Modeling Hedge Fund Returns

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Abstract

Since hedge funds trade in many of the same types of asset classes that mutual funds trade, they should respond to similar external forces as proxied by a set of macroeconomic variables. Thus, our analytical modeling of hedge fund returns is undertaken using macroeconomic factors to test for the commonality of factors with the mutual fund industry. The analysis is carried out using both OLS and WLS estimation procedures, but caution must be applied when interpreting the OLS results because of presence of heteroscedasticity in the cross-sectional data. The results of the macroeconomic model lead to the conclusion that the macroeconomic variables default premium and term-premium explain hedge fund return in general. This lends support to the similarity hypothesis that the macroeconomic factors that explain equity return also have explanatory power for hedge fund returns.

I. Introduction

Hedge funds have enjoyed healthy growth through the years and continue to increase in popularity, especially among high net-worth individuals. Recently, an increasing number of institutions have allocated a small portion of their assets to these alternative investments owing to their long-term success. But the term "hedge fund" is used to describe a wide range of investment vehicles that can vary substantially in terms of size, strategy, and organizational structures. One commonality surrounding hedge funds is the limited amount of information provided to potential investors. Typically information is limited to periodic (monthly, quarterly, or annual) returns. Even the leading hedge-fund databases provide incomplete information drawn from the fund-offering documents such as contractual provisions (fee structure, minimum investment size, and withdrawal provisions), descriptions of investments, styles of investment, and the periodic return. Unfortunately, what constitutes a hedge fund is debatable and an industry standard for their classification schemes does not exit.

We model hedge fund returns as a means of clarifying classifications using factor pricing from macroeconomic variables so that investors may obtain a better idea of the type and amount of risk for the investment they are undertaking. The starting point of our modeling is that hedge funds trade in many of the same types of asset classes that mutual funds trade. Thus, they should respond to similar external forces as proxied by a set of macroeconomic variables.

The paper proceeds as follows: Section I gives a brief history of the hedge fund industry. Section II provides a review of the literature. Data, modeling, and results are outlined in Section III. Section IV summaries our findings and contributions.

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II. A Brief History of the Hedge Fund Industry

In 1949, A.W. Jones introduced the concept of a hedge fund by combining a leveraged long stock position with a portfolio of short stocks in an investment fund with an incentive fee structure. From this simple concept, hedge fund investment practices and strategies continue to evolve. Consequentially, many hedge fund characteristics have changed significantly, but many of the fundamental features have remained the same. Moreover, hedge funds are no longer unique to the U.S. markets, but have become a fixture in the global marketplace. In the United States, the funds normally offer their shares in private placements and are limited to 100 or fewer high net-worth investors in order to make use of regulatory exemptions provided under the Securities Act of 1933, the Securities Exchange Act of 1934, and the Investment Company Act of l940.

Interest in hedge funds and their performance has waxed and waned over time, but recent publicity has lead to hedge funds enjoying healthy growth. For instance, the high net-worth investors created through the bull market of the late 1980s started to invest in hedge funds as a means of enhancing their returns. In 1990, there were about 600 hedge funds worldwide with assets of approximately $38 billion. According to industry publications, at the end of 1998, despite the publicized collapse of Long Term Capital Management (LTCM), there were some 3,300 hedge funds with assets of approximately $375 billion. Additional investments at the turn of the century have pushed the hedge fund industry over the $600 billion mark. Although hedge funds invest in a variety of liquid assets similar to mutual funds, they are quite different. Under current federal law, hedge funds have no limitations on management, virtually no limits on the composition of the portfolios, and no mandatory disclosure of information about holdings or performance.

III. Literature Review

The study of hedge funds is a recent phenomenon primarily due the availability of data. As such, most of the literature is less than a decade old, but has become more prevalent after the Asian and LTCM crises, focusing on performance attribution (i.e., modeling returns), performance evaluation, characteristics, and the impact on the financial markets. Performance attribution analysis attempts to find the key factors affecting hedge fund returns. A limited number of academic researches have focused on dissecting the sources of hedge fund returns focusing on the broader category of hedge fund performance or a particular hedge fund strategy. This empirical research focuses on three main areas: performance attribution (modeling returns), performance evaluation, and characteristics and impact on the financial markets.

For instance, when modeling hedge fund performance as a group, the researchers model hedge fund performance treating all the hedge funds in a database as a single group. No distinction is made between the different categories of hedge funds. Schneeweis and Spurgin (1998) determined a set of factors that can be used to explain the differences in the investment return of various fund categories. Ackermann et al. (1999), expanding upon this line of research, find that incentive fees can be used to explain risk-adjusted performance.

Different managers and databases classify hedge funds differently. One particular hedge fund could be grouped under one category (e.g. based on strategy) in one database, whereas the same

hedge fund would be listed under a different category (e.g. based on investment sector) in some other database. Researchers attempt to extract strategies from observed returns and try to reclassify hedge funds based on observed return characteristics. For instance, Fung and Hsieh (1997) find that Sharpe's style regression is not appropriate for discovering performance attributes, but nonlinear look-back straddles show promise. Brown and Goetzmann (2001), in the same line of research, find that investment styles contribute to about 20% of the cross sectional variability in performance. See Table 1 for a summary of the performance attribution literature.

The second research focus, performance evaluation, is essentially concerned with comparing the return earned on a hedge fund with the return earned on some other standard investment asset. Research in this area can be divided into three groups: benchmarking, performance persistence, and performance in a portfolio context. The first aspect, benchmarking, starts with a point of reference upon which to judge performance. This passive representation of a manager's investment process represents the prominent financial characteristics that the investment would exhibit in absence of active investment judgment. Key benchmarking research supports the fact that hedge funds outperform mutual funds, even on a risk adjusted basis. See, for instance, Ackermann et al. (1999), Brown et al. (1999), Edwards and Liew (1999), Agarwal and Naik (2000) and Edwards and Caglayan (2001).

The second aspect of performance evaluation, persistence, deals with the examination of whether hedge fund managers demonstrate persistence in their performance and how the survival rate affects performance persistence. Support for performance persistence was found by Park and Staum (1998) and Agarwal and Naik (2000). Brown et al. (1998, 1999) fails to establish a link between fees and performance. The third area of evaluation deals with performance in a portfolio context, i.e., do the diversification benefits of including hedge funds in a traditional portfolio of stocks and bonds have merit. A number of researchers, including Goldman Sachs and Co. (1998, 2000), Edwards and Liew (1999), Agarwal and Naik (2000), and Lamm and Ghaleg-Harter (2000), support the diversification effects of hedge funds. See Table 2 for a summary of the performance evaluation literature.

The third research area focuses on hedge fund characteristics. This area is the broadest focus group starting with general characteristics and progressing to performance attributes, as in Brown et al. (2001). Characteristics of the hedge fund industry including the fee structure, data conditioning biases, and the risk/return characteristic of various hedge fund strategies have been studied. For instance, see Park and Staum (1998), Schneeweis and Spurgin (1998), and Ackermann et al. (1999) for a thorough discussion of hedge fund characteristics. Returns are summarized in Edwards (1999), Fung and Hsieh (1999), and Lamm et al. (1999). Goetzmann et al. (1998) evaluates compensation issues. Finally, see Purcell and Crowley (1999), Fung and Hsieh (2000), and Lamm et al. (2000) for performance attributes. See Table 3 for a summary of the literature on hedge fund characteristics.

In the last area, researchers study the role of hedge funds in the financial market crisis and the implications for policy. For instance, the role of hedge funds in the Asian crisis is documented in Yago et al. (1998, 1999), Eichengreen and Mathieson (1998), and Brown et al. (2000, 2001). The collapse of LTCM is referenced in Edwards (1999). See Table 4 for a summary of literature on hedge funds and the financial markets.

Several conclusions can be reached from this extensive set of empirical work on hedge funds. For instance, hedge funds consistently outperform mutual funds but not standard market indices. Hedge fund returns typically are more volatile than mutual funds, but hedge funds offer diversification effects when added to a portfolio due to their low correlation with traditional asset classes. Hedge funds have been shown to have risk-adjusted performance persistence, but not any direct role in precipitating risk in the financial market. Research has also shown that there may be diminishing-return-to-scale in the hedge fund industry, that the incentive fee structure does not lead hedge fund managers to take more risk because of the possibility of non-survival, and that hedge funds follow a very dynamic strategy.

IV. Data and Methodology

The databases popular among researchers and the investment community include Zurich Capital Markets (ZCM/Hedge) database (formerly, MAR/hedge), which provides a comprehensive coverage of global hedge funds; Hedge Fund Research (HFR) database, which contains more equity-based hedge funds; and TASS, the information and research subsidiary of Credit Suisse First Boston Tremont Advisers. The database providers all offer hedge fund classifications and indices, unfortunately without much in common. Hedge fund categories listed in a particular database are based on the self-reported style classifications of the hedge fund managers. In addition, none of the databases provide information on the complete hedge fund universe. The databases also differ on their definition of a 'hedge fund'. For example, TASS is the only database that includes managed futures funds, which limit their activities to futures market. Since hedge fund managers employ a diverse array of investment strategies, the database providers must provide some sort of classification scheme. Although all the major databases rely on the voluntary information provided by the hedge fund managers, style definitions and the number of hedge fund categories differ among the database providers.

The data used for this study is the monthly hedge fund return of the Zurich Capital Markets/Hedge (ZCM/Hedge) database. ZCM/Hedge database was made available by LaPorte Asset Allocation System for this research. This database classifies hedge funds into four general classes and ten broad categories of investment styles. The classes are 'onshore' hedge fund (HF-US), 'offshore' hedge fund (HF-NON), 'onshore' fund-of-funds (FOF-US), and 'offshore' fund-of-funds (FOF-NON). Some of the categories have sub-classifications. The ZCM/Hedge database categories are shown in Figure 1.

Our study consists of three sub-periods of 48 months each: January 1989 to December 1992, January 1993 to December 1996, January 1997 to December 2000 and the total period (144 months) from January 1989 to December 2000. The study period is chosen to have enough observations for the maximum number of hedge funds. The study period is divided into three sub-periods of 48 months each in order to see if study period has any significant impact on the results and at the same time have enough observations to have statistically meaningful results.

This study considers both after-fee returns and before-fee returns. A before-fee return is more robust than the after-fee-return, because of the vagaries of the fee structure and the complexities of calculation. The investors are concerned with the after-fee return. In general, hedge funds

charge two types of fees: an asset management fee and an incentive fee. The asset management fee is based on amount of the assets in the fund, usually 1%, or 2% per year.

The incentive fee or the "carried interest" is the hedge fund manager's share in a fund's profit. Usually this is 20 percent and is paid annually in the United States. For offshore hedge funds, the incentive fee is calculated monthly or quarterly. Two other important features of a hedge fund fee structure are the *hurdle rate* and the *high water mark*.

The ZCM/Hedge database provides information on annual fee structure for each of the hedge funds. Subtracting 1/12th of the stated percent fee from the monthly return approximates the administrative fee. Both the hurdle rate and the high water mark feature are considered for computing the incentive fee. For example, the incentive fee was subtracted only if the fund in question had a positive cumulative return since it last charged an incentive fee and had crossed the hurdle rate. This takes care of the loss recovery requirement, the minimum return requirement and assures that there is no double counting of fees. The category returns are calculated using an equal-weighted and value-weighted approach. An equal-weighted portfolio invests equal amounts in each hedge fund irrespective of the size of the hedge fund. A value-weighted portfolio invests in hedge funds based on the market value of the hedge fund and thus gives more weight to larger hedge funds than smaller ones.

Even though there is great overlap in the instruments utilized by mutual funds and hedge funds, the differences in the way they use the instruments could produce different returns. This study examines whether hedge fund returns respond in the same way that mutual fund returns do to similar external forces as represented by changes in a set of macroeconomic variables. We acknowledge there may be differences in trading between hedge funds and mutual funds. Our goal is to test the commonality of factors that effect return for hedge funds and mutual funds in spite of trading differences.

Thus, the macroeconomic factor model uses observable economic time series data to measure the pervasive factors of a hedge fund's return. For instance, Chen, Roll, and Ross (1986) using the Fama-MacBeth cross-sectional regression approach find evidence of five priced factors within the mutual fund industry. The authors base their premises on the argument that, in selecting factors, one should consider forces that will explain changes in the discount rate used to discount future expected cash flows, and forces that influence the expected cash flows themselves. The factors include the yield spread between long and short interest rates for U.S. government bonds (*term-premium*), expected inflation, unexpected inflation, industrial production growth, and the yield spread between corporate high- and low-graded bonds (*default premium*). The authors find that aggregate consumption growth and oil prices did not have any incremental effects beyond the five factors. Connor (1995) finds five similar factors (default premium, inflation, term premium, industrial production, and unemployment) when exploring the returns within the U.S. equities market.

Our study uses an approach similar to that of Chen et al. (1986) and the specific variables from Connor (1995) to model hedge fund returns to see if similar factors explain hedge fund returns. Thus, our macroeconomic hypothesis is stated below.

H_0: *The macroeconomic factors (DP, INF, Term, IP, and UR which are defined below) that explain equity returns also have explanatory power for hedge fund returns.*

H_a: *The macroeconomic factors that explain equity returns have no explanatory power for hedge fund returns.*

The macroeconomic factors include the yield spread between corporate high- and low-grade bonds *(default premium-DP),* inflation *(INF),* the yield spread between long and short interest rates for US government bonds *(term-premium-TERM),* the change in natural log of industrial production index *(industrial production factor-IP),* and the change in the unemployment rate *(unemployment factor- UR)*. The expected signs for the five factors are DP>0, INF >0, TERM >0, IP>0, and UR <0.

The model is expressed in equation (1).

$$[R_{it}] = a_i[i] + b_{FKi}[Factor_{Kt}] + [e_{it}] \tag{1}$$

where $E[e_{it}] = 0$,
$E[e_{it}e_{it}'] = \Sigma$,
$E[Factor_{Kt}] = m_{FK}$,
$E[(Factor_{Kt} - m_{FK})(Factor_{Kt} - m_{FK})'] = \Omega_K$, and
$Cov(Factor_{Kt}, e_t') = \Theta$.

Equation (1) can be expressed as (2).

$$[R_{it}] = a_i[i] + b_{DPi}[DP_t] + b_{INFi}[INF_t] + b_{TERMi}[TERM_t] + b_{IPi}[IP_t] + b_{URi}[UR_t] + [e_t] \tag{2}$$

where R_{it} is the *(N x1)* vector of observed return for N hedge funds for time period t; i is the *(N x1)* vector of ones; $Factor_{Kt}$ is the *(Kx1)* vector of macroeconomic risk factors for time period t; b_{Ki} is the *(NxK)* matrix of factor sensitivities; Σ is the variance-covariance matrix of disturbances; Ω_K is the variance-covariance matrix of macroeconomic risk factors; and Θ is a *(KxN)* matrix of zeroes.

Before utilizing our model, we tested for the presence of multicollinearity, heteroscedasticity, and autocorrelation using variance-inflating factors, White's general heteroscedasticity test, and Newey-West variance-covariance estimator, respectively. The general findings support the position that our model should not be adversely affected by the presence of multicollinearity, heteroscedasticity, or autocorrelation. Specific test results are available from the authors.

The time series regression is carried out separately for each category and class of hedge fund in the ZCM database. For example, during the period 1989 to 1992, monthly returns of hedge funds belonging to the category *Event Driven* are regressed on the five macroeconomic variables (DP, INF, TERM, IP, and UR). Tables 5 and 6 provide the regression results for each time period by category and class of hedge funds respectively. Although the results displayed in the table are for

equal-weighted hedge fund returns on a before-fee basis, the corresponding results for value-weighted returns and hedge fund returns on an after-fee basis offer similar results and, therefore, are not formally reported. Time-series regressions are undertaken for categories and classes of hedge funds instead of individual hedge funds in order to reduce the errors-in-variables problem that is bound to occur because of the potential for autocorrelation between the state variables.

The tables report the factor sensitivities of each of the state variables. The statistical significance of the coefficients at the 1%, 5%, and 10% levels are also noted. The tables also report the adjusted R-square (adjusted for degrees of freedom) for the time-series regression. The negative adjusted R-square values should be taken as zero. The only two state variables that are significant are the *default premium (DP)* and the *term-premium (TERM)*. The significance of the coefficient does not vary much by the different test periods. The coefficients for the state variables *default premium* and *term-premium* are statistically significant for all the categories of hedge funds within the complete study period.

The economic interpretation of the positive coefficient of the *default premium* indicates that hedge funds profit by taking advantage of the expected change in yield spread between long-term government bonds and low grade bonds. As the spread widens, the fund is able to gain additional compensation (increased yield) for switching into riskier debt instruments (i.e., an inter-market spread swap). When the yield narrows, the fund is able to increase quality with little loss of yield by switching from low quality bonds to high quality bonds.

The coefficient of *default premium* is significant at a 10% level of significance or better and this is true within all the sub-periods, the complete study-period, and for all of the categories and classes of hedge funds. The only category that has a negative sign for the coefficient of the *default premium* is 'short-sellers'. The sign of the coefficient of the risk factor inflation (*INF)* is not consistent, though in aggregate it appears to be of positive sign. This state variable has been found to have a negative coefficient within the equities market (Chen et al., 1986). The positive sign of *INF* for hedge funds supports the conjecture that hedge funds are different from traditional investments. The coefficient of *INF* is not statistically significant.

The coefficient of the state variable *TERM* is positive and significant within all the study periods. The state-variable *TERM* measures a change in the long-term real rate of interest over short-term rates since *inflation* is included as one of the state variables. The long-term real rate of return affects the return on all forms of capital. Investors wanting protection against this possibility would assign a higher value to assets whose price increases when long-term rates decline. The positive risk premium on the state-variable *TERM* is puzzling at first glance because one would expect that hedge funds correlated with long-term bond returns to be more valuable than the hedge funds negatively correlated with long-term bonds. This apparent discrepancy is caused by the fact that hedge funds try to arbitrage away the spread differential in long-term and short-term instruments. It is plausible that the higher the positive *term-premium*, the better the chances of arbitrage for the hedge fund manager.

The signs of the coefficient of *growth in industrial production (IP)* and *change in unemployment rate (UR)* are not consistent. The coefficients are not significant for any of the study periods. Similar analysis is done for class of hedge funds. The results of the time-series regression are

displayed in Table 6. The results are very similar to the results for category of hedge funds. The two state variables that are significant are *DP* (Default Premium) and *TERM* (Term-premium). The regression statistics for both category and class using the five factor macroeconomic model are also displayed in Table 5 and Table 6.

In the multiple-factor model used in this analysis, testing the individual significance of the macroeconomic factors (*DP, INF, Term, IP,* and *UR*) is not the same as testing the overall significance of the macroeconomic factor model. The statistical insignificance of the individual macroeconomic factors does not mean that the factors are collectively statistically insignificant. Hence, a second null hypothesis of all the five coefficients of the state variables being simultaneously zero, as stated below, is tested.

> H_0: *The macroeconomic factors DP, INF, Term, IP, and UR are jointly statistically insignificant in explaining hedge fund returns, that is,* $b_{FKi} = 0$.
>
> H_a: *The macroeconomic factors DP, INF, Term, IP, and UR are jointly statistically significant in explaining hedge fund returns, that is,* $b_{FKi} \neq 0$.

The null hypothesis is rejected in general, thus lending support to the similarity hypothesis. Tables 5 and 6 also display the R-square of the five factor macroeconomic model. Although not all the R-square values are impressive, it appears that the model does explain approximately 25% of the variation in hedge fund return. The average R-square is 26.63%. The macroeconomic model does help in explaining the time-series variation in hedge fund return to some extent. Although all the five variables are not statistically significant, the signs of most of the coefficient of the state variables are explainable in terms of the investment philosophy of hedge funds.

The regression results using the five-factor macroeconomic model show that only two state variables, *default premium* and *term-premium,* are significant. The inclusion of the explanatory variables in the model was based on the premise that, since hedge funds and mutual funds trade in the same asset classes, the macroeconomic variables that have been found to have explanatory power in explaining return data of US equities should also be able to explain hedge fund return. It is interesting to see the outcome of dropping from the model the state variables that are found to be statistically insignificant in explaining hedge fund return. Testing a two-factor model amounts to restricting the coefficients of the other state variables to zero.

Tables 7 and 8 display the results of two-factor macroeconomic model for category and class of hedge funds, respectively. The highlighted t-statistics are significant at the 10% level of significance. The results are very similar to the five-factor model. The coefficients that are significant are the *default premium* and *term-premium*.

The validity of the restriction imposed by the two-factor model is tested using the general F-statistic for the difference between R^2 values for the larger, unconstrained (five-factor) model, and the smaller constrained model. The F-statistic values, not reported here, were lower than the critical values at a 5% level of significance. The constrained regression cannot be rejected as the model to explain hedge fund return.

V. Conclusion

The regression results using a five-factor macroeconomic model show that only two state variables, *default premium* and *term-premium*, are statistically significant. The economic interpretation of the positive coefficient of the *default premium* indicates that hedge funds profit by taking advantage of the expected change in yield spread between long-term government bonds and low grade bonds. Hedge funds try to arbitrage away the spread differential in long-term and short-term instruments. It is plausible that the higher the positive *term-premium* (positive coefficient on the variable *term*), the better the chances of arbitrage for the hedge fund manager.

The results of the macroeconomic model lead to the conclusion that the macroeconomic variables *default premium* and *term-premium* explain hedge fund return in general. This lends support to the similarity hypothesis that the macroeconomic factors that explain equity return also have explanatory power for hedge fund returns. Although not all the R-square values are impressive, it appears that the model does explain approximately 25% of the variation in hedge fund return. The study period is divided into three sub-periods of 48 months each in order to see if study period has any significant impact on the results. The results indicate that the choice of study period has no impact on the statistical significance of the variables.

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Table 1: Summary of Performance Attribution Literature

Author	Issue	Key Finding
Modeling hedge fund performance as a group		
Schneeweis and Spurgin (1998)	Use common set of factors to explain returns for active management of hedge funds, stock and bond mutual funds, and CTAs.	Factors used explain the differences in investment return of these asset classes.
Ackermann et al. (1999)	Isolate hedge fund characteristics that explain the performance and volatility of hedge funds.	Incentive fees consistently explain risk-adjusted performance.
Extracting strategies from observed returns		
Fung and Hsieh (1997)	Develop an integrated framework for analyzing traditional managers with relative return targets (mutual funds) as well as alternative managers with absolute return targets (hedge funds and commodity trading advisers).	Sharpe's style regression not appropriate for performance attribution of hedge funds and CTAs. Hedge funds and CTAs have low correlation with returns on mutual funds and standard asset classes.
Brown and Goetzmann (2001)	Study monthly return history of hedge funds. The authors use both return history and self-reported style information to characterize categories of hedge fund styles.	Differences in investment style contribute about 20% of the cross sectional variability in hedge fund performance. The natural groupings like the global equity, US equity hedge and *Global Macro* styles take more risk than other hedge funds.
Modeling particular hedge fund strategy		
Fung and Hsieh (2001)	Model the nonlinear relationships between style factors and the markets in which the hedge funds trade.	The trend-following strategies can be modeled using look-back straddles.

Table 2: Summary of Performance Evaluation Literature

Author	Issue	Key Finding
Benchmarking		
Ackermann et al. (1999)	Performance of hedge funds.	Hedge funds consistently outperform mutual funds and are more volatile than both mutual funds and market indices.
Brown et al. (1999)	Performance of offshore hedge funds.	Offshore funds returns as well as standard deviation were lower than *S&P 500*.
Edwards and Liew (1999)	Performance of hedge funds both as stand-alone investments and in a portfolio.	Hedge funds have provided attractive risk-adjusted returns and score high as stand-alone investments. Inclusion of hedge funds in diversified portfolio raises the Sharpe ratio
Agarwal and Naik (2000)	Out-performance of hedge fund strategies over a portfolio of passive strategies.	Hedge fund managers exhibit superior market timing and security selection ability.
Edwards and Caglayan (2001)	Performance of hedge funds and commodity funds in bear versus bull stock markets.	Almost all hedge fund styles exhibit significantly higher positive correlation with stock returns in bear markets than in bull markets.
Performance Persistence		
Park and Staum (1998)	Whether there is evidence of skill persistence in hedge funds	Evidence shows that hedge funds have risk-adjusted performance persistence.
Brown et al. (1998, 1999)	The evidence for performance persistence of offshore hedge funds.	Performance fees are unrelated to future performance.
Agarwal and Naik (2000)	Performance persistence within individual hedge fund strategies	Results indicate a reasonable amount of performance persistence but more so for losers.
Performance in a Portfolio Context		
Goldman Sachs and Co. (1998)	Potential benefits of including hedge funds in plan sponsors' portfolios.	Certain hedge fund strategies may improve the risk-adjusted returns for some pension plans
Edwards and Liew (1999)	Performance of hedge funds as assets in diversified stock and bond portfolios.	Inclusion of hedge funds in diversified portfolio raises the Sharpe ratio of the portfolios.
Agarwal and Naik (2000)	The risk-return trade-off observed by including hedge funds in the portfolio.	Hedge funds provide better opportunities for diversification.
Goldman Sachs and Co. (2000)	The theoretical impact of allocating 10% of the assets in pension plan to a portfolio of absolute return funds.	Hedge funds have a very good diversification benefit with low correlation with common asset class benchmarks.
Lamm and Ghaleg-Harter (2000)	Design a portfolio of hedge funds that possess the desired alpha and beta characteristics.	The efficient frontier shifts downward as restrictions are progressively tightened.

Table 3: Summary of Literature on Hedge Fund Characteristics

Author	Issue	Key Finding
Goetzmann et al. (1998)	The effect of high water-mark compensation scheme.	High water-mark lend to managers having an incentive to taking risk. Existence of high water-mark is due to diminishing returns to scale in the hedge fund industry.
Park and Staum (1998)	The issue of skill persistence and the short-comings of general risk measures.	Skill statistic is leverage-invariant.
Schneeweis and Spurgin (1998)	Misconceptions about hedge funds.	Not all hedge funds use derivatives. The principal economic benefit of hedge funds is to provide capital to relatively illiquid investment markets.
Ackermann et al.(1999)	Characteristics of hedge fund industry and the impact of data conditioning biases.	Positive relationship between the life of funds & size, and negative relationship between life of funds & incentive fee. Termination and self-selection biases are most powerful.
Edwards (1999)	Hedge fund industry study.	High returns of hedge funds reflect the high risk that hedge fund manager takes.
Fung and Hsieh (1999)	Return characteristics of different styles of hedge funds.	*Global/Macro* fund is positively correlated with stocks. *Fixed Income Arbitrage* return is insensitive to US equities.
Lamm et al. (1999)	Reasons for superior returns of hedge funds.	Lack of transparency and illiquidity contribute to superior performance.
Purcell and Crowley (1999)	Hedge fund structures and strategies, and analyze hedge fund performance.	Hedge funds are riskier than the traditional accounts. Hedge fund risk-return characteristics and correlation has diversification benefits.
Fung and Hsieh (2000)	Different types of biases present in the hedge fund performance data.	Suggest fund-of-funds as a better proxy for market portfolio based on the smaller impact of biases inherent to individual hedge fund returns.
Goldman Sachs (2000)	Trends in hedge fund industry.	The average equity-oriented hedge funds use less leverage than a fixed -income-oriented hedge fund even for comparable investment strategies.
Lamm et al. (2000)	Performance of hedge funds over a five-year period.	Individual hedge fund behavior differs significantly by the type of strategy employed. Hedge funds are highly correlated with each other.
Brown et al. (2001)	Whether hedge fund and CTA return variance depends upon the manager's performance. The factors contributing to fund disappearance.	Trade-off between maximizing single-period fee option and survival. Survival depends on volatility, age and both absolute and relative performance of the fund.

Table 4: Summary of Literature on Hedge Funds and the Financial Markets

Author	Issue	Key Finding
Yago et al. (1998, 1999)	Role of hedge funds in Asian crisis.	Hedge funds were at the rear end in liquidating their forward contracts on Asian currencies.
Eichengreen and Mathieson (1998)	The Asian currency trade.	Evidence shows that hedge funds were not the first to liquidate contracts.
Edwards (1999)	The policy implications of the collapse of LTCM.	Need for better risk management technique.
Brown et al. (2000, 2001)	Testing of the hypothesis that hedge funds were responsible for the 1997 crash in the Asian currencies.	Hedge fund managers as a group did not cause the crash.
Fung and Hsieh (2000)	Hedge fund exposures during a number of major market events.	No evidence of hedge funds using positive feedback trading strategies.

Figure 1: ZCM/Hedge Classification of Hedge Funds

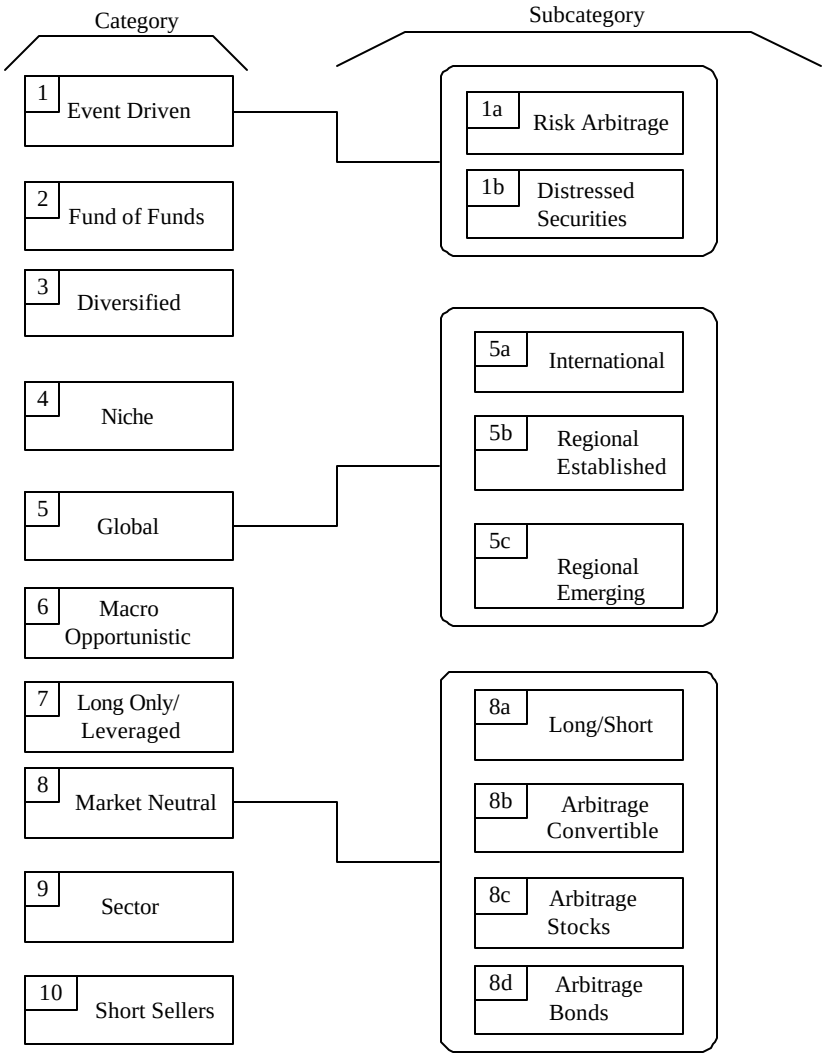

Table 5: Category Regression Coefficients using the Macroeconomic Factor Model

This table shows the time series regression results for each category of hedge fund in the ZCM database.

Category	Default Premium	Inflation	Term-premium	Industrial Production	Unemploy-ment	Adjusted R-square	F-stat
Panel A. January 1989-December 1992 (n=48)							
Event Driven	0.395***	-1.427**	0.374***	-7.736	-1.261	45.28%	8.78***
Global International	0.304**	-0.187	0.269	-21.059	-1.851	6.00%	1.60
Global Regional Established	0.636***	-0.858	0.925***	-6.946	-0.943	37.45%	6.63***
Global Regional Emerging	0.493	-7.920	0.224	34.339	0.978	-0.55%	0.95
Global US	0.669***	-1.386	0.766***	-10.437	-1.853	48.28%	9.78***
Global Macro	0.339***	1.126	0.447***	10.475	0.762	5.67%	1.56
US Opportunistic	0.602***	-1.674	0.503**	-141.748*	-0.987	37.88%	6.73***
Market Neutral	0.203***	-0.409	0.170***	10.850	-0.370	25.64%	4.24***
Sector	0.005	-5.237**	0.247	57.523	3.743	10.65%	2.12*
Short Sellers	-0.871***	5.524**	-0.836**	153.637*	0.139	35.49%	6.17***
Panel B. January 1993-December 1996 (n=48)							
Event Driven	0.919***	0.336	0.374***	3.919	1.117	35.34%	6.14***
Global International	0.664***	-0.885	0.843***	-42.198	1.376	15.29%	2.70**
Global Regional Established	1.145***	1.170	0.682***	72.476	1.795	17.69%	3.02**
Global Regional Emerging	1.503**	0.194	0.938*	-41.840	-0.388	0.37%	1.04
Global US	1.612***	5.730	1.143***	98.153	-2.910	14.84%	2.64**
Global Macro	0.765***	-1.630	1.390***	-14.126	0.850	22.19%	3.68***
US Opportunistic	0.901***	0.633	0.870***	141.898	4.882	11.75%	2.17*
Market Neutral	0.333***	-0.035	0.668***	-7.935	0.843	28.56%	4.75***
Sector	1.217***	0.295	0.340***	53.080	3.030	8.76%	1.90
Short Sellers	-2.077***	0.611	1.006***	-1.022	-4.450	11.31%	2.20*

Note: * Significant at 10% significance level; ** Significant at 5% significance level;
*** Significant at 1% significance level.

Note: The partial R-square estimates for the variables *default premium* and *term-premium* are similar to the adjusted R-square results.

Table 5 (cont): Category Regression Coefficients using the Macroeconomic Factor Model

Category	Default Premium	Inflation	Term-premium	Industrial Production	Unemploy-ment	Adjusted R-square	F-stat
Panel C. January 1997-December 2000 (n=48)							
Event Driven	0.879***	2.541**	0.711***	-26.350	1.046	51.84%	11.07***
Global International	0.876***	2.180	0.646***	25.121	2.471	22.39%	3.70***
Global Regional Established	1.470***	2.745	1.411***	17.344	1.036	33.59%	5.76***
Global Regional Emerging	1.808***	4.688	1.068**	-118.544	0.264	34.64%	5.98***
Global US	3.236***	6.741	2.228***	-10.518	-0.569	71.67%	12.06***
Global Macro	0.897***	0.049	1.054***	46.745	3.131	30.44%	5.12***
Market Neutral	0.362***	1.374**	0.342***	4.490	0.145	32.28%	6.54***
Sector	1.939***	5.070	1.892***	43.305	1.635	26.97%	5.46***
Short Sellers	-2.081***	-4.222	-1.996***	110.202	0.137	32.74%	4.48***
Panel D. January 1989-December 2000 (n=144)							
Event Driven	0.687***	0.858	0.631***	-2.521	-0.068	43.39%	22.83***
Global International	0.548***	0.806	0.489***	-6.119	-0.032	15.09%	6.06***
Global Regional Established	0.984***	0.835	0.977***	19.963	0.151	29.01%	12.67***
Global Regional Emerging	1.374***	0.853	0.965***	-51.560	0.794	13.11%	5.31***
Global US	1.669***	4.742*	1.341***	-59.866	-3.341	38.35%	15.60***
Global Macro	0.553***	0.959	0.684***	1.852	1.196	22.65%	9.37***
Market Neutral	0.282***	0.358	0.268***	11.474	-0.018	27.78%	6.69***
Sector	0.958***	1.081	0.962***	49.347	1.846	12.76%	11.97***
Short Sellers	-1.523***	0.334	-1.360***	78.466	-0.533	27.88%	5.18***
Event Driven	0.687	0.858	0.631	-2.521	-0.068	43.39%	12.05***

Note: * Significant at 10% significance level; ** Significant at 5% significance level; *** Significant at 1% significance level.

Note: The partial R-square estimates for the variables *default premium* and *term-premium* are similar to the adjusted R-square results.

Note: The category *US Opportunistic* disappeared from the database in 1998 and hence is not included in this study period and n is the number of observations.

Table 6: Class Regression Coefficients using the Macroeconomic Factor Model

This table shows the time series regression results for each class of hedge fund in the ZCM database. The classes are 'onshore' hedge fund (HF-US), 'offshore' hedge fund (HF-NON), 'onshore' fund-of-funds (FOF-US), and 'offshore' fund-of-funds (FOF-NON).

Class	Default Premium	Inflation	Term-premium	Industrial Production	Unemploy-ment	Adjusted R-square	F-stat
Panel A. January 1989- December 1992 (n = 48)							
HF-US	0.428***	-0.806	0.497***	-3.772	-0.712	37.60%	6.67***
HF-NON	0.355***	-0.671	0.447***	1.352	-0.750	41.13%	7.57***
FOF-US	0.062***	0.189	0.098***	10.197	-0.043	-3.78%	0.66
FOF-NON	0.034	-0.375	0.160	18.078	-0.338	-6.04%	0.46
Ex. FOF	0.399***	-0.801	0.477***	-1.378	-0.697	42.68%	8.00***
In. FOF	0.328***	-0.671	0.406***	1.632	-0.568	37.43%	6.62***
Panel B. January 1993- December 1996 (n = 48)							
HF-US	0.839***	0.803	0.718***	44.283	0.917	21.87%	3.63***
HF-NON	1.004***	1.679	0.914***	27.214	-0.291	20.72%	3.46***
FOF-US	0.671***	-0.493	0.616***	3.192	0.697	24.07%	3.98***
FOF-NON	0.656***	-1.039	0.683***	-10.075	0.333	14.90%	2.65**
Ex. FOF	0.898***	1.122	0.790***	37.075	0.455	25.51%	4.22***
In. FOF	0.847***	0.735	0.760***	28.379	0.456	25.50%	4.22***
Panel C. January 1997- December 2000 (n = 48)							
HF-US	1.189***	2.967	1.069***	0.230	0.734	36.56%	6.42***
HF-NON	0.935***	2.290	0.782***	-0.705	1.200	39.70%	7.19***
FOF-US	0.686***	1.913*	0.597***	9.163	1.403	32.15%	5.45***
FOF-NON	0.840***	2.010	0.723***	-4.956	1.918	31.56%	5.33***
Ex. FOF	1.084***	2.679	0.951***	-0.210	0.922	38.11%	6.79***
In. FOF	1.013***	2.512	0.887***	-0.026	1.091	37.70%	6.69***
Panel D. January 1989- December 2000 (n = 144)							
HF-US	0.771***	1.191	0.712***	11.129	-0.187	30.96%	13.82***
HF-NON	0.663***	1.127	0.646***	9.671	-0.417	31.56%	14.19***
FOF-US	0.346***	1.002*	0.339***	11.544	0.062	15.84%	6.38***
FOF-NON	0.411***	1.062	0.446***	-1.312	0.133	12.42%	5.06***
Ex. FOF	0.727***	1.134	0.684***	10.594	-0.254	33.19%	15.21***
In. FOF	0.654***	1.101	0.623***	8.996	-0.162	31.00%	13.85***

Note: * Significant at 10% significance level; ** Significant at 5% significance level;
*** Significant at 1% significance level.

Table 7: Category Regression Coefficients using a Two Factor Model

This table shows the time series regression results for each category of hedge fund in the ZCM database.

Category	Default Premium*	Term-premium*	Adj. R-square	F-stat*	Default Premium*	Term-premium*	Adj R-square	F-stat*
	*Panel A. 1989- 1992 (n = 48)***				*Panel B. 1993- 1996 (n = 48)***			
Event Driven	0.467	0.460	44.95%	20.19	0.948	0.865	38.31%	15.59
Global International	0.309	0.269	10.36%	3.72	0.720	0.737	18.48%	6.32
Global Regional Established	0.679	0.976	41.10%	17.40	1.141	0.917	19.71%	6.78
Global Regional Emerging	0.911	**0.761**	2.56%	**1.62**	1.541	1.177	6.80%	**2.72**
Global US	0.737	0.843	49.66%	24.19	1.563	1.312	13.06%	4.53
Global Macro	0.280	0.374	10.51%	3.76	0.765	0.880	25.69%	9.12
Market Neutral	0.221	0.188	28.76%	10.47	0.360	0.333	29.33%	10.75
Sector	0.288	0.622	5.98%	**2.49**	1.239	1.017	12.23%	4.27
Short Sellers	-1.188	-1.295	32.57%	12.35	-2.166	-1.656	15.13%	5.19
	*Panel C. 1997- 2000 (n = 48)***				*Panel D. 1989- 2000 (n = 144)***			
Event Driven	0.865	0.721	49.53%	23.94	0.665	0.608	43.68%	56.23
Global International	0.825	0.611	24.50%	8.60	0.529	0.469	16.35%	14.93
Global Regional Established	1.431	1.390	36.21%	14.34	0.954	0.942	30.20%	31.88
Global Regional Emerging	1.831	1.148	35.90%	14.16	1.372	0.977	14.60%	13.20
Global US	3.188	2.081	75.01%	33.82	1.536	1.163	35.07%	32.67
Global Macro	0.844	1.001	33.05%	12.63	0.529	0.663	22.93%	22.27
Market Neutral	0.348	0.336	30.50%	11.28	0.268	0.250	28.45%	29.36
Sector	1.863	1.845	28.83%	10.53	0.913	0.913	13.96%	12.58
Short Sellers	-2.108	-2.074	35.08%	13.69	-1.564	-1.421	28.80%	56.23

Note: *Significant at 10% level of significance except for the highlighted values.
Note: ** n is the number of observations for the study period.

Table 8: Class Regression Coefficients using a Two Factor Model

The classes are 'onshore' hedge fund (HF-US), 'offshore' hedge fund (HF-NON), 'onshore' fund-of-funds (FOF-US), and 'offshore' fund-of-funds (FOF-NON).

Class	Default Premium*	Term-premium*	Adj. R-square	F-stat*	Default Premium*	Term-premium*	Adj. R-square	F-stat*
	*Panel A. 1989- 1992 (n = 48)***				*Panel B. 1993- 1996 (n = 48)***			
HF-US	0.469	0.546	40.72%	17.14	0.832	0.703	24.57%	8.65
HF-NON	0.387	0.483	43.73%	19.26	1.004	0.903	24.11%	8.46
FOF-US	0.050	0.079	1.89%	**1.45**	0.673	0.620	28.21%	10.23
FOF-NON	**0.049**	0.172	0.12%	**1.03**	0.653	0.686	19.66%	6.75
Excluding FOF	0.439	0.524	45.22%	20.40	0.894	0.777	28.45%	10.34
Including FOF	0.361	0.444	40.40%	16.93	0.844	0.750	29.28%	10.73
	*Panel C. 1997- 2000 (n = 48)***				*Panel D. 1989- 2000 (n = 144)***			
HF-US	1.160	1.061	37.63%	15.18	0.734	0.670	31.41%	33.74
HF-NON	0.907	0.773	40.30%	16.86	0.629	0.606	31.74%	34.25
FOF-US	0.654	0.579	32.51%	12.32	0.314	0.304	15.62%	14.24
FOF-NON	0.810	0.713	32.80%	12.47	0.384	0.417	13.05%	11.73
Excluding FOF	1.055	0.943	38.99%	16.02	0.692	0.644	33.50%	37.03
Including FOF	0.984	0.878	38.54%	15.74	0.621	0.586	31.28%	33.54

Note: *Significant at 10% level of significance except for the highlighted values.
Note: ** n is the number of observations for the study period.