DO FUNDAMENTAL VARIABLES EXPLAIN HEDGE FUND RETURN?

Nandita Das*

Abstract

The analytical modeling of hedge fund returns is done using fundamental factors to test for the commonality of factors with the mutual fund industry. The analysis is carried out using OLS and WLS estimation procedures. Caution must be applied when interpreting the OLS results because of presence of heteroscedasticity in the cross-sectional data. The fundamental variables chosen are successful in explaining a portion of the hedge fund returns from hedge funds domiciled in the US, but not for those domiciled outside the US.

1.0 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.

Hedge fund return is modeled using fundamental variables. The model is a version of exact factor-pricing model, where the factors are the fundamental characteristics of the hedge funds. The hedge fund return is regressed on different characteristics of the fund and the market beta of the fund. This is the multifactor equivalent of the Black version of the CAPM.

The paper proceeds as follows: Section 2 provides a review of the literature. Data, methodology, and results are outlined in Section 3, Section 4 and Section 5 respectively. Section 6 summaries findings and contributions.

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* Wilkes University, USA; nandita.das@wilkes.edu

2.0 Literature Review

The systematic study of hedge funds is a recent phenomenon, encouraged primarily by the availability of data. Most of the literature is less than a decade old, and focuses on performance attribution, performance evaluation, characteristics, and the impact on the financial markets. When modeling hedge fund performance as a group, researchers typically model hedge fund performance by treating all the hedge funds in a database as a single group. Examples include Schneeweis and Spurgin (1998), Ackermann et al. (1999). Researchers have also attempted to extract strategies from observed returns to reclassify hedge funds based on observed return characteristics. Examples include Fung and Hsieh (1997), Brown and Goetzmann (2001).

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. 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), Edwards and Caglayan (2001), Kat and Menexe (2002), Amin and Kat (2003) and Malkiel and Saha (2005).

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 Amin (2002) Edwards (1999), Fung and Hsieh (1999), and Lamm et al. (1999). Goetzmann et al. (1998) evaluate compensation issues.

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), Brown et al. (2000, 2001) and Brunnermeir and Nagel (2004). The collapse of LTCM is referenced in Edwards (1999).

A summary of the empirical work on hedge funds leads to the following conclusions:

- hedge fund returns are volatile
- the inclusion of hedge funds in diversified portfolios raises efficiency of portfolios
- hedge funds have a low correlation with traditional asset classes
- fund-of- hedge funds offer diversification benefits to some extent
- hedge funds may have risk-adjusted performance persistence
- diminishing-return-to-scale may exist in the hedge fund industry
- hedge funds did not have any direct role in precipitating risk in the financial market
- incentive fee structures do not lead hedge fund managers to take more risk because of the possibility of non-survival
- hedge funds follow very dynamic strategies

Many papers have tried to model or replicate hedge fund performance. For example, Fung and Hsieh (1997) applied Sharpe's (1992) asset-class factor model to hedge funds, where the factors were derived statistically from a principal component analysis of the covariance matrix of their sample. . These model results are difficult to interpret in an economic sense. Other authors who modeled hedge fund returns using factors with economic interpretation such as indexes and fund characteristics include Schneeweis and Spurgin (1998), Ackermann and Ravencraft (1999), Laing (1999), Edward and Caglayan (2001) and Das et.al (2005). Fung and Hsieh (2001, 2004), and Agarwal and Naik (2000 and 2004) have attributed the hedge fund return to certain options-based strategies and other basic portfolios. Our research is motivation is based on Connor's model (1985). Arbitrage Pricing Theory (APT) provides an approximate relation for expected asset returns with an unknown number of unidentified factors. Connor (1984) presents a competitive version of APT with exact factor pricing feature. Connor (1984), Dybvig (1985), and Grinblatt and Titman (1985) have concluded that given a reasonable specification of the parameters of the economy, the theoretical deviations from exact factor pricing are likely to be negligible. The exact factor pricing models have some flexibility as to the specification of the factors. We explain the model details in section 5.

3.0 Data

The data used for this study is the monthly hedge fund return of the Center for International Securities and Derivatives Markets/Hedge (CISDM/Hedge) database. CISDM/Hedge database was made available by University of Massachusetts for this research. The CISDM/Hedge database provides monthly returns for all the funds. The study period for the present research has been selected to be between January 1994 and December 2004. CISDM/Hedge data has 184,095 observations of monthly returns for 2,930 funds. Some more funds had to be dropped from the study due to the unavailability of some key data that could not be derived from the available information. A study period dataset from January 1994 to December 2004 is constructed from the available dataset. The available monthly return observations that are used for the study are 167,009 for 2,930 funds.

This study considers after-fee returns and before-fee returns. 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 CISDM/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.

4.0 Methodology

As mentioned earlier our model is based on Connor’s multi-factor model which has some flexibility as to the specification of factors. Most empirical implementation of Connor’s model uses a proxy for the market portfolio as one factor. We use fundamental characteristics of hedge fund along with a market proxy to model hedge fund return. This is the multifactor equivalent to Black’s version of the capital asset pricing model (CAPM). The unconstrained version of the model is:

$$[R_{it}] = \alpha_i [\iota] + \gamma_{ik} [R_{kt}] + [\varepsilon_{it}] \tag{1}$$
$$\mathrm{E}[\varepsilon_{it}] = 0 \tag{2}$$
$$\mathrm{E}[\varepsilon_{it} \varepsilon_{it}'] = \Sigma \tag{3}$$
$$\mathrm{E}[R_{kt}] = \mu_k \tag{4}$$
$$\mathrm{E}[(R_{kt} - \mu_k)(R_{kt} - \mu_k)'] = \Omega_k \tag{5}$$
$$Cov(R_{kt}, \varepsilon_{it}') = \Theta \tag{6}$$

Where R_{it} is the *(N x1)* vector of returns for hedge fund *i;* ι is the *(N x1)* vector of ones; R_{kt} is the *(K x1)* vector of factor return; γ_{ik} is the *(N x K)* vector of factor sensitivities; ε_{it} is the *(N x1)* vector of disturbances; Σ is the variance-covariance matrix of disturbances; Ω_K is the variance-covariance matrix of fundamental risk factors; and Θ is a *(K x N)* matrix of zeroes.

The analysis is carried out separately for each class and category of hedge funds, using the Fama-MacBeth cross-sectional approach (1973). The hypothesis for the fundamental model is given below.

H_o: The fundamental characteristics of hedge funds are useful in explaining hedge fund return.

H_a: The fundamental characteristics of hedge funds do not have any explanatory power.

4.1 Fundamental Characteristics

The fundamental characteristics tested include market characteristics, age, size, fee, leverage, redemption frequency, minimum purchase, and asset class. The attributes are described below.

1. **Market Characteristic:** The market beta is used as a market-risk factor. The first step in the Fama-MacBeth approach involves estimating β for each of the hedge fund through an OLS regression of hedge fund return on market index. The square of market risk factor (β^2) is included as an explanatory variable to model any nonlinearities that may exist between hedge fund return and the market. The regression is carried out using three different market indices: *S&P 500*, *MSWI,* and *Russell 3000*.
2. **Age:** This is defined as the number of months the hedge fund has been in the database. Since this characteristic will vary for each month of the cross-sectional regression, this variable is lagged in order to remove the simultaneity bias.
3. **Size**: The average dollar value of assets under management is considered as a proxy for the *size* of a hedge fund.
4. **Fee**: In general, hedge funds charge two types of fees: an *asset management*

fee and an *incentive fee*. The *asset management fee* is based on the percentage of assets in the fund, usually 1 or 2 percentage points per year, and is almost same for all hedge funds. Therefore, the *asset management fee* is not considered as an attribute for the model. The *incentive fee* or the 'carried interest' is the hedge fund manager's share in the fund's profit. Usually this is 20 percent, but it could vary from zero percent to 50 percent. The *incentive fee* is used as a fund characteristic.

5. **Leverage**: Leveraging and other higher-risk investment strategies are a hallmark of hedge fund management. The ZCM/Hedge database has leverage for hedge funds described in various forms. All the forms are converted into a uniform measure of X times the asset value. Leverage varies from zero to 70 times the asset value.
6. **Redemption Frequency**: Hedge funds refrain from disclosure of their specific trading strategies. There is no direct measure of liquidity that could be calculated for hedge funds. Redemption frequency is considered as a measure of liquidity. The redemption frequency varies from daily to annual. Hedge funds with a redemption frequency of less than or equal to monthly are assigned a value of 1; hedge funds with a redemption frequency of greater than monthly are assigned a value of 2 and hedge funds with a redemption frequency greater than semiannually are assigned a value of 3 to indicate the extent of liquidity.
7. **Minimum Purchase**: It represents the size of a "unit share" in the particular hedge fund. It is used here not as a proxy for *size*, but as an obvious candidate in itself in explaining hedge fund return. Hedge funds try to make profit by arbitraging away the minor price differences between the market value and the fundamental value of the investment. Since the profit margin is very small, it is logical that they trade in bulk and minimum purchase is a characteristic that links directly to this behavior. It is expected that minimum purchase will be directly related to the hedge fund return.
8. **Asset Class**: The asset class is the broadest category, and defines the market in which the fund operates. For example, the asset classes could be stocks, *bonds*, currency (foreign exchange), options, futures, or warrants. Hedge funds are not required to give information as to their portfolio composition and avoid too much disclosure to discourage herding. This attribute is subdivided into four different sub-attributes: stocks, bonds, currency, and derivatives. Each of this subdivision is considered as a separate attribute for the modeling purpose and dummy variables are used to represent the use of the asset class by the hedge fund. The attribute derivative is composed of options, futures, and warrants. All the derivative instruments are clubbed together, and investment in any of these derivative instruments is considered as presence of the dummy variable derivatives.

4.1.1 Testing for multicollinearity

The first step in the development of the model is to explore the statistical characteristics of the fundamental variables. Table 1 and Table 2 display the correlation matrix for the state variables. All the fundamental variables are fund specific. The fundamental model has some variables (beta, beta-square, age, and size) that are time-dependent and fund specific. This means that the matrix of the cross-sectional regressors (independent variables) will be different for different time-periods. This creates a problem in calculating the correlation matrix for the regressors.

Since there are 132 time-periods, we will have to analyze 132 correlation matrices. The correlation matrix for January 1994 is shown in Table 1. The correlation matrices are computed for total hedge funds excluding FOF in order to have values for all the hedge funds. FOF is not included since all the data for the fundamental variables are not available for FOF.

Table 1. Correlation Coefficients for Fundamental Variables, January 1994.

	Beta	Beta-Sqr	Age	Size	Incent Fee	Leve rage	Rede mp	Min .Pur	Stock	Bond	Curr	Deri
Beta	1.00											
Beta-Square	.36	1.00										
Age	0	-.04	1.00									
Size	-.03	-.05	.14	1.00								
Incent. Fee	.06	.03	0	-.01	1.00							
Leve-rage	.03	-.01	.06	-.05	.17	1.00						
Redemp	-.04	-.04	-.06	-.06	.01	-.02	1.00					
Min. Pur.	-.11	-.09	-.10	-.07	-.05	-.09	.36	1.00				
Stock	0	-.04	-.01	-.05	-.09	-.06	.08	-.01	1.00			
Bond	.07	.06	-.09	0	.07	.13	.04	.09	-.31	1.00		
Curr	.12	.17	.02	.01	-.02	-.12	-.17	-.07	-.04	0.23	1.00	
Deri	.03	.06	.01	.01	.03	.08	-.05	.05	-.03	0.20	.11	1.00

As expected, the strongest correlation is between beta and beta-square. Even then, the correlation between these two variables is less than 0.6. In general, no variable has a correlation that should be of concern. Correlation matrices for other time-periods can be obtained and analyzed in a similar way. The presence of multicollinearity will distort the results of the significance of the slope coefficients.

It is important to check the extent of multicollinearity in the fundamental variables. The results of the auxiliary regression are reported in Table 2. None of the fundamental variables has VIF value greater than 2, leading to the conclusion that multicollinearity is not of concern for the variables chosen for the fundamental model.

Table 2. Results of the Multicollinearity Test for Fundamental Variables.

Variable	Number of Observations (n)	R-square	Variance Inflating Factor (VIF)	Number of Observations (n)	R-square	Variance Inflating Factor (VIF)
	Panel A. January, 1994			Panel B. December, 2004		
Beta	377	14.11%	1.1642	1244	64.76%	2.8379
Beta-Square	377	15.20%	1.1793	1244	64.02%	2.7791
Age	377	4.42%	1.0462	1244	5.60%	1.0593
Size	377	3.37%	1.0349	1244	4.71%	1.0495
Incentive Fee	377	4.09%	1.0427	1244	1.94%	1.0198
Leverage	377	8.57%	1.0937	1244	5.11%	1.0539
Redemption	377	16.61%	1.1991	1244	9.37%	1.1034
Minimum Purchase	377	16.94%	1.2040	1244	3.11%	1.0321
Stocks	377	12.08%	1.1374	1244	16.31%	1.1948
Bonds	377	21.49%	1.2738	1244	22.80%	1.2954
Currency	377	14.13%	1.1646	1244	11.56%	1.1307
Derivatives	377	5.86%	1.0622	1244	9.03%	1.0992

4.1.2 Testing for heteroscedasticity

Under the null hypothesis of no heteroscedasticity, the sample size (n) times the R^2 obtained from the auxiliary regression asymptotically follows the chi-square distribution with degrees of freedom equal to the number of regressors (excluding the constant term) in the auxiliary regression. That is, $n.R^2 \sim \chi^2_{df}$. If the chi-square statistic value $n.R^2$ exceeds the critical chi-square value at the chosen level of significance, the null hypothesis of no heteroscedasticity is rejected.

The test is carried out for total hedge funds (excluding FOF), for the first (January 1994) and last (December 2004) set of cross-sectional regression data. The results are reported in Table 3.

Table 3. Results of the Heteroscedasticity Test for Total Hedge Fund Data.

	Number of Observations	R-square	Chi-Square Stat
January, 1994	377	38.10%	143.62*
December, 2000	1244	4.57%	56.82**

*Significant at 10% level of significance - $\chi^2_{10\%,90df} = 107.56$.

**Not Significant at 5% level of significance - $\chi^2_{25\%,90df} = 98.6499$.

4.1.3 Weighted Least Square Estimation

As mentioned earlier, in presence of heteroscedasticity in the regression model, using the OLS estimator will lead to wrong inferences about the statistical significance of the slope coefficients. If the error terms are not homoscedastic, the variance-covariance matrix of the disturbance term cannot be written as $\sigma^2 I$, but must be written as a general matrix *G*. In such a case, the classical linear regression (CLR) model becomes generalized linear regression (GLR) model. In the GLR model, although β^{OLS} remains unbiased, it no longer has minimum variance among all linear unbiased estimators. The generalized least square (GLS) estimator β^{GLS} is BLUE. This estimator is obtained by minimizing an appropriately weighted sum of squared residuals (WLS estimation) instead of minimizing the sum of squared residuals (OLS estimation). Observations that are expected to have large residuals are given a smaller weight, and observations with expected smaller residuals are given a larger weight.

The GLS method produces a more efficient estimator by minimizing a weighted sum of squared residuals, where the weights are determined by the elements of the variance-covariance matrix *G* of the disturbance vector. The regression is carried out using the OLS and the WLS estimation procedure.

The WLS estimation procedure used here uses an iteratively reweighted least square algorithm, with the weights at each iteration calculated by applying a specific function to the residuals from the previous iteration. This algorithm gives lower weight to points that do not fit well. The results are less sensitive to outliers in the data as compared with ordinary least squares regression. Although robust, this procedure requires enough number of observations to do the iteration. The WLS regression could not be carried out for all the categories because of lack of enough return data for the categories.

4.1.4 Model

The model is implemented using a two-step approach. The regression involves estimating betas using time-series regression, and using the estimated betas for the cross-section regression of hedge funds. The hedge fund betas are estimated using rolling regression in the first step. The first set of betas is estimated for all hedge funds that are in the database as of December 1993 and have data available for at least the previous twelve months. For hedge funds that are in the database as of December 1993 and have previous data available for more than five years, the beta is calculated using only five years of data. The hedge fund return is regressed on the return of the market index *MSWI*. The regression is described in Equation 7.

$$[R_i] = \alpha_{im}[\iota] + \beta_{im}[R_{MSWI}] + [\varepsilon_i] \tag{7}$$

where R_i is the *(T x1)* vector of returns for hedge fund *i*; ι is the *(T x1)* vector of ones; and R_{MSWI} is the *(T x1)* vector of return for market index *MSWI*. *T* varies from 1 to a minimum of 12 or maximum of 60, depending on the availability of return data for the particular hedge fund. Thus, the estimated betas of individual hedge funds are from return data having a maximum of five years and a minimum of one year. This criterion is decided as a trade-off between having enough hedge funds for cross-sectional estimation and realizing that robust beta estimation should involve more time-series data. The fact that betas are not constant but change over time is taken into consideration by using rolling regressions. The next rolling betas are estimated for hedge funds that are in the database as of January 1994 and, meeting the above criterion of at least one year and maximum five years of time-series data.

In step two, a cross-sectional regression is carried out using the estimated betas, the squares of estimated betas, and other fundamental characteristics of the hedge funds as the independent variables. The following regression model is used:

$$\begin{aligned}[R_{it}] &= \gamma_{0t}[\iota] + \gamma_{1t}\left[\hat{\beta}_{i,t-1}\right] + \gamma_{2t}\left[\hat{\beta}^2_{i,t-1}\right] + \gamma_{3t}\left[Age_{i,t-1}\right] + \gamma_{4t}\left[Size_{i,t-1}\right] + \gamma_{5t}[Fee_i] \\ &+ \gamma_{6t}[Leverage_i] + \gamma_{7t}[\mathrm{Re}\,demption_i] + \gamma_{8t}[MinPur_i] \\ &+ \gamma_{9t}\left[D_{Stock_i}\right] + \gamma_{10t}\left[D_{Bonds_i}\right] + \gamma_{11t}\left[D_{Currency_i}\right] + \gamma_{12t}\left[D_{Derivattives_i}\right]\end{aligned} \tag{8}$$

where R_{it} is the *(N x1)* vector of returns for hedge fund ***i*** belonging to a class or a category; ι is the *(N x1)* vector of ones; and γ_{ik} is the *(N x K)* vector of factor sensitivities, *k* varies from 0 to 12 for 12 risk factors used in the regression. All the independent variables that are dependent on time, namely *beta, beta-square, age*, and *size* are lagged one period to avoid simultaneity that would otherwise be a problem in the regression. Dummy variables are used for the investment in the type of asset class, because of lack of information as to the exact portfolio composition. The expected signs of the coefficients are: *Beta* > 0; *BetaSquare* > 0; *Age* < 0; *Size* < 0; *Fee* > 0; *Leverage* < 0; *Redemption* > 0; and *AssetClass* > 0.

The general hypothesis to be tested is:

$H_o : \gamma_i = 0$ and $H_a : \gamma_i \neq 0$ for the coefficients of the independent variables.

The test-statistic $tstat(\hat{\gamma}_j)$ follows a t-distribution with *(T-1)* degrees of freedom.

$$tstat(\hat{\gamma}_j) = \frac{\hat{\gamma}_j}{\hat{\sigma}_j} \tag{10}$$

where: $\hat{\gamma}_j = \frac{1}{T}\sum_{t=1}^{T}\hat{\gamma}_{jt}$ and $\hat{\sigma}_j^2 = \frac{1}{T(T-1)}\sum_{t=1}^{T}\left(\hat{\gamma}_{jt} - \hat{\gamma}_j\right)^2$ (11)

The study period for the fundamental model is from January 1994 to December 2004 for the cross-sectional regression. The data from **January 1989 to December 1993** is used for the time-series regression to estimate the first beta for each hedge fund. The study is carried out on an after-fee and before-fee basis, and with equal-weighted and value-weighted return calculation. The cross-section regression is carried out for a seven-year period, from January 1994 to December 2000. The dependent variable is the return for all the hedge funds in a category or class for a time period t. Since a seven-year period (**n=84 months**) is used for the cross-section regression; there will be eighty-four estimates of γ_{it}

for each explanatory variable from the regression given in Equation 8. Using market beta as one of the explanatory variables in the regression controls the possibility of the correlation in the errors in the cross-sectional regression.

5.0 Results

Table 4 provides the coefficients and their significance levels for the cross-section regression for all the categories of hedge funds using the OLS and WLS estimation procedure. For the OLS regression the null hypothesis $H_o : \gamma_i = 0$ is not rejected at practically all levels of significance, for most of the explanatory variables. The explanatory variables that have explanatory power that is statistically significant are *redemption, minimum purchase,* and *stocks*, although this is not true for all of the categories. Not surprisingly, the results using WLS regression are different from those obtained using the OLS estimation procedure. The explanatory variables that have explanatory power that is statistically significant are *size, minimum purchase, and stocks*.

The variable *size* has a negative coefficient that is statistically significant. The economic interpretation of this result is the presence of diseconomies of scale in the hedge fund industry. As size increases, the possibility of capturing the profits using proprietary trading technique decreases. *Minimum purchase* has a positive coefficient and is statistically significant. This confirms the conjecture that higher level of investment in a funds leads to higher return. It is possible because the hedge fund manager is able to capture the profit attributable to minor price differential. The coefficient is significant but not large in absolute terms. This is because as the hedge fund manager trades in bulk to take advantage of the price differential, his action ultimately makes the market more efficient and soon there is no arbitrage opportunity left. This is possibly the reason why hedge funds managers try to avoid herding. The variable *stocks* has a positive coefficient that is statistically significant. The economic interpretation of this result is that hedge funds invest in the same traditional asset classes as mutual funds.

Table 5 displays the regression coefficients for the class of hedge funds using the OLS and the WLS estimation procedures. The independent variables *market beta, size, leverage, redemption frequency, minimum purchase, bonds,* and *currency* are statistically significant at a 10% level of significance for total hedge funds excluding FOF. The statistically significant positive coefficient of the variable *market beta* confirms the conjectures that the hedge funds, like mutual funds, are net long in the market. The negative coefficient of the variable *redemption* is not consistent with the hypothesis of higher return for less liquid investments. The positive coefficient of the variable *leverage* is exactly opposite of what was conjectured and what is famous in the popular press. It appears that though hedge funds use a high amount of leverage, use of the leverage has been beneficial to the hedge funds. The positive coefficient of the variable *minimum purchase* explains the fact that a higher amount of minimum purchase helps the hedge fund manager to profit from minor price differentials in the investments.

Table 4. Category Regression Coefficients

Variable	Event Driven (n=132)		Global Regional Established (n=132)		Global Macro (n=132)		Market Neutral (n=132)	
	OLS	WLS	OLS		OLS	WLS	OLS	WLS
Market Beta	0.590	**0.441*** **	0.307	**0.522*** **	**0.668***	0.333	0.026	**0.402**
Market Beta Square	-0.332	**0.780*** **	-0.033	0.459	0.164	0.277	0.077	-0.034
Age	-0.002	**-1.289*** **	**-0.002***	**-0.289** **	0.002	0.147	-0.001	-0.193
Size	0.000	**-0.002** **	0.000	**-0.001***	0.000	0.003	**0.000** **	**-0.001**
Incentive Fee	0.010	0.000	**-0.121** **	0.000	**-0.210***	**0.000***	**-0.081** **	0.000
Leverage	0.022	-0.047	0.041	**-0.157*** **	**0.165*** **	**-0.264*****	0.030	**-0.067**
Redemption	**0.062** **	0.025	**0.080*** **	-0.031	0.003	0.074	0.022	0.007
Min. Purchase	0.080	0.010	**0.159*** **	0.038	0.077	-0.031	**0.122*** **	0.008
Stocks	0.028	0.021	**0.112*** **	**0.086*** **	-0.132	0.068	**0.046** **	**0.040**
Bonds	**-0.044***	-0.013	0.042	**0.053***	-0.048	-0.044	**0.053** **	**-0.023**
Currency	0.054	**-0.035** **	0.016	**0.035***	-0.033	-0.029	**-0.060** **	**0.022**
Derivatives	0.003	**0.043** **	-0.027	**0.045***	**-0.114**	0.056	-0.002	-0.013

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

Table 5. Selected Class Regression Coefficients using the Fundamental Factor Model.

Variable	HF-US		HF-NON		Total Excluding FOF	
	OLS	WLS	OLS	WLS	OLS	WLS
Market Beta	0.232	**0.351*** **	0.267	**0.485*** **	0.236	**0.373*** **
Market Beta Square	-0.090	0.241	-0.023	0.276	-0.050	0.280
Age	0.003	-0.064	**-0.002** **	-0.071	0.000	**-0.132***
Size	0.000	0.000	0.000	**-0.001** **	0.000	0.000
Incentive Fee	-0.076	0.000	**-0.096** **	0.000	**-0.089** **	0.000
Leverage	**0.050***	**-0.117*** **	0.021	**-0.131*** **	**0.035***	**-0.116*** **
Redemption	0.036	-0.007	**0.068*** **	**0.031*** **	**0.058*** **	**0.017** **

Minimum Purchase	**0.075*** **	0.010	**0.142*** **	0.016	**0.116*** **	**0.018***
Stocks	0.048	**0.058*** **	0.026	**0.062*** **	0.038	**0.067*** **
Bonds	0.031	-0.009	0.028	**-0.032** **	**0.028***	**-0.027** **
Currency	0.024	-0.007	**-0.058** **	-0.001	-0.016	-0.006
Derivatives	-0.036	0.012	-0.034	0.021	-0.028	**0.019***

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

The positive coefficient of the variable *bonds* implies that hedge funds correlated with long-term bond returns are more valuable than hedge funds that are negatively correlated to long-term bond return. The negative coefficient of the variable *currency* hints that hedge funds have not been able to use currency as an investment instrument to their advantage. The difference between the results of hedge funds domiciled in the U.S. (*HF-US*) and those domiciled outside the U.S. (*HF-NON*) is that the variables - *size, leverage,* and *stocks* - are not significant for hedge funds domiciled outside the U.S. It appears that the fundamental variables chosen for the model are successful in explaining hedge fund return for the total hedge fund (excluding FOF) and hedge funds domiciled in the U.S. The same model is not successful in explaining the return of hedge funds domiciled outside the U.S.

It should be noted that the variables - *market beta-square, incentive fee,* and *derivatives* - do not have any explanatory power in either class or category of hedge funds. This suggests that the non-linear bets that hedge funds take on the market do not have much impact on the return. The fee structure of hedge funds does not have much explanatory power nor does the use of derivatives by hedge funds explain their higher return. Although the analysis is done using three market indices: the *S&P 500,* the *MSWI,* and the *Russell 3000,* both on a before-fee and after-fee basis, the results are reported only for the *MSWI* for the sake of brevity. The different market indices produce similar results, but the results are different for the OLS and WLS estimation procedures.

6.0 Conclusion

The fundamental factor model is developed using fund attributes that should have an effect on hedge fund return. The analysis is carried out using the OLS and the WLS estimation procedure. The results are different for the different estimation procedure leading to the conclusion that caution is appropriate when interpreting results from the OLS coefficients because of potential presence of heteroscedasticity in the cross-sectional data.

The variables that have explanatory power for the category of hedge funds are *size, minimum purchase, and stocks*. The negative coefficient of the variable *size* indicates the presence of diseconomies of scale in the industry. The positive coefficient of the variable *minimum purchase* confirms the conjecture that the hedge fund manager is able to capture the profit attributable to minor price differential through higher level of investment. The positive coefficient of the variable *stocks* tells that hedge funds invest in the same traditional asset classes as mutual funds.

For the class of hedge funds, the independent variables - *market beta*, *size, leverage, redemption frequency, minimum purchase, bonds, and currency* - are statistically significant. The positive coefficient of the variable *market beta* confirms the conjecture that the hedge funds are net long in the market. The negative coefficient of the variable *redemption* is not consistent with the hypothesis of higher return for less liquid investments. The positive coefficient of the variable *leverage* indicates that hedge fund managers have been able to use leverage to their advantage. The positive coefficient of the variable *minimum purchase* explains the fact that a higher amount of minimum purchase helps the hedge fund manager to profit from minor price differentials in the investments.

The positive coefficient of the variable *bonds* implies that hedge funds correlated with long-term bond returns are more valuable than hedge funds that are negatively correlated to long-term bond return. The negative coefficient of the variable *currency* indicates that hedge funds have not been able to use currency as an investment instrument to their advantage. It appears from the analysis that the fundamental variables chosen for the model are successful in explaining hedge fund return for hedge funds domiciled in the U.S. but not for hedge funds domiciled outside the U.S.

6.0 References

Ackerman, Carl, Richard McEnally and David Ravenscraft (1999), “The Performance of Hedge Funds: Risk, Return, and Incentives,” *The Journal of Finance*, 833-874.

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

Brown, Stephen J., William N. Goetzmann and James Park (2001), “Careers and Survival: Competition and Risk in the Hedge Fund and CTA Industry,” *The Journal of Finance*, (56:5), 1869-1886.

Brown, Stephen J. and William N. Goetzmann (1995), "Performance Persistence," *The Journal of Finance* 50:2, 679-698.

Brown, Stephen J., William N. Goetzmann and James Park (2000), "Hedge funds and the Asian Currency Crisis of 1997," *The Journal of Portfolio Management*, 95-101.

Brown, Stephen J., William N. Goetzmann and Roger G. Ibbotson (1999), "Offshore Hedge Funds: Survival and Performance 1989-1995," *Journal of Business* 72:1, 91-117.

Chen, Nai-Fu, Richard Roll and Stephen A. Ross (1986), "Economic Forces and the Stock Market," *The Journal of Business* 59:3, 383-403.

Connor, Gregory (1995), "The Three Types of Factor Models: A Comparison of Their Explanatory Power," *Financial Analysts Journal* 51:3, 42-46.

Das, Nandita and Muething, David L (2007), 'Bias in Hedge Fund Data', *Pennsylvania Journal of Business and Economics*

Das, Nandita, Kish, Richard J. and Muething, David L (2005), 'Modeling Hedge Fund Return', *Financial Decisions, Vol. 17, No. 3, Article 4.*

Das, Nandita: 'A New Approach to Hedge Fund Classification', *Indian Journal of Economics & Business*, Fall 2005.

Fama, Eugene F. and James D. MacBeth (1973), "Risk, Return, and Equilibrium: Empirical Tests," *The Journal of Political Economy* 81:3, 607-636.

Franklin, R. Edwards and Jimmy Liew (1999), "Hedge Funds Versus Managed Futures as Asset Classes," *Journal of Derivatives*, 45-64.

Franklin, R. Edwards (1999), "Hedge Funds and the Collapse of Long Term Capital Management," *Journal of Economic Perspectives* 13:2, 189-210.

Fung, William and David A. Hsieh (2002), "Benchmarks of hedge-fund performance: Information content and measurement bias," *Financial Analysts Journal*, 23-34.

_____ (2001a), "The Risk in Hedge Fund Strategies: Theory and Evidence from Trend Followers," *The Review of Financial Studies* 14:2, 313-341.

_____ (2001b), "Performance Characteristics of Hedge Funds and Commodity Funds: Natural versus Spurious Biases," *Journal of Financial and Quantitative Analysis* 35:3, 291-307.

_____ (1997a), "Empirical Characteristics of Dynamic Trading Strategies: The Case of Hedge Funds," *The Review of Financial Studies* 10:2, 275-302.

Goetzmann, William N., Jonathan Ingersoll Jr. and Stephen A. Ross (1998), "High Water Marks," NBER *Working Paper*, February.

Goldman, Sachs & Co. & FRM (2000), "Hedge Funds Revisited," *Pensions and Endowment Forum*, January.

Goldman, Sachs & Co. & FRM (1998), "Hedge Funds Demystified: Their Potential Role in Institutional Portfolios," *Pensions and Endowment Forum*, July.

McFall, Lamm Jr. R., and Tanya E. Ghaleb-Harter (2000a), "Hedge Funds as an Asset Class: An update on performances and attitude," *Deutsche Asset Management Journal*, 1-15.

_____ (2000b), "Optimal Hedge Fund Portfolios," *Deutsche Asset Management Journal*, 1-12.

_____ (2000c), "Performance Persistence in Hedge Funds: Winners Do Repeat," *Deutsche Asset Management Journal*, 1-8.

McFall, Lamm Jr. (1999), "Portfolio of Alternative Assets: Why not 100% Hedge Funds," *The Journal of Investing*, 87-97.

Purcell, David, and Paul Crowley (1999), "The Reality of Hedge Funds," *The Journal of Investing*, 26-44.

Schneeweis, Thomas (1998), "Managed Futures, Hedge Fund and Mutual Fund Performance: An Equity Class Analysis," *The Journal of Alternative Investments*, 11-14.

Schneeweis, Thomas and Richard Spurgin (1998), "Estimation: A Multi-factor Analysis of Hedge Fund, Managed Futures, and Mutual Fund Return and Risk Characteristics," *Journal of Alternative Investments,* 1-24.

Schneeweis, Thomas (1998), "Dealing with the myths of Hedge Fund Investment," *The Journal of Alternative Investments*, 11-14.