Style Analyses of Desirable Hedge Fund Strategies for Actual Investors

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Abstract

We select the top four hedge fund strategies as desirable ones based on the Prospect Ratio in this paper, and we examine the risk factors of each hedge fund strategy to specify the source of return in the past ten years. We use multifactor models based on GMM analysis. And we use AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion) to resolve the problem to specify the valid exogenous variables in each strategy. The result shows that the selected model contains only significant exogenous variables in each strategy.

JEL Classification : C-4, C-5, G-1, G-2

Key Words : Prospect Ratio, GMM, AIC, SIC

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1. Introduction

Hedge funds were used to "hedge" or protect against loss due to market uncertainties. The roots of hedge funds seem to be in the 1930s, but they formally broke ground with A.W. Jones in the late 1940s. The growth of hedge funds industry was slow, but steadily going well through the 1950s. The business of hedge funds began to bear fruits in the mid-1960s. Although they encountered some troubles with treacherous markets in the late 1960s and early 1970s, the business of hedge funds again enjoyed real growth and development in the 1980s. Recently, hedge funds encompass almost every financial product and tangible asset and follow both conservative and aggressive investing approaches. One of the measures to examine the exposure to risk in hedge funds is style analysis.

We can identify the factor exposures of hedge fund strategies through multifactor analysis. Fung and Hsieh (1997,2001,2004) and Schneeweis and Spurgin (1998) are among the initiators of style analysis in hedge fund strategies. In a recent paper, Jaeger and Wagner (2005) identify the risk exposures in each hedge fund strategy from Jan.1994 to Dec.2004. Gehin and Vaissie (2006) examine the exposure to risk factors by hedge fund strategy using data from Jan.1997 to Dec.2004. The results of these studies reveal that the measured exposures vary according to the historical data period and vendor's selection. Our main point in this paper is to single out the valid exogenous variables based on AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion) in selected four hedge fund strategies through a new ratio named Prospect Ratio developed by the author. Concerning exogenous variables, we mainly use the data in both U.S. and Japan. Because we have a strong concern to check how hedge fund strategies in U.S. had involved in Japanese market. And Pochon and Teiletche (2006) use both AIC and SIC for estimating a mixture of normal distribution for core assets in hedge funds.

In addition, although many articles on hedge fund strategies use the Sharpe Ratio such as Lo (2002) to measure each performance of hedge fund strategy, we propose to use the Prospect Ratio instead of Sharpe Ratio. The reason is explained in the selection criterion part of this paper.

2. Model

Sharpe (1992) introduced a multiple-factor model for the general mutual fund. Here, we apply this multiple-factor model to hedge fund style analysis. The multiple-factor model is $R_t = \alpha + \sum_k \beta_k F_{kt} + u_t$ (1)

where, R_t : Hedge Fund Return, β_k : Coefficient of Factor *k*, F_{kt} : Return of Factor *k*,
u_t : Error Terms

If we decompose the equation (1), $\sum_k \beta_k F_{kt}$ is referred to as style and α as skill.

In Sharpe's case, β_k is assumed to be non-negative and the sum of β_k is assumed to be equal 1, because a mutual fund is used. However, we can omit these constraints in the hedge fund case in order to allow for short sales and leverage. In addition, Ordinary Least Squares (OLS) is used for the style analysis of Sharpe's mutual fund. Here, we use the Generalized Method of Moments (GMM) to obtain β_k. GMM is based on *L* population moments for *k* parameters, θ_0 :

$$E_0 m(Y_t,\theta_0)=0 \quad \text{or} \quad E_0\begin{bmatrix} m_1(Y_t,\theta_0) \\ m_2(Y_t,\theta_0) \\ \vdots \\ m_L(Y_t,\theta_0) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix} \qquad (2)$$

To compute (2), we replace population moments with the sample analogs $m(y,\theta)$ and minimize $Q_T(\theta)=m(y,\theta)'W_T m(y,\theta)$ for some *L*x*L* weighting matrix W_T .

Selection Criterion

In this analysis, we select four hedge fund strategies. The selection criterion is based on the results shown in Table 1 [1] .

Table 1. Prospect Ratio and Skewness/Kurtosis Ratio (Jan.1996 - Dec.2005 : US$)

Hedge Fund Strategy	Prospect Ratio (a)	Skewness/Kurtosis Ratio (b)	(a)+(b)
Hedge Fund Aggregate	2.9665	-0.0474	2.9191
Market Neutral Equity	4.5035	-0.0043	4.4992
Macro	2.6861	-0.0081	2.6780
Multi-Strategy	2.5637	-0.0061	2.5576
Fixed Income (non-arbitrage)	1.6018	-0.0628	1.5390
Long/Short Equity	1.5445	-0.0448	1.4996
Fund of Funds - Multi-Strategy	1.3540	-0.0514	1.3027
Convertible Arbitrage	1.1726	-0.0968	1.0758
Fixed Income Arbitrage	0.9230	-0.0434	0.8796
Event Driven	0.8966	-0.0616	0.8350
Distressed	0.7857	-0.0508	0.7349
Fund of Funds - Single-Strategy	0.4979	-0.0453	0.4526
Emerging Markets	-0.0070	-0.0674	-0.0744
CTA/Managed Futures	-0.2704	-0.0713	-0.3417

Namely, the strategies having the top four highest values of (a)+(b) are selected as desirable hedge fund strategies for actual investors. Multi-Strategy is omitted due to high correlation with Long/Short Equity (see Table 2).

Table 2. Correlation Coefficients among Hedge Fund Strategies (Jan.1996 - Dec.2005 : US$)

Hedge Fund Strategy	HFA	MNE	MS	M	LSE	CA	FI(NA)	ED	FOFMS	D	FIA	EM	FOFSS	CMF
Hedge Fund Aggregate	1.0000													
Market Neutral Equity	0.9468	1.0000												
Multi-Strategy	0.9094	0.4256	1.0000											
Macro	0.3254	0.3779	0.7363	1.0000										
Long/Short Equity	0.9487	0.4601	0.8507	0.6852	1.0000									
Convertible Arbitrage	0.4255	0.3233	0.5682	0.3790	0.4748	1.0000								
Fixed Income (non-arbitrage)	0.8979	0.3020	0.7038	0.6839	0.6386	0.5365	1.0000							
Event Driven	0.8269	0.3193	0.7459	0.5851	0.8401	0.5579	0.7515	1.0000						
Fund of Funds - Multi-Strategy	0.8594	0.4851	0.8800	0.8204	0.8721	0.5965	0.7454	0.8357	1.0000					
Distressed	0.2299	0.2154	0.6407	0.4749	0.6863	0.5306	0.7201	0.8611	0.7417	1.0000				
Fixed Income Arbitrage	0.7897	0.1192	0.1793	0.2233	0.1542	0.4191	0.3188	0.2565	0.3567	0.2794	1.0000			
Emerging Markets	0.5484	0.2224	0.7387	0.5969	0.7021	0.4547	0.6883	0.7242	0.7595	0.7445	0.2476	1.0000		
Fund of Funds - Single-Strategy	0.7705	0.4520	0.8890	0.8248	0.9199	0.4996	0.7132	0.8247	0.9684	0.7143	0.2852	0.7683	1.0000	
CTA/Managed Futures	0.7265	0.1176	0.2058	0.5497	0.0497	0.0290	0.1801	0.0084	0.2783	-0.1326	0.0145	-0.0123	0.2342	1.0000

The Prospect Ratio, developed by the author, uses Tversky and Kahneman (1992)'s value function in the numerator and downside risk in the denominator.

That is to say, Prospect Ratio

$$= \frac{\frac{1}{T}\sum_{t=1}^{T}\Big(Max(r_t,0) \ -\delta(-Min(r_t,0))\Big) - r_{Target}}{\sigma_D} \qquad (3)$$

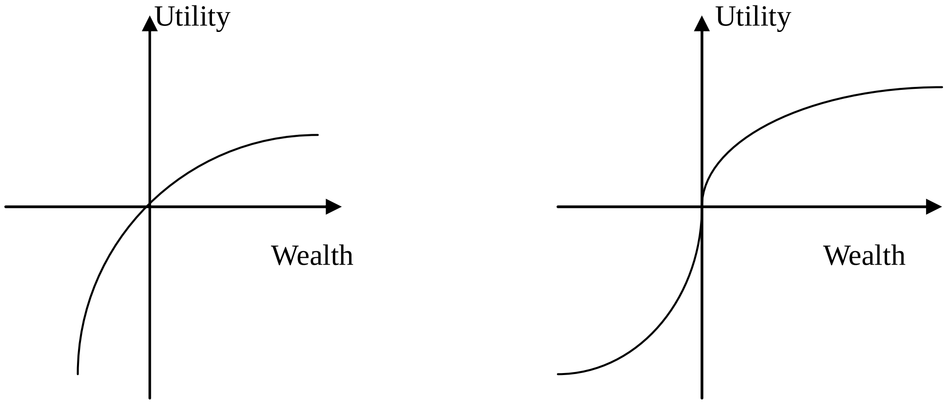
Where, $T = 120, \delta = 2.25, r_{Target} = 0.41$ percent [2].

The advantage of using the Prospect Ratio is that it fully accounts for investors' behavior under prospect theory. The idea behind prospect theory differs from the standard assumptions about investor behavior made by Markowitz and Sharpe regarding the utility function within a loss domain [3]. Prospect theory holds true not only to the hedge fund strategies but also to the traditional investment strategies (e.g., long only) from the behavioral finance view point. We can show the difference of utility functions between rational (in other words: traditional) investors and actual investors in Figure 1.

Figure 1.

Panel A Rational Investors

Panel B Actual Investors



The utility curve at left side shows that an investor's utility slowly rises as wealth increases. This is a typical risk-averse investor. In Panel B, however, the investor, when facing a loss, becomes risk-seeking but, when facing a profit, the investor becomes a risk-averse in the conventional sense.

So, we do not use Sharpe Ratio or Sortino Ratio as a performance measurement here. Since these measures are only valid when the return distribution is normal. For example, the paper written by Lo (2002) shows the improvement of Sharpe Ratio in terms of serially correlated return. But, he does not refer to higher order moments in this case. A skewness/kurtosis ratio has also been used by the author to supplement the Prospect Ratio. Evidence shows that the distributions of hedge fund strategies are not normally distributed in many cases. This means that consideration of higher moments such as skewness and kurtosis may be important. In this Table, a skewness/kurtosis ratio is calculated using downside risk and these ratios are negative for each strategy. The reason for this is that the weight of the negative value function is heavier than positive value function in equation (3). Given all of this, the sum of Prospect Ratio and skewness/kurtosis ratio will give us a more precise performance measurement [4].

3. Data Analysis

Market Neutral Equity

Market neutral equity is a class of hedge funds that follow strategies to exploit factors unique to particular stocks, but remain neutral on factors that reflect broader conditions in the sector, industry, level of market capitalization, country, or region.

The results for market neutral equity given by Generalized Method of Moments (GMM) are shown in Table 3. The risk factors that are used are the S&P 500, Transaction Volumes of New York Stock Exchange (TNY), Transaction Volumes of Tokyo Stock Exchange (TTKO), and CBOE Volatility Index (VIX). The reason we take these risk factors is to check the sensitivity to the market. The adjusted R^2 is the lowest (approximately 5.5%) among all the strategies. This implies that the net exposure to the market is negligible. Judging from the transition of the five years movement, the adjusted R^2 is decreasing over time. S&P 500 is the only risk factor that has a positive correlation with market neutral equity. There is a tendency for t-values associated with the S&P 500 to be significant during the period of positive adjusted R^2.

During the each period from Jan.99-Dec.03, Jan.00-Dec.04, and Jan.01-Dec.05, the adjusted R^2 is negative [5]. We can infer that the other risk factors have no affect on the return of market neutral equity. However, it is necessary to see which exogenous variables are important as a reference. So, we single out the valid exogenous variables by using AIC and SIC. Here, we propose three equations as follows:

$$R_{t|MNE} = \alpha + \beta_1 F_{1t|S\&P500} + \beta_2 F_{2t|TNY} + \beta_3 F_{3t|TTKO} + \beta_4 F_{4t|VIX} + u_t \qquad (4)$$

$$R_{t|MNE} = \alpha + \beta_1 F_{1t|S\&P500} + u_t \qquad (5)$$

$$R_{t|MNE} = \alpha + \beta_1 F_{1t|TNY} + \beta_2 F_{2t|TTKO} + \beta_3 F_{3t|VIX} + u_t \qquad (6)$$

Table 3. Market Neutral Equit

	Jan.96-Dec.05	Jan.96-Dec.00	Jan.97-Dec.01	Jan.98-Dec.02	Jan.99-Dec.03	Jan.00-Dec.04	Jan.01-Dec.05
Intercept	0.007592	0.010139	0.008987	0.008539	0.006918	0.005876	0.004755
	(9.374934)**	(9.032856)**	(8.326748)**	(7.391433)**	(6.364749)**	(5.983457)**	(7.528034)**
S&P 500	0.064988	0.090309	0.084047	0.072584	0.010056	-0.004283	-0.012298
	(2.968616)**	(2.893604)**	(3.145451)**	(2.209922)*	(0.453104)	(-0.196228)	(-0.682537)
TNY	0.006280	0.012088	0.007605	0.004561	0.001272	-0.001352	-0.001140
	(1.454229)	(1.543286)	(1.078033)	(0.601239)	(0.267535)	(-0.307986)	(-0.284410)
TTKO	0.001728	0.001935	0.008058	0.007498	0.004399	0.004673	0.002448
	(0.559519)	(0.349248)	(1.299599)	(1.346073)	(1.235114)	(1.109934)	(1.047526)
VIX	0.000511	-0.004590	-0.000643	0.003208	-0.000550	-0.003828	-0.001624
	(0.128118)	(-0.872782)	(-0.119449)	(0.513894)	(-0.094856)	(-0.664841)	(-0.390598)
Adjusted R^2	0.054647	0.113335	0.103753	0.046750	-0.047667	-0.045289	-0.056889

* Significant with 95% confidence (t-values in parentheses)
** Significant with 99% confidence

Table 4.

(a) The Result of AIC's Equation selection (Market Neutral Equity)

Order by AIC	AIC	Equation	k	Sum of squared residuals
1	-6.977790	(5)	2	0.006336
2	-6.949004	(4)	5	0.006203
3	-6.898195	(6)	4	0.006636

(b) The Result of SIC's Equation selection (Market Neutral Equity)

Order by SIC	SIC	Equation	k	Sum of squared residuals
1	-6.931332	(5)	2	0.006336
2	-6.832859	(4)	5	0.006203
3	-6.805278	(6)	4	0.006636

Judging from the Table 4, Equation (5) is selected. So, the S&P 500 is the only exogenous variable that affects the return of market neutral equity.

Macro

Macro trading and investment strategies developed historically as directional strategies. Several macroeconomic variables and indicators lead to macroeconomic views favorable to a particular asset. The results for macro given by the Generalized Method of Moments (GMM) estimation are shown in Table 5. Risk factors that we use are the Federal funds effective rate (Short Rate), Lehman Brothers Credit Indices (CI(AAA), CI(AA), CI(A), CI(BAA)), CBOE Volatility Index (VIX), Foreign Exchange between USA and Japan (FX(US/JP)), FX(US/BP), FX(US/EU), Morgan Stanley Capital International World (MSCI World), MSCI G7, MSCI Emerging Markets (MSCI EM), the 10 year Japanese government bond (JGB), 10 year U.S. government bond (USB), The Tokyo Commodity Exchange Index(TOCOM), and S&P Commodity Index(S&P COM). The reason we take these risk factors is that we want to check the effects of the interest rate, credit risk, volatility, currencies, stocks, bonds, and commodities for the macro strategy. However, in practice it is rather difficult for us to specify the risk factors in the macro strategy, because there are many transaction patterns in macro trading based on mispricings and arbitrage. The coefficient of determination of adjusted R^2 is approximately 31.2% during the period from Jan.96-Dec.05. As we can see in the macro, there is a tendency for the adjusted R^2 to be decreasing in the middle, but increasing in the latter periods. FX(US/JP), MSCI EM , and S&P COM have a positive correlation with macro, while, USB and TOCOM has a negative correlation with macro. There are all significant at the 95% confidence level except for FX(US/JP). Judging from movements of credit indices, macro strategies have shifted from risk seeking to risk averse until the middle of the whole sub-periods. It seems that Asian crisis which triggered the global financial crisis in 1998 may have affected this tendency to avoid the risk. Namely, the shift from CI(BAA) to Short Rate is apparent during the period from Jan.97-Dec.01 to Jan.98-Dec.02. With respect to FX(US/JP), it has a positive correlation with macro except for Jan.99-Dec.03, and Jan.01-Dec.05. There are no noteworthy relations in both FX(US/BP) and FX(US/EU) about macro except for Jan.01-Dec.05 of FX(US/EU). MSCI EM and S&P COM have a positive correlation, while, USB and TOCOM have a negative correlation with macro during the period of Jan.96-Dec.05. MSCI EM is important from Jan.99-Dec.03, because of its significance with 95% confidence. The reason perhaps lies in the recovery of emerging markets from their crises in 1998. USB shows a negative correlation with macro during the whole sub-periods. This may imply that macro transactions are related with USB. We also single out the valid exogenous variables by using AIC and SIC, and propose four equations as follows:

$$R_{t|MACRO} = \alpha + \beta_1 F_{1t|SR} + \beta_2 F_{2t|CIAAA} + \beta_3 F_{3t|CIAA} + \beta_4 F_{4t|CIA} + \beta_5 F_{5t|CIBAA} + \beta_6 F_{6t|VIX} + \beta_7 F_{7t|FUJ} +$$

$$\beta_8 F_{8t|FUG} + \beta_9 F_{9t|FUE} + \beta_{10} F_{10t|MSW} + \beta_{11} F_{11t|MS7} + \beta_{12} F_{12t|MSE} + \beta_{13} F_{13t|USB} + \beta_{14} F_{14t|JGB}$$

$$+ \beta_{15} F_{15t|TOCOM} + \beta_{16} F_{16t|S\&PCOM} + u_t \qquad (7)$$

$$R_{t|MACRO} = \alpha + \beta_1 F_{1t|SR} + \beta_2 F_{2t|CIAAA} + \beta_3 F_{3t|CIAA} + \beta_4 F_{4t|CIA} + u_t \quad (8)$$

$$R_{t|MACRO} = \alpha + \beta_1 F_{1t|FUJ} + \beta_2 F_{2t|MSE} + \beta_3 F_{3t|USB} + \beta_4 F_{4t|TOCOM} + \beta_5 F_{5t||S\&PCOM} + u_t$$

(9)

$$R_{t|MACRO} = \alpha + \beta_1 F_{1t|CIBAA} + \beta_2 F_{2t|VIX} + \beta_3 F_{3t|FUB} + \beta_4 F_{4t|FUE} + \beta_5 F_{5t|MSW} + \beta_6 F_{6t|MS7} + \beta_7 F_{7t|JGB} + u_t$$

(10)

Table 5.	Macro						
	Jan.96-Dec.05	Jan.96-Dec.00	Jan.97-Dec.01	Jan.98-Dec.02	Jan.99-Dec.03	Jan.00-Dec.04	Jan.01-Dec.05
Intercept	0.010280	0.013090	0.013289	0.012795	0.010229	0.005392	0.005772
	(8.526005)**	(6.192225)**	(8.595825)**	(7.481418)**	(5.563518)**	(3.943220)**	(5.181139)**
Short Rate	-0.014630	0.005781	0.102725	0.049661	0.020907	-0.038406	-0.025345
	(-0.609873)	(0.074035)	(3.004596)**	(2.498590)*	(1.106937)	(-2.065057)*	(-1.849220)
CI (AAA)	-0.013165	-0.041571	-0.060105	-0.039030	-0.017692	-0.006588	0.039495
	(-0.509012)	(-1.793250)	(-4.324741)**	(-1.523154)	(-0.675425)	(-0.286080)	(2.335058)*
CI (AA)	-0.040679	-0.124284	-0.073797	0.035800	0.060270	0.041779	-0.011248
	(-1.199188)	(-2.681207)**	(-2.179050)*	(0.826048)	(1.748905)	(0.953137)	(-0.518437)
CI (A)	0.013852	0.244270	0.215998	0.015138	-0.023193	-0.040340	-0.039548
	(0.380611)	(3.178469)**	(3.702347)**	(0.336501)	(-0.735140)	(-1.763017)	(-2.367070)*
CI (BAA)	0.014115	-0.105486	-0.127801	-0.068341	-0.048117	-0.001087	0.007259
	(0.720775)	(-1.484848)	(-2.432418)*	(-1.724074)	(-1.277126)	(-0.033784)	(0.438528)
VIX	0.019936	0.014298	0.022581	0.041662	0.034345	-0.006897	0.001144
	(1.720070)	(0.997698)	(1.712920)	(2.155202)*	(1.835099)	(-0.442629)	(0.118802)
FX(US/JP)	0.155568	0.247693	0.171926	0.113325	0.031954	0.116925	0.075264
	(3.036067)**	(4.964071)**	(3.488800)**	(2.318072)*	(0.443892)	(2.860431)**	(1.807972)
FX(US/BP)	0.209711	0.085537	0.162933	0.023284	0.045051	0.039753	-0.002647
	(1.538509)	(0.553101)	(1.067009)	(0.138000)	(0.297442)	(0.408768)	(-0.033303)
FX(US/EU)	-0.169361	-0.233303	-0.229570	-0.094736	-0.135935	0.075401	0.144439
	(-1.481815)	(-1.632194)	(-1.904141)	(-0.623559)	(-0.907391)	(0.705637)	(2.281126)*
MSCI World	0.182916	0.566356	0.633499	0.512442	0.998530	1.710811	0.248518
	(0.317829)	(1.104532)	(1.199212)	(0.551484)	(0.791383)	(1.685856)	(0.420463)
MSCI G7	-0.086673	-0.374971	-0.521189	-0.439029	-0.983330	-1.669745	-0.298091
	(-0.158432)	(-0.788749)	(-1.022063)	(-0.503580)	(-0.814984)	(-1.741933)	(-0.536408)
MSCI EM	0.103731	0.121513	0.118959	0.100311	0.140161	-0.016491	0.089546
	(2.487220)*	(1.842969)	(3.229534)**	(1.857447)	(2.458883)*	(-0.243236)	(1.526502)
USB	-0.054768	-0.090132	-0.121463	-0.092611	-0.103194	-0.080247	-0.063707
	(-2.176308)*	(-2.121821)*	(-2.839602)**	(-2.097756)*	(2.468446)*	(-2.131541)*	(-3.196255)*
JGB	-0.001029	-0.010383	-0.001906	0.013772	0.004767	0.018200	0.010268
	(-0.122985)	(-1.160710)	(-0.254727)	(1.459224)	(0.418479)	(1.629405)	(1.574068)
TOCOM	-0.067256	-0.016022	-0.052769	-0.080335	-0.064804	-0.027849	-0.058607
	(-2.008120)*	(-0.278888)	(-1.039736)	(-1.493512)	(-1.136569)	(-0.712236)	(-1.303374)
S&P COM	0.059671	-0.050052	-0.073444	0.041801	0.080845	0.078338	0.063360
	(2.052111)*	(-1.181481)	(-2.337900)*	(0.950891)	(1.659298)	(2.458330)*	(1.626681)
Adjusted R^2	0.311746	0.524041	0.531123	0.321092	0.281744	0.333632	0.424544

* Significant with 95% confidence (t-values in parentheses)

* * Significant with 99% confidence

Table 6.

(a) The Result of AIC's Equation selection (Macro)

Order by AIC	AIC	Equation	k	Sum of squared residuals
1	-5.452905	(9)	6	0.027234
2	-5.384549	(7)	17	0.024276
3	-5.369547	(10)	8	0.028631
4	-5.252808	(8)	5	0.033826

(b) The Result of SIC's Equation selection (Macro)

Order by SIC	SIC	Equation	k	Sum of squared residuals
1	-5.313530	(9)	6	0.027234
2	-5.183715	(10)	8	0.028631
3	-5.136662	(8)	5	0.033826
4	-4.989655	(7)	17	0.024276

Judging from the Table 6, Equation (9) is selected. So, we can confirm that FX(US/JP), MSCI EM, USB, TOCOM, and S&P COM are the exogenous variables that affect the return of macro.

Fixed Income (non-arbitrage)

Fixed income (non-arbitrage) is an investing strategy generally associated with hedge funds that are not based on the exploitation of inefficiencies in the pricing of bonds. The results for fixed income (non-arbitrage) given by the Generalized Method of Moments (GMM) estimates are shown in Table 7. The risk factors that we use are the 10 year Japanese government bond (JGB), 10 year Japanese Swap (JPSWAP), 10 year U.S. government bond (USB) and 10 year U.S. Swap (USSWAP). The reason we use these former risk factors is to check the effect of the government bond and swap rates in both the U.S. and Japan on the funds. The coefficient of determination of adjusted R^2 is approximately 16.7% during the period from Jan.96-Dec.05. However, the values of the adjusted R^2 in each period of the past five years are higher than the whole period and are relatively stable. This implies that a large portion of funds' returns are determined by the factors in the last five years rather than in the past whole period. Concerning fixed income (non-arbitrage), it seems that only USB and USSWAP are relevant to the fixed income (non-arbitrage) except for JPSWAP during the period from Jan.01-Dec.05. It is noteworthy that both USB and USSWAP are significant at a 99% confidence level during the whole period of time. In addition, USB has a positive correlation with fixed income (non-arbitrage), while, USSWAP has a negative correlation with fixed income (non-arbitrage). The t-values of recent past five years in both USB and USSWAP are increasing. This may imply that the relevance of USB and USSWAP is increasing for fixed income (non-arbitrage). Once again, we single out the valid exogenous variables by using AIC and SIC. Here, we propose three equations as follows:

$$R_{t|FINA} = \alpha + \beta_1 F_{1t|JGB} + \beta_2 F_{2t|TJPSWAP} + \beta_3 F_{3t|USB} + \beta_4 F_{4t|USSWAP} + u_t \qquad (11)$$

$$R_{t|FINA} = \alpha + \beta_1 F_{1t|USB} + \beta_2 F_{2t|USSWAP} + u_t \qquad (12)$$

$$R_{t|FINA} = \alpha + \beta_1 F_{1t|JGB} + \beta_2 F_{2t|TJPSWAP} + u_t \qquad (13)$$

Table 7. Fixed Income (non-arbitrage)

	Jan.96-Dec.05	Jan.96-Dec.00	Jan.97-Dec.01	Jan.98-Dec.02	Jan.99-Dec.03	Jan.00-Dec.04	Jan.01-Dec.05
Intercept	0.007760	0.010124	0.009048	0.007945	0.008412	0.006973	0.006470
	(7.792794)**	(9.240098)**	(8.376841)**	(6.666934)**	(10.71062)**	(16.26460)**	(15.99439)**
JGB	-0.000424	-0.039354	-0.035101	-0.034044	-0.001506	0.001628	0.003320
	(-0.052621)	(-1.532444)	(-1.450923)	(-1.422561)	(-0.321779)	(0.671459)	(1.404873)
JPSWAP	0.010266	0.105454	0.088044	0.091453	-0.005469	-0.004980	-0.006701
	(0.478134)	(1.733949)	(1.515588)	(1.532003)	(-0.968994)	(-1.696274)	(-2.437457)*
USB	0.418846	0.588106	0.487191	0.443464	0.244578	0.185352	0.214904
	(3.241465)**	(3.509249)**	(3.421801)**	(3.302527)**	(4.535963)**	(4.376658)**	(5.389494)**
USSWAP	-0.419271	-0.575787	-0.474712	-0.448836	-0.242442	-0.195707	-0.225491
	(-3.139761)**	(-3.118225)**	(-3.203915)**	(-3.032586)**	(-4.507465)**	(-4.614687)**	(-5.895461)**
Adjusted R^2	0.166501	0.391409	0.328200	0.322076	0.251585	0.262998	0.330309

* Significant with 95% confidence (t-values in parentheses)

* * Significant with 99% confidence

Table 8.

(a) The Result of AIC's Equation selection (Fixed Income (non-arbitrage))

Order by AIC	AIC	Equation	k	Sum of squared residuals
1	-6.436380	(12)	3	0.010708
2	-6.414033	(11)	5	0.010591
3	-6.251152	(13)	3	0.012887

(b) The Result of SIC's Equation selection (Fixed Income (non-arbitrage))

Order by SIC	SIC	Equation	k	Sum of squared residuals
1	-6.366692	(12)	3	0.010708
2	-6.297887	(11)	5	0.010591
3	-6.181464	(13)	3	0.012887

Judging from the Table 8, Equation (12) is selected. So, we can confirm that USB and USSWAP are the exogenous variables that affect the return of fixed income (non-arbitrage).

Long/Short Equity

Long/short equity is an investment strategy used by hedge funds, which earns its returns from stock picking, but isolates the risk as well as the return of a particular stock from the risk/return of the broader market or industry of which it is a part. The results of Long/Short Equity given by the Generalized Method of Moments (GMM) estimation are shown in Table 9. The risk factors that we employ are the S&P 500, TNY, TTKO, and VIX. The reason we use these risk factors is to check the effect of the S&P 500, TNY, TTKO, and VIX on the market. The coefficient of determination of adjusted R^2 is approximately 41.9% and is the highest among the selected four hedge fund strategies. It seems that the adjusted R^2 remains relatively constant except for the period from Jan.01-Dec.05. The adjusted R^2 during this period is approximately 65.3%, which is quite high and the reason for this may be that long/short equity followed the movement of the S&P 500 more closely. The t-values of both the S&P 500 and VIX are close to being significant during this particular period of time. The S&P 500 has a relatively strong correlation with long/short equity. While, the VIX has a negative correlation with long/short equity. The relationships with the S&P 500 and VIX are opposite, because option prices will become higher rapidly during the period of falling market price of equity rather than that of rising market price of equity, and the value of VIX is calculated based on the option price of S&P 500 Index. In other words, VIX is derived from S&P 500 options. For this class of hedge funds, we also single out the valid exogenous variables by using AIC and BIC. Here, we propose three equations as follows:

$$R_{t|L/S} = \alpha + \beta_1 F_{1t|S\&P500} + \beta_2 F_{2t|TNY} + \beta_3 F_{3t|TTKO} + \beta_4 F_{4t|VIX} + u_t \tag{14}$$

$$R_{t|L/S} = \alpha + \beta_1 F_{1t|S\&P500} + \beta_2 F_{2t|VIX} + u_t \tag{15}$$

$$R_{t|L/S} = \alpha + \beta_1 F_{1t|TNY} + \beta_2 F_{2t|TTKO} + \beta_3 F_{3t|VIX} + u_t \tag{16}$$

Table 9. Long/Short Equity

	Jan.96-Dec.05	Jan.96-Dec.00	Jan.97-Dec.01	Jan.98-Dec.02	Jan.99-Dec.03	Jan.00-Dec.04	Jan.01-Dec.05
Intercept	0.011814	0.015963	0.013688	0.013973	0.013975	0.008238	0.006886
	(5.291831)**	(3.428345)**	(3.616854)**	(3.897031)**	(3.816095)**	(4.291855)**	(5.079331)**
S&P 500	0.397995	0.463922	0.464770	0.410214	0.347274	0.153038	0.247005
	(5.660899)**	(3.375651)**	(4.255846)**	(3.340713)**	(2.633565)**	(1.820897)	(6.536795)**
TNY	0.019048	0.035831	0.054136	0.020580	0.012637	0.005668	0.000418
	(1.780650)	(1.991754)	(3.395888)**	(1.029722)	(0.975361)	(0.466314)	(0.043423)
TTKO	0.010929	0.013959	0.013658	0.022259	0.016906	0.022931	0.008983
	(1.751813)	(1.072255)	(1.140102)	(1.741123)	(1.608957)	(1.696076)	(1.956487)
VIX	-0.044991	-0.054954	-0.047399	-0.042513	-0.041612	-0.068324	-0.045504
	(-3.602518)**	(-3.321172)**	(-3.059811)**	(-2.011305)*	(-1.759632)	(-3.742624)**	(-4.714035)**
Adjusted R^2	0.419399	0.375618	0.435708	0.418951	0.310646	0.388495	0.652655

* Significant with 95% confidence (t-values in parentheses)
* * Significant with 99% confidence

Table 10.

(a) The Result of AIC's Equationl selection (Long/Short Equity)

Order by AIC	AIC	EQUATION	k	Sum of squared residuals
1	-4.936199	(14)	5	0.046425
2	-4.929111	(15)	3	0.048340
3	-4.652853	(16)	4	0.062668

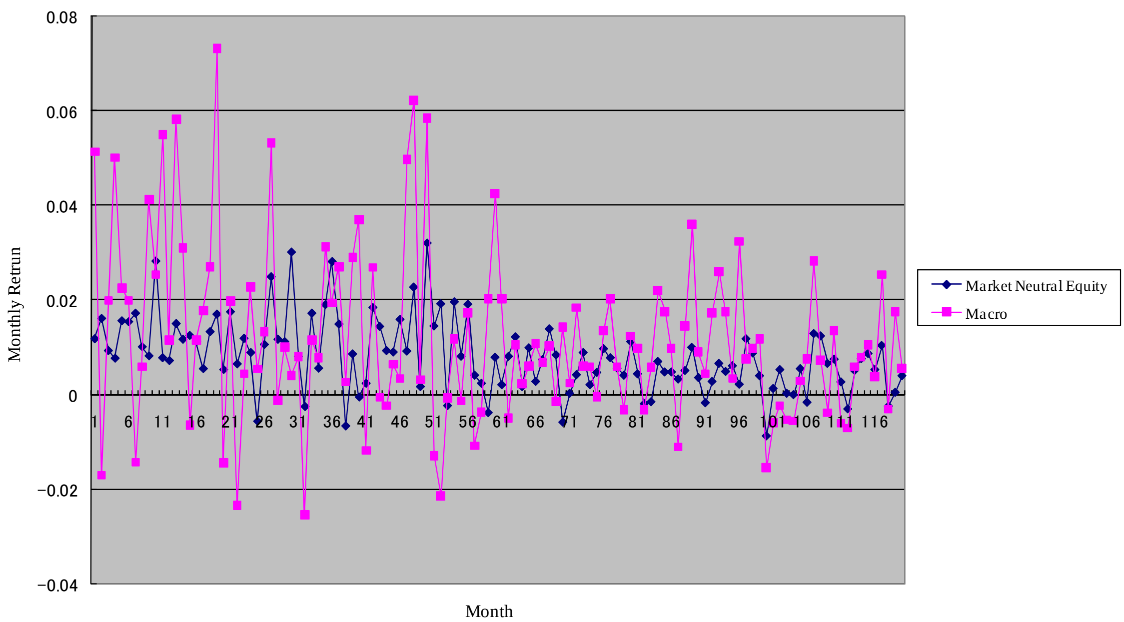
(b) The Result of SIC's Equationl selection (Long/Short Equity)

Order by SIC	SIC	EQUATION	k	Sum of squared residuals
1	-4.859424	(15)	3	0.048340
2	-4.820054	(14)	5	0.046425
3	-4.559937	(16)	4	0.062668

Judging from the Table 10, Equation (14) is selected in AIC, but Equation (15) is selected in SIC. We usually choose the result of SIC only when the sample size is large enough. Thus, we choose Equation (15) instead of Equation (14). So, we can confirm that the S&P 500 and VIX are the exogenous variables that affect the return of long/short equity.

The S&P 500 Index moves in an upward direction sharply during the period from Jan.97-Dec.01 as seen from the Table 11. Thus, the t-value of TNY is significant at the 99% confidence level only during this period of time.

Figure2.



4. Concluding Remarks

In this paper, we can see that market neutral equity has little exposure to the market such as S&P 500, but long/short equity has a positive correlation with the S&P 500 with the highest adjusted R^2. This difference comes from the investment style. Namely, the former strategy always balances the long and short positions, while the latter strategy doe not balance the long and short positions by changing the ratio of positions according to the perspective of the market. In macro, we find that FX(US/JP), MSCI EM, USB, TOCOM, and S&PCOM are significant with 95% confidence during the past ten years. The reason that only FX(US/JP) is significant in foreign exchange may be due to the historical low interest rates in Japan, so fund managers in macro can enjoy a lucrative opportunity by using the Yen to carry the transaction. Furthermore, the reason that only MSCI EM is significant in equity markets may be due to inefficient market characteristics checked by regulations. This means that arbitrage opportunities based on mispricing exist in MSCI EM. In addition, α is all positive and significant statistically in every strategy. So, we can confirm the existence of skills of hedge fund managers.

Finally, a difficult problem in style analysis is to determine the appropriate exogenous variables for each strategy. One of the main reasons may be in the insufficient information disclosure in hedge funds strategies. However, in the analysis of Jaeger and Wagner (2005), there exists a relatively high adjusted R^2 in each hedge fund strategy. The reason lies in the appropriate selection of risk factors. Thus, we can confirm that the selections of risk factors are very important in executing the style analysis in hedge funds strategies. In our case, we apply the AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion) to specify the valid exogenous variables in each strategy. The result shows that the selected equation contains only significant exogenous variables for each strategy.

APPENDIX

1. Prospect Ratio

$$\text{Prospect Ratio} = \frac{\frac{1}{T}\sum_{t=1}^{T}\Big(Max(r_t,0)-\delta(-Min(r_t,0))\Big)-r_{Target}}{\sigma_D}$$

$$\left(= \frac{\left(\frac{1}{T}\sum_{t=1}^{T}(Max(r_t,0)-\delta(-Min(r_t,0)))-r_{Target}\right)}{\sigma_D^2} * \sigma_D \right)$$

Note that Prospect Ratio can be rewritten as first order moment over second order moment multiply downside risk.

2. Skewness/Kurtosis Ratio

Skewness/Kurtosis Ratio $= \frac{1}{T}\sum_{t=1}^{T}\left(r_t - \bar{r}\right)^3 \Big/ \sigma^3 \Big/ \frac{1}{T}\sum_{t=1}^{T}\left(r_t - \bar{r}\right)^4 \Big/ \sigma^4$

$$= \left(\frac{1}{T}\sum_{t=1}^{T}\left(r_t - \bar{r}\right)^3 \Big/ \frac{1}{T}\sum_{t=1}^{T}\left(r_t - \bar{r}\right)^4\right) * \sigma$$

where, r_t is replaced by $\left(Max(r_t,0) - 2.25(-Min(r_t,0))\right)$ and $\bar{r}$ is replaced by $\frac{1}{T}\sum_{t=1}^{T}\left(Max(r_t,0) - 2.25(-Min(r_t,0))\right)$ in the case of Prospect Ratio.

Note that skewness/kurtosis ratio can be rewritten as third order moment over fourth order moment multiply downside risk.

3. Downside Risk

$$\sigma_D = \sqrt{\sum_{t=1}^{T}\frac{\min\left[\left(r_t - r_{Target}\right),0\right]^2}{T}}$$

where, r_{Target} is minimum target return and equals risk free rate(0.41 percent) in this case.

4. AIC (Akaike Information Criterion)

$$AIC = -2l/T + 2k/T \quad \left(\because l = -\frac{T}{2}\left(1 + \log(2\pi) + \log\left(\hat{e}'\hat{e}/T\right)\right)\right)$$

where, l is the value of the log of the likelihood function with k parameters estimated using T observations. $\hat{e}'\hat{e}$ is sum of squared residuals. It is based on -2 times the average log likelihood function, adjusted by a penalty function. In addition, smaller values of the AIC are preferred for model selection.

5. SIC (Schwarz Information Criterion)

$$SIC = -2l/T + (kLN(T))/T$$

The SIC is an alternative to the AIC that imposes a larger penalty for additional coefficients. Generally, SIC is better than AIC only when sample size is large enough.

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Notes

[1] We examine thirteen out of thirty three hedge fund strategies from HedgeFund.Net. The criterion of selection is based on the numbers of funds exceeding one hundred as of Dec. 30th, 2005. Other publicly available sources of hedge fund data are Altvest, HFR, MSCI, TASS, CTI, SPHF, and ZCAP/MAR,etc.
We take the data of monthly return and multiply them by 12 to annualize them.

[2] The value of δ depends on the samples selected. So, we choose the value of Tversky and Kahneman's value for convenience. This risk free rate is based on the data from HedgeFund.Net.

[3] The utility function of prospect theory is convex, not concave within a loss domain.

[4] Suppose that there exist Fund A and Fund B. Concerning mean, variance, skewness and kurtosis, each fund have the only one value, respectively. Thus, we can simply sum up Prospect Ratio and skewness/kurtosis ratio.

[5] Suppose that the number of sample is *n* and parameter is *k* respectively.
$AdjR^2 = 1-(1-R^2)\frac{n-1}{n-k}$. Thus, $AdjR^2$ becomes negative when $R^2 < \frac{k-1}{n-k}$.

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