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Risk and returns of hedge funds investment strategies

Abstract

This paper examines the risk and return performance of hedge fund investment strategies. Specifically, the authors examine the characteristics of the twelve main investment strategies commonly employed by hedge funds, and measure their risk exposures and risk-adjusted returns. The article finds that on average, hedge fund returns have relatively low correlations with the market and thus investments in hedge funds could potentially offer better opportunities for diversification. Using the Carhart (1997) multi-factor asset-pricing model, the authors estimate the alphas and betas of the twelve hedge fund investment strategies. It is found that each of these twelve investment strategies seem to produce on average positive and statistically significant alphas which measure abnormal returns in excess of what would be predicted by an equilibrium model such as the CAPM and a multi-factor asset-pricing model. In addition, the structure for management fee and incentive fee for each investment strategy does not seem to be in line with the level of positive alphas that a particular strategy is expected to produce. Overall, over our study period, these hedge fund investment strategies have low beta exposure, and are more likely to generate higher Sharpe ratios and positive alphas.

Keywords: hedge funds, risk-adjusted returns, investment strategies.
JEL Classification: G10, G11, G17, G20, G30, G32.

Introduction

The collapse of the long-term capital management in 1997, the liquidation of several hedge funds over the last few years, and recent government investigations into hedge fund insider trading scandals have left many investors demanding a better understanding of the hedge funds investment strategies. On the one hand, researchers argue that hedge funds strategies dominate mutual funds strategies and provide a more efficient investment opportunity set for investors (Liang, 1999). On the other hand, the common perception in the general public is that hedge funds investments are extremely risky and their operations are totally lack of transparency. While in extreme cases operational risk events can lead to fund failure, Brown et al. (2007) show that operational risk associated with conflicts of interest both within the fund and external to the fund can lead to a reduction in return of on average of 1.68 percent on an annualized basis. Because their trading strategies are considered proprietary and not disclosed to the investors, it is even more challenging to make a risk assessment.

In this study, we attempt to extend our understanding of hedge funds in several ways. First, we examine the performance of various hedge funds investment strategies. Second, using a multi-factor model, we estimate the factor loadings and alphas of different types of hedge funds strategies versus a broadly diversified benchmark index. Finally, we estimate the risk-adjusted returns performance of these strategies. We posit that the investors of hedge funds are highly sophisticated and are close to be "rational" and even "informed" investors in comparison to "naïve" or noise traders. Hence, we hypothesize that the investment strategies used by hedge funds are based on quantitative financial modeling, have low beta exposure, and are likely to generate higher Sharpe ratios and positive alphas.

Our sample consists of 7809 hedge funds with a total of 483,975 monthly return observations for a long stretch of time period from year 1972 through to year 2005 which covers market ups and downs over both stable and turbulent periods of hedge fund history. Using the Carhart (1997) multi-factor asset-pricing model, we examine in particular the alphas and betas of the twelve major hedge funds investment strategies for the period of January 1990 to March 2006. We find that each of these strategies outperform S&P 500 market index on a risk-adjusted basis. In addition, we find that hedge funds provide better opportunities for diversification by their low correlation with different indices. However, our exploration as to the pros and cons on hedge funds regulations is inconclusive.

The remainder of this paper is organized as follows. Section 1 reviews the literature, Section 2 describes the data and methodology, Section 3 presents empirical results, and the last Section concludes the paper.

1. Literature review

1.1. Definitions and history of hedge funds. Hedge funds are private investment partnerships that require these partners make substantial investments. They are largely unregulated pools of money managed by a hedge fund manager who typically has a great deal of flexibility including taking short positions, extensive use of leverage, and derivatives. In contrast, mutual fund managers are not allowed to take short positions, to borrow, and make limited use of derivatives (Koski and Pontiff, 1999). Koh et al. (2002) observes that more than half of U.S.

hedge funds manage amounts of less than US$25 million. It is estimated that 70% of hedge funds use leverage and about 18% borrowed more than one dollar for every dollar of capital. Another peculiar feature is the short life span of hedge funds. Hedge funds have an average life span of about 3.5 years. Hedge funds appear to be a highly opportunistic approach to investing that could present major gain or major loss within its short life-span.

Alternative investments have been around for quite some time. Kat and Palaro (2006) notes that the "the first hedge fund [is] said to be dating back to 1949". Academic research into hedge funds, however, only really made a presence in the late 1980s and the early 1990s. Garbaravicius and Dierick (2005) point out that there is no legal or even generally accepted definition of a hedge fund. Koh et al. (2002) present three determinants of what constitutes a hedge fund: (1) hedge funds 'hedge' the market by creating a market 'neutral' position; (2) the hedge fund manager is compensated by earning a percentage of the profits realized by his clients' assets; (3) the manager invests his own investment capital in the fund, ensuring that his incentives and those of his investors are truly aligned, thus creating a 'partnership'. Goetzmann et al. (1998) also observes that there's no common definition for a hedge fund. They are merely defined by their freedom from regulatory controls stipulated by the Investment Company Act of 1940. These controls limit short selling, fund leverage, holding 10% of the shares of any single company, or holding shares of other investment companies. According to Barry (2002), the Investment Company Act of 1940 prohibits hedge funds from marketing directly to U.S. investors.

There are two main types of hedge funds: U.S. onshore and offshore. Onshore U.S. hedge funds are what we've talked about previously whereas offshore hedge funds are limited liability corporations or partnerships setup in tax havens such as the Bahamas, Bermuda or the British Cayman islands, in order to minimize tax liabilities. Liang (1999) notes that offshore fund investors could be either "non-U.S. or U.S. tax-exempt investors". Offshore funds tend to offer more flexibility as they offer more privacy, enjoy certain tax advantages, and are not restricted as to the number of investors. One of the more innovative offshore fund structures which allows for both off-and-onshore investors is a Passive Foreign Investment Company (PFIC)[1].

[1] Passive Foreign Investment Company (PFIC) is a fund that accepts both offshore and onshore investors but must maintain at least a majority of offshore investors' assets in the fund at all times.

1.2. Hedge funds performance. Despite the recent increase of government investigation into the insider-trading behavior of several hedge funds, the industry remains largely unregulated. They are not required to disclose their trading positions, or report their risk and return performance. Most of the hedge fund returns are reported to data collectors on a voluntary basis. This posts a special challenge to measure the actual risk and return performance.

Previous researchers have inconclusive arguments related to hedge fund returns performance. The common perception is that hedge funds may have superior returns. In recent years, hedge funds often make headlines because of either a huge gain or a huge loss. There are many anecdotal stories about the stunning success of hedge fund managers and their skills. George Soros' Quantum Fund was reported to have obtained returns in excess of 30% per annum over a long period.

While some researchers documented a positive relation between the incentive fee and the funds performance (Ackermann, McEnally, and Ravenscraft, 1999; Brown, Goetzmann, and Ibbotson, 1999; Liang, 1999; Edwards and Caglayan, 2001), other researchers find it difficult to conclude that hedge funds can outperform the market or mutual funds (Agarwal et al., 2004; Fung and Hsieh, 1997). Ackermann et al. (1999) find that hedge funds outperform mutual funds even on a risk-adjusted basis even though the Sharpe ratio assumes a specific risk-return trade-off that may not reflect the preferences of the typical mutual fund investor. They also find that hedge funds are certainly more volatile compared to mutual funds with one exception, global stocks. Brown et al. (1999), Liang (1999), Capocci et al. (2005) find that hedge funds have been able to outperform various market indices, while the results from Ackermann et al. (1999), Agarwal and Naik (2004) are mixed.

Stulz (2007) identifies four main problems that academic researchers are faced with when assessing hedge fund performance. First, the sample reports of hedge fund performance are based on *biased samples*. Databases only report the performance of hedge funds that voluntarily send their returns to the sponsoring organizations. The range of estimates of these biases is wide, from roughly less than 100 basis points per year (Ackerman, McEnally, and Ravenscraft, 1999) to more than 400 basis points at the high end (Malkiel and Saha, 2005). Second, a fair estimate of hedge fund returns must *adjust performance for market exposures.* Because hedge funds' market risk exposure can vary tremendously over a short period of time, it is difficult to assess these exposures based on a limited sample of

monthly returns. A third difficulty in assessing hedge fund returns is that the past performance of a particular hedge fund may give a very selective view of its risk. The fourth difficulty in calculating hedge fund returns involves problems of *valuation*. Because hedge fund managers are not required to disclose their return performance periodically, they can use the flexibility that they have in valuing the securities they hold to massage their returns and present a picture of low risk and consistent performance (Getmansky, Lo, and Makarov, 2004).

Thus, these challenges give us the research motivation to further examine the risk-return performance of the investment strategies used by hedge funds.

1.3. Investment strategies. There is a number of different strategies used by hedge fund managers, each offering different degrees of risk and return. According to the Center for International Securities & Derivatives Markets (CISDM), there are twelve main hedge fund investment strategies described as follows:

1. *Equity Market Neutral* strategies take long equity positions and an approximately equal dollar-amount of offsetting short positions in order to achieve a net exposure as close to zero as possible.
2. *Convertible Arbitrage* strategies take long positions in convertible securities (usually convertible bonds) and try to hedge those positions by selling short the underlying common stock. Convertible bond arbitrage funds typically capitalize on the embedded option in these bonds by purchasing them and shorting the equities.
3. *Fixed Income* strategies attempt to take advantage of mispricing opportunities between different types of fixed income securities while neutralizing exposure to interest rate risk.
4. *Event Driven* strategies attempt to predict the outcome of corporate events and take the necessary position to make a profit. These trading managers invest in events like liquidations, spin-offs, industry consolidations, reorganizations, bankruptcies and so forth.
5. *Merger/Risk Arbitrage* strategies concentrate on companies that are the subject of a merger, tender offer or exchange offer. *Merger/Risk Arbitrage* strategies take a long position in the acquired company and a short position in the acquiring company.
6. *Distressed* strategies take positions in the securities of companies where the security's price has been, or is expected to be affected by a distressed situation like announcement of reorganization due to financial or business difficulties.
7. *Equity Hedge* strategies take long and short equity positions varying from net long to net short, depending if the market is bullish or bearish. The short exposure can also be a put option on a stock index, which is used as a hedging technique for bear market conditions.
8. *Global/Macro funds* refer to funds that rely on macroeconomic analysis to take bets on major risk factors, such as currencies, interest rates, stock indices and commodities.
9. *Short Selling* strategies take short positions in U.S. equities with expectation of price declines.
10. *Sector Funds* concentrate on selective sectors of the economy. For example, they may focus on technology stocks if these are overpriced and rotate across to other sectors.
11. *Long-only Funds* are funds that take long equity positions typically with leverage. Emerging market funds that do not have short-selling opportunities also fall under this category.
12. *Fund of Funds* refer to funds that invests in a pool of hedge funds. This strategy gives everyday investors a chance to join the excitement of investing in hedge funds. They specialize in identifying fund managers with good performance and rely on their good industry relationships to gain entry into hedge funds with good track records.

The strategies listed above, though not complete, are the main ones. They have different names from manager to manager but all have similar investment strategies.

2. Data and methodology

Our data on hedge funds are obtained from the Center for International Securities & Derivatives Markets (CISDM) database at the University of Massachusetts in Amherst. The CISDM hedge fund database is one of the three major hedge fund databases that have more than ten years of actual data collection experience. And the CISDM hedge fund database (formerly the MAR database) is the oldest hedge fund database in the market, followed by the HFR database and the TASS database. These three databases are widely used in academic and commercial hedge fund studies. For instance, the CISDM hedge fund database is used, among others, by Fung and Hsieh (1997), Schneeweis and Spurgin (1998), and Amin and Kat (2003a; 2003b). Thus, we can safely argue that the CISDM hedge fund database has the credibility for academic researchers to conduct research on hedge funds.

From the CISDM database, we have extracted a sample of 7809 hedge funds with a total of 483,975 monthly return observations from year 1972 through

to year 2005. Although CISDM Database me obtained has 7809 hedge funds, quite many hedge funds have missing data. We are thus left with a total of 483,975 monthly return data on individual hedge funds.

Survivorship bias is an important issue in hedge fund data. As pointed out in several studies (for instance, Brown et al., 2001), survivorship bias is very likely to be present and not negligible, although hardly measurable, for the period before 1994. This bias could potentially severely affect statistical inferences (Carhart et al., 2002). In order to minimize the survivorship bias problem, we select data on hedge fund indices based on hedge fund strategies instead of individual hedge funds. The hedge fund strategy indices are subject to less survivorship bias than individual hedge funds. Thus, from the CISDM database, we have collected monthly return data on hedge fund indices based on hedge fund strategies which are classified by the CISDM database for the period of January 1990-March 2006. The data on hedge fund strategy are constructed into indices in the CISDM database which include both live and dead funds. Thus, the data on hedge fund strategy indices are not subject to survivorship bias. Since hedge fund industry is very opaque, there are no observations on the changes of each hedge fund's strategy. All we can observe is the monthly returns of each of these twelve strategies over time which is presented in Figure 3 – annualized return performance by strategy and Figure 4 – the yearly volatility by strategy. To further minimize the survivorship bias problem, we include both live and dead funds so that we can correct for survivorship bias. Each of these twelve strategies has a total of 195 monthly returns data from January 1990 to March 2006. Thus, the sample size on the twelve major hedge fund strategies has a total of 2,340 monthly return observations.

Our benchmarking analyses employ the index data for the same corresponding period. We also computed and extracted data on four factors used in our asset valuation model, namely market excess returns factor, small stock portfolio returns minus large stock portfolio returns factor, value stock portfolio minus glamour stock portfolio factor, and momentum factor. The data on these four factors are extracted from CRSP for the period of January 1990-March 2006.

We use several methods to measure the returns and risk performance of hedge funds. In our first step of analysis, we measure our sampled hedge fund performance based on monthly holding period returns following the methods commonly used by previous researchers:

$$r_j = \frac{P_t}{P_{t-1}} - 1, \tag{1}$$

where r_j are the monthly returns, P_t is the price at time t.

Following previous researchers, our annual returns are computed as follows:

$$R_j = (1 + r)^{12}, \tag{2}$$

where R_j are the yearly returns.

In our regression analysis of hedge funds' risk-adjusted performance, we adopted a factor model based on the Carhart (1997) four-factor asset pricing model specified as follows:

$$r_{jt} - rf_t = \alpha + \beta_1 mktrf_{it} + \beta_2 smb_{it} + \\ + \beta_3 hml_{it} + \beta_4 umd_{it} + \varepsilon, \tag{3}$$

where $r_{it} - rf_t$ is the excess fund return; *mktrf* is the value weighted excess return on the market portfolio; *smb* is the difference in return between a small capital portfolio and a large capital portfolio; *hml* is the difference in return between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks, *umd* is the difference in return between a portfolio of past winners and a portfolio of past losers.

The rationale for using the Carhart (1997) multi-factor asset-pricing model lies in the recent literature on the cross-sectional variation of stock returns. Most mutual fund studies prior to the 90's make use of a Capital Asset Pricing Model (CAPM) based single index model. The intercept of such a model gives the Jensen alpha, which is usually interpreted as a measure of abnormal return in excess of what would be predicted by an equilibrium model like CAPM or Asset Pricing Theory (APT). Because of the wide diversity of stated investment styles, ranging from growth to small cap, it is preferable to use a multi-factor model to account for all possible investment strategies. The studies performed by Fama & French (1992; 1993; 1996) and Chan, Jegadeesh & Lakonishok (1996) lead us to question the adequacy of a single index model to explain mutual fund performance. Therefore the Fama & French (1993) 3-factor model has been considered to give a better explanation of fund behavior. Besides a value-weighted market proxy two additional risk factors are used, size and book-to-market. Although this model already improves average CAPM pricing errors, it is not able to explain the cross-sectional variation in momentum-sorted portfolio returns. Therefore, Carhart (1997) extends the Fama-French model by adding a fourth factor that captures the

Jegadeesh & Titman (1993) momentum anomaly. The resulting model is consistent with a market equilibrium model with four risk factors, which can also be interpreted as a performance attribution model, where the coefficients and premia on the factor-mimicking portfolios indicate the proportion of mean return attributable to four elementary strategies.

To compare the risk-adjusted return performance between various hedge fund strategies versus the performance of S&P 500 market index, we computed a yearly Sharpe ratio for each hedge fund strategy and for S&P 500 market returns. The Sharpe ratio is computed as follows:

$$Sharpratio = \frac{\overline{R}_i - \overline{R}_f}{\sigma_i}, \quad (4)$$

where R_i is the return on asset I, R_f is the risk-free rate (T-bill rate), σ_i is the standard deviation of monthly returns (volatility/risk of investment).

We also plotted an efficient frontier for each hedge fund strategy in contrast to the S&P 500 market efficient frontier.

3. Empirical results

Table 1 provides the summary statistics on our sample for each hedge fund strategy, hedge fund management fees, and hedge fund incentive fees. The first panel of Table 1 shows the summary statistics for the monthly returns of twelve hedge fund strategies, namely Equity Market Neutral, Convertible Arbitrage, Fixed Income, Event Driven, Merger/Risk Arbitrage, Distressed Securities, Equity Long/Short, Global Macro, Short Bias, Sector, Equity Long Only and finally Fund of Funds. Over the period of March 1972-November 2005, those hedge funds that adopted the Sector strategy achieved the highest monthly mean and median returns of 1.4% and 1% respectively, followed by equity Long/Short and Distressed Security strategy with a mean returns of 1.20% and median returns of 0.89% and 1.01%, respectively. Short Bias strategy achieved the lowest monthly mean and median returns 0.33% and 0.23%, respectively. In terms of total risk as measured by standard deviation, the Sector strategy has the highest volatility of returns.

The second panel of Table 1 shows the management fee structure for each of the twelve hedge fund strategies. The Global Macro strategy had the highest mean and median with 1.50% and 1.25%, respectively. All other strategies tend to have a mean between 1.20% and 1.30% and a median at 1% whereas Fund of Funds has a mean management fee of 1.40% and 1.50%, respectively. Short Bias has the lowest management fee of 1.11% and 1%, respectively. Event Driven also stands out with a median management fee of 1.50%.

Table 1. Summary statistics for hedge fund by strategy (March 1972-November 2005)

	Strategy	Mean	Median	Std. deviation	Minimum	Maximum
Return	Equity Market Neutral	0.68%	0.59%	3.59%	-82.00%	49.10%
	Convertible Arbitrage	0.90%	0.83%	3.07%	-41.03%	68.70%
	Fixed Income	0.60%	0.71%	2.71%	-59.68%	27.24%
	Event Driven	1.14%	1.00%	4.29%	-54.29%	88.47%
	Merger/Risk Arbitrage	0.78%	0.65%	3.41%	-34.62%	184.17%
	Distressed Securities	1.20%	1.01%	4.59%	-58.26%	60.98%
	Equity Long/Short	1.20%	0.89%	7.61%	-99.99%	904.48%
	Global Macro	1.01%	0.70%	5.96%	-68.64%	106.40%
	Short Bias	0.33%	0.23%	7.89%	-57.40%	72.21%
	Sector	1.41%	1.00%	8.19%	-78.01%	90.91%
	Equity Long Only	1.12%	1.04%	8.14%	-54.86%	83.54%
	Fund of Funds	0.75%	0.68%	2.51%	-89.00%	84.00%
Management fee	Equity Market Neutral	1.26%	1.00%	51.33%	0.00%	2.50%
	Convertible Arbitrage	1.25%	1.00%	45.87%	0.00%	2.00%
	Fixed Income	1.32%	1.00%	83.31%	0.00%	6.00%
	Event Driven	1.38%	1.00%	39.96%	0.00%	3.00%
	Merger/Risk Arbitrage	1.20%	1.00%	50.85%	0.00%	3.00%
	Distressed Securities	1.38%	1.00%	98.02%	0.00%	10.00%
	Equity Long/Short	1.19%	1.00%	79.05%	0.00%	20.00%
	Global Macro	1.50%	1.00%	75.38%	0.00%	5.00%
	Short Bias	1.11%	1.00%	49.09%	0.00%	2.50%
	Sector	1.20%	1.00%	37.27%	0.00%	2.50%
	Equity Long Only	1.17%	1.00%	44.33%	0.00%	2.40%
	Fund of Funds	1.40%	1.50%	40.40%	0.00%	2.50%

Table 1 (cont.). Summary statistics for hedge fund by strategy (March 1972-November 2005)

	Strategy	Mean	Median	Std. deviation	Minimum	Maximum
Incentive fee	Equity Market Neutral	1.26%	1.00%	51.33%	0.00%	2.50%
	Convertible Arbitrage	1.25%	1.00%	45.87%	0.00%	2.00%
	Fixed Income	1.32%	1.00%	83.31%	0.00%	6.00%
	Event Driven	1.38%	1.50%	39.96%	0.50%	3.00%
	Merger/Risk Arbitrage	1.20%	1.00%	50.85%	0.00%	3.00%
	Distressed Securities	1.38%	1.00%	98.02%	0.00%	10.00%
	Equity Long/Short	1.19%	1.00%	79.05%	0.00%	20.00%
	Global Macro	1.50%	1.25%	75.38%	0.00%	5.00%
	Short Bias	1.11%	1.00%	49.09%	0.00%	2.50%
	Sector	1.20%	1.00%	37.27%	0.00%	2.50%
	Equity Long Only	1.17%	1.00%	44.33%	0.00%	2.40%
	Fund of Funds	1.40%	1.50%	40.40%	0.00%	2.50%

Figure 1 and Figure 2 graphically present the mean monthly and annual returns of these 7809 hedge funds grouped by each of the twelve hedge fund strategies. As seen, the Sector strategy evidently has the highest mean monthly and annual return and Equity Long/Short and distressed securities. Short Bias, as discussed, has the lowest monthly and annual mean returns.

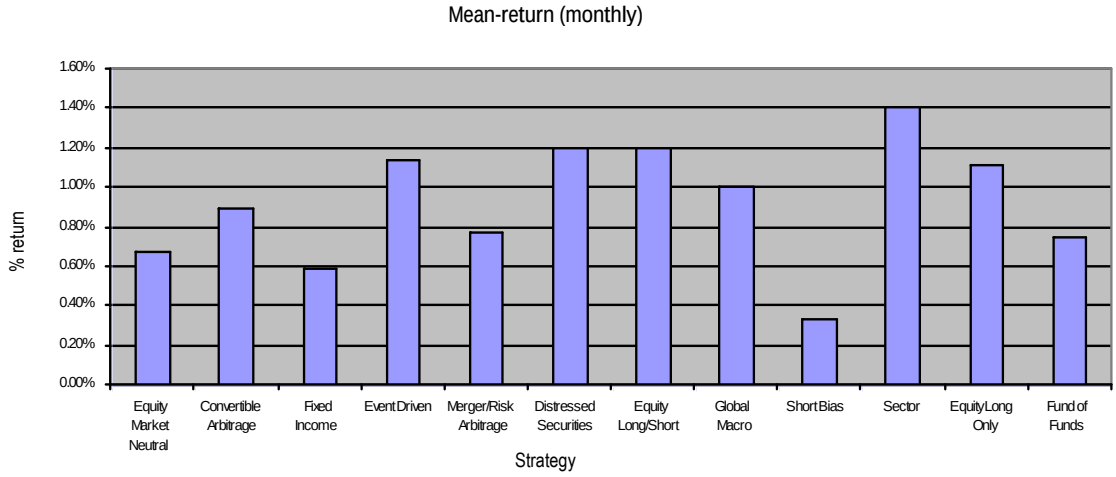

Fig. 1. Monthly mean returns for individual hedge funds by strategy

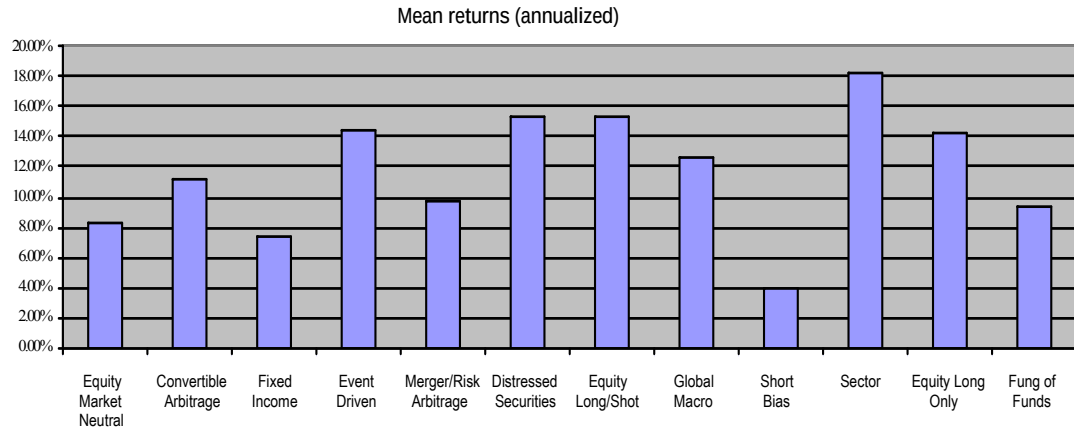

Fig. 2. Annualized mean returns for individual hedge funds by strategy

Figure 3 shows the yearly return performance of the hedge fund indices. All hedge fund indices seem to follow the market but always at a higher percentage. The only negative value for the indices is in the beginning of the 90's whereas the market (S&P 500) has dropped below 0% several times. The Sector strategy came about during the boom and specializing in technology, it did very well during the boom but as the bubble burst, it dropped down to the other indices. Note that it did *not* go below 0% whereas the overall market dropped severely as seen in the figure. Yet, this was a low point for the indices, but again, they clearly outperformed the market.

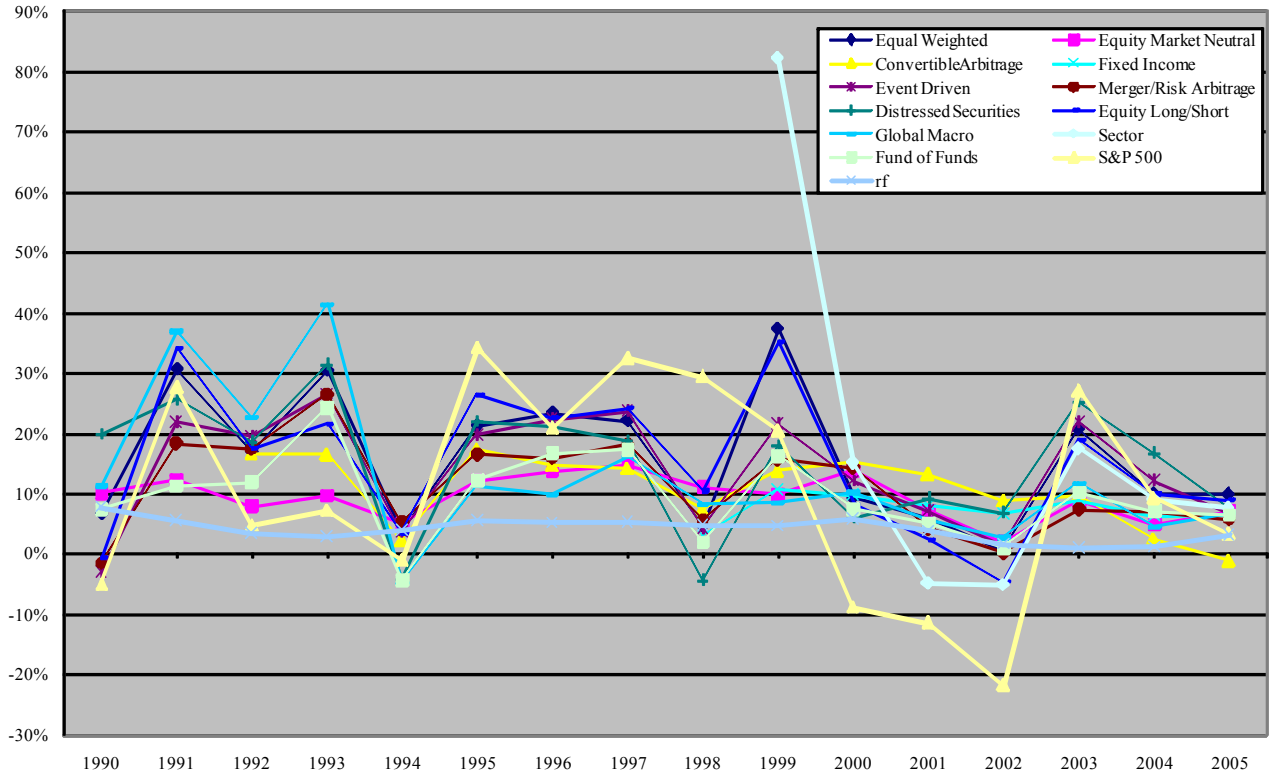

Fig. 3. Annualized mean returns for hedge fund strategy indices

Figure 4 shows the yearly return volatility of the hedge funds indices as measured by standard deviations of monthly returns for the period of 1990-2005. In this figure, as the sector strategy came about, it was the highest by far but has lately gone down to the other averages that seem to follow the market but with a definite lower return volatility. The market has a clear-cut higher return volatility.

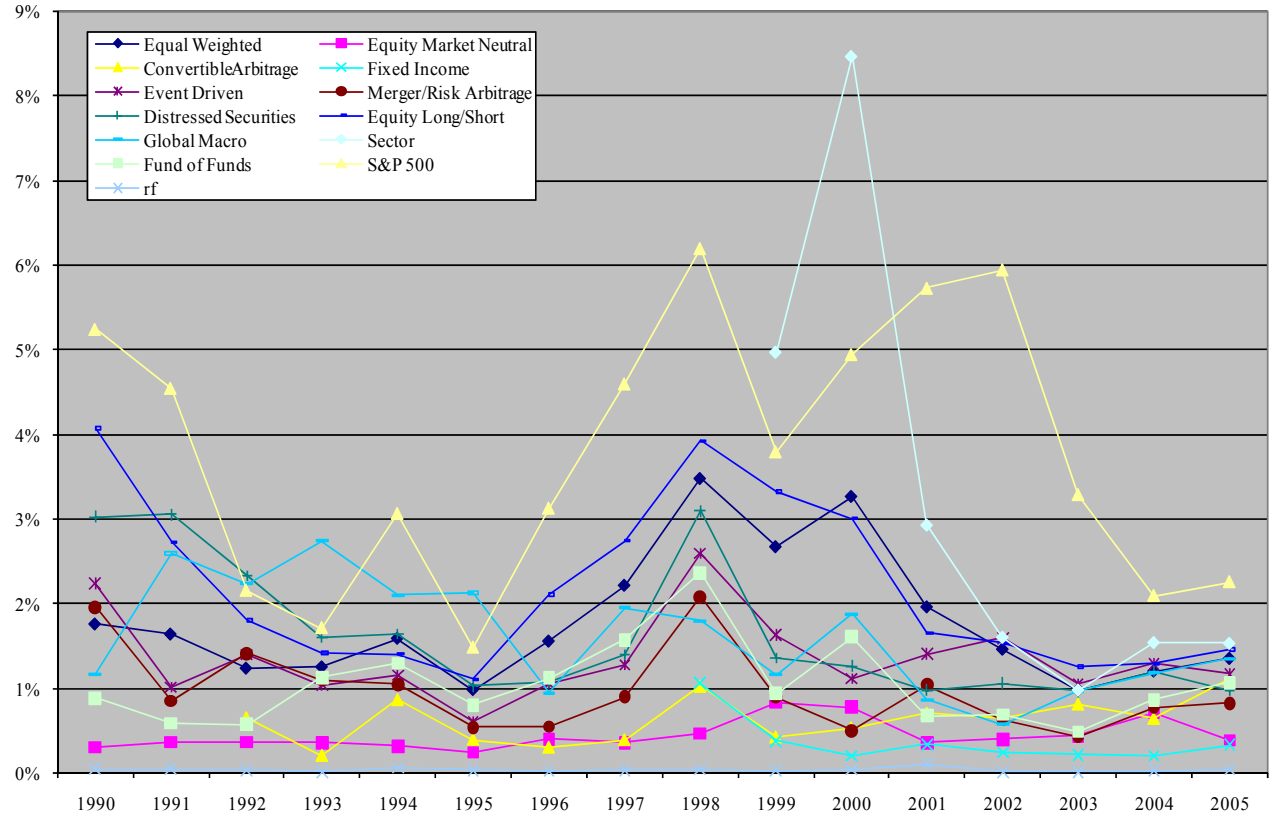

Fig. 4. Hedge fund return volatility by strategy

Table 2 shows the correlations of hedge funds as grouped by each strategy on comparison with S&P 500 index. The correlation between the market and most of the hedge fund strategies is generally low. However, the Equity Long/Short has the highest correlation of .762 with the market, followed by the Event Driven strategy which has a correlation of .630 and by the Fund of Funds which has a correlation of .518, whereas the Fixed Income has the lowest correlation of .072 followed by convertible arbitrage with a correlation at .273.

Table 2. Correlations

	S&P 500	Equally Weighted	Equity Market Neutral	Event Driven	Merger/Risk Arbitrage	Distressed Securities	Equity Long/Short	Global/ Macro	Fund of Funds	Fixed Income	Sector
Equal Weighted	.704**										
Equity Market Neutral	.353**	.551**									
Event Driven	.630**	.841**	.503**								
Merger/Risk Arbitrage	.469**	.685**	.454**	.865**							
Distressed Securities	.487**	.715**	.400**	.705**	.594**						
Equity Long/Short	.762**	.922**	.510**	.808**	.645**	.666**					
Global/ Macro	.432**	.616**	.372**	.505**	.474**	.545**	.573**				
Fund of Funds	.518**	.853**	.511**	.771**	.699**	.650**	. 737**	.683**			
Fixed Income	0.072	.351**	.260**	.425**	.427**	.491**	.293**	.461**	.473**		
Sector	.472**	.906**	.597*	.619**	.512**	.596**	.859**	.443**	.775**	.255**	
Convertible Arbitrage	.273**	.541**	.420**	.607**	.589**	.557**	.468**	.419**	.620**	.472**	.269**

Notes: ** Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level.

Table 3 shows the multiple regression results based on the four-factor model for each strategy group. We report the intercepts or alphas of each regression, both unstandardized and standardized beta coefficients, t-stats, p-values, as well as adjusted R-squares. A common way to evaluate hedge fund investment strategies is to estimate the "alpha" of the strategy, which is the performance of the strategy that cannot be explained by beta risk (Stulz, 2007). The skill of a hedge fund manager is required to produce alpha returns, but not to take beta risk. The alphas of our four-factor model indicate that, if statistically significant, whether a hedge fund strategy outperforms or underperforms the market after factoring in the market effect, small firm effect, value effect, and momentum effect.

The results show that all the alphas are positive and statistically significant. For instance, the sector strategy outperforms the market with a statistically significant positive alpha of 0.7% per month. This means that the fund earns .7% more than the risk-free rate after taking into account the compensation earned through the fund or after factoring in the beta risks in the market, in small firm factor, in value factor, and in momentum factor. Convertible arbitrage, event driven and distressed securities all have an alpha of 0.5% whereas Equity Long/Short and Global Macro have alphas of 0.4%. Equity Market Neutral, Fixed Income and Merger/Risk Arbitrages' alphas are at 0.3% and fund of funds have the definite lowest alpha at 0.2%.

Table 3. Regression of the four-factor model

Strategy	Indep. var.	Unstand. beta	Stand. beta	t-stat.	p-value	Alpha	Adj. R-square
Equal Weighted	mktrf	0.375	0.787	19.965	0.000		0.809
	smb	0.218	0.405	10.972	0.000	0.005	
	hml	0.045	0.079	1.856	0.065	(7.681)	
	umb	0.055	0.133	3.909	0.000		
Equity Market Neutral	mktrf	0.071	0.602	8.529	0.000		0.387
	smb	0.052	0.393	5.945	0.000	0.003	
	hml	0.057	0.399	5.262	0.000	(10.345)	
	umb	0.026	0.256	4.211	0.000		

Table 3 (cont.). Regression of the four-factor model

Strategy	Indep. var.	Unstand. beta	Stand. beta	t-stat.	p-value	Alpha	Adj. R-square
Convertible Arbitrage	mktrf	0.060	0.364	4.009	0.000		0.152
	smb	0.054	0.309	3.617	0.000	0.005	
	hml	0.040	0.215	2.187	0.030	(9.820)	
	umb	-0.006	-0.042	-0.541	0.589		
Fixed Income	mktrf	0.018	0.182	1.298	0.198		0.036
	smb	0.031	0.291	2.244	0.028	0.003	
	hml	0.023	0.207	1.381	0.171	(5.454)	
	umb	0.003	0.034	0.288	0.774		
Event Driven	mktrf	0.297	0.813	15.606	0.000		0.666
	smb	0.189	0.458	9.380	0.000	0.005	
	hml	0.183	0.414	7.399	0.000	(6.556)	
	umb	-0.006	-0.020	-0.437	0.663		
Merger/Risk Arbitrage	mktrf	0.185	0.662	9.599	0.000		0.414
	smb	0.125	0.396	6.128	0.000	0.003	
	hml	0.147	0.434	5.855	0.000	(4.737)	
	umb	0.011	0.046	0.767	0.444		
Distressed Securities	mktrf	0.285	0.633	9.298	0.000		0.429
	smb	0.208	0.410	6.418	0.000	0.005	
	hml	0.171	0.314	4.287	0.000	(4.605)	
	umb	0.015	0.038	0.644	0.520		
Equity Long/Short	mktrf	0.496	0.858	23.308	0.000		0.833
	smb	0.223	0.341	9.889	0.000	0.004	
	hml	0.075	0.107	2.713	0.007	(4.667)	
	umb	0.069	0.138	4.350	0.000		
Global Macro	mktrf	0.260	0.596	7.848	0.000		0.290
	smb	0.090	0.182	2.565	0.011	0.004	
	hml	0.125	0.236	2.898	0.004	(2.829)	
	umb	0.082	0.219	3.343	0.001		
Sector	mktrf	0.464	0.502	7.371	0.000		0.810
	smb	0.276	0.310	4.669	0.000	0.007	
	hml	-0.273	-0.286	-3.836	0.000	(2.590)	
	umb	0.199	0.320	5.411	0.000		
Fund of Funds	mktrf	0.195	0.682	10.696	0.000		0.500
	smb	0.118	0.366	6.128	0.000	0.002	
	hml	0.082	0.238	3.470	0.001	(2.926)	
	umb	0.051	0.208	3.793	0.000		

The four factors, namely market effect, small firm effect, value effect, and momentum effect are mostly positively correlated with hedge fund returns and the results are mostly statistically significant. Equity Market Neutral has all positive correlations and they are significant. Convertible Arbitrage, on the other hand are all positive and significant except for the momentum factor which stands out as negative but also less significant. Fixed Income has the same characteristics where are all correlations are positive but they are all less significant than for example equity market neutral. Event drive has the same exact characteristics as convertible arbitrage being all positive except for the momentum factor which is also less significant. Merger/Risk Arbitrage and distressed securities have the same distinctiveness being all positive but the momentum effect has less significance. Equity Long/Short, Global Macro, Sector and Fund of Funds all have positive and highly significant values.

Figure 5 shows the efficient frontier constructed by the annualized mean returns and standard deviations of the twelve hedge fund strategy indices. Equally-weighted hedge fund strategy index outperforms all other strategy indices based on hedge fund risk-return efficient frontier curve. Sector strategy has the highest return, but also has the highest risk. All the hedge fund strategy indices outperform the S&P500 index based on risk-return criteria. Distressed Securities, Equity Long/Short and Event Driven appears to be the best reward to risk whereas Fixed Income seems to be the least risky but also least rewarding strategy. Global Macro gives the impression of being the least rewarding strategy with respect to risk.

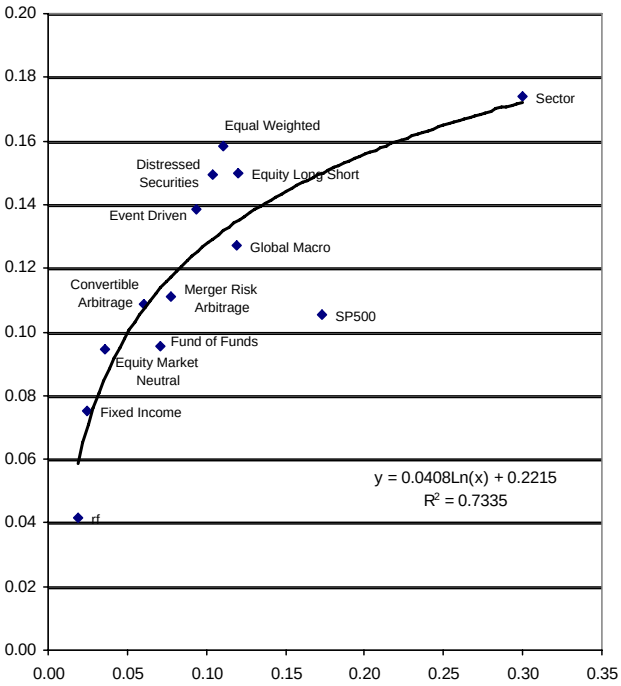

Fig. 5. Hedge fund efficient frontie

Table 4 shows the results of Sharpe ratios for each strategy group. Sharpe ratios indicate the excess returns adjusted for risk. In other words, Sharpe ratio is the reward-to-risk ratio. Again, all strategies generally outperform the market with a few exceptions where Global Macro and Fund of Funds drop below the market a few times. Sector appears the best strategy overall through the technology boom but has dropped below the other strategies, even below the market after the bubble burst. Distressed Securities appear the best strategy over the last 3 years and they all follow the same pattern of the market, while staying above the market with about 1-10% with a few exceptions.

Table 4. Sharpe ratios by strategy

Year	Equal Weighted	Equity Market Neutral	Convertible Arbitrage	Fixed Income	Event Driven	Merger/Risk Arbitrage	Distressed Securities	Equity Long/Short	Global Macro	Sector	Fund of Funds	S&P 500
1990	-0.636	7.693			-4.855	-4.756	3.982	-2.062	2.986		-0.362	-2.472
1991	15.241	18.486			16.020	14.924	6.579	10.493	12.084		9.637	4.859
1992	10.835	12.037	20.145		11.425	9.912	6.474	7.800	8.565		14.692	0.568
1993	21.934	18.815	67.128		22.640	21.325	17.817	13.193	14.055		18.931	2.529
1994	-0.150	3.830	-1.914		-0.169	1.319	-4.916	-0.293	-4.144		-6.340	-1.611
1995	15.866	26.501	29.985		23.269	20.223	15.932	18.821	2.743		8.298	19.378
1996	11.676	21.196	31.742		16.221	19.719	14.801	8.275	4.959		10.264	5.021
1997	7.599	26.534	23.025		14.417	14.364	9.662	6.915	5.609		7.690	5.928
1998	-0.048	13.535	2.587	-1.719	-0.217	0.433	-2.957	1.444	1.918		-1.222	3.969
1999	12.191	6.203	21.827	15.765	10.367	12.378	9.783	9.168	3.360	15.594	12.316	4.156
2000	1.070	10.295	17.614	19.236	5.621	16.904	0.050	0.804	2.309	1.094	1.015	-2.996
2001	1.059	9.468	13.324	12.506	2.356	0.459	5.555	-0.864	2.033	-2.955	2.004	-2.667
2002	-0.808	0.842	10.980	19.881	-0.248	-2.223	4.884	-4.118	1.927	-4.248	-0.923	-3.954
2003	20.077	17.670	10.606	35.772	19.769	14.722	25.012	14.291	11.157	16.708	18.738	7.933
2004	7.367	5.310	2.030	25.001	8.521	7.489	12.909	6.799	2.849	5.119	6.903	3.855
2005	4.942	10.048	-3.878	10.240	2.945	3.099	4.343	3.925	2.592	2.843	3.060	0.014

Conclusion

In conclusion, our findings indicate that the twelve major hedge fund investment strategies seem to outperform S&P 500 market index on a risk-adjusted basis over our study period. The sector strategy evidently has the highest mean monthly and annual return and Equity Long/Short and Distressed Securities. Short Bias, as discussed, has the lowest monthly and annual mean returns. All hedge fund strategy indices seem to follow the market but always at a higher percentage.

The correlation between the market and most of the hedge fund strategies is relatively low except for the Equity Long/Short which has the highest corre-

lation of .762 with the market, followed by the Event Driven strategy and the Fund of Funds. We find that hedge funds provide better opportunities for diversification by their low correlation with the market.

The twelve hedge fund investment strategies seem to produce on average positive and statistically significant alphas. The Sector strategy has the largest and statistically significant positive alpha of 0.7% per month indicating that this strategy earns 0.7% more than the risk-free rate after factoring the market risk premium, small firm effect, value effect, and momentum effect. Interestingly, the structure for management fee and incentive fee for each investment strategy does not seem to be in line with the level of positive alphas that a particular strategy can produce. For instance, Fund of Funds has one of the highest incentive and management fee structure but it produces the lowest alpha. Overall, hedge funds have low beta exposure, and are more likely to generate higher Sharpe ratios and positive alphas.

Based on hedge fund risk-return efficient frontier, Equally-weighted hedge fund strategy seem to outperform all other strategies. Sector strategy has the highest return, but also has the highest risk. All the hedge fund strategy indices outperform the market index based on risk-return criteria. Distressed Securities, Equity Long/Short and Event Driven appears to be the best reward to risk whereas Fixed Income seems to be the least risky but also least rewarding strategy.

In terms of Sharpe ratio performance measurement, all strategies generally outperform the market for most of the time periods.

Overall, hedge funds seem to provide an attractive investment opportunity for exploiting market inefficiencies, market failures and arbitrage opportunities.

However, we have to acknowledge that we still have a very limited knowledge about hedge funds. Although our sample data show that hedge funds on average have performed well over the last decade compared to the stock market, our conclusions could still be relatively tenuous due to the fact that hedge fund managers are operating in an opaque environment and are not required to disclose their return performance periodically and they can potentially massage their returns over time and report low risk and consistent performance.

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