

# **What Drives Equity Market Neutral Hedge Fund Returns?**

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## **Abstract**

We investigate equity market neutral hedge fund performance related to a number of equity market neutral style factors and economic variables. Equity market neutral style factors related to long-short (highest/lowest quintile) S&P 500 equal-weighted portfolios ranked on earnings-price (EP), price-to-book (PB), price momentum (PRM), and size (MKT) show performance that can be explained by the Fama-French market risk premium (RmRf), size (SMB) and book-to-market (HML) factors, the momentum (UMD) factor, as well as economic factors such as the shape of the yield curve (YLD), a default premium (PREM), an inflation change measure (INFCH) and a measure of market volatility (VIX). We then examine hedge fund index returns. An index of equity market neutral hedge fund returns in excess of t-bill returns (EMNE) has a significantly positive alpha (0.43% per month) and low but significant beta (around 0.07) relative to various market index excess returns. In expanded regressions, much of the EMNE returns can be explained by the style factors (particularly EP and PB) and economic variables and the alpha is no longer significant. The equity market neutral style factors and economic variables also explain much of the excess returns of other non-directional and directional hedge fund style portfolios as well. Our research sheds light on some key drivers behind equity market neutral returns and highlights the importance of economic conditions in explaining hedge fund returns. The “good news” is that EMNE returns are negatively related to the shape of the yield curve and positively related to market volatility, suggesting an important counter-cyclical role for such a strategy.

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## What Drives Equity Market Neutral Hedge Fund Returns?

### 1. Introduction

The growth in hedge fund assets has exploded during the past fifteen years to over \$1 trillion,<sup>1</sup> as have the various investment styles employed by managers. Recently, an increased number of studies have examined the behavior of hedge fund returns to better understand what drives performance. Such a determination is a key issue related to hedge funds given their lack of transparency. Fung and Hsieh (2001) follow Sharpe's (1992) approach to create a model of asset-based style factors for hedge funds. Agarawal and Naik (2004) further characterize systematic risk exposure through a multifactor model approach in the spirit of Fung and Hsieh.

In this study, we focus our research primarily on the “classic” hedge fund style: equity market neutral strategies. According to the website of the well-known Credit Suisse First Boston (CSFB)/Tremont Hedge Fund Indices (see [www.hedgeindex.com](http://www.hedgeindex.com)), equity market neutral strategies are described as follows: “This investment strategy is designed to *exploit equity market inefficiencies* and usually involves being simultaneously long and short matched equity portfolios of the same size within a country. Market neutral portfolios are designed to be either *beta* or *currency neutral*, or both. *Well-designed portfolios typically control for industry, sector, market capitalization, and other exposures.* Leverage is often applied to enhance returns” [note: emphasis added, as indicated in italics].<sup>2</sup>

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<sup>1</sup> As estimated by Malkiel and Saha (2005).

<sup>2</sup> This style is very distinct from another style known as long-short equity, described by CSFB/Tremont as follows: “This directional strategy involves equity-oriented investing on both the long and short sides of the market. The objective is not to be market neutral. Managers have the ability to shift from value to growth, from small to medium to large capitalization stocks, and from a net long position to a net short position. Managers may use futures and options to hedge. The focus may be regional, such as long/short US or European equity, or sector specific, such as long and short technology or healthcare stocks. Long/short equity funds tend to build and hold portfolios that are

This description of equity market neutral strategies raises some interesting observations, or hypotheses, that can be examined or tested through empirical analysis. For example, if such strategies are able to exploit market inefficiencies, then these strategies should, on average, provide significant out-performance after adjusting for risk; or in other words, these strategies should provide significant “alpha.” Measures of market beta should not be significantly different from zero. Similarly, any other betas relative to various “exposures” or factors should not be significantly different from zero.

In order to test these propositions, one needs to identify various risk factors beyond the traditional market factor (i.e., the Capital Asset Pricing Model) that might explain returns. This is important because a strategy may appear to be neutral relative to the market but may have exposure to other well-known factors. The finance literature has identified various factors that relate to portfolio strategies such as going long in small stocks and short in large stocks, going long in value stocks and short in growth stocks, and going long in stocks that have experienced large price increases and short in those that have not. As such, investors may be better off simply replicating such long/short strategies directly rather than through hedge fund investments.

While much attention has been placed on these portfolio strategies as risk factors, less attention has been placed on economic factors that may impact on performance. Examination of economic factors as explanatory variables for equity market neutral hedge funds may shed light on the ability of such funds to act as a counter-balance during depressed economic times. For example, when traditional long-only equity funds are performing poorly during slow economic periods,

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substantially more concentrated than those of traditional stock funds.” Categorization is not clear-cut. For example, Agarwal and Naik (2004) categorize the long/short equity CSFB/Tremont hedge fund index as “nondirectional.”

any counter-cyclical performance of these hedge funds may be beneficial from a portfolio diversification perspective.

Our study makes three contributions to the literature. First, we create and examine the properties of four asset-based style factors based on equity market neutral market strategies (using data from January 1980 to August 2005) which extends previous factor-related studies such as Fama and French (1992, 1993, 1996). The strategies are based on rankings and monthly updates of equal-weighted portfolios of S&P 500 stocks and involve going long (short) on the highest (lowest) ranked quintile sorted on earning/price (EP), price/book (PB), price momentum (PRM) and market capitalization (MKT). We examine the properties of each of these return series. Initially, these strategies show positive returns even after accounting for transaction costs.

We then examine some factors that explain the equity market neutral style factors or strategies. Not surprisingly, the style factors are related to the well-known Fama-French market risk premium (RmRf), size (SMB) and book-to-market (HML) factors as well as the price momentum (UMD) factor although some of the correlations are smaller than might be expected. For example, and the PB/HML correlation is 0.58, the MKT/SMB correlation is 0.43, suggesting some real and unexplained differences between the similar strategies, possibly related to the different universes and methodologies.<sup>3</sup> We also consider a set of economic variables including the shape of the yield curve (YLD), a default premium (PREM), an inflation change measure (INFCH) and a measure of market volatility (VIX). The economic variables, many of which have been examined extensively in the finance literature, are meant to capture various business cycle

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<sup>3</sup> While neither set of style factors represents a true investable strategy due to rebalancing cost and short-sell constraints, the EP, PB, PRM, and MKT strategies focus on more liquid stocks and provide a much more straightforward investing approach. We also include an estimate of transaction costs.

stages as a strong expansionary phase is generally characterized as one with an upward or increased sloping yield curve, a small or narrowing default premium, a low or decreasing inflationary environment, and a low or decreased volatility marketplace. Most of these variables help to explain the equity market neutral strategy (or style factor) returns. When measured in excess returns (i.e., above t-bill returns) and after accounting for various risk factor proxies and economic variables, these long/short strategies result in negative alphas.

Second, we examine the CSFB/Tremont equity market neutral index return series (available from January 1994 to May 2005) to explain what drives average equity market neutral hedge fund return performance (i.e., based on aggregation of firms in the CSFB/Tremont universe of hedge funds), measured in excess of t-bill returns (EMNE). The style strategy excess return series has a significantly positive alpha (0.43% per month) and low but significant beta (around 0.07) relative to various market index excess returns. In expanded regression analysis, EMNE returns can be explained by the style factors (particularly EP and PB) and economic variables (particularly YLD and VIX) and the alpha is no longer significant. The “good news” is that EMNE returns are negatively related to the shape of the yield curve and positively related to market volatility, suggesting an important counter-cyclical role for such a strategy.

Third, we extend our analysis to other hedge fund styles, as a robustness check and to examine whether style factors and economic variables that are significant in explaining equity neutral returns also explain returns from other styles. We consider the overall CSFB/Tremont hedge fund index excess returns as well as twelve other non-directional and directional style indices. As expected, some of the style factors and economic variables do either a better or worse job at

explaining both non-directional and directional excess hedge fund returns versus the equity market neutral style.

The paper is organized as follows. Section 2 reviews the hedge fund literature with a focus on performance measurement. Section 3 describes the data and methodology. Results are presented in section 4. The paper's conclusions are presented in section 5.

## **2. Literature Review**

An early attempt at explaining portfolio performance was developed by Sharpe (1992), in the context of a linear framework, through various style-based factors. Fama and French (1992, 1993) developed a three-factor model consisting of the market risk premium (RmRf), return difference in small versus large market capitalization portfolios (SMB) and return difference in book-to-market portfolios (HML). Fama and French (1996) examine the inclusion of a fourth factor, the price momentum (UMD) factor, based on Carhart's (1997) model.

Jacob and Levy (1993) pre-date more recent empirical hedge fund analysis by presenting a case for the benefits and opportunities of long/short strategies. Hedge fund performance is subsequently examined by Brown, Goetzmann and Ibbotson (1999), Ackermann, McEnally and Ravenscraft (1999), Liang (1999, 2001), and Agarwal and Naik (2000). Alexander (2001) examines the testing of zero-investment long/short strategies and notes that the estimate of economic profits is unbiased but imperfect given short selling constraints. Lo (2001) examines unique aspects of risk management for hedge funds and provides a call for more risk transparency while preserving the proprietary nature of hedge funds. Ennis and Sebastian (2003)

question how market-neutral a diversified hedge fund investment actually is. Brown and Goetzmann (2003) reach a similar conclusion by focusing on hedge fund style analysis. Finally, Brunnermeier and Nagel (2004) found that hedge funds were heavily invested in technology stocks around the recent “tech bubble” and were able to capture much of the upward swings but reduced their positions as stocks were about to decline.

In the context of hedge funds and style factors, Fung and Hsieh (2002) question how hedge fund managers’ return characteristics differ from returns of the assets they are trading by developing a model of asset-based style factors. They conclude that hedge fund strategies that are directional can be modeled with long-only asset-based style factors but non-directional strategies require new models. Agarwal and Naik (2004) examine the risk exposure of hedge funds using a multifactor model of excess returns on equities and fixed income securities as well as options. They also examine the out-of-sample hedge fund performance. They found that some hedge fund returns resemble the performance of put-writing returns. They also found more hedge fund positive correlation in down-markets but not in up markets. Patton (2005) examined individual hedge funds categorized as market neutral and found evidence against these funds actually being market neutral. He defined neutrality in terms of both breadth (reflecting market neutrality) and depth (reflecting completeness). Neutrality depth includes “mean neutrality” and “variance neutrality.” He found that about one-quarter of so-called market neutral funds exhibit some significant market exposure. Finally, Kooli (2005) examined the abnormal performance using a calendar-time approach developed for event studies. He found that hedge funds outperform the market but less so after accounting for additional factors.

### **3. Data and Methodology**

We collect data from a variety of sources. The style factors are based on earnings-to-price (EP) ratios, price-to-book value of equity (PB) ratios, price momentum (PRM) ratios and market capitalization (MKT). Prices and market capitalizations are from Interactive Data Corp. while book values are from Compustat and earnings estimates are from IBES. The strategies are based on rankings and monthly updates of equal-weighted portfolios of S&P 500 stocks and involve going long (short) on the highest (lowest) ranked quintile sorted on EP, PB, PRM, and MKT. An estimate of transaction costs is included. We chose these particular long/short style factors rather than simply relying on Fama-French factors because they are closer to investable styles since they focus on portfolios of the most liquid stocks and the portfolio formation techniques, based on highest and lowest quintiles, are quite straightforward.

Market indices and U.S. treasury-bill (t-bill) returns ( $R_f$ ) are available from Kenneth French's website (used to create excess returns) and index returns include the S&P 500 return series (SP) and the MSCI World index (MSCI) are available from Datastream.

The CSFB/Tremont hedge fund indices are available from [www.hedgeindex.com](http://www.hedgeindex.com). Funds must have a minimum of US \$50 million assets under management, a minimum one-year track record, and current audited financial statements. The indices are calculated on an asset-weighted basis and rebalanced monthly. To minimize survivorship bias, funds are not removed from until they are fully liquidated or fail to meet the financial reporting requirements. While our primary focus is on the equity market neutral index and corresponding index returns measured in excess of U.S. t-bill returns (EMNE), we also examine the overall CSFB/Tremont hedge fund index excess

returns (HFIE), convertible arbitrage (CAE), dedicated short bias (DSBE), emerging markets (EME), event-driven (EDE), event-driven distressed (EDDE), event-driven multi-strategy (EDMSE), event-driven risk-arbitrage (EDRAE), fixed-income arbitrage (FIAE), global-macro (GME), long-short equity (LSEE), managed futures (MFE), and multi-strategy (MSE) excess returns.

The Fama-French factors including the market risk premium (RmRf), small-minus-big market capitalization portfolios (SMB), value (high book/price) -minus-growth (low book/price) portfolios (HML), as well as the (up-minus-down) momentum variable (UMD) are available from <http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/>.<sup>4</sup>

Interest rate data to derive the YLD and PREM data series are derived from the Federal Reserve Statistical Release series found at <http://www.federalreserve.gov/releases/h15/data.htm>. YLD is the difference between the 10-year treasury note yield and the three-month t-bill yield, while PREM is the difference between the Moody's seasoned Aaa and Baa bond yields. The inflation change variable (INFCHG) is derived from the U.S. Department of Labor Bureau of Labor

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<sup>4</sup> According to the Kenneth French's website: "The Fama/French benchmark factors, Rm, SMB, and HML, are constructed from six size/book-to-market benchmark portfolios that do not include hold ranges and do not incur transaction costs. RmRf, the excess return on the market, is the value-weighted return on all NYSE, AMEX, and NASDAQ stocks (from CRSP) minus the one-month Treasury bill rate (from Ibbotson Associates). SMB (Small Minus Big) is the average return on three small portfolios minus the average return on three big portfolios,  $SMB = 1/3 (Small\ Value + Small\ Neutral + Small\ Growth) - 1/3 (Big\ Value + Big\ Neutral + Big\ Growth)$ . HML (High Minus Low) is the average return on two value portfolios minus the average return on two growth portfolios,  $HML = 1/2 (Small\ Value + Big\ Value) - 1/2 (Small\ Growth + Big\ Growth)$ . See Fama/French, 1993, "Common Risk Factors in the Returns on Stocks and Bonds," *Journal of Financial Economics*, for a complete description of the factor returns... We use six value-weight portfolios formed on size and prior (2-12) returns to construct UMD. The portfolios, which are formed monthly, are the intersections of 2 portfolios formed on size (market equity, ME) and 3 portfolios formed on prior (2-12) return. The monthly size breakpoint is the median NYSE market equity. The monthly prior (2-12) return breakpoints are the 30<sup>th</sup> and 70<sup>th</sup> NYSE percentiles. UMD (Up Minus Down) is the average return on the two high prior return portfolios minus the average return on the two low prior return portfolios,  $UMD = 1/2(Small\ High + Big\ High) - 1/2(Small\ Low + Big\ Low)$ ."

Statistics series found at <http://www.bls.gov/data/home.htm> and represents changes in the all-item urban consumer price index year-over-year series.

Volatility measure (VIX), is based on two sources. The 1980-1985 data represent trailing 250-day annualized standard deviations of S&P 500 returns. The 1986-2005 data are annualized implied volatility measures from the (old) VIX S&P 100 volatility index (see [www.cboe.com](http://www.cboe.com)).

Monthly returns from each of the equity market neutral trading strategies are represented as  $R_i$ , whereby  $i = EP, PB, PRM, \text{ or } MKT$  for earnings-price, price-to-book, price momentum, or market capitalization, respectively. Returns are also represented by the equity market neutral index as well as the other various hedge fund index style return series.

Returns (or excess returns) are regressed on a number of style-based and economic variable factors as indicated in the following equation:

$$R_{i,t} = a_i + \sum_{j=1}^n \beta_{i,j} F_{j,t} + \varepsilon_{i,t} \quad t = 1, \dots, T \quad (1)$$

where  $a_i$  is an intercept term,  $F_{j,t}$  represent the  $j = 1, \dots, n$  factor returns in period  $t$ ,  $\beta_{i,j}$  are the coefficients or betas for each factor and  $\varepsilon_{i,t}$  is an error term for time  $t$ .

## 4. Results

### 4.1 Style Factors

Market neutral strategy performance for each of the four EP, PB, PRM and MKT strategies are presented in Figure 1. Rolling (twelve-month) average monthly returns are presented for each. This figure highlights the increased volatility of performance around 2000. Up to 2000, the rolling monthly returns generally range from -2% to +2%, but then fluctuate between -5% and +8%.

Summary statistics are presented in panel A of table 1. All strategies except PRM show positive and significant returns (EP, and PB t-test p-values are below 2% while the MKT t-test p-value is 8%). Thus many of these strategies appear, at first blush, to offer significant performance and are neutral to the market – however we have not yet properly controlled for other risk factors. The PRM strategy is most volatile while the MKT strategy is the least volatile. As indicated in figure 1, the volatility appears to be greatest in the latter part of the sample. EP and PRM show negative skewness while PB and MKT show positive skewness. Among these strategies, EP shows the largest Sharpe ratio, as measured by the average return in excess of the t-bill return divided by the standard deviation.

Summary statistics are also presented for the Fama-French factors (RmRf, SMB, and HML) as well as the momentum factor (UMD). The EP and PRM strategies have higher returns than the excess market return, with a smaller standard deviation. The MKT return is almost three times

that of the somewhat similar Fama-French SMB, albeit with a slightly higher standard deviation. The PB return is slightly higher than the HML return, again with a higher standard deviation. The UMD return is higher than the PRM return but with a lower standard deviation. RmRf, and UMD show negative skewness. RmRf provides a benchmark Sharpe ratio, as measured by the average return in excess of the t-bill return divided by the standard deviation, of 0.032. Only EP and UMD have greater Sharpe ratios.

Panel A of table 1 also presents summary statistics for the economic variables. Over this period, the yield curve is, on-average, upward sloping as expected, although there are periods of inverted yield curves (as indicated by a negative minimum value for YLD). The default premium is around 1% but ranges from 0.55% to 2.69%, indicating variability in economic conditions. Inflation has trended downward slightly over the period. The volatility measure over the period is consistent with annualized U.S. market standard deviations measured over much longer periods. YLD and INFCH show negative skewness.

Panel B of table 1 presents correlations among the variables. Among the style strategies, PB and MKT are most highly correlated (0.69), followed by EP and PB (0.45). This suggests that there was a tendency for “value” stocks (low PB) to have smaller market capitalization. It is not surprising that low (high) P/E stocks tend to be low (high) P/B stocks as well. PB and MKT are significantly negatively related to PRM (-0.36 and -0.18 respectively). Not surprisingly the style factors are related to the Fama-French size (SMB) and book-to-market (HML) factors as well as the price momentum (UMD) factor although some of the correlations, while significant, are well below 1.00. For example, the PB/HML correlation is 0.58, and the MKT/SMB correlation is

0.43, suggesting some real and unexplained differences between the similar strategies. Many of the style strategies are significantly negatively related to inflation changes. Interestingly, the Fama-French market risk premium is significantly negatively related to the volatility measure.

Table 2 presents results of regressions of the monthly style factor excess returns (i.e., above t-bill returns) on the various Fama-French factors as well as the economic variables. Much of the EP strategy returns can be explained by the Fama-French factors. The return is significantly positively related to HML and significantly negatively related to UMD (and marginally significantly related to SMB). These results suggest the EP strategy is driven by the performance of value stocks (high EP and high book-to-market) versus growth stocks (low EP and low book-to-market). Performance over this period is also driven to some extent by larger stocks. These factors combine to subsume any market effects. EP excess returns are negatively related to the momentum factor. The addition of economic variables as explanatory factors does not impact on the results suggesting the other factors are not dependent on economic conditions. While the intercept term was significant in the initial CAPM regression with one market factor, once additional factors are included the intercept is no longer significant, suggesting no positive alpha.

The PB strategy shows a somewhat similar pattern compared with EP. The intercept or alpha relative to the market factor (in the CAPM regression) is positive although not significant. In relation to the Fama-French factors, the PB excess returns are significantly positively related to the HML factor, as expected, and significantly positively related to the SMB factor, suggesting a small cap effect. Unlike the EP strategy, the market effect is also significant. PB excess returns are negatively related to the momentum factor. In terms of economic variables, this strategy is

positively significantly related to the volatility measure – the strategy performs well when markets are more volatile.

In terms of the PRM strategy, the initial alpha based on the CAPM regression is virtually zero. With the inclusion of the Fama-French factors, the price momentum strategy is significantly negatively related to the market factor (suggesting a counter-cyclical effect) and the SMB factor (suggesting momentum is driven by larger stocks). The addition of the UMD factor is significantly positive as expected. With the addition of the economic variables, the price momentum strategy tends to perform better in economic expansions which are associated with an upward sloping yield curve and a lower default premium.

Finally, the MKT strategy shows a positive alpha in the CAPM regression but one that is not significant. The strategy is significantly positively related to all of the three Fama-French factors, suggesting small stocks do better when the market is up, and is driven in part by value stocks. The strategy is significantly positively related to SMB (not surprisingly). With the addition of the momentum variable, the size-based strategy is significantly negatively related to UMD, suggesting small stocks do better when momentum is not as strong. The strategy also tends to do better in volatile markets.

## 4.2 Hedge Fund Returns

Table 3 presents results related to the equity market neutral index (with available data from 1994 to 2005). Summary statistics are presented in panel A. Average monthly returns of 0.80% are

significantly positive.<sup>5</sup> The standard deviation is much lower than that of the U.S. market risk premium (RmRf) or the world index excess return (MSCIE). In contrast, no other strategy has significant positive returns over this sample period. The monthly range of returns for EMN is only -1.2% to 3.3%, much tighter than some of the style strategies that range up to 50% between the best and worst months. The EMN index can be thought of as a proxy for a fund-of-hedge funds and clearly demonstrates the diversification benefits versus some pure style portfolios. The economic variables in this subperiod are of similar order of magnitude compared with the overall period.

Correlations are presented in panel B. EMN is positively and significantly related to the U.S. market risk premium and the world market risk premium. EMN is negatively and significantly related to the yield curve variable suggesting, all else equal, that the strategy is somewhat counter-cyclical to overall economic conditions. No other EMN correlations are significant. Interestingly, the size factor MKT is significantly related to all other non-economic factors – positively in all cases expect PRM.

Table 4 examines the drivers of equity market neutral hedge fund excess returns (EMNE). We begin with a simple CAPM regression using U.S. market risk premium excess return, RmRf, although results are similar using a world market excess return (MSCIE). The intercept term can be interpreted as alpha. In this first regression, the beta is significantly positive but very low (0.07) as expected in such a market neutral strategy. Thus the first observation is that, on average, equity market neutral strategies are not truly neutral, but do exhibit very little pure

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<sup>5</sup> A critique of reported hedge fund returns in general is that they do not represent investable returns due to a number of biases. In the last few years a CSFB/Tremont investable index has been available but the time period is too short for any meaningful analysis.

market exposure. The alpha is positive and significant (0.44) and represents an annualized return of 5.4%. The adjusted R-square is 13.1%. Thus in a CAPM world, it appears that such strategies offer superior performance.

The second regression examines the impact of the addition of the four style factors (EP, PB, PRM, and MKT). The market beta now increases slightly to 0.10. The EP coefficient is significant (positive) at the 1% level as is the PB variable (but negative), while the PRM variable is significant (negative) at the 10% level. The alpha decreases slightly to 0.43 or 5.3% on an annualized basis. The adjusted R-square increases to 21.8%. Thus in addition to the small but significant market beta factor, equity market neutral fund performance captures a value effect as measured by the price-earnings ratio, but a growth effect as captured by the price-to-book ratio. This suggests that the Fama-French HML factor may not be capturing all of the value-growth effect. With the negative price momentum coefficient, this suggests that equity market neutral captures some price reversal effects rather than continuation of strong 12-month performance. The MKT variable is not significant suggesting size is not a relevant factor driving equity market neutral performance.

The third and fourth equations add the economic variables (YLD, PREM, INFCH, and VIX). In both regressions the adjusted R-square increases to over 27% -- a fairly substantial increase – and the alpha becomes small (0.02 or less) or negative and insignificant. If we are willing to consider these economic factors as reflective of risks for which one expects to be compensated, then the equity market neutral strategies, on average, are not providing superior performance. The RmRF, EP, PB, PRM and MKT coefficients are a similar order of magnitude and

significance as in the previous regressions, suggesting an orthogonal impact of the economic variables. The dominant style factors continue to be RmRf, EP, PB, and to a lesser extend PRM. The yield variable is significant and negative, and the volatility variable is significant and positive (particularly in the third regression that excludes the two economic variables with the least significance). This it appears that, in addition to the factors described above, the equity market neutral excess return alpha can be explained by the shape of the yield curve (the strategy tends to do worse will the yield curve is steeper suggesting a counter-cyclical strategy), and market volatility (the strategy tends to do better during more volatile times which often occur during economic slowdowns or recessions).

The remaining regressions examine the other hedge fund style excess returns. Not surprisingly, given the variety of styles, some of the models explain much of the excess return variability (as measured by the adjusted R-square) and others very little. There is a clear dichotomy with five of the styles less than 8% of the variability is explained – convertible arbitrage (CAE), fixed-income arbitrage (FIAE), global macro (GME), managed futures (MFE), and multi-strategy (MSE) – while for the remaining seven styles – dedicated short bias (DSBE), emerging markets (EME), event-driven (EDE), event-driven distressed (EDDE), event-driven multi-strategy (EDMS), event-driven risk arbitrage (EDRA), long-short equity (LSE) – more than 35% of the variability is explained, and for the overall index (which is value-weighted) 41% is explained.

Among these seven “equity-related” styles, all have significant world market premium betas (ranging from 0.12 to 0.52) and as expected DSBE has a significant negative beta (-0.96). There is prevalence among the remaining six strategies to have a growth tilt over this time period as

evidenced by significant and negative PB coefficients (positive for the DSBE strategy), while the EP coefficients don't appear to show any consistent trend. There does not appear to be a consistent price momentum effect. There is also a small-cap tilt as evidenced by significant and positive MKT coefficients (negative for the DSBE strategy) for most of the equity-related strategies.

In terms of the economic variables, CAE, EDRAE and LSEE (marginal at 10%) have significant and negative YLD coefficients while many others have negative but not significant coefficients. Thus similar to the equity market neutral strategy, these other hedge fund strategies tend to be counter-cyclical as measured by the shape of the yield curve. EDE, EDMSE and FIAE show a positive relationship with a wider default premium spread. CAE, EME, EDE, EDDE (marginal at 10%), EDMSE, and FIAE performance is positively related to higher inflation. Unlike the equity market neutral strategy, most of the event-driven strategies (EDE, EDDE, EDMSE and EDRAE) have significant and negative VIX coefficients, suggesting lower volatility is better for these types of strategies. Managed futures tends to do better in more volatile times.

## 5. Conclusions

We investigate equity market neutral hedge fund performance. Equity market neutral style factors related to long-short (highest/lowest quintile) S&P 500 equal-weighted portfolios ranked on earnings-price, price-to-book, price momentum, and size show performance that can be explained by the Fama-French factors as well as a momentum factor and economic factors such as the shape of the yield curve, a default premium, an inflation change measure and a measure of market volatility. We then examine hedge fund index returns. An index of equity market neutral

hedge fund returns in excess of t-bill returns has a significantly positive alpha and low but significant beta relative to various market index excess returns. In expanded regressions, much of the returns can be explained by the style factors and economic variables and the alpha is no longer significant. The equity market neutral style factors and economic variables also explain much of the excess returns of other non-directional and directional hedge fund style portfolios as well.

Our research sheds light on some key drivers behind equity market neutral returns and highlights the importance of economic conditions in explaining hedge fund returns. For the most part, equity market neutral funds show very little market exposure. Performance appears to be superior when measured against a variety of long/short style factors, but not with the addition of economic factors. The “good news” is that equity market neutral returns are negatively related to the shape of the yield curve and positively related to market volatility, suggesting an important counter-cyclical role for such a strategy. Further research in this area can investigate equity market neutral returns at the individual hedge fund level.

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**Table 1**  
**Style Factor Return and Economic Variable Summary Statistics (1980-2005)**

Style factors are based on equity market neutral market strategies, using monthly data from January 1980 to August 2005. The strategies are based on rankings and monthly updates of equal-weighted portfolios of S&P 500 stocks and involve going long (short) on the highest (lowest) ranked quintile sorted on earning/price (EP), price/book (PB), price momentum (PRM), and market capitalization (MKT). The market risk premium (RmRf), small-minus-big portfolio (SMB), and high-minus-low book-to-price portfolio (HML) are the Fama-French factors while up-minus-down is the momentum factor (UMD). The shape of the yield curve (YLD) is the difference between the long-term government yield and the t-bill yield, the default premium (PREM) is the difference between Moody's Baa and Aaa bonds, inflation change (INFCH) is the change in the year-over-year consumer price index, and volatility (VIX) is measured as the historical S&P 500 volatility (pre-1986) or the CBOE VIX implied volatility (post-1986). Sharpe Ratio (measures the mean return in excess of the t-bill return divided by the standard deviation. Summary statistic measures (except t-tests) are percentages. The t-test (and corresponding p-value) examines the extent to which the mean monthly return is significantly different from zero. Correlations reported in bold represent significance from zero with p-values less than 0.050.

**Panel A: Summary Statistics**

	EP	PB	PRM	MKT	RmRf	SMB	HML	UMD	YLD	PREM	INFCH	VIX
Mean	0.78	0.54	0.37	0.38	0.63	0.13	0.42	0.85	1.85	1.08	-0.31	20.12
Median	0.92	0.47	0.81	0.23	1.06	0.05	0.41	1.11	2.01	0.95	-0.10	18.75
Std. Dev.	4.45	3.88	5.87	3.80	4.50	3.29	3.23	4.42	1.27	0.46	1.74	6.86
Skewness	-0.46	0.00	-1.07	0.51	-0.78	0.74	0.02	-0.57	-0.73	1.26	-0.49	1.74
Kurtosis	3.83	3.74	5.47	2.76	2.66	8.47	2.44	5.52	0.58	1.34	0.97	5.48
Maximum	18.74	18.55	18.53	19.60	12.43	22.09	13.74	18.38	4.42	2.69	4.60	61.41
Minimum	-23.56	-17.68	-31.84	-12.52	-23.13	-16.78	-13.20	-25.00	-2.65	0.55	-6.00	9.82
t-test	3.07	2.43	1.10	1.75	2.45	0.70	2.29	3.38	25.53	41.85	-3.21	51.45
(p-value)	(0.002)	(0.016)	(0.270)	(0.080)	(0.015)	(0.485)	(0.023)	(0.001)	(0.000)	(0.000)	(0.002)	(0.000)
Sharpe Ratio	0.066	0.014	-0.019	-0.027	0.032	-0.107	-0.019	0.083	-	-	-	-

**Panel B: Correlations**

	EP	PB	PRM	MKT	RmRf	SMB	HML	UMD	YLD	PREM	INFCH	VIX
EP	1.000	<b>0.450</b>	<b>-0.131</b>	<b>0.108</b>	<b>-0.356</b>	<b>-0.349</b>	<b>0.653</b>	<b>-0.179</b>	-0.020	0.037	-0.024	0.043
PB		1.000	<b>-0.640</b>	<b>0.686</b>	-0.026	-0.060	<b>0.579</b>	<b>-0.584</b>	0.041	0.087	-0.080	0.009
PRM			1.000	<b>-0.530</b>	<b>0.144</b>	0.040	<b>-0.072</b>	<b>0.910</b>	0.001	-0.049	-0.027	-0.051
MKT				1.000	<b>0.242</b>	<b>0.432</b>	<b>0.122</b>	<b>-0.413</b>	0.072	<b>0.165</b>	-0.089	-0.009
RmRf					1.000	<b>0.203</b>	<b>-0.514</b>	-0.027	0.057	0.039	-0.023	<b>-0.290</b>
SMB						1.000	<b>-0.410</b>	<b>0.115</b>	0.090	0.080	-0.064	-0.070
HML							1.000	<b>0.128</b>	0.010	0.000	-0.077	0.031
UMD								1.000	-0.024	-0.030	-0.016	-0.052
YLD									1.000	0.036	<b>-0.120</b>	<b>-0.126</b>
PREM										1.000	<b>-0.402</b>	-0.004
INFCH											1.000	0.060
VIX												1.000

**Table 2**  
**Style Factor Regression Analysis**

Style factors excess returns (the dependent variables) are based on equity market neutral market strategies, using monthly data from January 1980 to August 2005. The strategies, all measured in excess of monthly t-bill returns, are based on rankings and monthly updates of equal-weighted portfolios of S&P 500 stocks and involve going long (short) on the highest (lowest) ranked quintile sorted on earning/price (EPE), price/book (PBE), price momentum (PRME) and market capitalization (MKTE). The market risk premium (RmRf), small-minus-big portfolio (SMB), and high-minus-low book-to-price portfolio (HML) are the Fama-French factors while up-minus-down is the momentum factor (UMD). The shape of the yield curve (YLD) is the difference between the long-term government yield and the t-bill yield, the default premium (PREM) is the difference between Moody's Baa and Aaa bonds, inflation change (INFCH) is the change in the year-over-year consumer price index, and volatility (VIX) is measured as the historical S&P 500 volatility (pre-1986) or the CBOE VIX implied volatility (post-1986). Int is the intercept term and Adj R<sup>2</sup> is the adjusted R-square. Coefficient significance is indicated by p-values in parentheses.

	<b>Int</b>	<b>RmRf</b>	<b>SMB</b>	<b>HML</b>	<b>UMD</b>	<b>YLD</b>	<b>PREM</b>	<b>INFCH</b>	<b>VIX</b>	<b>Adj R<sup>2</sup></b>
EPE	0.51 (0.032)	-0.35 (0.000)								0.121
EPE	-0.02 (0.915)	-0.02 (0.639)	-0.12 (0.051)	0.83 (0.000)						0.428
EPE	0.08 (0.712)	-0.04 (0.480)	-0.12 (0.071)	0.81 (0.000)	-0.10 (0.030)					0.435
EPE	-0.35 (0.686)	-0.03 (0.571)	-0.11 (0.080)	0.81 (0.000)	-0.09 (0.037)	0.05 (0.741)	0.19 (0.683)	0.09 (0.478)	0.01 (0.809)	0.429
PBE	0.06 (0.773)	-0.02 (0.73)								-0.003
PBE	-0.62 (0.003)	0.33 (0.000)	0.26 (0.000)	1.04 (0.000)						0.467
PBE	-0.17 (0.176)	0.27 (0.000)	0.31 (0.000)	0.94 (0.000)	-0.44 (0.000)					0.713
PBE	-1.31 (0.015)	0.30 (0.000)	0.31 (0.000)	0.96 (0.000)	-0.44 (0.000)	0.07 (0.487)	-0.02 (0.932)	0.01 (0.913)	0.05 (0.007)	0.717
PRME	0.00 (0.997)	0.18 (0.014)								0.016
PRME	0.23 (0.509)	-0.31 (0.003)	0.03 (0.801)	0.35 (0.007)						0.039
PRME	-0.99 (0.000)	-0.17 (0.000)	-0.10 (0.040)	-0.08 (0.135)	1.21 (0.000)					0.839
PRME	-0.16 (0.791)	-0.19 (0.000)	-0.10 (0.022)	-0.10 (0.054)	1.20 (0.000)	0.24 (0.023)	-0.65 (0.041)	-0.09 (0.316)	-0.03 (0.174)	0.844
MKTE	0.24 (0.273)	0.21 (0.000)								0.058
MKTE	-0.71 (0.000)	0.36 (0.000)	0.87 (0.000)	0.68 (0.000)						0.423
MKTE	0.35 (0.020)	0.32 (0.000)	0.72 (0.000)	0.61 (0.000)	-0.35 (0.000)					0.582
MKTE	-2.47 (0.000)	0.36 (0.000)	0.72 (0.000)	0.63 (0.000)	-0.34 (0.000)	0.08 (0.469)	0.44 (0.194)	0.04 (0.637)	0.07 (0.001)	0.595

**Table 3**  
**Equity Market Neutral Index and Economic Variable Summary Statistics (1994-2005)**

The index used is the CSFB/Tremont Equity Market Neutral Index (EMN), monthly data from January 1994 to May 2005. Asset-based style factors are based on rankings and monthly updates of equal-weighted portfolios of S&P 500 stocks and involve going long (short) on the highest (lowest) ranked quintile sorted on earning/price (EP), price/book (PB), and price momentum (PRM). The market risk premium (RmRf), is one of the Fama-French factors. The excess return of the Morgan Stanley world index excess return (MSCIE) is also examined. The shape of the yield curve (YLD) is the difference between the long-term government yield and the t-bill yield, the default premium (PREM) is the difference between Moody's Baa and Aaa bonds, inflation change (INFCH) is the change in the year-over-year consumer price index, and volatility (VIX) is measured as the historical S&P 500 volatility (pre-1986) or the CBOE VIX implied volatility (post-1986). Summary statistic measures (except t-tests) are percentages. The t-test (and corresponding p-value) examines the extent to which the mean monthly return is significantly different from zero. Correlations reported in bold represent significance from zero with p-values less than 0.050.

*Panel A: Summary Statistics*

	<b>EMN</b>	<b>RmRf</b>	<b>MSCIE</b>	<b>EP</b>	<b>PB</b>	<b>PRM</b>	<b>MKT</b>	<b>YLD</b>	<b>PREM</b>	<b>INFCH</b>	<b>VIX</b>
Mean	0.80	0.61	0.39	0.59	0.65	0.24	0.40	1.71	0.80	0.01	21.92
Median	0.79	1.29	0.78	0.84	0.47	0.74	0.33	1.56	0.72	0.10	21.70
Std. Dev.	0.87	4.47	4.07	5.69	4.58	7.40	4.32	1.09	0.22	0.95	7.47
Skewness	0.32	-0.73	-0.58	-0.43	-0.03	-1.07	0.83	0.08	1.22	-0.35	0.75
Kurtosis	0.29	0.70	0.62	2.40	3.87	4.05	2.74	-1.08	0.48	-0.19	0.64
Maximum	3.26	8.16	8.84	18.74	18.55	18.53	19.60	3.70	1.41	1.90	48.33
Minimum	-1.15	-15.99	-13.75	-23.56	-17.68	-31.84	-9.99	-0.53	0.55	-2.50	9.82
t-test	10.82	1.60	1.11	1.22	1.65	0.38	1.07	18.44	42.24	0.10	34.34
(p-value)	(0.000)	(0.111)	(0.268)	(0.224)	(0.102)	(0.707)	(0.286)	(0.000)	(0.000)	(0.922)	(0.000)

*Panel B: Correlations*

	<b>EMN</b>	<b>RmRf</b>	<b>MSCIE</b>	<b>EP</b>	<b>PB</b>	<b>PRM</b>	<b>MKT</b>	<b>YLD</b>	<b>PREM</b>	<b>INFCH</b>	<b>VIX</b>
<b>EMN</b>	1.000	<b>0.365</b>	<b>0.345</b>	0.048	-0.010	0.115	0.022	<b>-0.324</b>	-0.089	0.138	0.047
<b>RmRf</b>		1.000	<b>0.938</b>	<b>-0.465</b>	0.000	0.067	<b>0.175</b>	-0.022	-0.087	0.096	<b>-0.338</b>
<b>MSCIE</b>			1.000	<b>-0.410</b>	0.065	0.006	<b>0.209</b>	0.034	-0.049	0.082	<b>-0.362</b>
<b>EP</b>				1.000	<b>0.508</b>	-0.131	<b>0.192</b>	-0.057	0.017	-0.105	0.058
<b>PB</b>					1.000	<b>-0.454</b>	<b>0.784</b>	-0.022	0.114	0.027	0.006
<b>PRM</b>						1.000	<b>-0.319</b>	-0.006	0.000	-0.139	0.006
<b>MKT</b>							1.000	0.083	<b>0.221</b>	0.040	0.053
<b>YLD</b>								1.000	<b>0.474</b>	<b>-0.235</b>	<b>-0.223</b>
<b>PREM</b>									1.000	<b>-0.188</b>	<b>0.405</b>
<b>INFCH</b>										1.000	0.017
<b>VIX</b>											1.000

**Table 4**  
**Equity Market Neutral Index versus Other Style Regression Analysis**

The main dependent variable is the CSFB/Tremont Equity Market Neutral Index, monthly data from January 1994 to May 2005, measured as returns in excess of t-bill returns (EMNE). Asset-based style factors are based on equity market neutral market strategies, using monthly data. The strategies are based on rankings and monthly updates of equal-weighted portfolios of S&P 500 stocks and involve going long (short) on the highest (lowest) ranked quintile sorted on earning/price (EP), price/book (PB), price momentum (PRM), and market capitalization (MKT). The market risk premium (RmRf), is a Fama-French factor. The shape of the yield curve (YLD) is the difference between the long-term government yield and the t-bill yield, the default premium (PREM) is the difference between Moody's Baa and Aaa bonds, inflation change (INFCH) is the change in the year-over-year consumer price index, and volatility (VIX) is measured as the historical S&P 500 volatility (pre-1986) or the CBOE VIX implied volatility (post-1986). Regression analysis dependent variables also include the CSFB/Tremont indices in excess of t-bill returns: overall hedge fund index (HFIE), convertible arbitrage (CAE), dedicated short bias (DSBE), emerging markets (EME), event-driven (EDE), event-driven distressed (EDDE), event-driven multi-strategy (EDMSE), event-driven risk-arbitrage (EDRAE), fixed-income arbitrage (FIAE), global-macro (GME), long-short equity (LSEE), managed futures (MFE), and multi-strategy (MSE). Int is the intercept term and Adj R<sup>2</sup> is the adjusted R-square. Coefficient significance is indicated by p-values in parentheses.

	Int	RmRf	EP	PB	PRM	MKT	YLD	PREM	INFCH	VIX	Adj R <sup>2</sup>
<b>EMNE</b>	0.44 (0.000)	0.07 (0.00)									0.131
<b>EMNE</b>	0.43 (0.000)	0.10 (0.000)	0.07 (0.000)	-0.09 (0.010)	-0.02 (0.082)	0.02 (0.424)					0.218
<b>EMNE</b>	0.02 (0.938)	0.11 (0.000)	0.06 (0.000)	-0.09 (0.006)	-0.02 (0.107)	0.02 (0.429)	-0.09 (0.129)			0.02 (0.008)	0.279
<b>EMNE</b>	-0.18 (0.532)	0.11 (0.000)	0.08 (0.000)	-0.09 (0.006)	-0.02 (0.105)	0.02 (0.548)	-0.13 (0.095)	0.53 (0.190)	0.09 (0.192)	0.02 (0.124)	0.287
<b>HFIE</b>	0.55 (0.441)	0.32 (0.000)	0.01 (0.740)	-0.09 (0.278)	0.13 (0.000)	0.13 (0.040)	-0.16 (0.434)	0.63 (0.533)	0.20 (0.246)	-0.02 (0.454)	0.408
<b>CAE</b>	-0.09 (0.871)	0.05 (0.169)	0.02 (0.524)	-0.04 (0.516)	0.01 (0.806)	0.06 (0.185)	-0.28 (0.063)	1.05 (0.166)	0.282 (0.028)	0.00 (0.920)	0.068
<b>DSBE</b>	2.02 (0.050)	-0.96 (0.000)	-0.07 (0.260)	0.39 (0.001)	-0.06 (0.191)	-0.45 (0.000)	0.05 (0.860)	-1.94 (0.182)	-0.20 (0.410)	-0.02 (0.678)	0.751
<b>EME</b>	-1.73 (0.270)	0.61 (0.000)	0.12 (0.166)	-0.28 (0.111)	0.12 (0.099)	0.37 (0.009)	0.41 (0.348)	3.11 (0.162)	0.74 (0.049)	-0.07 (0.285)	0.357
<b>EDE</b>	0.83 (0.096)	0.22 (0.000)	0.05 (0.094)	-0.06 (0.027)	0.04 (0.103)	0.13 (0.005)	-0.15 (0.292)	1.38 (0.052)	0.25 (0.036)	-0.06 (0.005)	0.449
<b>EDDE</b>	0.97 (0.108)	0.24 (0.000)	0.05 (0.180)	-0.03 (0.611)	0.04 (0.205)	0.12 (0.025)	-0.12 (0.462)	1.31 (0.126)	0.23 (0.109)	-0.06 (0.019)	0.390
<b>EDMSE</b>	0.68 (0.230)	0.21 (0.000)	0.05 (0.142)	-0.08 (0.210)	0.04 (0.094)	0.13 (0.010)	-0.13 (0.425)	1.35 (0.094)	0.30 (0.030)	-0.05 (0.019)	0.362
<b>EDRAE</b>	1.18 (0.003)	0.12 (0.000)	0.05 (0.044)	-0.10 (0.016)	0.01 (0.731)	0.15 (0.000)	-0.25 (0.024)	0.46 (0.405)	0.10 (0.291)	-0.04 (0.010)	0.368
<b>FIAE</b>	0.06 (0.888)	0.01 (0.614)	0.02 (0.445)	0.00 (0.940)	0.02 (0.217)	0.01 (0.816)	-0.01 (0.918)	1.20 (0.052)	0.18 (0.088)	-0.04 (0.035)	0.045
<b>GME</b>	0.75 (0.557)	0.27 (0.002)	0.09 (0.221)	-0.08 (0.578)	0.12 (0.046)	0.10 (0.370)	-0.25 (0.470)	1.02 (0.570)	0.04 (0.887)	-0.03 (0.620)	0.071
<b>LSEE</b>	0.11 (0.068)	0.52 (0.000)	-0.03 (0.395)	-0.13 (0.067)	0.20 (0.000)	0.21 (0.000)	-0.30 (0.102)	0.61 (0.510)	0.23 (0.136)	0.01 (0.738)	0.713
<b>MFE</b>	-2.22 (0.111)	-0.00 (0.961)	0.05 (0.500)	-0.00 (0.983)	0.11 (0.088)	0.12 (0.325)	0.37 (0.335)	-1.17 (0.552)	-0.12 (0.707)	0.12 (0.034)	0.042
<b>MSE</b>	-0.16 (0.753)	0.03 (0.352)	-0.05 (0.084)	0.07 (0.180)	0.03 (0.252)	-0.01 (0.865)	0.12 (0.405)	-0.54 (0.449)	0.11 (0.361)	0.03 (0.102)	0.003

**Figure 1**  
**Style Factor Returns**

Style factors are based on equity market neutral market strategies, using monthly data from January 1980 to August 2005. The strategies are based on rankings and monthly updates of equal-weighted portfolios of S&P 500 stocks and involve going long (short) on the highest (lowest) ranked quintile sorted on earning/price (EP), price/book (PB), price momentum (PRM), and market capitalization (MKT). Monthly 12-month moving average returns are presented.

