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Investor Sentiment and Time-Varying Market Risk in Market-Neutral Hedge Funds

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This paper examines whether market risk in market-neutral hedge funds is associated with investor sentiment. It is expected that market risk of these hedge funds depends on investor sentiment caused by return-chasing behavior of investors. The results provide support for this expectation, and thus the risk in the market neutral hedge fund strategy caters to investors' preferences. The exposure of market-neutral hedge funds to commonly used empirical risk factors is also altered by investor sentiment.

Keywords: Hedge funds, Investor sentiment

INTRODUCTION

The growth of the hedge fund industry after the last millennium shows that hedge funds are considered as important components of investors' portfolios. The market-neutral hedge fund strategy is a considerable choice for investors whose goal is steady returns in all market conditions. Specifically, the aim of this strategy is to produce absolute returns, which means that the returns must not be relative to some fixed benchmarks. From the investor viewpoint, the problem is to find out whether the returns are truly absolute.

It is a challenge for a hedge fund manager to maintain market neutrality and produce absolute returns as the best performing funds are exposed to market risk, and have more volatile returns (see Capocci [2006]). The exposures of hedge fund returns to some benchmarks may also be time varying. The approach to measure time-varying exposure of funds conditionally on public information is established since the study of Ferson and Schadt [1996]. However, the challenge for hedge fund analysts is to find conditioning variables that explain the time-varying exposure.

As market-neutral hedge funds are not strictly market neutral, these funds may follow investor sentiment to yield better returns or otherwise cater to the preferences of investors. For example, a market-neutral fund may be dollar-neutral and the risk exposures of the long and short sides of its investment portfolio may have different market exposures indeed. Consequently, this study examines whether investor sentiment is associated with time-varying market risk of market-neutral hedge funds. The main goal of this study is to adopt the perspective of behavioral finance in hedge fund analysis to develop new tools for the performance analysis of hedge funds.

This study does not adopt same conditional variables used by the previous literature on the performance of hedge funds (see, e.g., Kat and Miffre [2002], Kazemi and Schneeweis [2003], Hûbner and Papageourgiou [2006]). Instead, this study considers that the variables which explain time-varying risk in hedge fund strategies can be found form measures of investor sentiment. As a result, this study suggests the use of behavioral finance in the analysis of hedge fund performance.

It is hypothesized that market exposures of market-neutral hedge funds are related to investor sentiment, which is measured as the Chicago Board Options Exchange (CBOE) put/call ratio. More precisely, when the put/call ratio is high (low), market-neutral hedge funds decrease (increase) their market exposure. The hypothesis of this study is based on the evidence of the return-chasing behavior of investors, which put pressure on fund managers to tilt toward high-beta stocks (see Karceski [2002]). For market-neutral hedge funds, managers would tilt their long positions toward high-beta stocks. Also, hedge fund managers are also investors and human and therefore are also exposed to behavioral biases.

The tracking of investor sentiment, as shown by De Long, Shleifer, Summers, and Waldmann [1990], will relate market-neutral hedge funds to noise traders who prefer to hold more risky assets when the sentiment is high. This

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sentiment-driven behavior may not be irrational at all since Delong et al. also shows that by following noise traders it is possible to produce better returns than in pure fundamental-based investment strategy.

The results of this study support the hypothesis and show that stock market exposure of market-neutral hedge funds is conditional on investor sentiment. This implicates that when investor sentiment is high, the long stock positions of market-neutral hedge funds tilt toward high-beta and value stocks.

The remainder of this paper is organized as follows: The second section briefly reviews literature related to conditional performance of hedge funds. The third section is for hypothesis of this study. The fourth section presents the methods of this study. The fifth section presents data of this study. The sixth section discusses the results. The seventh section gives the final conclusions and implications of this study.

BACKGROUND

In measuring the performance of hedge funds, it is natural to use conditional information as hedge funds are by their very nature dynamic investment vehicles. In their pioneering study, Kat et al. [2002] adopt conditioning variables in the performance measurement of hedge funds. Their results suggest that making the use of conditional information in the performance measurement can improve the analysis in the case of hedge funds.

Kazemi et al. [2003] study the conditional performance of hedge funds using the stochastic discount factor (SDF) approach. Kazemi et al. use instruments such as credit spread and the VIX implied volatility in the performance model to explain conditional returns of hedge funds. Nevertheless, they find that the estimated alphas are virtually the same for both relative and SDF pricing approaches. Thus, this finding implies that the use of conditioning information does not alter the performance measurement significantly.

Hűbner et al. [2006] also use the VIX implied volatility as a conditioning variable and includes it into the performance regression with optional factors. To sum it up, they use four conditional factors, 12 option-based factors, and 8 asset-based actors in their analysis. In addition, they include some new option-based factors to capture information from implied higher moments. They find that these factors increase the explanatory power of various models across all the hedge fund strategies.

HYPOTHESIS DEVELOPMENT

The results of Xu [2004] suggest that the performance of mutual funds has an inverse relation to investor sentiment. As a result of this inverse relation, mutual funds are more attractive investment objects as they provide better performance when the sentiment is low and investors are more risk averse. However, considering hedge funds that are wilder than conventional mutual funds may change the view.

Market-neutral hedge funds are especially of interest when it comes to sentiment-driven behavior of hedge funds as they are capable of allocating their funds in different stocks. In contrast, some other hedge fund strategies, for example, hedge funds that follow the distressed hedge fund strategy, invest in one particular type of stocks and do not allocate their funds to all kinds of stock. The asset allocation viewpoint is important as different stocks have different kind of risk characteristics, and thus the allocation has an impact of the risk of the overall portfolio.

The previous literature shows that hedge funds may change their risk exposures aggressively (see, e.g., Brealy and Kaplanis [2001], Fung and Hsieh [2004]. The implication of this kind of evidence is that hedge funds are capable of following investor sentiment if they are willing to do so. Besides, there are two arguments that relate the dynamic behavior of hedge funds to investor sentiment: first, the managers of market-neutral hedge funds are also investors and therefore are also exposed to human behavior. Frijns, Koellen, and Lehnert [2007] show that investors prefer to invest more in the risky asset under high sentiment than under low sentiment.

Second, hedge funds have a competition of capital inflows into the hedge fund sector. Karceski [2002] suggests that return-chasing behavior of mutual fund investors drives mutual fund managers to tilt toward high-beta stocks during up markets because managers compete for the capital inflows into the mutual fund sector. This behavior may be related to investor sentiment as high returns are associated with high investor sentiment (see, e.g., Fisher and Statman [2000], Brown and Cliff [2004]). Thus, return-chasing behavior of hedge fund investors which is associated with investor sentiment should have an impact on the asset allocation of market-neutral managers when they compete for capital inflows or resist capital outflow. As a result, the above arguments lead to the hypothesis:

> H: Market risk of the market neutral hedge fund strategy has a positive relation to investor sentiment.

DATA

This study uses monthly data for the period November 1995 to February 2007. The sample of this study comprises 135 monthly observations. The sample does not begin earlier than November 1995 because there are no earlier observations for the CBOE total put/call ratio. For this ratio, a high (low) put/call ratio relates to a low (high) investor sentiment. The put/call ratio is chosen to measure investor sentiment as it is a well-acknowledged measure of investor sentiment. Also, Bandopadhyaya [2006] suggests that the CBOE put/call ratio is a better measure of investor sentiment than the VIX implied volatility. Figure 1 offers a graphic presentation of the ratio over the estimation period of this study.

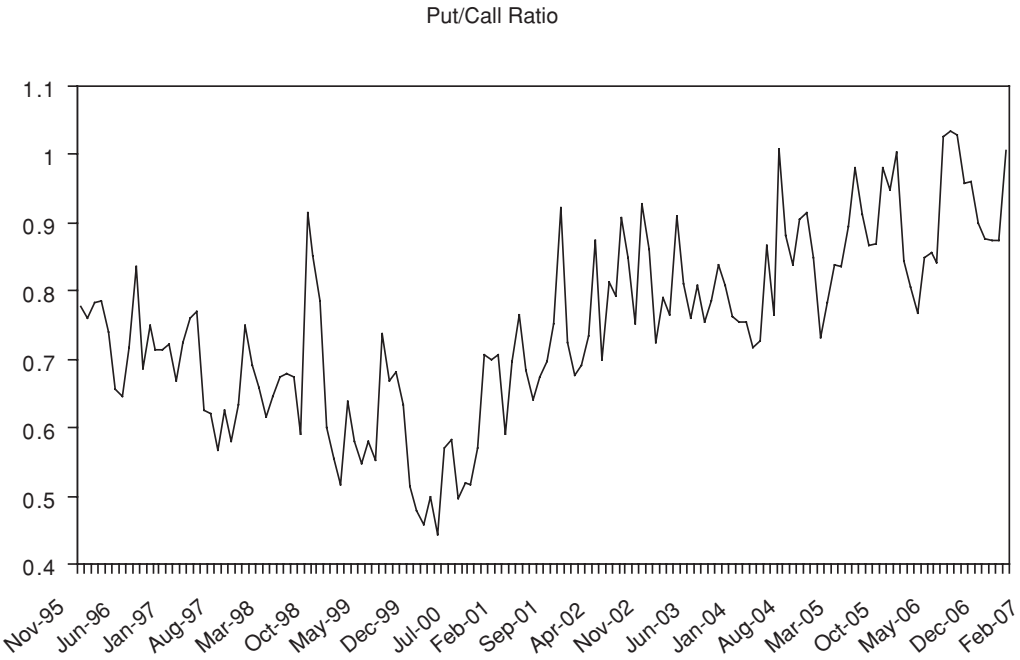

FIGURE 1 The CBOE total put/call ratio from December 1995 to February 2007.

For the returns of market-neutral hedge funds, the logarithmic excess returns of the CSFB/Tremont Equity Market-Neutral Index, Hedge Fund Research (HFR) Equity Market-Neutral Index, and the portfolio of 420 equity market neutral hedge funds listed in the Lipper TASS database are used. The first of these return series is value-weighted, and the last two are equally weighted. The excess logarithmic returns of the S&P 500 are used as a proxy for market returns. All excess returns are calculated on the continuously compounded U.S. 3-month T-bill rate.

To measure conditional behavior of the time-varying market risk, an instrument is formed that determines the time-varying behavior of the market risk in hedge fund returns. The instrument is a product of the lagged values of demeaned put/call ratio and the market returns. The Fama and French [1993] factors, which are the performance of small stocks against big stocks (SMB), the performance of value stocks relative to growth stocks (HML), and the Carhart's [1997] momentum factor (UMD) are used as control variables.

Also, an instrument for time-varying behaviour of the SMB factor is formed in the same way as the instrument for the market risk in hedge fund returns. Table 1 defines the variables of the sample of this study, and Table 2 presents the summary statistics of the sample. The summary statistics show that all variables departure significantly from normality.

METHODOLOGY

The analyses of this study focus on the conditional behavior of market exposure of market neutral hedge fund returns on investor sentiment. However, investor sentiment also affects the cross-section of stock returns, and it relates to several firm characteristics such as age, size, and dividend payout (see Baker and Wurgler [2006]). As a result, when performing the analyses, other control variables such as SMB, HML, and UMD are included in the model.

The analyses begin with Model 1, which measures the conditional performance of market-neutral hedge funds in relation to high and low put/call ratio regimes by using the

TABLE 1
Variable Definitions.

CSFB	The excess logarithmic returns of CSFB/Tremont equity market-neutral hedge fund index
EQ	The excess logarithmic returns of equally weighted portfolio of 420 equity market neutral hedge funds from the Lipper TASS database
HFR	The excess logarithmic returns of Hedge Fund Research (HFR) equity market-neutral hedge fund index
SP500	The excess logarithmic returns of S&P 500
INST	The product of lagged Chicago Board Options Exchange total put/call ratio and the logarithmic excess returns of S&P 500 index
UMD	Carhart's (1997) momentum factor
HML	Fama and French (1993) HML factor
SMB	Fama and French (1993) SMB factor
SMBI	The product of the lagged Chicago Board Options Exchange total put/call ratio and the SMB factor
HMLI	The product of the lagged Chicago Board Options Exchange total put/call ratio and the HML factor
UMDI	The product of the lagged Chicago Board Options Exchange total put/call ratio and the UMD factor

TABLE 2
Summary Statistics.
This table presents statistics that describe the full sample from December 1995 to February 2007 and includes 135 observations.

	CSFB	EQ	HFR	SP500		INST
Mean	0.55	0.48	0.62	0.31		0.07
Median	0.53	0.43	0.54	0.74		0.03
Maximum	2.78	2.63	3.59	8.75		2.61
Minimum	−1.59	−1.04	−1.67	−16.18		−2.21
Std. Dev.	0.73	0.6	0.88	4.31		0.56
Skewness	0.23	0.49	0.38	−0.71		0.41
Kurtosis	3.96	3.9	4.02	4.02		7.76
Jarque-Bera	6.39**	9.95**	9.12**	17.31***		131.05***
	UMD	HML	SMB	SMBI	UMDI	SMBI	HMLI
Mean	0.73	0.34	0.33	0	−0.13	0	0.01
Median	0.77	0.37	−0.12	0.02	−0.02	0.02	0
Maximum	18.4	14.92	14.62	2.9	2.6	2.9	6.01
Minimum	−25.05	−20.79	−11.6	−4.23	−5.32	−4.23	−4.57
Std. Dev.	5.47	4.36	3.7	0.63	0.8	0.63	0.87
Skewness	−0.59	−0.85	0.37	−1.5	−2.33	−1.5	1.69
Kurtosis	7.24	8.82	4.32	20.54	17.97	20.54	25.69
Jarque-Bera	109.27***	206.62***	12.87***	1767.74***	1373.09***	1767.74***	2939.50***

*Refers to a statistical significance at the 10% level; **refers to a statistical significance at the 5% level; ***refers to a statistical significance at the 1% level.

ordinary least squares (OLS) method as follows:

$$r_{ep,t} = \beta_0 + I_{i,t} + \beta_1 r_{em,t} + \beta_2 I_{i,t} r_{em,t} + \beta_3 SMB_{i,t} + \beta_4 HML_{i,t} + \beta_5 UMD_{i,t} + e_t, \quad (1)$$

where $r_{ep,t}$ defines the excess returns of a hedge fund portfolio; $I_{i,t}$ defines a dummy variable, which is 1 if the lagged value of the CBOE put/call ratio is above its median and 0 otherwise; $r_{em,t}$ defines the excess returns of the S&P 500; $SMB_{i,t}$ defines the SMB factor; $HML_{i,t}$ defines the HML factor; and $UMD_{i,t}$ defines the UMD factor. The purpose of the use of Model 1 is to test at the very general level whether put/call ratio has an impact on the performance of market-neutral hedge funds.

The first model uses two regimes defined by the median of the CBOE put/call ratio. However, it may be possible that the extreme regimes of investor sentiment have the most impact on time-varying market risk in market-neutral hedge funds. Thus, a new regime switching model should be developed to take into account this possible deficiency of Model 1.

Model 2 provides a test on the relation between time-varying market risk in market-neutral hedge funds and extreme investor sentiment regimes. Model 2 measures the performance of market-neutral hedge funds in relation to extreme put/ratio regimes by using the OLS method as follows:

$$r_{ep,t} = \beta_0 + I_{h,t} + I_{l,t} + \beta_1 r_{em,t} + \beta_2 I_{h,t} r_{em,t} + \beta_3 I_{l,t} r_{em,t} + \beta_4 SMB_{i,t} + \beta_5 HML_{i,t} + \beta_6 UMD_{i,t} + e_t, \quad (2)$$

where $I_{h,t}$ defines a dummy variable which is 1 if the lagged value of the CBOE put/call ratio is above its 80% quantile and 0 otherwise, and $I_{l,t}$ defines a dummy variable which is 1 if the lagged value of the CBOE put/call ratio is below its 20% quantile and 0 otherwise.

While the first two models assumes that market risk in the market-neutral hedge fund strategy is conditional on certain regimes of investor sentiment, Model 3 is developed to allow for a linear relation between the market risk and investor sentiment. The exposure to firm characteristics of market-neutral hedge funds also may be conditional on investor sentiment. Therefore, Model 3 is estimated to account for the time-varying exposure to the market SMB, HML, and UMD factors by using the OLS method as follows:

$$r_{ep,t} = \beta_0 + \beta_1 r_{em,t} + \beta_2 SMB_{i,t} + \beta_3 HML_{i,t} + \beta_4 UMD_{i,t} + \beta_5 INST_{i,t} + \beta_6 SMBI_{i,t} + \beta_7 HMLI_{i,t} + \beta_8 UMDI_{i,t} + e_t, \quad (3)$$

where $SMBI_{i,t}$ defines the product of the lagged value of the CBOE total put/call ratio and the SMB factor, $HMLI_{i,t}$ defines the product of the lagged value of the CBOE total put/call ratio and the HML factor, and $UMDI_{i,t}$ defines the product of the lagged value of the CBOE total put/call ratio and the UMD factor.

EMPIRICAL RESULTS

Table 3 presents the regression statistics estimated using Model 1 for the CSFB, EQ, and HFR portfolios. The results for these portfolios mainly support the hypothesis of

TABLE 3
High and Low Put/Call Regimes and Market Risk in Market-Neutral Hedge Funds.
This table presents ordinary least squares (OLS) parameter estimates of Model 1 for the returns of the CSFB/Tremont value weighted Equity Market Neutral strategy index, the Hedge Fund Research equally weighted Equity Market Neutral strategy index, and equally weighted portfolio of 420 equity market neutral hedge funds listed in the Lipper TASS hedge fund database. Model 1 is the following:

$$r_{ep,t} = \beta_0 + I_{i,t} + \beta_1 r_{em,t} + \beta_2 I_{i,t} r_{em,t} + \beta_3 SMB_{i,t} + \beta_4 HML_{i,t} + \beta_5 UMD_{i,t} + e_t,$$

where $r_{ep,t}$ defines the excess returns of a hedge fund portfolio; $I_{i,t}$ defines a dummy variable which is 1 if the lagged value of the CBOE put/call ratio is above its median and 0 otherwise; $r_{em,t}$ defines the excess returns of the S&P500 index; $SMB_{i,t}$ defines the SMB factor; $HML_{i,t}$ defines the HML factor, and $UMD_{i,t}$ defines the UMD factor. The sample is from December 1995 to February 2007 and includes 135 monthly observations. This table also presents Akaike information criterion (AIC), Schwartz information criterion (SIC), adjusted R-squares, and residual autocorrelation with lag n defined as resAR(n) which significance is based on Q-statistics. The standard errors are Newey-West (1987) heteroskedasticity and autocorrelation –consistent (lag 4). *t*-statistics are presented on the right hand side of the coefficient estimates. All returns are monthly in excess over the monthly U.S. 3-month T-bill rate and are expressed as percentages.

	CSFB		EQ		HFR	
C	0.586***	6.42	0.443***	5.68	0.544***	5.30
(PUTCAL(-1)>0)	−0.062	−0.49	−0.109	−1.21	−0.188*	−1.68
SP500	0.094***	4.25	0.074***	6.11	0.084***	3.64
SP500*(PUTCAL(-1)>0)	−0.058**	−2.02	−0.034**	−2.43	0.018	0.67
HML	0.004	0.17	0.061***	2.98	0.063**	2.58
SMB	0.007	0.41	0.051***	4.82	0.058***	3.88
UMD	−0.005	−0.33	0.063***	5.48	0.139***	8.40
MA(1)			0.419***	3.91	0.331***	5.22
Adj. R^2	0.18		0.35		0.45	
AIC	2.07		1.44		2.03	
SIC	2.23		1.61		2.21	
resAR(1)	0.163		−0.007		−0.025	
resAR(5)	0.009		0.015		0.062	
resAR(10)	−0.062		0.078		0.072	
N	134		134		134	

*Refers to a statistical significance at the 10% level; **refers to a statistical significance at the 5% level; ***refers to a statistical significance at the 1% level.

this study. Admittedly, the support for the HFR portfolio is much weaker than the support for the CSFB and EQ portfolios. Specifically, the level of statistical significance for a different exposure to market returns during the regime of low sentiment is at the 1% level for the EQ portfolio and the 10% level for the CSFB portfolio, while the exposure is not statistically significant for the HFR portfolio.

An interesting characteristic is that the impact of the regime of low investor sentiment is statistically significant only on the returns of the HFR portfolio. In particular, the regression statistics suggest that the alpha for the HFR portfolio is 0.188% lower during the regime of low sentiment.

The fit of Model 1 to the returns of the HFR portfolio is better than the fit to the returns of the CSFB and EQ portfolios as the adjusted R^2 is 45% for the returns of the HFR portfolio, 35% for the returns of the EQ portfolio, and 18% for the returns of the CSFB portfolio. Also, the HML, SMB, and UMD factors explain the returns of the EQ and HFR portfolios while these factors do not have statistically significant impact on the returns of the CSFB portfolio.

Table 4 presents the regression statistics estimated using Model 2 for the CSFB, EQ, and HFR portfolios. The results for the EQ and CSFB portfolios support the hypothesis of this study. However, the results for the HFR portfolio do not support the hypothesis. The extreme low sentiment has a statistically significant impact on market risk in the returns of the CSFB and EQ portfolios. Also, the impact of high investor sentiment is statistically significant on market risk in the returns of the CSFB portfolio. In general, the impact of low (high) investor sentiment is always negative (positive) on market risk of market-neutral hedge fund portfolios. Moreover, the extremes of investor sentiment have a statistically significant impact on the returns of every examined hedge fund portfolio. This exposure is not explained by changes in market risk.

The Akaike (AIC) and Schwartz (SIC) information criteria suggest that Model 2 outperforms Model 1 in explaining the returns of market-neutral hedge fund portfolios, yet the only exception is the SIC criterion for the returns of the HFR portfolio. The information criterion statistics suggest that the

TABLE 4
Extreme Put/Call Regimes and Market Risk in Market-Neutral Hedge Funds.
This table presents ordinary least squares (OLS) parameter estimates of Model 2 for the returns of the CSFB/Tremont value weighted Equity Market Neutral strategy index, the Hedge Fund Research equally weighted Equity Market Neutral strategy index, and equally weighted portfolio of 420 equity market neutral hedge funds listed in the Lipper TASS hedge fund database. Model 2 is the following:

$$r_{ep,t} = \beta_0 + I_{h,t} + I_{l,t} + \beta_1 r_{em,t} + \beta_2 I_{h,t} r_{em,t} + \beta_3 I_{l,t} r_{em,t} + \beta_4 SMB_{i,t} + \beta_5 HML_{i,t} + \beta_6 UMD_{i,t} + e_t,$$

where $r_{ep,t}$ defines the excess returns of a hedge fund portfolio; $I_{h,t}$ defines a dummy variable which is 1 if the lagged value of the CBOE put/call ratio is above its 80% quantile and 0 otherwise; $I_{l,t}$ defines a dummy variable which is 1 if the lagged value of the CBOE put/call ratio is below its 20% quantile and 0 otherwise; $r_{em,t}$ defines the excess returns of the S&P500 index; $SMB_{i,t}$ defines the SMB factor; $HML_{i,t}$ defines the HML factor, and $UMD_{i,t}$ defines the UMD factor. The sample is from December 1995 to February 2007 and includes 135 monthly observations. This table also presents Akaike information criterion (AIC), Schwartz information criterion (SIC), adjusted R-squares, and residual autocorrelation with lag n defined as resAR(n) which significance is based on Q-statistics. The standard errors are Newey-West (1987) heteroskedasticity and autocorrelation –consistent (lag 4). *t*-statistics are presented on the right hand side of the coefficient estimates. All returns are monthly in excess over the monthly U.S. 3-month T-bill rate and are expressed as percentages.

	CSFB		EQ		HFR	
C	0.567***	7.69	0.341***	4.74	0.387***	4.27
(PUTCAL(-1)>0.8q)	−0.234*	−1.89	−0.074	−0.77	0.014	0.14
(PUTCAL(-1)<0.2q)	0.168	1.07	0.315**	2.45	0.359**	2.35
SP500	0.080***	3.25	0.055***	5.03	0.074***	3.76
SP500*(PUTCAL(-1)>0.8q)	−0.133***	−3.41	−0.046*	−1.85	−0.007	−0.22
SP500*(PUTCAL(-1)<0.2q)	0.018	0.59	0.032**	2.18	0.044	1.45
HML	−0.001	−0.05	0.059***	2.92	0.072***	3.12
SMB	0.007	0.40	0.052***	5.08	0.061***	4.92
UMD	−0.007	−0.51	0.060***	5.04	0.138***	8.22
MA(1)			0.405***	3.61	0.298***	4.37
Adj. R^2	0.25		0.39		0.47	
AIC	2.00		1.39		2.02	
SIC	2.19		1.60		2.24	
resAR(1)	0.098		−0.045		−0.032	
resAR(5)	−0.015		0.009		0.089	
resAR(10)	−0.141		0.076		0.070	
N	134		134		134	

*Refers to a statistical significance at the 10% level; **refers to a statistical significance at the 5% level; ***refers to a statistical significance at the 1% level.

extremes of investor sentiment may have the major impact on risk and risk exposures of market-neutral hedge funds.

Table 5 presents the regression statistics estimated using Model 3. For every examined portfolio, the regression statistics support the hypothesis of this study. In other words, the parameter estimates of Model 3 suggest that the exposure of the returns of the HFR, CSFB, and EQ portfolios to the market factor is conditional on investor sentiment. For these portfolios, the result is statistically significant at the 1% level. As the coefficient for INST is negative, the results implicate that when put/call ratio is high implicating low investor sentiment, the exposure of market-neutral hedge funds to market risk is lower.

In general, the regression statistics estimated using Model 3 also suggest that the exposure of the returns of market-neutral hedge funds to the HML, SMB, and UMD factors is conditional on investor sentiment. Especially for the returns of the CSFB portfolio, the conditionality of this exposure is important as the coefficients for the HML, SMB, and UMD factors are not statistically significant. Thus, the test statistics imply that the exposure of the returns of the CSFB portfolio to these factors is time-varying and conditional on investor sentiment, and therefore a static exposure is not found.

The returns of the examined portfolios other than CSFB do not show statistically significant and conditional exposure to the SMB factor. The results suggest that the returns of the HFR portfolio show conditional exposure to the UMD factor, which is conditional on investor sentiment, while this exposure is not conditional for the other examined portfolios of market-neutral hedge funds.

When summing up the regression statistics for all models examined in this study, the examined hedge fund returns have interesting time-series structures. Specifically, the returns of the CSFB portfolio do not strongly follow autoregressive or moving average processes. Instead, the returns of the EQ and HFR portfolios seem to follow the MA(1) process regardless of which model is used. Moreover, when Model 3 is used, the returns of the EQ and HFR portfolios AR(7) are needed to remove autocorrelation from the residuals of the Model.

TABLE 5
Conditional Analysis of the Performance of Market-Neutral Hedge Funds.
This table presents ordinary least squares (OLS) parameter estimates of Model 3 for the returns of the CSFB/Tremont value weighted Equity Market Neutral strategy index, the Hedge Fund Research equally weighted Equity Market Neutral strategy index, and equally weighted portfolio of 420 equity market neutral hedge funds listed in the Lipper TASS hedge fund database. The sample is from December 1995 to February 2007 and includes 135 monthly observations. Model 3 is the following:

$$r_{ep,t} = \beta_0 + \beta_1 r_{em,t} + \beta_2 SMB_{i,t} + \beta_3 HML_{i,t} + \beta_4 UMD_{i,t} + \beta_5 INST_{i,t} + \beta_6 SMBI_{i,t} + \beta_7 HMLI_{i,t} + \beta_8 UMDI_{i,t} + e_t,$$

where $SMBI_{i,t}$ defines the product of the lagged value of the CBOE total put/call ratio and the SMB factor; $HMLI_{i,t}$ defines the product of the lagged value of the CBOE total put/call ratio and the HML factor, and $UMDI_{i,t}$ defines the product of the lagged value of the CBOE total put/call ratio and the UMD factor. This table also presents Akaike information criterion (AIC), Schwartz information criterion (SIC), adjusted R-squares, and residual autocorrelation with lag n defined as resAR(n) which significance is based on Q-statistics. The standard errors are Newey-West (1987) heteroskedasticity and autocorrelation –consistent (lag 4). *t*-statistics are presented on the right hand side of the coefficient estimates. All returns are monthly in excess over the monthly U.S. 3-month T-bill rate and are expressed as percentages.

	CSFB		EQ		HFR	
C	0.560***	8.61	0.313***	4.33	0.381***	5.00
SP500	0.068***	3.74	0.056***	7.74	0.094***	6.94
INST	−0.360***	−2.71	−0.254***	−4.92	−0.274***	−2.65
HML	−0.013	−0.52	0.036**	2.40	0.060***	2.71
HML_INST	−0.392***	−3.22	−0.296***	−3.20	−0.466**	−2.44
SMB	0.016	1.09	0.069***	9.83	0.074***	5.39
SMB_INST	−0.289**	−2.55	0.045	0.68	−0.171	−1.42
UMD	−0.001	−0.07	0.073***	9.75	0.143***	11.29
UMD_INST	−0.068	−0.54	−0.049	−0.80	−0.309***	−3.08
MA(1)			0.350***	3.54	0.297***	3.64
AR(7)			0.356**	4.22	0.201**	2.43
Adj. R^2	0.23		0.48		0.52	
AIC	2.02		1.20		1.93	
SIC	2.21		1.44		2.18	
resAR(1)	0.104		−0.016		−0.029	
resAR(5)	0.015		0.082		0.156	
resAR(10)	−0.052		0.128		0.101	
N	134		134		134	

*Refers to a statistical significance at the 10% level; **refers to a statistical significance at the 5% level; *** refers to a statistical significance at the 1% level.

CONCLUSION

This study examines whether market risk in market-neutral hedge funds is associated with investor sentiment. In particular, the results show that when sentiment is high the market risk of the market-neutral hedge fund strategy is high as well, and vice versa. The only exception is the use of regime switching models, which do not provide statistically significant support for the returns of the HFR index.

The main conclusion is that market risk in market-neutral hedge funds is conditional on the CBOE put/call ratio which is associated with investor sentiment. The results also show evidence that during extremely high and low regimes of investor sentiment the exposure of the returns of market-neutral hedge funds to market risk is most altered by investor sentiment.

The results of this study continue the evidence of the relation between fund management and investor sentiment. In relation to the study of Xu [2004], which suggests that mutual funds deliver better performance when the sentiment is low, this study shows evidence that hedge funds actually decrease their market exposure when the sentiment is low. This behavior, in a way, caters to investors' preferences.

The results also suggest that the exposure of the returns of market-neutral hedge funds to the HML, SMB, and UMD factors may be conditional on investor sentiment. This evidence suggests that conditional exposure to the HML factor is similar for all examined portfolios of market-neutral hedge funds. Admittedly, exposures to the SMB and UMD factors of different hedge fund portfolios slightly differ across the portfolios.

In conclusion, market-neutral hedge funds seemingly allocate their assets according to investor sentiment, but the exact characteristics of the allocated stocks are not strongly evidenced. So far, book-to-market ratio and market risk are the strongest candidates as the results for the HML and market factors are the most convenience. The use of three different kind of models supports the robustness of the result that market risk in market-neutral hedge funds is associated with investor sentiment.

The results of this study encourage investigating the relation between behavioral finance and hedge fund management open to future research. Furthermore, the analysis of this study provides new tools to analyze the conditional performance of market-neutral hedge funds.

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REFERENCES

Baker, M. and J. Wurgler. "Investor Sentiment and the Cross-Section of Stock Returns." *Journal of Finance*, 55, (2006), pp. 2219–2257.

Bandopadhyaya, A. "Measures of Investor Sentiment: Who Wins the Horse Race?" Working Paper 1012 (2006), Boston, University of Massachusetts.

Brealy, R. and E. Kaplanis. "Hedge Funds and Financial Stability: An Analysis of Factor Exposures." *International Finance*, 4, (2001), pp. 161–187.

Capocci, D. "Neutrality of Market Neutral Funds." *Global Finance Journal*, 17, (2006), pp. 309–333.

Carhart, M. M. "On Persistence in Mutual Fund Performance." *Journal of Finance*, 52, (1997), pp. 679–698.

De Long, J. B., A. Shleifer, L. H. Summers and R. J. Waldmann. "Noise Trader Risk in Financial Markets." *Journal of Political Economy*, 98, (1990), pp. 703–738.

Dickey, D. A. and W. A. Fuller. "Distribution of the Estimators for Autoregressive Time Series with a Unit Root." *Journal of the American Statistical Association*, 74, (1979), pp. 427–431.

Fama, E. and K. French. "Common Risk Factors in the Returns on Stock and Bonds." *Journal of Financial Economics*, 33, (1993), pp. 3–56.

Ferson, W. E. and R. W. Schadt. "Measuring Fund Strategy and Performance in Changing Economic Conditions." *Journal of Finance*, 51, (1996), pp. 425–461.

Fisher, K. L. and M. Statman. "Investor Sentiment and Stock Returns." *Financial Analysts Journal*, 56, (2000), pp. 16–23.

Fung, W. and D. A. Hsieh. "Hedge Funds Benchmarks: A Risk-based Approach." *Financial Analyst Journal*, 60, (2004), pp. 65–80.

Frijns, B., E. Koellen and T. Lehnert. "On the Determinants of Portfolio Choice." *Journal of Economic Behaviour & Organization*, (2007), (forthcoming).

Hűbner, G. and N. Papageourgiou. "Optional and Conditional Components in Hedge Fund Returns." Working Paper (2006), University of Liege.

Karceski, J. "Returns-Chasing Behavior, Mutual Funds, and Beta's Death." *Journal of Financial and Quantitative Analysis*, 37, (2002), pp. 559–594.

Kat, H. and J. Miffre. "Performance Evaluation and Conditional Information." Working Paper (2002), University of Reading.

Kazemi, H. and T. Schneeweis. "Conditional Performance of Hedge Funds." Working Paper (2003), CISDM.

Xu, J. "Does Mutual Fund Performance Vary with Investor Sentiment?" Working Paper (2004), University of Texas at Austin.