%	3.37%
HFRI Convertible Arbitrage Index	1.14%	0.31%	1.08%	-0.28%	-2%	-0.07%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	-6.20%	1.02%	1.80%	-1.57%	4%	-0.24%	8.80%	4.86%
S&P500 Return	-2.66%	2.83%	4.57%	-2.73%	-2%	-0.41%	13.99%	14.29%
Lehman Aggregate Bond Index	0.43%	-0.95%	-1.54%	0.59%	1%	0.23%	7.93%	3.79%

Change in the Long-Term Yield	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	-0.69%	-0.12%	-0.11%	0.05%	0%	0.57%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	-0.95%	0.38%	5.58%	-0.68%	-5%	0.24%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	-2.25%	0.36%	5.78%	-0.89%	-4%	-0.04%	13.40%	3.98%
HFRI Macro Index	8.66%	0.10%	2.63%	-1.35%	-11%	0.38%	17.69%	9.21%
HFRI Fund of Funds Index	-1.81%	0.89%	3.99%	-1.37%	-2%	0.24%	11.22%	6.22%
HFRI Equity Market Neutral Index	3.07%	-0.55%	-0.93%	0.45%	-2%	-0.09%	11.05%	3.37%
HFRI Convertible Arbitrage Index	-0.91%	0.33%	3.47%	-0.46%	-3%	-0.07%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	-6.20%	0.02%	2.58%	-0.63%	4%	0.16%	8.80%	4.86%
S&P500 Return	10.86%	2.18%	1.78%	-2.62%	-13%	-0.49%	13.99%	14.29%
Lehman Aggregate Bond Index	12.62%	-1.65%	0.27%	-1.74%	-13%	-1.09%	7.93%	3.79%

Intra-Month Volatility of S&P500 Index	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	4.84%	10.50%	10.52%	15.48%	16%	34.98%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	1.17%	-3.00%	9.93%	-0.77%	-11%	2.22%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	1.89%	-0.24%	1.38%	-0.80%	-3%	0.79%	13.40%	3.98%
HFRI Macro Index	7.71%	-0.82%	7.08%	0.74%	-15%	-1.41%	17.69%	9.21%
HFRI Fund of Funds Index	0.95%	-2.08%	7.73%	-0.02%	-9%	0.90%	11.22%	6.22%
HFRI Equity Market Neutral Index	0.03%	-0.13%	1.51%	-0.95%	-2%	0.85%	11.05%	3.37%
HFRI Convertible Arbitrage Index	0.11%	-0.45%	2.48%	-0.40%	-3%	0.66%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	3.24%	-0.45%	1.54%	-1.64%	-5%	1.39%	8.80%	4.86%
S&P500 Return	3.10%	-5.05%	12.61%	-2.03%	-16%	4.44%	13.99%	14.29%
Lehman Aggregate Bond Index	1.74%	0.12%	-1.11%	0.25%	-1%	-0.37%	7.93%	3.79%

Implied Volatility Index	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	10.61%	16.19%	16.22%	22.34%	23%	39.25%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	-0.76%	-3.43%	4.67%	-0.80%	-4%	3.11%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	1.84%	-0.82%	-0.06%	0.16%	-2%	0.55%	13.40%	3.98%
HFRI Macro Index	7.39%	0.63%	2.75%	-0.24%	-10%	-1.02%	17.69%	9.21%
HFRI Fund of Funds Index	0.15%	-1.51%	2.89%	-0.90%	-3%	1.89%	11.22%	6.22%
HFRI Equity Market Neutral Index	-1.21%	-0.38%	0.91%	-0.72%	0%	0.92%	11.05%	3.37%
HFRI Convertible Arbitrage Index	0.06%	0.09%	2.12%	-1.57%	-2%	0.96%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	1.72%	-1.37%	4.07%	-0.65%	-6%	1.26%	8.80%	4.86%
S&P500 Return	2.89%	-6.57%	4.89%	-0.15%	-8%	4.54%	13.99%	14.29%
Lehman Aggregate Bond Index	1.81%	0.25%	-1.89%	0.02%	0%	-0.28%	7.93%	3.79%

Change in Implied Volatility Index	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	-12.4%	-0.69%	-0.68%	0.77%	1%	11.24%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	9.12%	-1.18%	5.41%	-1.33%	-15%	1.04%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	1.96%	-0.91%	2.53%	0.10%	-4%	0.44%	13.40%	3.98%
HFRI Macro Index	8.59%	-0.80%	4.05%	-1.47%	-13%	1.10%	17.69%	9.21%
HFRI Fund of Funds Index	2.45%	-1.04%	4.68%	-1.13%	-7%	1.42%	11.22%	6.22%
HFRI Equity Market Neutral Index	-2.89%	-0.05%	3.57%	-0.55%	-1%	0.34%	11.05%	3.37%
HFRI Convertible Arbitrage Index	2.56%	-0.50%	2.45%	-0.96%	-5%	0.82%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	-1.62%	0.19%	2.97%	-0.85%	-1%	0.55%	8.80%	4.86%
S&P500 Return	19.26%	-2.34%	6.09%	-1.67%	-25%	0.88%	13.99%	14.29%
Lehman Aggregate Bond Index	2.34%	-0.78%	3.62%	-0.21%	-6%	0.36%	7.93%	3.79%

Intra-Month Volatility of Bond Return	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	1.95%	3.71%	3.74%	4.63%	5%	8.91%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	-0.34%	1.30%	-0.69%	-1.15%	1%	-0.10%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	-1.42%	0.82%	1.82%	-0.09%	0%	-0.87%	13.40%	3.98%
HFRI Macro Index	5.97%	0.39%	4.54%	-0.11%	-11%	-0.90%	17.69%	9.21%
HFRI Fund of Funds Index	3.33%	1.76%	1.33%	-1.98%	-5%	-0.45%	11.22%	6.22%
HFRI Equity Market Neutral Index	1.39%	-0.19%	-0.61%	-0.06%	-1%	0.27%	11.05%	3.37%
HFRI Convertible Arbitrage Index	-0.65%	-0.42%	0.60%	-0.43%	0%	0.78%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	-0.24%	-0.97%	3.19%	-0.88%	-3%	1.41%	8.80%	4.86%
S&P500 Return	2.65%	2.66%	-1.48%	-2.13%	-1%	-0.66%	13.99%	14.29%
Lehman Aggregate Bond Index	4.00%	-0.80%	-0.21%	-0.07%	-4%	0.50%	7.93%	3.79%

Change in Intra-Month Volatility of Bond Return

	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	-3.20%	-0.67%	-0.64%	0.42%	0%	3.97%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	4.66%	-1.04%	-0.42%	0.09%	-4%	0.89%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	1.13%	-1.02%	0.55%	-0.83%	-2%	1.42%	13.40%	3.98%
HFRI Macro Index	0.34%	-1.09%	3.25%	0.47%	-4%	0.62%	17.69%	9.21%
HFRI Fund of Funds Index	2.81%	-1.59%	3.04%	-0.33%	-6%	1.35%	11.22%	6.22%
HFRI Equity Market Neutral Index	-0.18%	-0.60%	0.25%	0.38%	0%	0.22%	11.05%	3.37%
HFRI Convertible Arbitrage Index	1.95%	-0.68%	1.53%	-1.26%	-3%	1.27%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	0.11%	-1.13%	2.84%	-1.14%	-3%	1.68%	8.80%	4.86%
S&P500 Return	3.72%	-0.61%	0.60%	-1.99%	-4%	2.46%	13.99%	14.29%
Lehman Aggregate Bond Index	-0.76%	-0.52%	-0.83%	-0.51%	2%	0.89%	7.93%	3.79%

S&P 500 Index Return

	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	-14.5%	-0.40%	-0.36%	2.94%	3%	11.44%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	-24.6%	-0.22%	6.31%	-2.7%	18%	-1.81%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	-5.3%	1.16%	2.66%	-0.8%	3%	-1.10%	13.40%	3.98%
HFRI Macro Index	-19.4%	-1.21%	9.02%	0.2%	10%	-1.57%	17.69%	9.21%
HFRI Fund of Funds Index	-10.5%	0.46%	4.27%	-1.2%	6%	-0.40%	11.22%	6.22%
HFRI Equity Market Neutral Index	-2.5%	0.25%	0.69%	-0.7%	2%	0.35%	11.05%	3.37%
HFRI Convertible Arbitrage Index	-4.0%	0.47%	-0.04%	-0.2%	4%	-0.69%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	0.2%	-0.51%	2.82%	-1.8%	-3%	1.62%	8.80%	4.86%
S&P500 Return	-54.8%	-4.72%	4.13%	-11.1%	51%	-7.67%	13.99%	14.29%
Lehman Aggregate Bond Index	-7.0%	0.00%	1.41%	-0.5%	6%	-0.37%	7.93%	3.79%

Small Cap Return

	Low		Medium		High		All Dates	
	Min	Max	Min	Max	Min	Max		
	-19.4%	15.93%	16.19%	22.30%	22%	39.25%		
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
HFRI Equity Hedge Index	-2.87%	-1.79%	5.03%	-0.90%	-2%	2.26%	20.08%	9.46%
HFRI Relative Value Arbitrage Index	-0.27%	0.82%	0.27%	0.19%	0%	-1.19%	13.40%	3.98%
HFRI Macro Index	6.10%	1.06%	3.63%	-0.47%	-10%	-1.21%	17.69%	9.21%
HFRI Fund of Funds Index	-1.87%	0.18%	3.23%	-1.01%	-1%	0.73%	11.22%	6.22%
HFRI Equity Market Neutral Index	-1.65%	-0.14%	0.65%	-0.67%	1%	0.69%	11.05%	3.37%
HFRI Convertible Arbitrage Index	-1.00%	0.68%	2.01%	-1.56%	-1%	0.44%	11.53%	3.51%
HFRI Fixed Income: Arbitrage Index	0.80%	-1.29%	4.55%	-0.62%	-5%	1.22%	8.80%	4.86%
S&P500 Return	-1.75%	-3.08%	7.08%	-0.60%	-5%	3.08%	13.99%	14.29%
Lehman Aggregate Bond Index	2.05%	0.27%	-1.86%	0.02%	0%	-0.32%	7.93%	3.79%

Appendix VI: Hedge Fund Index Correlations

Correlation of Hedge Fund Style Indices (1998-2000)

	CSFB	HFR	EACM
CSFB-Tremont Hedge Fund	1.00		
HFRI Fund Weighted Composite	0.85	1.00	
EACM 100	0.92	0.93	1.00
CSFB-Tremont Convertible Arbitrage	1.00		
HFRI Convertible Arbitrage	0.82	1.00	
EACM Convertible Hedge	0.70	0.80	1.00
CSFB-Tremont Equity Market Neutral	1.00		
HFRI Equity Market Neutral	0.18	1.00	
EACM L/S Equity	0.00	0.51	1.00
CSFB-Tremont Event Driven	1.00		
HFRI Event Driven Index	0.91	1.00	
EACM Event	0.91	0.87	1.00
CSFB-Tremont Global Macro	1.00		
HFRI Macro Index	0.71	1.00	
EACM Global Asset Allocators	0.50	0.69	1.00
CSFB-Tremont Long-Short	1.00		
HFRI Equity Hedge	0.95	1.00	
EACM Equity Hedge	0.97	0.96	1.00
HFRI Distressed	N/A	0.93	
EACM Bankruptcy	N/A	0.84	1.00
HFRI Merger Arbitrage	N/A	0.90	
EACM Merger Arbitrage	N/A	0.95	1.00

Appendix VII: Measures of Return and Risk Performance

Return: Represents the actual percentage growth in total value over the reported time period. Calculated as: (Ending Value of Portfolio$_t$+1- Beginning Value of Portfolio$_t$)/(Beginning Value of Portfolio$_t$ where the Ending Value of Portfolio is Determined by Multiplying Beginning Value of the Portfolio by the continuous Actual Monthly Total Rates of Return).

S&P 500: Total Rate of Return—Percentage Change in Price Plus Dividend Yield.

Lehman Brothers Government/Corporate Bond Index: Total Rate of Return—Percentage Change in Index Value (Index Value includes percentage change in price plus coupon return).

MSCI: Morgan Stanley Capital International World Stock Index: Total Rate of Return—Percentage Change in Value of the Portfolio.

Lehman Brothers World Government Bond Index: Total Rate of Return—Percentage Change in Index Value (Index Value includes percentage change in price plus coupon return).

Performance Measures

Annualized Rate of Return: Annualized Rate of Return. (Annualized Growth Rate required for Beginning Value of the asset or portfolio to grow to Ending Value of the asset or portfolio).

Standard Deviation (Annualized): A measure of the annualized dispersion (distance) of the observations (return performance) from the mean (or average) observation. Calculated as the standard deviation of the monthly return times the square root of 12.

Sharpe Ratio: A ratio that represents a rate of return adjusted for risk (standard deviation), and is calculated as ((Annualized Rate of Return—Annualized Risk Free Rate of Return)/ Standard Deviation (Annualized)). The One Year Treasury Bill Yield was used to determine the Annualized Rate of Return for the Risk Free Rate.

Correlation: The standardized co-movement of the portfolio's monthly total returns with the corresponding comparison asset's total monthly returns. Correlations will range between 1.00 and -1.00.