

‘When There Is No Place to Hide’: Correlation Risk and the Cross-Section of Hedge Fund Returns

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ABSTRACT

This paper investigates the importance of correlation risk exposure in explaining cross-sectional differences in hedge funds’ performance and risk. While hedge funds and mutual funds are both pooled investment vehicles with a delegated portfolio manager they differ in important ways. Differences in both legal frameworks and investment mandate imply that hedge funds are more exposed to correlation risk. A hedge fund’s ability to enter long-short positions can reduce a fund’s equity market beta, but it exposes the fund to unexpected changes in correlations. We find that high correlation risk exposure explains a statistically and economically significant percentage of hedge funds’ absolute returns and that correlation risk is priced in the cross-section of hedge fund returns. We find that funds with negative loadings on the negative correlation risk premium have maximum drawdowns that are higher as those of funds that sell protection against increases in correlation. Failure to account for correlation risk exposures leads to an overestimation of funds’ risk-adjusted performance. Our findings have important implications for hedge fund risk management, the categorization of hedge funds according to risk exposure and recent legislation that allows mutual funds to follow so-called 130/30 long-short strategies.

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THIS PAPER INVESTIGATES THE IMPORTANCE OF CORRELATION RISK EXPOSURE IN EXPLAINING cross-sectional differences in hedge funds’ performance and risk. Hedge funds can be expected to be exposed to correlation risk for several reasons. Hedge funds and mutual funds have a similar economic function, in that they are pooled investment vehicles with a delegated portfolio manager.

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However, they differ in important ways. Such differences, namely legal structure, regulation and investment mandate, presage that hedge funds are more exposed to correlation risk than mutual funds.

Though rarely noted, differences in legal structure between mutual funds and hedge funds have important consequences for differences in leverage, liquidity, risk-taking and investment strategies. Hedge funds' limited partnership structure allows for asset segregation, and the liquidity lock-ups imposed to investors by hedge funds allow for prime brokerage contracts that facilitate leveraging, trading in OTC derivatives and short-selling. By contrast, most mutual funds, as Almazan et al (2004) document, are restricted (by government regulations or investor contracts) with respect to using leverage, trading derivatives and short-selling and those that are permitted to do it, do so to a limited extent, due to the restrictions imposed by prime brokers to counterparties that offer daily liquidity to their clients.¹ Because correlation risk arises due to the application of combined long/short positions, combined positions in index and individual options, and the trading of derivatives, such as correlation swaps, hedge funds' laxer regulatory constraints increase the potential correlation risk exposure.

While mutual funds use investors' cash to invest primarily in publicly traded shares and provide investors with daily access to liquidity, hardly any hedge funds provide daily access to liquidity. Mutual funds' assets are held in brokerage accounts and unlike hedge funds' OTC contracts are not subject to counterparty risk. As the 2007-2008 period has shown, counterparty risk becomes particularly acute when losses on broad portfolios occur. Thus, correlation risk in hedge funds can be exacerbated in times when prime brokers increase hedge funds' collateral requirements and mandate haircuts in response to higher perceived counterparty risk. In order to meet higher collateral requirements, hedge funds may be forced to liquidate long and short positions in different pockets of their portfolio, thus increasing correlations across hedge fund categories

Apart from the differences in legal structure, the other main difference between hedge funds and mutual funds lies in their different investment mandate or business model. This has important implications for the size of α and β that mutual funds and hedge funds aim to achieve as well as their potential correlation risk exposure. While the mandate of most mutual funds is to generate *relative* returns (relative to a benchmark such as the S&P500, for example), hedge funds have an *absolute* return objective (Ineichen (2002)). Similarly, while the main risk for mutual funds is active risk (relative to the benchmark), most hedge funds aim at minimizing total risk.

Absolute return managers therefore have different incentives regarding risk management. The portfolios of most long-only mutual fund managers closely track the benchmark (with significant β exposure) and they are mainly concerned about tracking error or active risk relative to a benchmark. When a relative return manager refers to risk she typically means active risk. When an absolute return manager speaks of risk she normally means total risk. Hedge funds aim at generating positive returns in excess of cash (for example, LIBOR) while minimizing β . However, traditional long-only

¹Koski and Pontiff (1999), Deli and Varma (2002), Almazan, Brown, Carlson, and Chapman (2004), and Agarwal, Boyson and Naik (2007).

mutual fund or relative return managers whose benchmark is, for example, the S&P 500 consider a ‘low risk’ position as holding all 500 stocks with weights close to their weights in the index. On the other hand, shifting 10 percent of high beta stocks into cash is perceived as an increase in risk as tracking error is increased. However, absolute return managers would view such a shift as decreasing risk. The incentive of a hedge fund manager is to identify stable α and maintain low β with respect to traditional asset classes.²

Why do these differences in investment mandate matter? Many institutional investors have absolute return benchmarks.³ Pension funds with real liabilities have an interest in matching assets that do not decline in recession periods since during these periods the present value of their liabilities (discounted by now much lower bond rates) increases and cash inflows decreases. Endowment funds such as HMC often face real absolute return hurdles (Viceira (2001)). Central banks that manage reserves also have a significant preference for cash like returns and are averse to losses. Money market funds, that operate in the low risk-low average return market segment, compete to generate few additional extra basis points of return by means of ‘LIBOR plus alpha’ strategies; thus, their demand for absolute return funds.

Hedge funds’ investment mandate of achieving absolute returns induces hedge funds to implement long-short strategies and use derivatives to reduce total risk and market beta. The risk profile inherent in long-short strategies is different in nature from those related to the use of directional options and dynamic stop-loss strategies, because it exposes a fund particularly to *correlation risk* rather than volatility risk. Figure 1 illustrates the correlation risk inherent in a hypothetical long-short equity spread trade. At the end of March 2009, the deadline was approaching for General Motors to negotiate one of the most complex financial restructurings in history. The US Treasury’s auto taskforce was about to lay out \$5bn in federal financing to suppliers in a deal that protects the core of the industry but could spell the end for some weak suppliers: some will come out as winner, some as losers. In the attempt to chase a unique opportunity, many hedge funds started to take long/short positions in some of the firms that will be affected by this unprecedented decision. Suppose that GM and Ford have an average beta of 1.5 and 1.2, respectively, and a hedge fund manager thinks that Ford’s better growth opportunities following the government intervention are not priced in and lead to an expected annualized alpha of 2 percent. The same manager thinks that GM is correctly priced, so that no alpha can be generated by GM. If the mandate of the hedge fund is to generate absolute returns, then the portfolio manager will attempt to create a long/short portfolio with a market beta of zero by going long Ford and short GM. Obviously, since Ford’s beta is lower the value of the short position in GM will be lower than the value of the long position in Ford. The exact portfolio is shorting $-1.2/1.5 (= -0.8)$ dollars of GM shares for each dollar held in Ford shares. If the manager is right, the expected return of this strategy is 2 percent on an unlevered basis, with

²Recently, Panageas and Westerfield (2008) show that a hedge fund manager’s risk taking incentives do not just depend on the common 2%/20% compensation contract, but also crucially on the investment horizon. They show that a hedge fund manager that maximizes his expected discounted compensation over an infinite horizon will *limit* his risk-taking.

³Sometimes *real* absolute return benchmarks.

no market risk. Because of its legal structure, prime brokerage contract and low market risk, hedge funds often operate with leverage. In this example, for instance, a $3\times$ leverage will generate a 6 percent annual return and no market risk.

Is this a low risk portfolio? Unfortunately, not. Suppose that a market-wide shock (say a worsening of the credit crunch) occurs, the market drops 10 percent, Ford is not able to generate any alpha, the automobile industry is particularly affected by the worsening of the crisis, and the correlation of the two stocks increases to the point of both having an *ex post* beta of two. A simple calculation shows that the previous portfolio will generate an ex post return equal to *minus* four percent ($-0.04=1\times(-0.2)+(-0.8)\times(-0.2)$) on an unlevered basis and -12% if leveraged on a $3\times$ basis. The strategy loses more than an investment in the market index! What happened? The situation looks familiar to most hedge funds these days. The catch is that during large market-wide shocks and unexpected correlation changes any long/short portfolio can become exposed to larger losses. Funds that promise to generate absolute returns may do so by taking traditional beta exposures being thereby exposed to unexpected changes in correlations.

This simple example shows that the institutional differences and incentive structures of mutual funds and hedge funds may expose them to different types of risks. This is immediately apparent from their balance sheets' economic structure: While typical long-only mutual funds tend to have low gross dollar exposures relative to their net exposures, hedge funds' long/short positions imply higher gross dollar exposures and lower net exposures, on average. The previous example suggests that funds with low net exposures but high gross exposures can be expected to be more exposed to correlation risk. This is indeed one of our findings in our empirical tests.

This issue is important for regulatory reasons. While, according to some classifications, Relative Value and Long/Short Equity strategies are considered conservative from a risk perspective given their lack of directional exposure, our discussion above suggests that such a categorization may ignore the inherent correlation risk exposure of these hedge fund strategies. Global Macro and CTA funds, on the other hand, which are often labelled aggressive due to their directional exposure are less likely to load on correlation risk in the same way. Figure 2 presents a classification that is meant to illustrate classifications often found in industry presentations. These classifications are not based on precise quantitative indicators, but they suggest that strategies labelled 'conservative' are less risky than aggressive strategies. However, according to our findings on the extent of correlation risk in Long-Short Equity strategies, classifications such as those in Figure 2 are misleading, since they neglect the risk due to unexpected changes in correlations. In the last twenty years, hedge funds' assets under management have grown and the strategy composition in the hedge fund industry changed. As Figure 3 shows, Macro (directional) funds dominated the industry in 1990. Today, Long/Short Equity strategies (with high potential correlation risk exposure) are the largest investment strategy by assets under management. The changed nature of the asset management industry has made correlation risk exposure more relevant for investors. Recent examples of hedge fund correlation crises illustrate the intuition behind the relationship between correlation risk and hedge fund returns. Khandani and Lo (2007) report that during the week of August 6, 2007, many Long/Short Equity funds experienced unprecedented losses which ranged from -5% to -30% per month according to

press reports. However, equity market losses over the month of August were not very high by historical standards. The authors hypothesize that the losses were initiated by the rapid unwinding of sizeable quantitative Long/Short Equity portfolios. Sudden break-downs in correlations can trigger unexpected losses in such portfolios.

For correlation risk to matter it should be a systematic priced risk factor. This finds supporting evidence in both the equity, credit, and option literature. First, sudden increases in correlations occurs at the same time both across international equity markets and across asset classes. Figure 4 shows that during recent correlation crises (in March 2008 and November 2007) correlation across equity markets and fixed income market increased substantially. Panel A shows the realized correlation between the S&P500 and Nikkei index jumped to 0.6 while the S&P500/FTSE 100 correlation rose above 0.7. During the same period, in credit markets the base correlations implied by the North American CDX index rose above 0.9 and the base correlation implied by the iTraxx Europe index rose above 0.9. Sudden increases in correlations appear to occur across markets and asset classes during similar bad states. As a result, investors are likely to find it difficult to diversify away correlation shocks. Moreover, since sudden increases in correlations coincide with market downturns, when marginal utility is likely to be high, correlation risk commands a risk premium. Even in option markets, there is supporting evidence of the existence of a correlation risk premium. It is well known that the implied variance on index options is higher than the realized variance. At the same time, individual stock options exhibit very small variance risk premia (Bakshi and Kapadia (2003), Bollen and Whaley (2004) and Carr and Wu (2004)). Driessen, Maenhout and Vilkov (2009) do not find evidence of a statistically significant negative variance risk premium and argue that the source of the large negative index variance risk premium is a correlation risk premium. Direct independent evidence of their claim can be obtained by looking at (model-free) market variance and correlation swaps. Figure 5 Panel B shows that the implied correlation has largely exceeded the realized correlation (the sample period includes from 1996 until 2008). This confirms Driessen, Maenhout and Vilkov (2009) result that the correlation risk premium is an important component of the variance risk premium and therefore it can have important asset pricing implications.

To investigate the impact of correlation risk in the cross-section of hedge fund returns, we construct a time-series of variance and correlation risk premia from 1996 until 2008. We use market data from actual correlation swaps to measure pure correlation risk. An important advantage of our approach with respect to alternative synthetic strategies is that correlation swaps provide delta and gamma neutral real-world prices at which hedge funds may have transacted. Since our correlation swap times series is available for the 2000-2008 period we use synthetic correlation swap returns based on DMV (2006) to backfill the time series⁴. Another important advantage of using correlation swaps is that they allow monthly hedge fund returns to be correctly benchmarked from the beginning of each month until the end of each month. We study the following four questions.

First, we examine whether hedge fund index returns have statistically and economically signif-

⁴We construct synthetic correlation swap returns for 1996-2000 are constructed by use using daily stock returns to calculate realized correlations and by backing out implied correlations from individual and S&P500 index option implied volatilities and S&P500 market index weights.

icant loadings on the correlation risk factor. We find that a value-weighted index of hedge fund returns and in particular the hedge fund categories Long/Short Equity, Low Net Exposure, Merger Arbitrage and Fixed Income Relative Value have statistically significant negative exposure to the correlation risk factor. The implied correlation risk premium is *negative*, large in absolute value and statistically significant.

Second, we ask whether at the individual fund level correlation risk exposures help explain cross-sectional differences in fund performance and risk. We find that this is indeed the case. Funds with high negative correlation risk exposure generate an economically significant portion of their returns by following strategies that implicitly sell insurance against unexpected increases in correlation risk. The funds in the decile with the most negative correlation risk beta *t*-statistic have an average annualized return of 9.00 percent, where 7.90 percent of this return is explained by correlation risk exposure. This result is important since it provides new insights into the determinants of hedge funds' risk and performance. It also suggests that ignoring funds' correlation risk exposure leads to biased estimates of funds' alpha and, more generally, performance attribution metrics.

Third, we ask whether funds' correlation risk exposures determine funds' drawdowns and whether monitoring them is important for risk management. We find that this is indeed the case: in crisis periods such as the fourth quarter of 2008, funds with high positive loadings on the *negative* correlation risk premium have maximum drawdowns that are more than 10% higher than those of funds that sell protection against increases in correlation. Our results are robust to the use of alternative data bases, equal-weighted indices instead of value-weighted indices and alternative benchmarks that include liquidity factors. Our robustness tests show that in contrast to the value-weighted equivalent, an equally-weighted index of Equity Market Neutral funds is economically and statistically significantly exposed to correlation risk suggesting that many small funds in this category are exposed to correlation risk. We also find that our results are not explained by current hedge fund factor models. This result is important, since it shows that failure to account for correlation risk exposures leads to an overestimation of funds' risk-adjusted performance.

Fourth, we examine whether correlation risk is priced in the cross-section of hedge fund returns. Use use Fama-MacBeth type two-pass regressions and find that the correlation risk premium based on hedge fund returns is statistically significantly and negative.

These results are important for several reasons. First, they show that ignoring correlation risk exposures leads to biased estimates of fund alpha. These findings are relevant for both hedge fund investors and hedge fund managers. Hedge fund investors can monitor the correlation risk exposure of different hedge fund categories to optimally diversify risk across funds. Long/Short Equity managers can use the correlation risk factor to identify increases in correlation risk in a portfolio and potentially hedge out this risk by buying correlation risk insurance when the risk of market wide deleveraging is increasing.

Second, the results are important for hedge fund selection as maximum drawdown in hedge fund returns are found to be important when making redemption decisions.⁵ For example, funds of hedge

⁵See Goetzmann and Zhao (1993) for drawdown minimization. Browne and Kosowski (2009) survey recent work on

funds, that select managers while ignoring hedge funds' correlation risk may end up with a portfolio exposed to significant drawdown risk.

Third, hedge funds are more lightly regulated but do have to provide information about certain positions to the SEC, CFTC and FSA. Recent European investment fund regulation in the UCITS III directive relaxes some of these investment restrictions on mutual funds.⁶ Our conclusions regarding correlation risk in hedge funds, therefore also have important implications for the correlation risk in funds. The UCITS III directive allows, for example, for funds to follow so called 130/30 strategies, which implies that a fund may be 130 percent long, 30% short and invest a maximum of ten percent of assets in transferable securities.

Our work is related to four different areas of the literature. First, we build on the pioneering work of Fung and Hsieh (1997, 2001, 2004) and Agarwal and Naik (2004), who propose option based replicating portfolios as benchmarks to calculate risk adjusted performance for hedge funds. Bondarenko (2004) constructs a time series for a synthetic variance swap contract and examines hedge fund index return exposures to the variance risk premium. Kong (2008) studies individual hedge funds' exposures to the variance risk factor.

A second area of the literature has well documented that correlations vary over time and that they tend to increase in times of crisis (Bollerslev, Engle and Woolridge (1988), Moskowitz (2003), Engle and Sheppard (2005), Roll (1988) and Jorion (2000)). Recently, Pollet and Wilson (2009) find that changes in the sample variance of daily US stock market excess returns are almost completely captured by changes in the product of the average variance for the largest 500 individual stocks and the average correlation between all pairs of stocks for the largest 500 stocks. They find that the average correlation strongly predicts future excess stock market returns, but the average variance has no discernible forecasting power.

Third, the recent portfolio choice literature has developed models with an endogenously determined correlation risk premium that highlight the importance of correlation risk hedging. Buraschi, Porchia and Trojani (2006) simultaneously model stochastic correlation and volatility. They find that the optimal demand to hedge correlation risk is a non-negligible fraction of the myopic portfolio, which often dominates the pure volatility hedging demand. Buraschi, Trojani and Vedolin (2008) develop a structural model with economic uncertainty and disagreement risk that endogenously explains volatility and correlation risk premia.

Fourth, another strand of the academic literature has examined option implied correlations (Longstaff, Santa-Clara and Schwartz (2003), Collin-Dufresne and Goldstein (2001), Campa and Chang (1998) and Lopez and Walter (2000)). Driessen, Maenhout and Vilkov (2006, abbreviated DMV (2006))) are the first to construct a mimicking portfolio for the correlation risk premium based on equity index and individual put options. They show that the correlation risk premium is statistically and economically significantly *negative* and that exposures to the premium explain

drawdown minimization including applications to hedge funds.

⁶A UCITS compliant fund can be freely marketed to the public in all 30 countries of the European Economic Area as well as countries such as Switzerland, Singapore and Hong Kong.

cross-sectional differences in option returns. Bakshi and Kapadia (2003), Bondarenko (2003, 2004) and Duarte and Jones (2007) examine equity options and find evidence of volatility risk premia.

The paper is structured as follows. In Section I we describe the data used in the study. In Section II we review the hedge fund return decomposition methodology as well as the construction of the variance and correlation risk factors. Section III presents empirical results for hedge fund index returns and individual hedge fund returns. Section IV concludes.

I. Data

Our survivorship bias-free hedge fund return data is from the BarclayHedge data base, which contains net-of-fee hedge fund returns from 1990 until December 2008. This high quality database contains 9357 hedge funds and funds of funds in December 2008.

Even compared to other high quality hedge fund data bases such as the TASS/Lipper data base, the BarclayHedge data base has very comprehensive cross-sectional information about hedge funds. Apart from the high quality of the time-series data in the data base it is the detailed cross-sectional information that motivates us to use the BarclayHedge data base. One of the cross-sectional variables is information about a fund's net long and short exposures. As explained earlier, long/short spread trades by construction reduce equity market beta, but they increase correlation risk exposures. The funds in our sample may have different net long/short exposures and it would be interesting to focus on the group of funds with the lowest net long/short exposure, since this group can be expected to have a particularly large correlation risk exposure. Moreover, given that investment objectives are self-reported, they may not always accurately reflect funds' trading strategies and, in particular, their long and short exposures. Therefore, we use information about funds' net long/short exposure to construct two subgroups of funds that are required to have a net long/short exposure below 30%. The first subgroup, which we label (LNX for Low Net Exposure) consists of Long/Short Equity funds that fulfill this requirement and the second subgroup (which we label All LNX) consist of all funds that fulfil this requirement. Table 1 reports diagnostics for all funds and for the investment objectives we focus on. After applying a range of data filters and excluding funds of funds, our sample includes 6722 individual hedge funds. Of these, 770 are Long/Short Equity funds, 41 Low Net Exposure, 368 All Low Net Exposure funds, 186 Option Trader funds, 187 Equity Market Neutral funds, 56 Merger Arbitrage funds and 245 Fixed Income Relative Value funds. As an alternative hedge fund data base, we also employ the Lipper/Tass data base to show that our results are robust to other data bases.

We obtained actual correlation swap data from a major international bank for the period April 2000-December 2008. A correlation swap is an over-the-counter contract that pays the difference between a standard estimate of the realized correlation and the fixed correlation swap rate. Since the correlation swap costs zero to enter, the correlation swap rate represents the risk-adjusted expected value of the realized correlation.

The data consists of daily implied and realized correlation quotes for one month maturity cor-

relation swaps for the S&P500. The correlation swap series corresponds to a *long* correlation swap position and is calculated as the realized correlation at the end of each month minus the implied correlation at the beginning of the month. To illustrate, an unexpected increase of correlation during the month is likely to lead to a higher realized than implied correlation and therefore to a net payment to the correlation swap buyer.

Since the correlation swap quote data is only available after March 2000 we create a synthetic correlation swap time series for the period January 1996- March 2000. We follow DMV (2006) and use options and stock return data to construct the correlation swap time series. This involves backing out implied correlations from individual and index option implied volatilities and market index weights as well as using daily stock returns to calculate realized correlations. We obtain options data from the Optionmetrics volatility surface file and stocks data from the OptionMetrics security price file. The data is available from January 1996 until September 2008. Given the limitations imposed by the availability of options data, we focus on the subsample of hedge fund returns from January 1996 until December 2008.

We use daily data for S&P 500 index options and for individual options on all the stocks in the S&P 500 index list. Optionmetrics provides a daily interpolated implied volatility surface, calculated with a kernel smoothing algorithm from option prices, for a maturity of 30 calendar days, at deltas from -0.2 to -0.8, with increments of 0.05. We obtain option moneyness and put and call option prices from the volatility surface using Black-Scholes' formula. Options with zero open interest, or with negative bid-ask spread, or with missing implied volatility or delta are discarded. We also eliminate options with extreme moneyness, which have Black-Scholes delta below -0.15 for calls and above -0.05 for puts. We only retain options that have at least three strike prices available at each of the two nearest maturities. For the risk-free rate, we use the OptionMetrics data on the zero-coupon curve to obtain the 30-days zero-coupon rate.

II. Methodology

A. Hedge Fund Return Decomposition

In this section, we describe the performance measurement framework that we apply to our sample of hedge fund returns, as well as the construction of the variance and correlation risk factors.

In order to examine the effects of correlation risk and variance risk exposure, we augment the Fung and Hsieh (2001) seven factor model with a factor-mimicking portfolio for correlation risk. The Fung and Hsieh (2001) seven-factor model (FH) decomposes a hedge fund's return $r_{i,t}$ into the risk-adjusted performance (α_i) and risk exposures (β_i^k):

$$r_{i,t} = \alpha_i + \beta_i^1 SNPMRF_t + \beta_i^2 SCMLC_t + \beta_i^3 BD10RET_t + \beta_i^4 BAAMTSY_t + \beta_i^5 PTFSBD_t + \beta_i^6 PTFSFX_t + \beta_i^7 PTFSCOM_t + \varepsilon_t^i, \quad (1)$$

where $r_{i,t}$ is the monthly return on portfolio i in excess of the one-month T-bill return, $SNPMRF$ is the S&P 500 return minus risk free rate, $SCMLC$ is the Wilshire small cap minus large cap return, $BD10RET$ is the change in the constant maturity yield of the 10 year treasury, $BAAMTSY$ is the change in the spread of Moody's Baa - 10 year treasury, $PTFSBD$ is the bond PTFS, $PTFSFX$ currency PTFS and $PTFSCOM$ is the commodities PTFS, where PTFS is primitive trend following strategy (see Fung and Hsieh (2004)). Fung and Hsieh (1999, 2000, 2001), Mitchell and Pulvino (2001) and Agarwal and Naik (2004) show that hedge fund returns relate to conventional asset class returns and option-based strategy returns. Other papers that measure hedge fund performance relative to the Fung and Hsieh (2001) model include Kosowski, Naik, and Teo (2007) and Fung, Hsieh, Ramadorai, and Naik (2007).

The Fung and Hsieh (2001) model does not include an equity market PTFS or other proxies for equity market volatility premia. Bondarenko (2004) constructs a variance risk factor and adds it to the CAPM benchmark model to examine hedge fund index returns. Given recent evidence by Driessen, Maenhout and Vilkov (2008) that index variance risk is to a large extent explained by correlation risk, we augment the Fung and Hsieh (2001) model by adding a correlation risk factor (CR_t). We label the resulting 8-factor model, the *BKT* benchmark model:

$$\begin{aligned}
r_{i,t} = & \alpha_i + \beta_i^1 SNPMRF_t + \beta_i^2 SCMLC_t + \beta_i^3 BD10RET_t + \beta_i^4 BAAMTSY_t \\
& + \beta_i^5 PTFSBD_t + \beta_i^6 PTFSFX_t + \beta_i^7 PTFSCOM_t + \\
& + \beta_i^8 CR_t + \varepsilon_t^i,
\end{aligned} \tag{2}$$

In robustness checks we show that the variance risk factor is not significant when added to the eight factor BKT model, thus supporting the observation that correlation risk explains variance risk. The next section reviews the construction of the correlation and variance risk factors. In robustness checks we examine whether the correlation risk factor is still significant after accounting for variance risk. The next section reviews the construction of the correlation and variance risk factors.

B. Construction of Risk Factors

B.1. Correlation Risk Factor

A correlation swap can be used to hedge against unexpected changes in correlations. A swap buyer pays implied correlation (or the swap rate) and received realized correlation over time. Since the correlation swap costs zero to enter, the correlation swap rate represents the risk-neutral expected value of the realized correlation.

A correlation swap gives exposure to the average pairwise correlation of a pre-determined basket of stocks. The *swap strike* is the level of (average pairwise) correlation that is bought or sold, and is typically scaled by a factor of 100 (i.e. a correlation of 0.55 is quoted as a strike of 55). The payout of a correlation swap is the notional amount multiplied by the difference between the swap strike

and the subsequent realized average pairwise correlation on the basket of underlyings.

$$payout = notional \times (\text{realized average pairwise correlation} - \text{strike})$$

Our correlation risk proxy corresponds to a *long* correlation swap position (realized minus implied correlation). The advantage of using correlation swap quotes is that the time series captures pure correlation risk exposure. In the absence of actual correlation swap quotes the literature has proposed synthetic correlation risk exposures based on options. There are several disadvantages to this synthetic approach, however. First, since the portfolio hedging is based on historical hedge ratios calculated at the beginning of the month, there is no guarantee that the resulting synthetic correlations swap portfolio is only exposed to pure correlation risk. The quoted correlation swap gives direct exposure to the level of delivered (average pairwise) correlation. As a result no dynamic hedging/replication. Second, the hedge ratios are calculated based on several simplifying assumptions regarding the portfolio weights of each stock in the stock index.

An investor that is long (short) a correlation swap pays implied (realized) and receives realized (implied) correlation. The absolute return of these two factor-mimicking portfolios is the same, but our factor-mimicking portfolio has a negative return on average, which corresponds to buying insurance against unexpected increases in correlation. Thus, one could interpret a hedge fund's positive beta with respect to our negative correlation risk premium as 'buying insurance against unexpected correlation risk'. We choose this specification since factor-mimicking portfolios earn negative correlation risk and negative variance risk premium.

Since we only have actual correlation swap quotes from April 2000 onwards we construct synthetic correlation swap time series for January 1999 - March 2000. We follow DMV (2006) and estimate the implied correlation from option prices. Given the time-series of model-free implied variances from index and individual options, the implied correlation $IC(t)$.

$$IC(t) = \frac{\sigma_{MF,I}^2(t) - \sum_{i=1}^N w_i^2 \sigma_{MF,i}^2(t)}{\sum_{i=1}^N \sum_{j \neq i} w_i w_j \sqrt{\sigma_{MF,i}^2(t)} \sqrt{\sigma_{MF,j}^2(t)}}$$

Our analysis confirms that in August 2007 the *realized* correlation risk premium was 5.3% and a value-weighted index of Long-Short Equity funds had return of -1.7 percent that month. Even more dramatically we find that in September and October 2008 the correlation risk factor return rose to 29 and 17 percent, respectively. In these months the long-short equity funds lost 7.7 percent and 9.9 percent, respectively.

Another important advantage of using correlation swaps is that they allow monthly hedge fund returns to be correctly benchmarked from the beginning of each month until the end of each month. Given that index options expire on the Saturday after the third Friday of each month, one can only capture the volatility and correlation risk premium in options from the third Friday until the third Friday of each month when using the DMV (2007) option-based approach. Buying an option and

selling it at a later stage may capture changes in implied volatility but it does not isolate the effect of the volatility or correlation risk premium. The later can be only be measured by comparing the purchase price of the option to the payoff of the option or by using variance or correlation swap contracts.

It is important to note several caveats associated with swaps in comparison with options. Correlation swap prices may be model free but unlike options they are not listed and are over-the-counter-derivatives. Options are liquid instruments while correlation swap quotes embed a rent for the intermediary and a potential illiquidity premium. Therefore the real correlation risk premium is likely to be the one based on correlation swaps plus the rent from the intermediary.

B.2. Variance Risk Factor

The factor-mimicking portfolio for the variance risk premium of the index is based on a synthetic variance swap contract, which has a payoff equal to the difference between implied and realized variance over the life of the contract. The implied variance is estimated from a model-free approach which does not depend on any particular option-pricing model (Carr and Madan (1998), Britten-Jones and Neuberger (2000), Bondarenko (2003) Jiang and Tian (2005)).

One of the advantages of the variance risk contract compared to mimicking portfolios based on equity index straddles or equity index puts is that the variance contract allows us to isolate directly variance risk from other risks, such as shocks to the level of the equity index.

We construct the variance risk premium as follows. The continuously-resampled realized variance from time 0 to time T can be expressed as follows:

$$V_{iT} = \int_0^T \phi_i^2(t) dt,$$

where $\phi_i^2(t)$ is the instantaneous variance of stock i at time t . We use U_0 to denote the time-0 price of the variance contract, which at maturity- T has a payoff V_T . The price of the variance contract is the risk-neutral expected integrated variance and thus reflects expectations of future variance:

$$U_0 = E_0^Q [V_T].$$

The return on the variance contract, r_{VR} , can be expressed as $r_{VR} = \frac{V_T}{U_0} - 1$.

Britten-Jones and Neuberger (2000) show that the risk-neutral expected integrated variance can be estimated by means of the price of traded call and put options, across a continuum of strike prices. If $C_a(K, t)$ denotes the price of a T -maturity call option on asset a with strike price K at time t , then U_0 can be written as

$$U_0 = 2 \int_0^\infty \frac{C_a(K, T) - \max(S(t) - K, 0)}{K^2} dK,$$

which is called the *model-free implied variance (MFIV)*. We follow the discretization procedure of Jiang and Tian (2005) to estimate *MFIV* from option data.

B.3. Volatility and Correlation Risk Premia: Similarities and Differences

In Merton's (1973) ICAPM model, investors want to hedge sources of risk that are correlated with their marginal utilities of their life time investment-consumption plan. Thus, the hedging demand is higher for those sources of risk which are (a) very persistent; (b) correlated with the expected return of the investment opportunity set.

There are several empirical and theoretical arguments that support the existence of a systematic correlation risk premium. From a theoretical point, the existence of a systematic volatility risk premium has been motivated in Drechsler and Yaron (2008), who show the link between macro-economic uncertainty and the variance risk premium. Buraschi, Trojani and Vedolin (2008) study a structural model of a multiple tree economy (orchard) with uncertainty. They show that, even in presence of idiosyncratic shocks, uncertainty can produce co-movement in asset prices, endogenous time-varying correlations and correlation risk premia. They build a dataset based on a large panel of firm-specific earnings forecasts and, using a common component in the heterogeneity in beliefs to proxy for market-wide uncertainty, they find strong evidence that correlation risk premia are highest during periods in which market-wide disagreement is large, which occurs during crisis periods and down markets.

Empirical evidence shows that market-wide increases in correlations often occur at times of low market returns (see Figure 4) and are a key driver of changes in investment opportunities. Moreover, we find that the time series of implied correlation from correlation swaps is indeed more persistent than other traditional proxies of risk traditionally used to measure hedge fund risk exposure.

Table 2 reports summary statistics for monthly risk factors including the *negative* variance risk and correlation risk premia. As mentioned above these correspond to long positions in variance and correlation swaps. The mean of the S&P500 excess return in our sample is 0.20 percent per month while the mean of the variance risk and correlation risk premia are -16.73 (in percent squared per month) and -10.72 percent per month, respectively. The magnitude of the correlation risk premium is consistent with those found in the literature. To verify our results we compare our results for the components of the correlation risk premium with those reported in DMV (2006) who report an average correlation risk premium of -18 percent per year, an average monthly realized correlation of 28.7% and an average monthly implied correlation of 47.6% for their sample (1996-2003). For the same subsample (1996-2003) we obtain an average monthly correlation risk premium of 16.6 percent, an average monthly realized correlation of 27.2 percent and an average monthly implied volatility of 43.9 percent. These numbers are very similar.

Drechsler and Yaron (2008) report a variance risk premium for the period 1990-2007 between 12 and 18 percent depending on the choice of implied and realized variance proxy. The mean of the variance risk premium is strongly influenced by several months at the end of 2008 which have significantly increased the arithmetic average of the variance risk premium. The monthly variance risk premium in October September, October and November of 2008 was *plus* 2.1, 4.6, 2.0 percent per month respectively, thus possibly reminding investors and proprietary trading desks of the difference between a risk premium and an arbitrage.

The annualized Sharpe Ratios during the period 1996-2008 are: 0.15 for the S&P 500 and -2.5 for the negative correlation risk premium in our sample. Although this would suggest that selling correlation risk is attractive for a mean-variance investor, one has to bear in mind that the distribution of the correlation risk and variance risk premium are non-normal and strategies that are *short* variance or correlation swaps may experience occasionally very large losses. The monthly correlation risk premium (which corresponds to long correlation swap position) in October September, October and November of 2008 was *plus* 29.4, 17.4, 12.5 percent per month respectively. These realized returns in crisis times show that shorting correlation swaps can be very risky, even if in the past (before 2008) there have been long periods over which the correlation risk premium had a statistically and economically significantly *negative* mean.

As Carr and Wu (2008) point out Sharpe Ratio's from synthetic contracts may be misleading to the extent that they differ from market prices. The actual profitability of a swap will depend on several practical issues such as the actual availability of variance swap quotes, their bid-ask spreads, and their similarity to the synthetic values.

From a theoretical perspective correlation risk should matter if correlation risk is persistent. We calculated the autocorrelation function of the implied correlation and implied variance based on correlation swaps. We find that at lags of 1-12 months the autocorrelation coefficients of the correlation time series are much higher than the for the implied variance. The one, two and three month lag autocorrelation coefficient for the implied correlation (variance) time series are 0.770, 0.6044 and 0.5408 (0.5834, 0.3335 and 0.3079). This evidence suggests that correlation risk is more persistent and therefore more likely to be priced than pure volatility risk. This interpretation is further strengthened by our results below which show that the correlation risk factor is still significant but variance risk factor is insignificant when both are used at the same time in a benchmark model for hedge fund returns. Buraschi, Porchia and Trojani (2006) find similar results in the context of an optimal portfolio choice problem with correlation risk. Calibrations of their and find that the optimal demand to hedge correlation risk is a non-negligible fraction of the myopic portfolio, which often dominates the pure volatility hedging demand.

From an empirical point of view, market wide deleveraging following widespread economic turmoil, such as in August 1998, March 2008 and September-October 2008, provides an example of a systematic correlation shock. In these cases hedge funds suffer losses from sudden widespread changes in correlations that coincide with collapses in risky asset prices. We find that most losses for hedge funds that are exposed to unexpected correlation risk shocks occur during down-markets rather than up-markets.

C. Correlation Matrix of Hedge Fund Index Returns and Benchmark Factors

To gain further insight into the properties of the variance and correlation risk premia, in Table 3 we report the variance-covariance matrix of the hedge fund index returns and the benchmark factors. Low Net Exposure, Long/Short Equity funds and Fixed Income Relative Value funds have the most negative correlation with the *negative* correlation risk premium. The monthly variance risk premium

has a sizable positive correlation (0.50) with the correlation risk factor.

Since correlations may differ in different market environments, such as up- and down-markets, Figure 6 plots the correlation risk factor against the equity market risk premium. Unexpected spikes in realized correlations indeed tend to coincide with equity market decreases. Evidence of higher correlation risk exposure in down-markets supports an interpretation of correlation risk as a systematic risk factor.

III. Empirical Results

A. Hedge Fund Index Return and Correlation Risk Exposure

Hedge fund strategies are extremely heterogeneous. Therefore, we are careful to examine both value-weighted hedge fund indices as well as individual hedge fund returns by investment objective. Moreover, we examine both the time series as well as the cross-section of hedge fund returns. Our time series analysis below shows that hedge funds are exposed to correlation risk. In our cross-sectional analysis we show that differences in correlation risk exposure explain differences in risk-adjusted return as well as drawdowns. Moreover, we carry out Fama-Macbeth type two-pass regressions that combine time series and cross-sectional information and in individual hedge fund returns and show that correlation risk is priced in the cross-section of hedge fund returns and that the resulting correlation risk premium is negative and economically and statistically significant.

In the previous section we showed that Long/Short Equity funds and Low Net Exposure funds' returns are correlated with the correlation risk premium. Now we examine the importance of the correlation risk premium in explaining aggregate hedge fund index returns.

Table 4 shows that a value-weighted index of all hedge funds as well as several value-weighted hedge fund index categories have highly statistically significant negative correlation risk betas. These include Long/Short Equity, Low Net Exposure, Merger Arbitrage, Fixed Income Relative Value and Options Trader funds whose correlation risk beta t -statistics range from -2.93 to -1.67. Some hedge funds pursue so-called dispersion strategies that involve selling index put options and buying single-name put options. The results by investment objective shows that it is crucial to carefully interpret each strategy's risk exposure in the context of the economic drivers of each strategy.

Ignoring correlation risk exposures for funds with negative correlation risk betas overestimates the funds' risk-adjusted performance and underestimates their risk. Long/Short Equity funds and Low Net Exposure funds have FH model alphas of 6.82 percent and 6.43 percent per year, respectively. However, an application of the BKT 8-factor model leads to a reduction of the alphas by about 1 and 4 percent per year to 5.21 percent per year (for Long/Short Equity) and 2.85 percent per year (for Low Net Exposure Long/Short Equity funds).

The BKT model's correlation risk factor captures fund's volatility risk exposure as Panel C shows. Since the correlation risk and variance risk factors are relatively highly correlated we cannot simply add the variance risk factor due to potential multi-collinearity. The residual from a regression

of the variance risk factor on the correlation risk factor can be interpreted as the component of the variance risk factor that is not explained by correlation risk. If we save this residual we find that it is not significant when adding it to the eight factor BKT model. This supports the observation that correlation risk explains most variance risk and that it is correlation risk that matters for hedge fund risk exposures. Neither Long/Short Equity nor Low Net Exposure funds have a statistically significant variance risk beta in a model that includes the BKT factors and a variance risk factor. In fact, none of the strategies have a statistically significant exposure to the variance risk factor when the BKT factors are included. This finding is consistent with the fact that by construction, compared to a long only strategy, a long/short strategy reduces both the stock market beta and volatility risk beta, but leads to higher correlation risk exposure. Thus, the reason why some studies (Bondarenko (2004)) find that hedge funds have significant exposure to variance risk may be because of the omission of a correlation risk factor in the regressions. This conclusion is supported by evidence that most of the variance risk premium in index options is due to the correlation risk premium (Driessen, Maenhout and Vilkov (2009)). It is important to note that we constructed the group of Low Net Exposure funds in such a way that it includes funds from all investment objectives except Long/Short Equity, thus providing an independent assessment of the importance of correlation risk for portfolios with long and short exposures.

The other hedge fund investment objective that has a statistically significant negative correlation risk beta is Options Trader (OPTS). This group also has statistically significant positive exposure to the variance risk factor. Merger Arbitrage and Fixed Income Relative Value (FIRV) also have high negative correlation risk betas. None of the hedge fund investment objectives has statistically significant positive exposure to the correlation risk factor.

To shed further light on the relationship between correlation risk and hedge fund we examine individual crisis months. We find that in August 1990 and September-October 2008 Long/Short Equity funds experience large losses and that these losses coincide with large negative returns from a short correlation swap strategy. The example of the August 1998 and September-October 2008 correlation crises applies more generally to the risk of other hedge fund investment objectives such as fixed income and relative value funds as the LTCM collapse suggests. The reason is that any risk arbitrage and convergence trade strategy is intrinsically based on assumptions about correlations between asset prices.⁷ In recent years, credit derivative hedge funds have sprung up that explicitly trade correlation. These funds take long-short positions in different tranches of asset-backed securities such as CDOs and CLOs and thus take bets on changes in default correlations of the underlying

⁷See HBS case 'Long-Term Capital Management' (Perold (1999)) and the May 1, 2008, Financial Times article 'Fixed income traders pulled into deleveraging vortex': *'Traders making some of the safest bets on the planet – on tiny price moves in ultra-secure US government debt – were hammered in March as hedge funds scrambled to sell assets to cover losses in other markets. [...] The falls are a repeat in miniature of the near-collapse of LTCM in 1998 following big losses on US Treasuries arbitrage trades [...]. But this time round the crisis spread even more rapidly from market to market, taking down arbitrageurs in US Treasuries and convertible bonds among several exposed strategies, because the amount of money hedge funds now run is so much higher. Trades prepared by some highly leveraged funds to protect them from a repeat of LTCM didn't work, either.'*

reference entities. Some hedge funds trade correlations directly using options, variance swaps or correlation swaps.⁸ Structured products desks that sell structured index products with downside protection to retail investors implicitly take on correlation risk when they write put options. The banks may sell this exposure by entering correlation swaps other investors such as hedge funds.⁹

As explained in the introduction we would expect hedge funds with long and short positions to be exposed to correlation risk. Similarly we would not expect hedge funds that are mainly long and not short to exhibit correlation risk exposed. Interestingly this is what we find in Table 4. The categories Equity Long (EL), Emerging Markets (EMG) and Distressed securities) do not have a statistically significant exposure to correlation risk (see Panel B). Hedge funds' choice to pursue long and short strategies to reduce market risk is due to their risk preferences. What explains a hedge fund manager' risk preferences and risk aversion in theory?

First, as Panageas and Westerfield (2009) point out a hedge fund manager only engages in risk shifting in the presence of a high-water market contract in simple two-period models without capital market frictions and with convex incentive structures. In a dynamic setting with an infinite horizon a risk-neutral manager would choose a bounded portfolio despite the option-like character of her compensation.

Second, there is another important institutional reason in practice that explains why hedge fund managers may behave in a risk averse fashion. This is related to the role played by the prime broker that the hedge fund relies on for leverage and securities lending. In a repeated game context the fund managers will also fear the removal of leverage and other services after a series of excessive drawdowns. The hedge fund receives capital from not just one, but from two counterparties: the investor and the prime broker. The incentive structure for the hedge fund manager is convex with respect to the investor perspective, but concave with respect to the prime broker. It is reasonable to argue that even if a fund manager could impose a 'gate' to prevent the investor to redeem, a fund cannot impose a 'gate' to prevent the prime broker from closing positions and seizing collateral¹⁰. Therefore the hedge fund manager is averse to volatility and seems risk mitigation through hedging (that is long and short positions), thus exposing the fund to correlation risk. This should apply even more to highly leveraged strategies.

Our evidence confirms the above reasoning. Panel B shows that strategies EL, EMG and DS are not exposed to correlation risk. To the extent that these strategies are less dependent on leverage and securities lending, they should not only be less exposed to correlation risk, but also more exposed to volatility risk. This is indeed what Panel C of Table 4 shows. The betas with respect to the variance risk residuals for strategies Equity Long, Distressed securities and Emerging Markets are all statistically significant: $\beta_{\text{Res. VR}}^{EL} = -3.01$, $\beta_{\text{Res. VR}}^{DS} = -2.6$ and $\beta_{\text{Res. VR}}^{EMG} = -4.42$.

⁸See Granger and Allen (2005) JPMorgan report 'Correlation Vehicles'.

⁹'We have hedge fund clients who are very active traders of volatility, correlation and dispersion. Trading correlation and dispersion as an asset class can have a diversification effect,...' (Denis Frances, Global Head of Equity Derivatives Flow Sales at BNP Paribas, FTfm, 28/1/2008).

¹⁰See Khandani and Lo (2009) on gates and hedge fund illiquidity.

The above evidence suggests that the correlation risk factor is a statistically significant explanatory variable of hedge fund index returns. For Long/Short Equity and Low Net Exposure funds, for example, the correlation risk loading explains 1.5 percent and 1.7 percent of the annual return at the fund index level. However, the main focus of our study is on the ability of the correlation risk premium to explain *cross-sectional* differences in hedge funds' performance and risk. Therefore, in the next section we turn to correlation risk exposures at the individual hedge fund return level.

B. Individual Hedge Fund Returns and Correlation Risk Exposure

B.1. All Funds

In Table 5 we sort all hedge funds into deciles depending on the t -statistic of their BKT model correlation risk beta β_{CR}^{BKT} to distinguish between funds with the most significant positive and negative exposure to the correlation risk factor. The correlation risk beta β_{CR}^{BKT} for funds in these decile portfolios ranges from an average of -0.15 for decile 1 to an average of 0.1 for decile 10. What is striking is that the average absolute return of the funds in the top and bottom deciles are similar (9.00 and 8.35 percent per year, respectively). Moreover, the returns of funds in the top and bottom deciles are relatively high compared to the funds in the fifth and sixth deciles, which have an average absolute return of 6.1 percent per year.

However, the BKT model risk decomposition reveals dramatic differences in risk exposures and risk-adjusted performance. The bottom decile group of funds derives about 4.56 percent of its performance per year from *negative* exposure to the correlation risk factor and has a BKT model alpha of 7.9 percent per year. Funds in the top decile, on the other hand, lose on average 9.68 percent per year due to their negative exposure to the correlation risk premium and their BKT model alpha is 16.43 percent per year. Thus the BKT model alphas for the top and bottom decile differ by 16 percent per year. If one ignored correlation risk and used the CAPM model alphas one would find that the alphas of the fund's in the lowest and highest deciles only differ by 1.04 percent per year. This would significantly underestimate the risk and overestimate the risk-adjusted performance of funds in decile 1.

To further shed light on differences in the riskiness of funds in bottom and top decile, we report in Figure 7 the difference in monthly returns between the decile 10 and decile 1 portfolio over time. Each month funds are sorted into decile 1 or decile 10 based on their rolling 12 month correlation risk beta. The figure reports the difference in monthly returns between the two portfolios and clearly shows that losses on portfolio 1 (with extreme negative correlation risk beta) spike in times of crisis relative to portfolio 10. In the fourth quarter of 2008 the difference in the two portfolios was more than 10 percent.

The analysis in Table 5 is based on funds in all investment objectives and includes funds with insignificant correlation risk exposures (at the index level). It may be that there are important differences in the contribution of the correlation risk premium to funds' total returns by hedge fund investment objective. Therefore, next we investigate individual funds correlation risk exposures for

investment objectives that have statistically significant correlation risk betas at the index level.

B.2. Results by Investment Objective

Long/Short Equity Funds. Long/Short Equity funds were found to have the highest correlation risk exposure at the index level. Therefore, in the first panel of Table 6 we first sort this group of funds by their correlation risk beta t -statistics and report their CAPM and BKT model alphas and betas.

Panel A shows that ignoring correlation risk exposures severely overestimates the performance of some Long/Short Equity funds. For the funds in the bottom decile we find that the BKT model alpha (of 2.5 percent) is 6 percent lower than the FH model alpha (of 8.52 percent).

The BKT model captures several risk exposures, but correlation risk exposure alone accounts on average for 5.97 percent per year of annual return of Long/Short Equity funds in decile 1 (which has the highest negative exposure to correlation risk).

Funds in the top decile make losses on average due to their positive correlation risk factor. Long/Short Equity funds with the largest positive correlation factor exposure lose 3.6 percent per year on average due to the correlation risk premium. Adjusting for this effect increases the risk-adjusted performance significantly and the alpha rises from 6.2 percent per year for the FH model to 9.5 percent per year for the BKT model.

Low Net Exposure (LNX) Funds. As explained earlier, long/short spread trades by construction reduce equity market beta but increase correlation risk exposures. Therefore, we construct a subgroup of Long/Short Equity funds for which we have information about their net long and short exposures. Panel B of Table 6 reports results for the subgroup of low net exposure funds. The group of Low Net Exposure funds with the lowest correlation risk factor beta ($\beta_{CR}^{LNX,high} = -0.054$) earn a return of 5.6 percent per year and 4.4 percent per year of this return is accounted for by the funds' exposure to the correlation risk premium. The Low Net Exposure funds with the highest ($\beta_{CR}^{LNX,low} = 0.038$) correlation risk factor beta, on the other hand lose 1.4 percent per year due to their negative correlation risk beta. Taking into account correlation risk exposure thus leads to different conclusions about the risk-adjusted performance of the Low Net Exposure funds. The relationship between the FH alpha and correlation risk beta is generally positive but not monotonic which may be due to the fact that some of the portfolios only contain 4 funds and may thus lead to noisy portfolio return estimates. Of the 770 Long/short equity funds only 41 full fill the low net exposure criterion.

Options Trader Funds. Some hedge funds trade correlations directly using options, variance swaps or correlation swaps.¹¹ Structured products desks that sell structured index products with

¹¹See Granger and Allen (2005) JPMorgan report 'Correlation Vehicles'.

downside protection to retail investors implicitly take on correlation risk when they write put options. The banks may sell this exposure by entering correlation swaps other investors such as hedge funds.¹²

The third group of funds that has a highly statistically significant negative correlation risk factor beta at the fund index level is the group of Options Trader funds. This group of funds differs from Long/Short Equity and Low Net Exposure funds in that the average absolute return of funds with high negative correlation risk factor exposure is higher than the average absolute return of funds in the top decile. Funds in the bottom decile have a return of 10.46 percent per year which is almost the same as the average return for the high correlation risk factor beta decile (of 10.43 percent per year).

However, correlation risk exposure explains 14 percent of the difference in the return between the highest and lowest decile groups in Panel C of Table 6. The BKT model alphas are $\alpha_{BKT}^{OPTS,low} = 2.53$ and $\alpha_{BKT}^{OPTS,high} = 16.33$ percent per year for the highest and lowest correlation risk beta funds. This shows that some Options Trader funds are significantly exposed to correlation risk and earn an economically significant premium as a result. The relationship between correlation risk beta and return is not monotonic however. This may be due to the fact that hedge funds in the Option Trader category generally engage in higher frequency derivatives trading and carefully monitor their risk exposures to correlation risk. Long/Short Equity funds may inadvertently expose themselves to correlation risk due to unexpected changes in stock correlations. Options Trader funds, on the other hand are generally rather sophisticated in that they trade pure volatility and correlation risk directly by investing in index variance swaps, individual variance swaps and correlation swaps (Granger and Allen (2005)).

Merger Arbitrage Funds. Merger Arbitrage funds are another objective that has a statistically significant negative exposure to correlation risk at the index level. Moreover, similar to Long/Short Equity funds, this group of funds typically engages in trades that are long one group of stocks and short another group of stocks. Michell and Pulvino (2001) examine the characteristics of merger arbitrage strategies. One of the features of this strategy which makes it different from Long/Short Equity strategies is that it focuses on pairs of companies involved in merger events. While quantitative Long/Short Equity funds may invest in hundreds of stocks based on historical covariance matrices, Merger Arbitrage funds are mainly exposed to unexpected movements in the prices of target and acquiring companies.

According to Panel D of Table 6 Merger Arbitrage funds in the decile with the most extreme *negative* correlation risk beta have the highest absolute return (10.39 percent and FH model alpha (10.19)) which decile 10 consists of funds with an average absolute return of 2 percent. However, 3.85 percent of the superior performance of decile 1 are explained by the significant correlation risk exposure of this decile $t_{\beta_{CR}} = -3.41$.

¹² 'We have hedge fund clients who are very active traders of volatility, correlation and dispersion. Trading correlation and dispersion as an asset class can have a diversification effect,...' (Denis Frances, Global Head of Equity Derivatives Flow Sales at BNP Paribas, FTfm, 28/1/2008).

All funds with Low Net Exposure To show that a key determinant of the correlation risk exposure is related to a fund's net exposure and that this does not just apply to Long/Short Equity funds, we examine all funds with low net exposure in Panel E of Table 6. Our results are qualitatively the same as for the Long/Short Equity funds. Funds in decile 1 with the most extreme negative correlation risk beta have the very similar average absolute returns (3.69 percent) as the funds in decile 10 (4.06 percent). However, the results show that 2.81 percent of the total return in decile 1 are explained by the correlation risk premium.

Overall our results show that not only are hedge funds in several hedge fund categories significantly exposed to correlation risk, but cross-sectional differences in returns between funds are explained by differences in correlation risk betas.

B.3. Cross-sectional differences in returns and Correlation Risk

We have seen in Table 2 that the correlation risk factor a time series average that is economically and statistically significantly negative. For the correlation risk factor to be interpreted as a systematic risk factor, ideally we should find that it is priced cross-sectionally and that the risk premium is negative and statistically significant. This is indeed what we find in Table 7 which reports results from Fama-Macbeth type two-pass regressions. The exposures are estimated in a first step by regressing the time-series of each excess hedge fund return on the risk factors. In a second step, we run a cross-sectional regression of average monthly excess hedge fund returns on the betas from the first pass regression. The resulting correlation risk premium is -11.9 percent. Interestingly the market risk premium is not statistically significant in our second model. This may be due to the relatively small number of 216 monthly observations on which the tests are based.

C. Robustness Checks

In this section we show that our results are robust to the use of equal-weighted instead of value-weighted indices and alternative factor models that include a liquidity factor.

C.1. Alternative Hedge Fund Data Base: Tass/Lipper

The BarclayHedge data base is a very high quality data base but as a robustness check we also repeat the analysis using the Tass/Lipper data base which has been used extensively in the hedge fund literature. Using the Tass/Lipper data base rather than the BarclayHedge database does not change our conclusions. Table 8 shows that a value-weighted index of Long/Short Equity funds from the Tass/Lipper data base has a negative correlation risk beta. Interestingly, Equity Market Neutral Funds from the Tass/Lipper data base have a statistically significant negative exposure to the correlation risk factor (t -statistic of -2.00). Apart from confirming our earlier results for Long/Short Equity funds, the finding of negative exposure for Equity Market Neutral funds supports the analysis by Khandani and Lo (2007) regarding the 'quant' crisis in August 2007.

C.2. Equal-Weighted Versus Value-Weighted Indices

The finding for Equity Market Neutral funds is further corroborated by evidence from equal-weighted indices based on the BarclayHedge data in Table 9. Using equal-weighted indices of Equity Market Neutral funds from the BarclayHedge data base leads to a statistically significant negative correlation risk betas ($t = 1.93$). This suggests that many Equity Market Neutral funds that are of below average size have significant negative correlation risk beta.

The equal-weighted results for the other categories further strengthen our findings of negative correlation risk beta. An equal weighted average of all individual hedge funds has as correlation risk beta of -0.01 with a t-statistic of -1.79 while the t-statistic of the Long/Short Equity index' correlation risk beta is -3.17.

C.3. Robustness to Liquidity Risk Factor

In Table 10 show that correlation risk is not related to liquidity risk. Recent work by Aragon (2006) has documented that hedge fund alpha is linked to hedge fund lock up periods and may thus be partly due to asset liquidity. We augment the BKT model with the Fontaine and Garcia (2008) liquidity factor and show that a value-weighted index of all funds as well as the Low Net Exposure category, for example, continue to have a statistically and economically significant negative beta with respect to the negative correlation risk premium after augmenting the BKT model with a liquidity risk factor.¹³

IV. Conclusion

In this paper, we have shown that correlation risk exposures explain cross-sectional differences in hedge fund performance and risk. We illustrate how hedge funds' legal structure and investment mandate imply that hedge funds can be expected to be more exposed to correlation risk than mutual funds. In our empirical results, we find that high negative correlation risk factor exposure explains a statistically and economically significant percentage of hedge fund returns. Building on empirical and theoretical work showing that assets exposed to market-wide increases in correlations command a risk premium, we examine hedge funds' betas with respect to a factor-mimicking portfolio for correlation risk. We find that funds with negative loadings on the negative correlation risk factor premium - that is sellers of insurance against unexpected increases in correlation or long positions in correlation swaps- have maximum drawdowns that are significantly higher than those of funds with positive correlation risk betas.

Our results are of relevance to investors and fund managers. We show that risk-adjusted (alpha) performance measures that ignore correlation risk exposures underestimate fund risk and overestimate fund performance. Moreover, correlation risk is related to maximum drawdown measures,

¹³We thank Jean-Sebastien Fontaine and Rene Garcia for kindly providing us with the data.

which are a key metric used by hedge fund investors for fund selection. Long/Short Equity funds with baskets of long and short positions are exposed to correlation risk and suffer sudden large losses when correlations unexpectedly increase. Monitoring and hedging correlation risk exposure is therefore important for hedge fund portfolio risk management. Our findings have important implications for hedge fund risk management, the categorization of hedge funds according to risk measures and recent (UCITS III) legislation that allows mutual funds to follow so-called 130/30 long-short strategies.

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Table 1: Statistics of Hedge Funds Returns

This table reports summary statistics for monthly value-weighted hedge fund index excess returns of 15 hedge funds categories. The first row reports results for a value-weighted average of all hedge funds excluding funds of funds. Low Net Exposure (LNX) funds are Long/Short Equity funds that are reported to have a net long/short exposure below 30 percent. FIAB are Fixed Income-Asset Backed Securities (FIAB) funds. All LNX are all hedge funds with net long/short exposure below 30 percent. The value-weights are rebalanced every month based on a fund's asset under management. Returns are expressed in percent per month. The sample period is January 1996 to December 2008. Columns 2 to 9 report the mean, standard deviation, skewness, kurtosis, minimum, median, maximum of monthly index returns. Columns 10 to 14 report alpha and beta coefficients (with respect to the S&P500), the Sharpe Ratio (SR), the Treynor's measure (TM), and the M-squared measure.

Investment Objective	# Funds	mean	std	skew	kurt	min	med	max	alpha	beta	SR	TM	Msq
ALL (except FoF)	6722	0.48	1.65	-0.68	4.89	-7.0	0.46	4.2	0.44	0.22	0.29	2.0	1.61
Long/Short Equity (LSE)	770	0.64	2.25	0.19	6.26	-8.9	0.65	9.6	0.58	0.33	0.29	1.8	1.59
Low Net Exposure (LNX)	41	0.58	2.25	0.35	5.15	-7.3	0.60	9.8	0.54	0.23	0.26	2.3	1.46
Equity Long (EL)	532	0.40	3.40	-1.49	7.08	-15.2	0.88	6.0	0.28	0.62	0.12	0.4	0.83
Equity Market Neutral (EMKN)	187	0.22	1.18	-0.23	6.32	-3.6	0.28	5.5	0.22	-0.01	0.19	-35.3	1.14
Options Trader (OPTS)	186	0.66	3.34	-1.78	19.11	-21.6	0.65	15.3	0.64	0.10	0.20	6.4	1.19
Event Driven (ED)	189	0.57	2.43	-2.50	14.54	-14.8	0.91	4.7	0.50	0.33	0.23	1.5	1.35
Distressed Securities (DS)	74	0.66	3.40	-1.19	11.00	-17.2	1.02	14.1	0.61	0.26	0.19	2.3	1.17
Merger Arbitrage (MA)	56	0.36	1.11	-1.56	10.86	-6.3	0.47	3.1	0.34	0.14	0.33	2.5	1.78
Fixed Income (FI)_Relative Value	245	0.25	1.46	-1.35	6.60	-5.4	0.37	3.8	0.22	0.15	0.17	1.4	1.06
FIAB	86	0.23	0.70	-1.63	10.62	-4.0	0.29	2.1	0.22	0.01	0.32	16.5	1.74
Convertible Arbitrage (CA)	129	0.25	2.36	-0.90	7.83	-10.3	0.30	8.0	0.18	0.34	0.11	0.5	0.78
Macro (MAC)	181	0.55	1.93	0.59	4.93	-4.3	0.46	8.5	0.52	0.14	0.28	3.8	1.58
Emerging Markets (EMG)	415	0.37	4.36	-1.71	8.89	-20.8	1.08	9.9	0.25	0.59	0.08	0.4	0.68
Funds of Funds (FOF)	2635	0.31	1.95	-1.06	7.62	-8.1	0.40	6.3	0.26	0.27	0.16	1.0	1.02
Multi-strategy	1262	0.65	2.27	0.12	3.65	-6.5	0.70	8.0	0.65	0.00	0.29	-18.4	1.59
Fixed Income	368	0.25	1.40	-1.20	6.58	-5.4	0.39	3.8	0.21	0.17	0.18	1.2	1.10

Table 2: Summary Statistics for Benchmark Factors

This table reports the summary statistics for different benchmark factors. The sample period is from January 1996 to December 2008. We report the statistical properties for non-overlapping monthly returns of the variance risk and correlation risk premia as well as the Fung and Hsieh model risk factors. Columns 2 to 8 report the mean, standard deviation, skewness, kurtosis, minimum, median and maximum of monthly returns. Columns 9 to 13 report alpha and beta coefficients (with respect to S&P500), Sharpe Ratio (SR), Treynor's measure (TM), and the M-squared measure. Alpha and Sharpe Ratio are expressed in percent per month. The variance risk premium is constructed from realized and implied volatility estimates. VR and CR correspond to short variance and short correlation swap strategies. VR is reported in percentages squared per month. From January 1996 until March 2000 CR is based on synthetic correlation swaps followed by market quotes from April 2008 until December 2008. Both CR and VR are winsorized.

	mean	std	skew	kurt	min	med	max	alpha	beta	SR	TM	Msg
VR	-16.73	37.09	6.14	63.73	-124.45	-17.26	350.28	-15.96	-3.92	-0.45	4.07	-1.74
CR	-10.72	16.45	-0.51	3.06	-62.81	-7.61	29.41	-10.42	-1.52	-0.65	6.85	-2.65
SNPmRf	0.20	4.50	-0.74	4.11	-16.82	0.77	9.31	0.00	1.00	0.04	0.00	0.49
SCMLC	-0.14	3.94	0.24	6.42	-16.38	-0.17	18.41	-0.13	-0.01	-0.03	9.01	0.14
BD10RET	0.29	2.20	0.16	4.97	-7.57	0.20	9.45	0.31	-0.10	0.13	-3.03	0.89
BAAMTSY	0.02	1.75	-2.42	17.34	-12.10	0.13	4.14	-0.02	0.19	0.01	-0.10	0.34
PTFSBD	-1.26	14.40	1.42	6.26	-25.60	-4.16	68.43	-1.17	-0.48	-0.09	2.43	-0.10
PTFSFX	1.15	18.59	1.08	4.42	-30.15	-1.92	69.22	1.32	-0.89	0.06	-1.49	0.58
PTFSCOM	0.78	14.40	1.22	5.27	-24.20	-2.20	64.36	0.88	-0.50	0.05	-1.76	0.54

Table 3: Correlation Matrix of Risk Factors and Hedge Funds Indices

This table reports the correlation matrix of the BKT model risk factors as well as hedge fund index returns. The sample period is from January 1996 to December 2008. Panel A shows the unconditional correlation matrix. See Column 1 of Table 1 for investment objective abbreviations. Panel B reports monthly returns for hedge fund indices and benchmark factors in recent stock market crisis months.

Panel A: Unconditional Correlation Matrix

	CR	All	LSE	LNE	EL	EMKN	OPTS	ED	DS	MA	FI	FIAB	CA	MAC	EMG	SNP mRf	SCM LC	BD10 RET	BAAm TSY	PTFS BD	PTFS FX	PTFS COM
CR	1.00	-0.38	-0.36	-0.38	-0.37	-0.05	-0.26	-0.35	-0.11	-0.36	-0.35	-0.13	-0.36	-0.26	-0.22	-0.42	0.01	0.11	-0.23	-0.02	0.09	-0.04
ALL	-0.38	1.00	0.78	0.69	0.81	0.21	0.29	0.74	0.62	0.59	0.62	0.35	0.74	0.66	0.79	0.59	0.22	0.02	0.43	-0.02	-0.02	0.03
LSE	-0.36	0.78	1.00	0.81	0.80	0.02	0.19	0.68	0.50	0.64	0.52	0.22	0.84	0.59	0.68	0.66	0.39	-0.10	0.32	-0.14	-0.10	-0.09
LNE	-0.38	0.69	0.81	1.00	0.66	-0.01	0.21	0.65	0.51	0.56	0.46	0.22	0.71	0.53	0.62	0.46	0.38	-0.16	0.34	-0.16	-0.07	-0.05
EL	-0.37	0.81	0.80	0.66	1.00	0.11	0.23	0.76	0.53	0.65	0.60	0.25	0.75	0.41	0.77	0.82	0.23	-0.12	0.55	-0.14	-0.21	-0.13
EMKN	-0.05	0.21	0.02	-0.01	0.11	1.00	-0.10	0.26	0.18	0.21	0.15	0.24	-0.05	-0.01	0.10	-0.01	-0.16	0.11	-0.03	-0.15	0.04	0.02
OPTS	-0.26	0.29	0.19	0.21	0.23	-0.10	1.00	0.16	0.07	0.13	0.12	0.05	0.12	0.30	0.19	0.14	0.08	0.02	0.15	-0.09	0.04	0.12
ED	-0.35	0.74	0.68	0.65	0.76	0.26	0.16	1.00	0.67	0.76	0.66	0.41	0.74	0.42	0.78	0.61	0.20	-0.23	0.52	-0.33	-0.18	-0.15
DS	-0.11	0.62	0.50	0.51	0.53	0.18	0.07	0.67	1.00	0.40	0.51	0.39	0.61	0.21	0.69	0.35	0.16	-0.18	0.44	-0.31	-0.15	-0.09
MA	-0.36	0.59	0.64	0.56	0.65	0.21	0.13	0.76	0.40	1.00	0.51	0.35	0.58	0.35	0.54	0.55	0.29	-0.19	0.38	-0.24	-0.11	-0.14
FI	-0.35	0.62	0.52	0.46	0.60	0.15	0.12	0.66	0.51	0.51	1.00	0.43	0.69	0.27	0.58	0.48	0.16	-0.01	0.55	-0.20	-0.17	-0.17
FIAB	-0.13	0.35	0.22	0.22	0.25	0.24	0.05	0.41	0.39	0.35	0.43	1.00	0.36	0.07	0.37	0.11	0.05	-0.05	0.37	-0.09	-0.23	-0.15
CA	-0.36	0.74	0.84	0.71	0.75	-0.05	0.12	0.74	0.61	0.58	0.69	0.36	1.00	0.45	0.75	0.65	0.30	-0.11	0.48	-0.14	-0.20	-0.18
MAC	-0.26	0.66	0.59	0.53	0.41	-0.01	0.30	0.42	0.21	0.35	0.27	0.07	0.45	1.00	0.43	0.33	0.12	0.14	-0.05	0.07	0.17	0.21
EMG	-0.22	0.79	0.68	0.62	0.77	0.10	0.19	0.78	0.69	0.54	0.58	0.37	0.75	0.43	1.00	0.61	0.17	-0.18	0.58	-0.23	-0.24	-0.14
SNPmRf	-0.42	0.59	0.66	0.46	0.82	-0.01	0.14	0.61	0.35	0.55	0.48	0.11	0.65	0.33	0.61	1.00	-0.02	-0.21	0.49	-0.15	-0.22	-0.16
SCMLC	0.01	0.22	0.39	0.38	0.23	-0.16	0.08	0.20	0.16	0.29	0.16	0.05	0.30	0.12	0.17	-0.02	1.00	-0.13	0.22	-0.06	0.01	-0.03
BD10RET	0.11	0.02	-0.10	-0.16	-0.12	0.11	0.02	-0.23	-0.18	-0.19	-0.01	-0.05	-0.11	0.14	-0.18	-0.21	-0.13	1.00	-0.27	0.23	0.17	0.11
BAAmTSY	-0.23	0.43	0.32	0.34	0.55	-0.03	0.15	0.52	0.44	0.38	0.55	0.37	0.48	-0.05	0.58	0.49	0.22	-0.27	1.00	-0.15	-0.32	-0.22
PTFSBD	-0.02	-0.02	-0.14	-0.16	-0.14	-0.15	-0.09	-0.33	-0.31	-0.24	-0.20	-0.09	-0.14	0.07	-0.23	-0.15	-0.06	0.23	-0.15	1.00	0.21	0.19
PTFSFX	0.09	-0.02	-0.10	-0.07	-0.21	0.04	0.04	-0.18	-0.15	-0.11	-0.17	-0.23	-0.20	0.17	-0.24	-0.22	0.01	0.17	-0.32	0.21	1.00	0.36
PTFSCOM	-0.04	0.03	-0.09	-0.05	-0.13	0.02	0.12	-0.15	-0.09	-0.14	-0.17	-0.15	-0.18	0.21	-0.14	-0.16	-0.03	0.11	-0.22	0.19	0.36	1.00

Panel B: Monthly Excess Returns in Crisis Months (in percent per month)

	CR	All	LSE	LNE	EL	EMKN	OPTS	ED	DS	MA	FI	FIAB	CA	MAC	EMG	SNP mRf	SCM LC	BD10 RET	BAAm TSY	PTFS BD	PTFS FX	PTFS COM
Sep_08	29.41	-6.93	-4.57	-4.97	-10.80	-2.94	-0.12	-10.36	-17.14	-3.02	-5.09	-3.88	-10.18	0.61	-19.54	-8.98	0.94	0.08	-5.57	9.15	30.69	31.54
Jul_07	13.51	0.35	0.60	0.53	-0.21	1.21	-0.80	1.20	10.12	-0.39	-1.43	0.74	0.20	0.96	2.86	-3.50	-8.16	2.00	-1.93	-13.06	20.82	-3.21
Feb_07	24	0	0.6	0.7	0.9	1.2	-1.5	1.1	4.5	0.4	0.8	1.0	0.8	-0.8	2.1	-2.3	1.2	2.2	0.8	-3.0	-19	1.3
May_06	9	-1	-2.2	-3.0	-2.6	0.2	-2.8	-0.5	2.3	0.3	0.6	1.8	0.7	-3.2	-4.5	-3.3	-2.7	-0.4	0.1	-7.4	15.3	-5.0
Oct_05	12.6	-1.1	-1.5	-0.5	-3.0	-0.3	0.2	-1.8	-0.5	-0.9	0.0	-0.4	-0.5	-1	-3	-1.9	-1.4	-1.8	-0.8	-10	-2.4	-11

Table 4: Return Decomposition of Hedge Fund Index Returns

This table reports alpha and beta coefficients of hedge fund index returns for different investment objectives. Panel A reports results based on the seven-factor Fung-Hsieh model. The columns show the annualized hedge fund index return, the annualized alpha, the FH betas and the t-statistics of the alpha and FH betas. Panel B reports the alphas for the BKT 8-factor model. Panel C is based on a 9-factor model that includes the BKT model factors and a residual. The residual is from a regression of the variance risk premium on the correlation risk premium. The sample period is January 1996 to December 2008.

Panel A: FH-7 Model Alpha and Betas

	All	LSE	LNE	ELEMKN	OPTS	ED	DS	MA	FIRV	FIAB	CA	MAC	EMG	FOF	Multi	FIALL	ALLLN	
HF ret (% p.a.)	5.77	7.73	6.97	4.81	2.64	7.91	6.79	7.91	4.38	2.97	2.70	3.01	6.57	4.39	3.74	7.77	2.98	10.42
Alpha (% p.a.)	4.67	6.82	6.43	2.95	1.95	6.36	5.56	6.53	3.99	2.01	2.68	2.18	5.36	2.49	2.61	6.69	2.17	10.10
Beta SNP	0.21	0.37	0.22	0.58	-0.01	0.08	0.25	0.12	0.13	0.10	-0.02	0.31	0.23	0.42	0.22	0.06	0.12	0.21
Beta SCM	0.09	0.26	0.22	0.20	-0.05	0.06	0.09	0.07	0.08	0.04	0.00	0.18	0.10	0.12	0.12	0.03	0.06	0.16
Beta BD10RET	0.15	0.10	0.00	0.19	0.08	0.14	0.01	0.00	0.00	0.14	0.02	0.11	0.16	0.10	0.11	0.23	0.12	0.02
Beta BAAMTSY	0.21	-0.14	0.08	0.31	0.05	0.29	0.35	0.64	0.05	0.37	0.17	0.20	-0.25	0.85	0.31	0.12	0.30	-0.02
Beta PTFSBD	0.00	-0.01	-0.01	0.00	-0.02	-0.03	-0.04	-0.06	-0.01	-0.01	0.00	0.00	0.00	-0.04	-0.02	0.03	-0.01	0.00
Beta PTFSFX	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	-0.01	0.00	0.02	0.00	0.00	0.00
Beta PTFSKOM	0.01	0.00	0.01	0.01	0.00	0.04	0.00	0.01	0.00	0.00	0.00	-0.01	0.02	0.01	0.01	0.04	0.00	0.00
t-stat Alpha	3.92	4.91	3.60	1.78	1.71	1.97	3.28	2.25	4.75	1.80	4.20	1.37	3.30	0.81	1.95	3.41	2.15	6.43
t-stat SNP	8.20	12.47	5.84	16.63	-0.43	1.14	7.02	2.02	7.02	4.04	-1.62	9.14	6.61	6.38	7.73	1.34	5.80	6.36
t-stat SCM	3.61	8.57	5.60	5.44	-1.94	0.80	2.52	1.10	4.58	1.55	-0.07	5.26	2.98	1.81	4.29	0.69	2.52	4.75
t-stat BD10RET	3.10	1.83	0.07	2.89	1.70	1.07	0.08	-0.01	0.05	3.23	0.95	1.81	2.43	0.83	2.05	2.94	2.97	0.28
t-stat BAAMTSY	3.10	-1.68	0.82	3.24	0.69	1.54	3.56	3.80	0.96	5.66	4.69	2.12	-2.67	4.74	3.99	1.04	5.15	-0.24
t-stat PTFSBD	0.40	-0.74	-1.10	-0.25	-2.54	-1.35	-3.81	-3.33	-2.19	-1.99	-0.32	-0.41	0.36	-1.96	-2.01	2.80	-1.39	-0.10
t-stat PTFSFX	1.50	0.23	0.71	-0.33	0.93	0.80	0.70	0.37	1.07	0.67	-1.22	-0.38	1.52	-0.40	0.75	2.20	0.32	0.40
t-stat PTFSKOM	1.84	0.21	0.64	0.62	0.29	1.87	0.22	0.70	-0.43	-0.53	-0.43	-0.77	2.46	0.57	0.70	3.27	-0.53	-0.35
adj R ²	46.39	60.63	35.01	75.44	3.43	3.46	49.52	24.95	40.45	39.88	14.42	53.05	26.53	47.79	51.36	22.50	45.90	30.45

Panel B: BKT

	All	LSE	LNE	ELEMKN	OPTS	ED	DS	MA	FIRV	FIAB	CA	MAC	EMG	FOF	Multi	FIALL	NEALL	
HF ret (% p.a.)	5.77	7.73	6.97	4.81	2.64	7.91	6.79	7.91	4.38	2.97	2.70	3.01	6.57	4.39	3.74	7.77	2.98	10.42
Alpha (% p.a.)	3.26	5.21	2.85	2.68	1.59	0.70	3.48	8.11	2.77	0.25	2.56	0.52	3.70	4.34	0.77	3.65	0.49	6.07
Beta CR	-0.01	-0.01	-0.03	0.00	0.00	-0.04	-0.02	0.01	-0.01	-0.01	0.00	-0.01	-0.01	0.01	-0.01	-0.02	-0.01	-0.03
Beta SNP	0.19	0.35	0.18	0.58	-0.01	0.01	0.23	0.14	0.11	0.08	-0.02	0.29	0.21	0.44	0.20	0.02	0.10	0.17
Beta SCM	0.09	0.26	0.22	0.20	-0.05	0.06	0.09	0.07	0.08	0.04	0.00	0.18	0.11	0.12	0.13	0.03	0.06	0.16
Beta BD10RET	0.15	0.10	0.01	0.19	0.08	0.15	0.01	0.00	0.00	0.15	0.02	0.12	0.16	0.10	0.11	0.24	0.12	0.03
Beta BAAMTSY	0.21	-0.14	0.07	0.31	0.04	0.27	0.34	0.65	0.04	0.36	0.17	0.19	-0.26	0.86	0.30	0.11	0.30	-0.04
Beta PTFSBD	0.00	-0.01	-0.01	0.00	-0.02	-0.03	-0.04	-0.06	-0.01	-0.01	0.00	-0.01	0.00	-0.03	-0.02	0.03	-0.01	0.00
Beta PTFSFX	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	-0.01	0.01	0.02	0.00	0.00	
Beta PTFSKOM	0.01	0.00	0.00	0.01	0.00	0.03	0.00	0.01	0.00	-0.01	0.00	-0.01	0.02	0.01	0.00	0.04	-0.01	-0.01
t-stat Alpha	2.26	3.09	1.34	1.32	1.14	0.18	1.69	2.29	2.73	0.18	3.27	0.27	1.87	1.15	0.47	1.54	0.40	3.31
t-stat CR	-1.69	-1.67	-2.93	-0.23	-0.45	-2.55	-1.77	0.78	-2.10	-2.29	-0.28	-1.50	-1.47	0.85	-1.98	-2.24	-2.42	-3.82
t-stat SNP	7.09	11.10	4.54	15.39	-0.56	0.17	5.97	2.17	5.87	3.00	-1.61	8.03	5.66	6.26	6.57	0.46	4.63	4.83
t-stat SCM	3.64	8.63	5.76	5.42	-1.93	0.84	2.56	1.10	4.65	1.59	-0.06	5.29	3.00	1.81	4.35	0.71	2.58	4.99
t-stat BD10RET	3.18	1.89	0.18	2.88	1.71	1.18	0.14	-0.03	0.13	3.35	0.96	1.87	2.49	0.79	2.14	3.06	3.10	0.43
t-stat BAAMTSY	3.03	-1.77	0.69	3.22	0.66	1.44	3.50	3.83	0.86	5.61	4.66	2.05	-2.75	4.77	3.93	0.95	5.11	-0.44
t-stat PTFSBD	0.25	-0.89	-1.38	-0.26	-2.57	-1.59	-3.97	-3.25	-2.39	-2.20	-0.35	-0.54	0.24	-1.87	-2.20	2.63	-1.62	-0.43
t-stat PTFSFX	1.57	0.30	0.84	-0.32	0.94	0.91	0.77	0.34	1.16	0.76	-1.21	-0.32	1.58	-0.43	0.83	2.31	0.41	0.56
t-stat PTFSKOM	1.64	0.01	0.30	0.58	0.23	1.59	0.01	0.79	-0.68	-0.81	-0.46	-0.94	2.28	0.67	0.46	3.03	-0.82	-0.82
adj R ²	47.05	61.10	38.19	75.28	2.90	6.93	50.24	24.75	41.79	41.55	13.88	53.44	27.10	47.69	52.30	24.55	47.61	36.31

Panel C: BKT + Residual VR

	All	LSE	LNE	ELEMKN	OPTS	ED	DS	MA	FIRV	FIAB	CA	MAC	EMG	FOF	Multi	FIALL	NEALL	
HF ret (% p.a.)	5.77	7.73	6.97	4.81	2.64	7.91	6.79	7.91	4.38	2.97	2.70	3.01	6.57	4.39	3.74	7.77	2.98	10.42
Alpha (% p.a.)	2.91	5.11	2.77	2.09	1.41	0.39	2.71	6.85	2.65	0.15	2.35	0.23	3.50	2.78	0.28	3.52	0.41	5.82
Beta CR	-0.01	-0.01	-0.03	-0.01	0.00	-0.05	-0.02	0.00	-0.01	-0.01	0.00	-0.02	-0.01	0.00	-0.02	-0.03	-0.01	-0.03
Beta Residual VR	-1.59	-0.48	-0.39	-2.68	-0.80	-1.41	-3.50	-5.73	-0.53	-0.44	-0.92	-1.33	-0.89	-7.09	-2.19	-0.57	-0.36	-1.13
Beta SNP	0.18	0.35	0.18	0.56	-0.02	0.00	0.20	0.10	0.11	0.07	-0.03	0.28	0.20	0.39	0.18	0.02	0.10	0.16
Beta SCM	0.08	0.25	0.21	0.17	-0.06	0.04	0.05	0.01	0.08	0.03	-0.01	0.17	0.10	0.04	0.10	0.02	0.05	0.15
Beta BD10RET	0.15	0.10	0.01	0.19	0.08	0.15	0.00	-0.01	0.00	0.15	0.02	0.12	0.16	0.09	0.11	0.23	0.12	0.02
Beta BAAMTSY	0.13	-0.17	0.05	0.17	0.00	0.19	0.16	0.35	0.01	0.34	0.13	0.12	-0.30	0.50	0.19	0.08	0.28	-0.10
Beta PTFSBD	0.00	-0.01	-0.01	0.00	-0.02	-0.03	-0.04	-0.05	-0.01	-0.01	0.00	0.00	0.00	-0.03	-0.01	0.03	-0.01	0.00
Beta PTFSFX	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	-0.01	0.01	0.02	0.00	0.00	
Beta PTFSKOM	0.01	0.00	0.00	0.01	0.00	0.03	0.00	0.01	0.00	-0.01	0.00	-0.01	0.02	0.01	0.00	0.04	-0.01	-0.01
t-stat Alpha	2.04	3.01	1.29	1.05	1.01	1.37	2.01	2.60	0.11	3.05	0.12	1.76	0.78	0.18	1.48	0.34	3.17	
t-stat CR	-2.18	-1.75	-2.95	-0.82	-0.70	-2.66	-2.60	0.06	-2.29	-2.38	-0.80	-1.78	-1.64	0.02	-2.60	-2.30	-2.50	-4.03
t-stat Residual VR	-2.49	-0.62	-0.40	-3.01	-1.28	-0.81	-3.97	-3.75	-1.16	-0.72	-2.66	-1.53	-1.00	-4.42	-3.08	-0.53	-0.66	-1.38
t-stat SNP	6.70	10.82	4.39	15.08	-0.77	0.03	5.51	1.60	5.60	2.84	-2.06	7.70	5.42	5.81	6.15	0.36	4.45	4.54
t-stat SCM	2.91	8.13	5.43	4.56	-2.21	0.59	1.52	0.10	4.18	1.33	-0.77	4.71	2.62	0.67	3.49	0.54	2.31	4.46
t-stat BD10RET	3.17	1.88	0.17	2.89	1.68	1.16	0.06	-0.12	0.10	3.33	0.91	1.84	2.47	0.74	2.13	3.04	3.08	0.40
t-stat BAAMTSY	1.69	-1.86	0.44	1.66	0.04	0.94	1.57	1.96	0.27	4.73	3.12	1.19	-2.91	2.63	2.29	0.62	4.30	-1.00
t-stat PTFSBD	0.54	-0.81	-1.32	0.07	-2.41	-1.48	-3.69	-2.95	-2.25	-2.10	-0.05	-0.37	0.35	-1.48	-1.90	2.67	-1.53	-0.28
t-stat PTFSFX	1.57	0.29	0.83	-0.37	0.92	0.89	0.76	0.30	1.15	0.75	-1.27	-0.35	1.56	-0.52	0.81	2.30	0.40	0.54
t-stat PTFSKOM																		

Table 5: FH and BKT Model Regression Coefficients for Individual Hedge Funds

In this table, we report regression coefficients for individual hedge funds that are sorted by their BKT correlation risk beta t-statistic into deciles. Column 3 reports results for decile 1, which contains individual hedge funds with the most extreme negative correlation risk beta. Given the construction of the CR time-series, funds in this decile can be interpreted as selling insurance against unexpected increases in correlation. Column 12 reports results for decile 10, which contains funds with the highest correlation risk beta. These funds can be interpreted as buying insurance against unexpected increases in correlation. The last column reports the cross-sectional mean for all hedge funds. Rows 1 and 6 report the BKT model correlation risk beta. Row 2 reports the average absolute return per year. Rows 3 to 4 report FH model results. Rows 5 to 16 report BKT model results. Rows 14 to 16 report t-statistics for several BKT model betas. Rows 17 to 19 report the contribution of alpha and several BKT model betas to the total absolute return. Alpha and hedge funds returns are annualized and expressed in a percentage format. The sample period is from January 1996 to December 2008.

		low	2	3	4	5	6	7	8	9	high	mean
	beta_CR	-0.150	-0.093	-0.081	-0.059	-0.043	-0.026	-0.009	0.013	0.038	0.103	-0.031
	Return (% p.a.)	9.00	7.80	7.08	5.80	6.72	5.51	5.79	5.51	5.05	8.35	6.66
FH7 Model	FH7 Alpha (% p.a.)	8.50	6.53	5.68	5.33	6.31	5.71	5.30	5.47	4.09	7.46	6.04
Coefficients	t_alpha	1.46	1.40	1.17	1.15	1.26	1.08	1.00	0.99	0.91	1.01	1.14
BKT Model	BKT Alpha (% p.a.)	0.43	-0.30	-0.67	1.62	2.97	4.29	4.59	6.27	6.85	16.43	4.25
	beta_CR	-0.150	-0.093	-0.081	-0.059	-0.043	-0.026	-0.009	0.013	0.038	0.103	-0.031
	beta_snp500	0.004	0.067	0.159	0.170	0.138	0.128	0.228	0.205	0.243	0.371	0.171
	beta_SCMLC	0.090	0.080	0.081	0.053	0.076	0.035	0.078	0.081	0.087	0.079	0.074
	beta_BD10RET	-0.012	0.063	0.069	0.054	0.030	0.040	0.010	0.027	0.020	-0.042	0.026
	beta_BAAMTSY	-0.041	0.187	0.211	0.234	0.322	0.259	0.265	0.187	0.156	0.258	0.204
	beta_PTFSBD	0.021	0.017	0.006	0.004	0.008	0.000	0.001	0.000	-0.005	-0.004	0.005
	beta_PTFSFX	0.008	0.014	0.017	0.014	0.019	0.012	0.010	0.008	0.013	0.015	0.013
	beta_PTFSOM	0.028	0.019	0.015	0.016	0.018	0.008	0.002	0.015	0.008	0.011	0.014
	t_alpha	0.42	0.67	0.61	0.70	0.90	0.85	0.82	0.94	0.97	1.48	0.84
	t_beta_CR	-2.80	-1.84	-1.41	-1.05	-0.73	-0.44	-0.13	0.22	0.68	1.58	-0.59
	t_beta_SNP	0.46	0.82	1.05	1.30	1.32	1.18	1.50	1.66	1.73	2.20	1.32
	contrib_alpha	0.43	-0.30	-0.67	1.62	2.97	4.29	4.59	6.27	6.85	16.43	4.25
	contrib_CR	7.90	7.15	6.82	3.85	3.62	1.52	0.78	-0.87	-2.94	-9.68	1.81
contrib_SNP500	0.53	0.55	0.04	0.00	0.15	0.12	0.18	-0.32	0.24	0.69	0.22	

Table 6: FH and BKT Model Regression Coefficients by Investment Objective

In this table, we report, by hedge fund category, regression coefficients for individual hedge funds that are sorted by their BKT correlation risk beta into deciles t-statistic. Column 3 reports results for decile 1, which contains individual hedge funds with the lowest correlation risk beta. Column 12 reports results for decile 10, which contains funds with the highest correlation risk beta. The last column reports the cross-sectional mean for all hedge funds. Rows 1 and 6 report the BKT model correlation risk beta. Row 2 reports the average absolute return per year. Rows 3 to 4 report FH model results. Rows 5 to 16 report BKT model results. Rows 14 to 16 report t-statistics for several BKT model betas. Rows 17 to 19 report the contribution of alpha and several BKT model betas to the total absolute return. Alpha and hedge funds returns are annualized and expressed in a percentage format. The sample period is from January 1996 to December 2008. Panel A-F report results for investment objectives Long/Short Equity, LNX (Long/Short Equity Funds with Low Net Exposure), Option Strategies, Merger Arbitrage, ALL LNX (All funds with Low Net Exposure).

A: Long/Short Equity

		low	2	3	4	5	6	7	8	9 high	mean	
	beta_CR	-0.097	-0.090	-0.058	-0.054	-0.042	-0.028	-0.019	-0.003	0.015	0.064	-0.031
	Return (% p.a.)	7.90	6.41	6.46	5.89	7.32	5.61	5.44	6.53	3.93	6.54	6.20
FH7 Model	FH7 Alpha (% p.a.)	8.53	7.22	5.71	6.68	7.17	6.45	4.91	5.17	3.27	6.17	6.13
Coefficients	t_alpha	1.87	1.40	1.27	1.44	1.35	1.09	0.78	0.98	0.72	0.85	1.17
BKT Model	BKT Alpha (% p.a.)	2.51	2.76	1.78	4.88	5.51	5.01	4.24	5.06	4.24	9.45	4.54
	beta_CR	-0.097	-0.090	-0.058	-0.054	-0.042	-0.028	-0.019	-0.003	0.015	0.064	-0.031
	beta_snp500	0.135	0.105	0.167	0.222	0.208	0.247	0.146	0.299	0.339	0.336	0.220
	beta_SCMLC	0.214	0.159	0.164	0.128	0.198	0.167	0.079	0.178	0.177	0.134	0.160
	beta_BD10RET	0.044	-0.011	-0.037	-0.020	0.022	-0.024	-0.096	-0.009	-0.074	-0.111	-0.032
	beta_BAAMTSY	-0.069	0.185	0.113	0.212	0.041	0.127	0.021	0.116	-0.110	-0.003	0.063
	beta_PTFSBD	-0.008	-0.008	-0.002	-0.001	0.016	0.006	-0.010	-0.004	-0.005	-0.010	-0.003
	beta_PTFSFX	-0.005	0.006	0.010	0.007	0.002	0.008	-0.006	-0.003	0.004	0.011	0.004
	beta_PTFSKOM	0.009	0.002	-0.002	0.003	-0.005	0.004	-0.007	-0.003	0.005	-0.004	0.000
	t_alpha	0.78	0.75	0.61	1.04	0.97	0.76	0.62	0.88	0.67	1.05	0.81
	t_beta_CR	-2.81	-2.05	-1.63	-1.20	-0.86	-0.62	-0.33	-0.04	0.32	1.26	-0.80
	t_beta_SNP	1.57	1.00	1.47	1.67	1.72	2.08	1.61	1.90	3.33	2.21	1.85
	contrib_alpha	2.51	2.76	1.78	4.88	5.51	5.01	4.24	5.06	4.24	9.45	4.54
	contrib_CR	5.97	4.35	4.17	1.87	2.07	1.60	0.67	0.13	-0.98	-3.57	1.63
contrib_SNP500	-0.43	0.64	0.69	-0.25	0.32	0.04	-0.46	-0.64	0.22	0.59	0.07	

Panel B: Long/Short Equity Funds with Low Net Exposure (LNX)

		low	2	3	4	5	6	7	8	9 high	mean	
	beta_CR	-0.054	-0.076	-0.043	-0.039	-0.025	-0.026	-0.005	0.003	0.012	0.038	-0.021
	Return (% p.a.)	5.55	5.02	6.99	9.77	4.82	0.00	7.36	5.96	5.26	-1.14	4.96
FH7 Model	FH7 Alpha (% p.a.)	4.76	4.41	7.30	10.01	6.60	2.84	7.19	7.82	5.70	-4.91	5.17
Coefficients	t_alpha	1.52	0.80	1.79	1.96	1.61	0.85	1.88	2.10	0.96	-0.54	1.29
BKT Model	BKT Alpha (% p.a.)	0.40	2.94	6.47	8.83	5.99	2.50	7.10	7.85	5.93	-3.91	4.41
	beta_CR	-0.054	-0.076	-0.043	-0.039	-0.025	-0.026	-0.005	0.003	0.012	0.038	-0.021
	beta_snp500	0.278	0.077	-0.036	0.185	0.187	0.253	0.279	0.297	0.352	0.243	0.212
	beta_SCMLC	0.184	0.033	0.099	0.029	0.237	-0.010	-0.066	-0.042	0.046	-0.077	0.043
	beta_BD10RET	0.017	-0.074	0.080	0.173	-0.060	-0.062	-0.193	-0.225	-0.193	-0.094	-0.063
	beta_BAAMTSY	0.153	0.358	0.240	0.129	0.170	0.216	-0.034	-0.152	0.079	0.391	0.155
	beta_PTFSBD	-0.019	-0.009	0.000	-0.005	0.029	0.005	0.004	0.028	0.013	-0.021	0.003
	beta_PTFSFX	0.002	0.006	-0.010	0.021	0.011	-0.012	0.003	-0.016	-0.010	0.009	0.000
	beta_PTFSKOM	-0.009	0.005	0.008	0.032	-0.007	-0.026	0.020	0.013	0.017	0.019	0.007
	t_alpha	0.13	0.56	1.62	1.58	1.42	0.78	1.80	2.04	0.99	-0.34	1.06
	t_beta_CR	-2.61	-1.74	-1.38	-0.98	-0.69	-0.53	-0.14	0.06	0.32	0.89	-0.68
	t_beta_SNP	3.70	0.50	0.55	1.22	1.49	1.27	1.90	1.54	2.10	1.33	1.56
	contrib_alpha	0.40	2.94	6.47	8.83	5.99	2.50	7.10	7.85	5.93	-3.91	4.41
	contrib_CR	4.41	1.75	0.79	1.05	0.68	0.26	0.11	0.01	-0.34	-1.41	0.73
contrib_SNP500	0.01	-0.06	0.09	-1.35	-0.33	-1.01	-0.24	-0.78	0.62	1.56	-0.15	

Panel C: Options

		low	2	3	4	5	6	7	8	9 high	mean	
	beta_CR	-0.207	-0.293	-0.110	-0.087	-0.071	-0.033	-0.022	0.031	0.081	0.089	-0.062
	Return (% p.a.)	10.46	22.30	13.55	10.83	12.00	10.28	10.75	9.33	9.25	10.43	11.92
FH7 Model	FH7 Alpha (% p.a.)	10.75	32.72	14.88	16.67	17.86	16.90	18.36	13.34	13.66	15.27	17.04
Coefficients	t_alpha	1.49	1.42	1.87	1.69	1.63	2.01	1.58	1.03	1.23	1.53	1.55
BKT Model	BKT Alpha (% p.a.)	2.53	26.10	11.20	15.46	16.25	16.58	17.97	13.24	14.70	16.33	15.04
	beta_CR	-0.207	-0.293	-0.110	-0.087	-0.071	-0.033	-0.022	0.031	0.081	0.089	-0.062
	beta_snp500	-0.046	-0.361	-0.065	0.037	-0.319	0.146	-0.005	0.202	0.340	0.437	0.037
	beta_SCMLC	0.019	0.171	0.076	-0.016	0.330	0.144	0.085	0.125	0.077	0.173	0.118
	beta_BD10RET	0.027	0.255	-0.028	-0.097	-0.083	0.288	-0.117	-0.002	-0.600	-0.396	-0.075
	beta_BAAMTSY	0.218	0.168	0.210	0.002	0.326	0.684	0.616	0.151	0.772	-0.004	0.314
	beta_PTFSBD	0.024	0.199	0.032	0.063	0.018	0.041	0.088	0.014	-0.010	0.051	0.052
	beta_PTFSFX	-0.027	-0.036	0.004	0.018	-0.005	0.001	-0.008	-0.029	0.049	0.009	-0.002
	beta_PTFSCOM	0.004	-0.106	-0.014	-0.047	0.020	-0.021	-0.026	0.045	-0.004	-0.007	-0.016
	t_alpha	0.27	1.12	1.46	1.54	1.37	1.96	1.51	1.01	1.22	1.63	1.31
	t_beta_CR	-4.00	-2.29	-1.64	-1.28	-0.88	-0.46	-0.19	0.17	0.61	1.06	-0.89
	t_beta_SNP	-0.22	-0.05	0.16	0.15	-0.17	0.64	0.29	0.67	1.20	1.47	0.42
	contrib_alpha	2.53	26.10	11.20	15.46	16.25	16.58	17.97	13.24	14.70	16.33	15.04
contrib_CR	8.66	15.28	4.58	0.51	1.93	0.54	0.61	-0.65	-1.31	-0.33	2.98	
contrib_SNP500	0.42	-4.18	-1.43	0.02	-2.39	-0.98	-0.72	-1.05	1.18	-1.51	-1.06	

Panel D: Merger Arbitrage

		low	2	3	4	5	6	7	8	9 high	mean	
	beta_CR	-0.109	-0.013	-0.021	-0.051	-0.011	-0.009	-0.007	-0.003	0.001	0.003	-0.022
	Return (% p.a.)	10.39	4.05	4.24	10.03	3.05	3.59	1.89	-0.80	5.27	2.00	4.37
FH7 Model	FH7 Alpha (% p.a.)	10.19	3.62	2.87	5.34	2.54	3.04	0.74	-1.48	5.07	1.06	3.30
Coefficients	t_alpha	2.36	3.12	2.34	1.86	2.85	1.79	1.47	-0.05	2.21	0.79	1.87
BKT Model	BKT Alpha (% p.a.)	7.77	2.05	0.62	2.13	1.93	2.32	0.21	-1.58	5.16	1.29	2.19
	beta_CR	-0.109	-0.013	-0.021	-0.051	-0.011	-0.009	-0.007	-0.003	0.001	0.003	-0.022
	beta_snp500	-0.018	0.055	0.134	0.065	0.048	0.093	0.104	0.079	0.077	0.042	0.068
	beta_SCMLC	-0.024	0.063	0.116	0.039	0.023	0.032	0.098	0.097	0.009	0.080	0.053
	beta_BD10RET	-0.077	0.049	-0.070	0.009	-0.008	0.036	-0.028	-0.028	0.005	-0.026	-0.014
	beta_BAAMTSY	0.214	0.108	0.106	-0.601	-0.004	0.138	0.133	0.078	-0.006	0.059	0.023
	beta_PTFSBD	0.012	-0.008	-0.012	0.027	0.001	-0.008	-0.017	-0.003	0.003	-0.005	-0.001
	beta_PTFSFX	0.010	0.005	-0.002	-0.008	0.007	0.005	0.004	-0.002	0.008	0.006	0.003
	beta_PTFSCOM	-0.008	-0.010	-0.001	-0.083	-0.015	-0.005	-0.027	-0.027	-0.009	-0.010	-0.019
	t_alpha	1.83	1.40	1.00	1.17	2.33	1.15	0.86	-0.28	2.02	0.64	1.21
	t_beta_CR	-3.41	-1.95	-1.43	-1.03	-0.86	-0.71	-0.35	-0.08	0.07	0.20	-0.96
	t_beta_SNP	-0.11	1.95	1.94	1.81	1.62	2.58	2.46	1.62	1.74	1.54	1.72
	contrib_alpha	7.77	2.05	0.62	2.13	1.93	2.32	0.21	-1.58	5.16	1.29	2.19
contrib_CR	3.85	1.58	2.31	3.12	0.56	0.73	0.53	0.09	-0.09	-0.24	1.25	
contrib_SNP500	-0.11	0.17	0.91	-0.08	-0.08	0.03	-0.74	-0.76	0.25	0.46	0.01	

Panel E: All Funds with Low Net Exposure (LNX ALL)

		low	2	3	4	5	6	7	8	9 high	mean	
	beta_CR	-0.083	-0.069	-0.051	-0.058	-0.037	-0.029	-0.022	-0.008	0.007	0.060	-0.029
	Return (% p.a.)	3.69	5.44	5.55	7.98	9.12	2.59	4.32	6.95	5.42	4.06	5.51
FH7 Model	FH7 Alpha (% p.a.)	4.25	6.13	4.64	7.33	9.62	5.39	3.56	5.96	4.77	0.70	5.24
Coefficients	t_alpha	1.29	1.77	1.26	1.43	1.98	1.04	0.72	1.22	1.21	0.45	1.24
BKT Model	BKT Alpha (% p.a.)	1.58	4.20	3.23	6.41	8.69	5.06	3.35	5.84	4.91	1.93	4.52
	beta_CR	-0.083	-0.069	-0.051	-0.058	-0.037	-0.029	-0.022	-0.008	0.007	0.060	-0.029
	beta_snp500	0.016	0.054	0.052	0.166	0.043	0.028	0.043	0.163	0.177	0.277	0.102
	beta_SCMLC	0.099	0.017	0.035	0.058	0.144	-0.004	-0.057	0.077	0.027	-0.092	0.030
	beta_BD10RET	-0.065	0.045	0.032	0.003	-0.072	-0.062	-0.165	-0.105	-0.144	-0.136	-0.067
	beta_BAAMTSY	0.155	0.272	0.232	0.224	0.045	0.377	0.299	-0.087	-0.023	0.173	0.167
	beta_PTFSBD	-0.005	0.007	-0.002	-0.005	-0.009	-0.011	-0.024	0.002	-0.002	-0.039	-0.009
	beta_PTFSFX	-0.004	0.003	0.012	0.008	0.008	0.007	0.013	-0.001	-0.003	0.021	0.006
	beta_PTFSCOM	0.007	-0.010	-0.005	-0.014	0.006	-0.010	0.001	-0.024	0.015	0.016	-0.002
	t_alpha	0.55	1.38	0.87	1.18	1.72	0.96	0.64	1.11	1.20	0.62	1.02
	t_beta_CR	-2.80	-1.89	-1.61	-1.20	-0.88	-0.63	-0.38	-0.13	0.18	1.20	-0.81
	t_beta_SNP	0.62	0.48	0.56	1.09	0.44	0.38	0.38	0.97	1.03	1.15	0.71
	contrib_alpha	1.58	4.20	3.23	6.41	8.69	5.06	3.35	5.84	4.91	1.93	4.52
contrib_CR	2.81	1.89	1.82	1.00	0.89	0.36	0.29	0.17	-0.12	-1.39	0.77	
contrib_SNP500	0.38	-0.09	0.08	0.90	-0.33	1.13	0.20	-0.98	0.38	-0.14	0.15	

Table 7: The Cross-section of Hedge Fund Excess Returns and Correlation Risk Exposure

This table reports estimates for the risk premia on market index as well as the Fung and Hsieh (2004) factor and the correlation risk factor (CR). In column 2 we report results for the market and the correlation risk factor (Model 1). In column 3 we report results for the Fung and Hsieh (2004) model and the correlation risk factor. The exposures are estimated in a first step, regressing the time-series of each excess hedge fund return on the risk factors. In a second step, we run a cross-sectional regression of average annualized excess hedge fund returns on the betas from the first pass regression. The table reports the t-statistics (based on Newey-West standard errors) in brackets and the cross-sectional R^2 . The sample period is January 1996 to Dec 2008.

Model	Model 1 (MKT+CR)	Model 2 (FH7+CR)
Intercept	6.52	5.83
	20.52	17.25
Correl Risk	-11.45	-11.93
	-2.10	-1.89
Mkt Risk	-2.60	-0.86
	-3.54	-0.96
SCMBC		4.42
		3.12
BD10RET		-0.37
		-0.36
BAAmTSY		-1.53
		-3.19
PTFSBD		13.43
		1.88
PTFSFX		3.38
		0.43
PTFSCOM		15.46
		2.14
Adj R ²	2.30	6.16

Table 8: Returns based on TASS/Lipper Database

This table reports alpha and beta coefficients of hedge fund index returns from the TASS/Lipper database. The columns show results for all funds, long/short equity (LSE), equity market neutral (EMKN), event driven (ED), fixed income (FI), convertible arbitrage (CA), macro (MAC) and emerging markets (EMG) funds as well as funds of funds and multi-strategy funds. Panel A reports results based on the seven-factor Fung-Hsieh model. The columns show the annualized hedge fund index return, the annualized alpha, the betas and the t-statistics of the alpha and betas. Panel B reports the alphas for the BKT 8-factor model. The sample period is January 1996 to December 2008.

Panel A: FH -7 Model Alpha and Betas

	All	LSE	EMKN	ED	FI	CA	MAC	EMG	FOF	Multi
HF ret (% p.a.)	6.81	9.89	5.816	5.92	1.96	3.09	4.23	8.07	3.40	7.36
Alpha (% p.a.)	5.56	8.74	5.189	5.46	1.59	2.23	2.32	6.12	2.49	6.22
Beta SNP	0.274	0.460	0.088	0.128	0.008	0.115	0.179	0.604	0.122	0.286
Beta SCM	0.154	0.356	-0.006	0.107	-0.006	0.030	-0.021	0.233	0.090	0.071
Beta BD10RET	0.109	0.115	0.084	-0.029	0.061	0.153	0.232	0.004	0.092	0.137
Beta BAAmTSY	0.173	-0.044	0.164	0.316	0.325	0.334	0.390	0.447	0.343	0.118
Beta PTFSBD	-0.017	-0.014	0.002	-0.019	-0.009	-0.006	-0.017	-0.042	-0.016	-0.003
Beta PTFSFX	0.006	0.001	0.006	0.003	-0.006	-0.005	0.009	0.009	0.006	0.002
Beta PTFSKOM	0.011	0.003	0.004	0.002	-0.001	0.001	0.018	0.002	0.007	0.000
t-stat Alpha	3.84	4.29	6.219	5.81	2.33	1.51	0.93	1.84	2.21	5.28
t-stat SNP	8.92	10.64	4.995	6.42	0.58	3.65	3.38	8.54	5.09	11.45
t-stat SCM	4.92	8.06	-0.306	5.23	-0.44	0.93	-0.39	3.22	3.70	2.80
t-stat BD10RET	1.89	1.42	2.528	-0.77	2.25	2.59	2.34	0.03	2.06	2.93
t-stat BAAmTSY	2.06	-0.37	3.371	5.78	8.17	3.88	2.69	2.30	5.22	1.72
t-stat PTFSBD	-1.97	-1.14	0.405	-3.45	-2.16	-0.66	-1.17	-2.12	-2.30	-0.44
t-stat PTFSFX	0.84	0.06	1.347	0.71	-1.69	-0.71	0.77	0.57	0.98	0.34
t-stat PTFSKOM	1.20	0.24	0.707	0.43	-0.19	0.16	1.17	0.08	1.02	0.03
adj R ²	50.38	56.85	27.119	59.81	44.16	27.04	16.09	49.70	44.93	56.37

Panel B: BKT

	All	LSE	EMKN	ED	FI	CA	MAC	EMG	FOF	MULTI
HF ret (% p.a.)	6.81	9.89	5.82	5.92	1.96	3.09	4.23	8.07	3.40	7.36
Alpha (% p.a.)	4.29	7.22	4.31	4.96	1.50	0.86	1.40	4.47	1.28	5.13
Beta CR	-0.019	-0.023	-0.013	-0.008	-0.001	-0.021	-0.014	-0.025	-0.018	-0.017
Beta SNP	0.250	0.431	0.072	0.119	0.007	0.088	0.162	0.573	0.099	0.266
Beta SCM	0.148	0.347	-0.010	0.104	-0.007	0.022	-0.026	0.224	0.084	0.066
Beta BD10RET	0.103	0.109	0.080	-0.031	0.061	0.147	0.228	-0.003	0.087	0.133
Beta BAAmTSY	0.168	-0.050	0.160	0.314	0.324	0.328	0.386	0.439	0.337	0.113
Beta PTFSBD	-0.017	-0.014	0.002	-0.019	-0.009	-0.006	-0.017	-0.042	-0.015	-0.003
Beta PTFSFX	0.007	0.002	0.006	0.004	-0.006	-0.004	0.010	0.010	0.006	0.003
Beta PTFSKOM	0.008	0.000	0.002	0.002	-0.001	-0.001	0.016	-0.001	0.005	-0.002
t-stat Alpha	2.63	3.14	4.61	4.66	1.93	0.52	0.50	1.19	1.02	3.88
t-stat CR	-1.66	-1.42	-2.00	-1.00	-0.25	-1.76	-0.69	-0.93	-2.04	-1.75
t-stat SNP	7.40	9.04	3.70	5.37	0.41	2.56	2.75	7.31	3.77	9.67
t-stat SCM	4.69	7.84	-0.57	5.05	-0.47	0.70	-0.48	3.07	3.44	2.56
t-stat BD10RET	1.80	1.34	2.43	-0.83	2.23	2.50	2.29	-0.03	1.96	2.85
t-stat BAAmTSY	2.00	-0.43	3.32	5.74	8.13	3.84	2.65	2.26	5.19	1.66
t-stat PTFSBD	-1.98	-1.14	0.42	-3.45	-2.15	-0.66	-1.16	-2.12	-2.31	-0.44
t-stat PTFSFX	0.96	0.16	1.50	0.78	-1.66	-0.59	0.81	0.63	1.14	0.46
t-stat PTFSKOM	0.94	0.03	0.40	0.27	-0.23	-0.11	1.05	-0.06	0.71	-0.23
adj R ²	50.95	57.14	28.57	59.81	43.81	28.07	15.79	49.65	46.08	56.97

Table 9: Return Decomposition of Equally-Weighted Hedge Fund Index Returns

This table reports alpha and beta coefficients of equally-weighted hedge fund index returns for different investment objectives (for abbreviations). Panel A reports results based on the seven-factor Fung-Hsieh model. The columns show the annualized hedge fund return, the annualized alpha, the betas and the t-statistics of the alpha and betas. Panel B reports the alphas for the BKT 8-factor model. For simplicity, we report the betas and their t-statistics for the equity market premium, the correlation risk premium only. The sample period is from January 1996 to December 2008.

Panel A: FH -7 Model Alpha and Betas

	All	LSE	LNE	ELEMKN	OPTS	ED	DS	MA	FI	FIAB	CA	MAC	EMG	
HF ret (% p.a.)	7.35	9.46	10.81	8.13	4.12	14.52	7.71	5.41	4.38	3.47	8.71	2.89	6.14	8.23
Alpha (% p.a.)	6.36	8.80	9.85	7.01	3.52	12.15	7.03	4.65	4.00	2.51	7.93	2.19	4.99	6.71
Beta SNP	0.221	0.390	0.313	0.647	0.036	0.270	0.298	0.153	0.113	0.103	0.004	0.160	0.267	0.525
Beta SCM	0.120	0.279	0.173	0.364	0.003	0.053	0.172	0.129	0.055	0.028	0.025	0.067	0.083	0.168
Beta BD10RET	0.107	0.032	0.067	0.026	0.077	0.367	0.028	-0.044	0.019	0.142	0.153	0.119	0.156	-0.017
Beta BAAMTSY	0.222	-0.074	0.105	0.204	0.036	0.565	0.181	0.484	0.098	0.422	0.174	0.488	0.002	0.628
Beta PTFSD	0.007	-0.003	-0.005	-0.001	-0.009	0.005	-0.007	-0.036	-0.007	-0.015	-0.015	-0.002	0.018	-0.025
Beta PTFSEFX	0.015	0.002	0.009	-0.002	0.006	0.009	0.001	0.006	0.005	-0.004	-0.001	-0.005	0.015	0.007
Beta PTFSCOM	0.016	0.002	0.005	0.006	0.002	0.038	-0.002	0.003	-0.005	0.000	0.001	-0.006	0.018	-0.001
t-stat Alpha	6.03	6.02	5.30	4.70	3.77	3.36	7.17	3.18	5.20	2.69	7.16	1.86	3.69	2.36
t-stat SNP	9.85	12.57	7.92	20.43	1.81	3.52	14.34	4.92	6.93	5.17	0.18	6.39	9.29	8.70
t-stat SCM	5.25	8.81	4.31	11.26	0.13	0.68	8.09	4.07	3.28	1.39	1.05	2.64	2.83	2.73
t-stat BD10RET	2.55	0.55	0.90	0.44	2.08	2.55	0.72	-0.77	0.61	3.83	3.48	2.55	2.89	-0.15
t-stat BAAMTSY	3.61	-0.87	0.97	2.35	0.67	2.68	3.17	5.69	2.20	7.76	2.70	7.14	0.02	3.80
t-stat PTFSD	1.17	-0.29	-0.44	-0.09	-1.59	0.22	-1.26	-4.16	-1.42	-2.59	-2.32	-0.29	2.19	-1.47
t-stat PTFSEFX	2.79	0.31	0.99	-0.29	1.35	0.51	0.18	0.82	1.30	-0.79	-0.09	-0.84	2.28	0.50
t-stat PTFSCOM	2.45	0.22	0.45	0.67	0.42	1.69	-0.25	0.32	-1.01	0.08	0.21	-0.79	2.13	-0.04
adj R ²	56.99	63.10	40.26	83.34	2.99	17.11	73.88	54.29	40.49	55.73	10.53	57.59	43.05	54.51

Panel B: BKT

	All	LSE	LNE	ELEMKN	OPTS	ED	DS	MA	FI	FIAB	CA	MAC	EMG	
HF ret (% p.a.)	7.35	9.46	10.81	8.13	4.12	14.52	7.71	5.41	4.38	3.47	8.71	2.89	6.14	8.23
Alpha (% p.a.)	5.05	5.65	4.95	5.73	2.27	5.27	5.09	4.19	2.68	0.93	9.22	0.46	4.34	8.38
Beta CR	-0.010	-0.025	-0.039	-0.010	-0.010	-0.054	-0.015	-0.004	-0.010	-0.012	0.010	-0.014	-0.005	0.013
Beta SNP	0.205	0.354	0.255	0.632	0.021	0.190	0.276	0.147	0.098	0.084	0.019	0.139	0.259	0.545
Beta SCM	0.120	0.280	0.175	0.365	0.003	0.055	0.172	0.129	0.055	0.029	0.025	0.068	0.083	0.168
Beta BD10RET	0.110	0.038	0.077	0.029	0.080	0.381	0.032	-0.044	0.021	0.146	0.151	0.123	0.157	-0.020
Beta BAAMTSY	0.216	-0.087	0.085	0.198	0.031	0.536	0.173	0.482	0.093	0.416	0.179	0.481	-0.001	0.635
Beta PTFSD	0.006	-0.005	-0.009	-0.002	-0.010	0.000	-0.009	-0.037	-0.008	-0.016	-0.014	-0.003	0.017	-0.024
Beta PTFSEFX	0.015	0.003	0.010	-0.002	0.007	0.011	0.001	0.006	0.005	-0.003	-0.001	-0.004	0.016	0.007
Beta PTFSCOM	0.015	-0.001	0.000	0.005	0.001	0.031	-0.004	0.002	-0.006	-0.001	0.003	-0.008	0.017	0.001
t-stat Alpha	3.95	3.26	2.29	3.15	2.00	1.22	4.36	2.34	2.91	0.83	6.85	0.32	2.63	2.41
t-stat CR	-1.79	-3.17	-3.94	-1.23	-1.93	-2.77	-2.90	-0.45	-2.49	-2.45	1.67	-2.12	-0.68	0.84
t-stat SNP	8.61	10.95	6.33	18.65	1.01	2.36	12.67	4.42	5.69	4.02	0.77	5.27	8.41	8.41
t-stat SCM	5.31	9.10	4.54	11.29	0.15	0.71	8.31	4.07	3.36	1.44	1.04	2.69	2.83	2.72
t-stat BD10RET	2.63	0.68	1.09	0.49	2.17	2.71	0.84	-0.75	0.71	3.98	3.44	2.65	2.91	-0.18
t-stat BAAMTSY	3.54	-1.05	0.82	2.29	0.58	2.60	3.10	5.65	2.11	7.76	2.80	7.11	-0.01	3.83
t-stat PTFSD	1.02	-0.57	-0.80	-0.20	-1.76	-0.01	-1.54	-4.17	-1.66	-2.84	-2.18	-0.48	2.12	-1.39
t-stat PTFSEFX	2.88	0.44	1.18	-0.25	1.43	0.63	0.29	0.83	1.42	-0.71	-0.16	-0.76	2.30	0.47
t-stat PTFSCOM	2.24	-0.15	0.00	0.52	0.19	1.39	-0.60	0.26	-1.32	-0.21	0.40	-1.05	2.03	0.06
adj R ²	57.62	65.22	45.60	83.40	4.76	20.70	75.12	54.04	42.51	57.19	11.60	58.57	42.84	54.42

Table 10: Robustness to Liquidity Factor Inclusion

This table reports alpha and beta coefficients of hedge fund index returns for different investment objectives. Panel A reports results based on the baseline eight-factor BKT model. The columns show the annualized hedge fund index return, the annualized alpha, the BKT beta and the t-statistics of the alpha and BKT betas. Panel B reports the alphas from an augmented BKT model that also includes the Fontaine and Garcia (2008) liquidity risk factor. The sample period is January 1996 to Dec 2008.

Panel A: BKT

	All	LSE	LNE	EL	EMK	OPTS	ED	DS	MA	FIRV	FIAB	CA	MAC	EMG	FOF	Multi	FIALL	LNX _{ALL}
HF ret (% p.a.)	5.77	7.73	6.97	4.81	2.64	7.91	6.79	7.91	4.38	2.97	2.70	3.01	6.57	4.39	3.74	7.77	2.98	10.42
Alpha (% p.a.)	3.26	5.21	2.85	2.68	1.59	0.70	3.48	8.11	2.77	0.25	2.56	0.52	3.70	4.34	0.77	3.65	0.49	6.07
Beta CR	-0.01	-0.01	-0.03	0.00	0.00	-0.04	-0.02	0.01	-0.01	-0.01	0.00	-0.01	-0.01	0.01	-0.01	-0.02	-0.01	-0.03
Beta SNP	0.19	0.35	0.18	0.58	-0.01	0.01	0.23	0.14	0.11	0.08	-0.02	0.29	0.21	0.44	0.20	0.02	0.10	0.17
Beta SCM	0.09	0.26	0.22	0.20	-0.05	0.06	0.09	0.07	0.08	0.04	0.00	0.18	0.11	0.12	0.13	0.03	0.06	0.16
Beta BD10RET	0.15	0.10	0.01	0.19	0.08	0.15	0.01	0.00	0.00	0.15	0.02	0.12	0.16	0.10	0.11	0.24	0.12	0.03
Beta BAAMTSY	0.21	-0.14	0.07	0.31	0.04	0.27	0.34	0.65	0.04	0.36	0.17	0.19	-0.26	0.86	0.30	0.11	0.30	-0.04
Beta PTFSBD	0.00	-0.01	-0.01	0.00	-0.02	-0.03	-0.04	-0.06	-0.01	-0.01	0.00	-0.01	0.00	-0.03	-0.02	0.03	-0.01	0.00
Beta PTFSFX	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	-0.01	0.01	0.02	0.00	0.00	
Beta PTFSKOM	0.01	0.00	0.00	0.01	0.00	0.03	0.00	0.01	0.00	-0.01	0.00	-0.01	0.02	0.01	0.00	0.04	-0.01	-0.01
t-stat Alpha	2.26	3.09	1.34	1.32	1.14	0.18	1.69	2.29	2.73	0.18	3.27	0.27	1.87	1.15	0.47	1.54	0.40	3.31
t-stat CR	-1.69	-1.67	-2.93	-0.23	-0.45	-2.55	-1.77	0.78	-2.10	-2.29	-0.28	-1.50	-1.47	0.85	-1.98	-2.24	-2.42	-3.82
t-stat SNP	7.09	11.10	4.54	15.39	-0.56	0.17	5.97	2.17	5.87	3.00	-1.61	8.03	5.66	6.26	6.57	0.46	4.63	4.83
t-stat SCM	3.64	8.63	5.76	5.42	-1.93	0.84	2.56	1.10	4.65	1.59	-0.06	5.29	3.00	1.81	4.35	0.71	2.58	4.99
t-stat BD10RET	3.18	1.89	0.18	2.88	1.71	1.18	0.14	-0.03	0.13	3.35	0.96	1.87	2.49	0.79	2.14	3.06	3.10	0.43
t-stat BAAMTSY	3.03	-1.77	0.69	3.22	0.66	1.44	3.50	3.83	0.86	5.61	4.66	2.05	-2.75	4.77	3.93	0.95	5.11	-0.44
t-stat PTFSBD	0.25	-0.89	-1.38	-0.26	-2.57	-1.59	-3.97	-3.25	-2.39	-2.20	-0.35	-0.54	0.24	-1.87	-2.20	2.63	-1.62	-0.43
t-stat PTFSFX	1.57	0.30	0.84	-0.32	0.94	0.91	0.77	0.34	1.16	0.76	-1.21	-0.32	1.58	-0.43	0.83	2.31	0.41	0.56
t-stat PTFSKOM	1.64	0.01	0.30	0.58	0.23	1.59	0.01	0.79	-0.68	-0.81	-0.46	-0.94	2.28	0.67	0.46	3.03	-0.82	-0.82
adj R ²	47.05	61.10	38.19	75.28	2.90	6.93	50.24	24.75	41.79	41.55	13.88	53.44	27.10	47.69	52.30	24.55	47.61	36.31

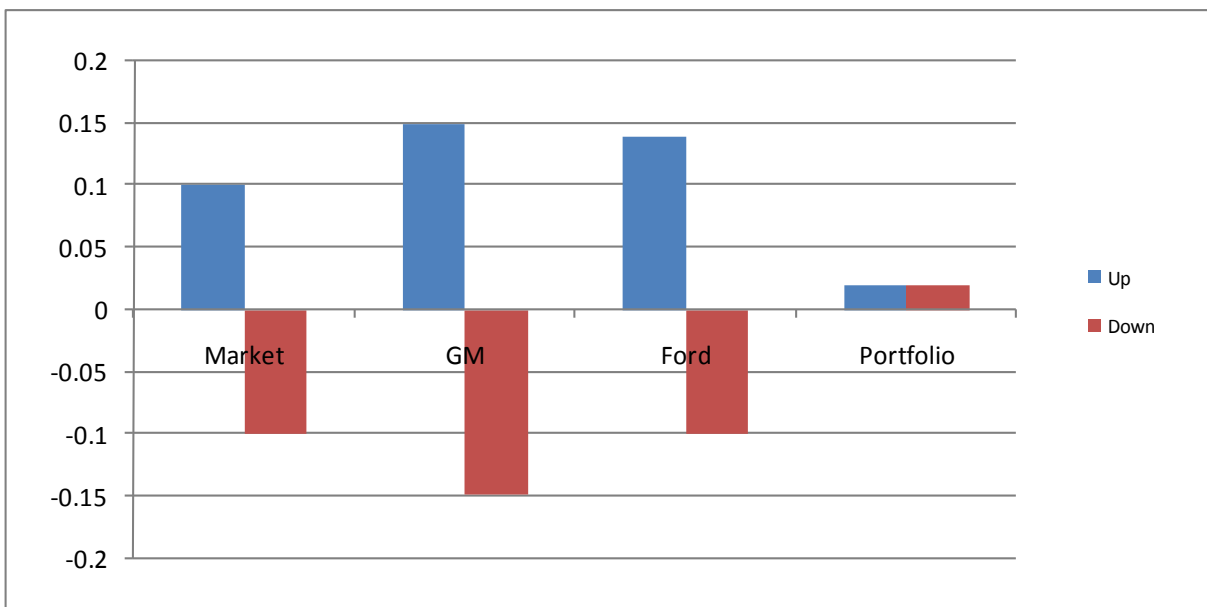
Panel B: BKT+Liquidity Factor

	All	LSE	LNE	EL	EMK	OPTS	ED	DS	MA	FIRV	FIAB	CA	MAC	EMG	FOF	Multi	FIALL	LNX _{ALL}
HF ret (% p.a.)	5.77	7.73	6.97	4.81	2.64	7.91	6.79	7.91	4.38	2.97	2.70	3.01	6.57	4.39	3.74	7.77	2.98	10.42
Alpha (% p.a.)	4.02	2.23	-3.43	1.50	4.84	-2.16	6.43	14.88	0.03	3.67	4.53	2.37	4.14	12.63	3.17	5.26	2.81	4.62
Beta CR	-0.01	-0.01	-0.02	0.00	-0.01	-0.04	-0.02	0.01	-0.01	-0.02	0.00	-0.01	-0.01	0.01	-0.02	-0.03	-0.02	-0.03
Beta SNP	0.19	0.34	0.17	0.58	-0.01	0.01	0.23	0.15	0.11	0.08	-0.02	0.29	0.21	0.45	0.20	0.02	0.11	0.16
Beta SCM	0.09	0.26	0.22	0.20	-0.05	0.06	0.09	0.07	0.08	0.04	0.00	0.18	0.11	0.12	0.12	0.03	0.05	0.16
Beta BD10RET	0.15	0.11	0.02	0.19	0.08	0.15	0.01	-0.01	0.01	0.14	0.02	0.12	0.16	0.09	0.11	0.23	0.12	0.03
Beta BAAMTSY	0.20	-0.11	0.15	0.33	0.00	0.30	0.31	0.56	0.08	0.32	0.15	0.17	-0.26	0.76	0.27	0.09	0.27	-0.02
Beta PTFSBD	0.00	-0.01	-0.01	0.00	-0.02	-0.03	-0.04	-0.06	-0.01	-0.02	0.00	-0.01	0.00	-0.04	-0.02	0.03	-0.01	0.00
Beta PTFSFX	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	-0.01	0.01	0.02	0.00	0.00	
Beta PTFSKOM	0.01	0.00	0.00	0.01	0.00	0.03	0.00	0.02	0.00	0.00	0.00	-0.01	0.02	0.01	0.00	0.04	0.00	-0.01
Beta Liq	0.00	0.01	0.03	0.00	-0.01	0.01	-0.01	-0.03	0.01	-0.01	-0.01	0.00	0.00	-0.03	-0.01	-0.01	-0.01	0.01
t-stat Alpha	1.86	0.89	-1.10	0.49	2.35	-0.37	2.10	2.84	0.02	1.86	3.94	0.82	1.40	2.26	1.32	1.49	1.57	1.69
t-stat CR	-1.74	-1.35	-2.45	-0.13	-0.84	-2.38	-1.98	0.45	-1.65	-2.71	-0.70	-1.63	-1.48	0.48	-2.20	-2.31	-2.71	-3.62
t-stat SNP	7.09	10.98	4.38	15.25	-0.39	0.11	6.07	2.32	5.74	3.24	-1.43	8.07	5.64	6.47	6.68	0.51	4.80	4.74
t-stat SCM	3.62	8.72	5.96	5.42	-2.01	0.85	2.53	1.06	4.79	1.55	-0.13	5.26	2.98	1.77	4.33	0.70	2.55	5.00
t-stat BD10RET	3.15	1.94	0.25	2.89	1.68	1.20	0.11	-0.08	0.19	3.35	0.92	1.84	2.48	0.76	2.12	3.04	3.08	0.45
t-stat BAAMTSY	2.78	-1.27	1.42	3.23	0.06	1.56	3.01	3.23	1.52	4.84	3.91	1.74	-2.69	4.09	3.42	0.74	4.47	-0.22
t-stat PTFSBD	0.24	-0.84	-1.33	-0.25	-2.66	-1.56	-4.02	-3.32	-2.36	-2.30	-0.42	-0.56	0.23	-1.95	-2.24	2.61	-1.68	-0.41
t-stat PTFSFX	1.56	0.31	0.88	-0.31	0.93	0.91	0.76	0.33	1.21	0.75	-1.24	-0.33	1.57	-0.45	0.82	2.30	0.40	0.57
t-stat PTFSKOM	1.66	-0.08	0.16	0.55	0.35	1.55	0.08	0.89	-0.82	-0.69	-0.34	-0.89	2.28	0.78	0.54	3.05	-0.73	-0.86
t-stat Liq	-0.47	1.61	2.73	0.53	-2.13	0.67	-1.30	-1.74	2.48	-2.34	-2.31	-0.86	-0.20	-2.00	-1.35	-0.61	-1.74	0.71
adj R ²	46.77	61.52	40.78	75.16	5.18	6.57	50.47	25.77	43.77	43.28	16.35	53.35	26.62	48.74	52.56	24.23	48.33	36.10

Fig 1: Correlation Risk in Long-Short Spread Trades

This figure illustrates the correlation risk inherent in long-short spread trades in the context of a hypothetical long-short equity example using Ford and General Motors (GM). It shows that the effect of correlation risk is distinct from volatility risk. Panel A illustrates the situation when ex post betas are equal to expected betas. Suppose that GM and Ford have an average expected beta of 1.5 and 1.2, respectively, and a hedge fund manager thinks that Ford's better growth opportunities are not priced in and lead to an expected annualized alpha of 2 percent. The same manager thinks that Ford is correctly priced, so that no alpha can be generated by Ford. If the mandate of the hedge fund is to generate absolute returns, then the portfolio manager will attempt to create a long/short portfolio with a market beta of zero by going long GM and short Ford. Obviously, since Ford's beta is lower the value of the short position in Ford will be higher than the value of the long position in GM. The exact portfolio is shorting $1.5/1.2 (=0.8)$ dollars of Ford shares for each dollar held in GM shares. If the manager is right, the expected return of this strategy is 2 percent on an unlevered basis, with no market risk. Panel B illustrates then situation when correlations unexpectedly change and ex post betas are higher than ex ante betas. Suppose that a market-wide shock occurs, the market drops 10 percent, GM is not able to generate any alpha, and the correlation of the two stocks increases to the point of both having an ex post beta of two. A simple calculation shows that the previous portfolio will generate an ex post return equal to four percent ($=0.04=1*0.2+(-0.8)*(-0.2)$) on an unlevered basis.

Panel A: Expected Return on Long Ford and Short GM Position



Panel B: Effect of Correlation Risk (Unexpected Change in Correlation)

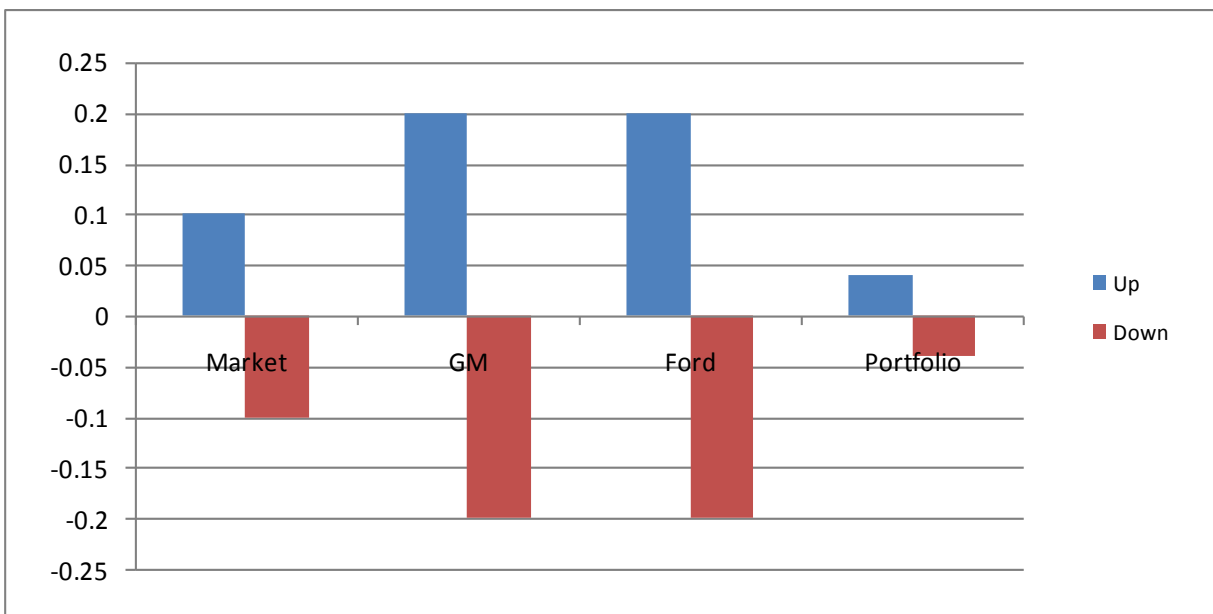


Figure 2: Hedge Fund Taxonomy

This figure illustrates classification of hedge fund categories according to their risk properties (as often found in industry classifications).

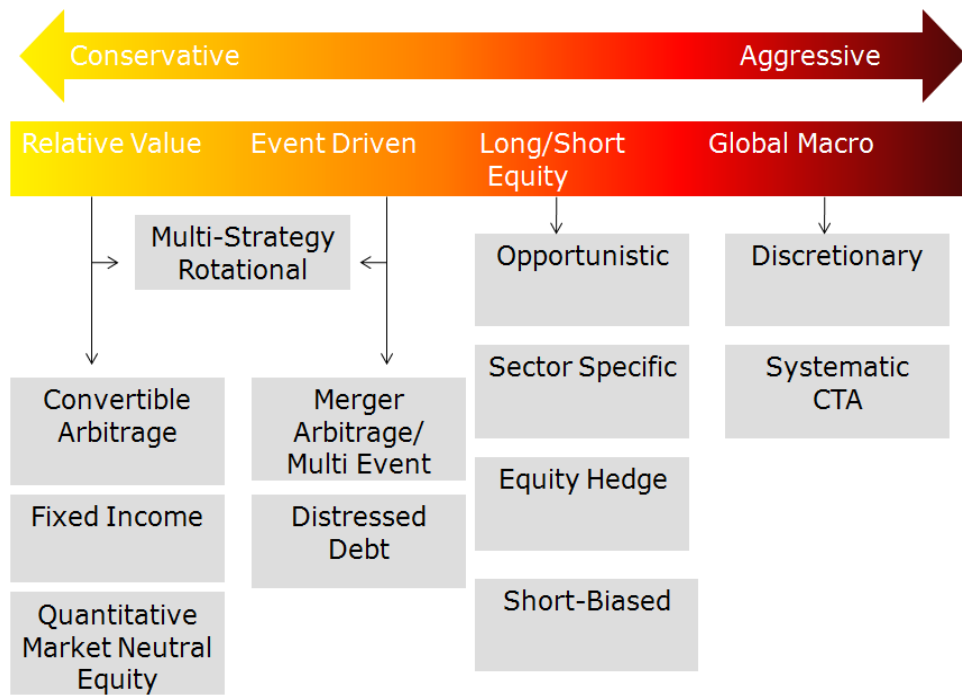
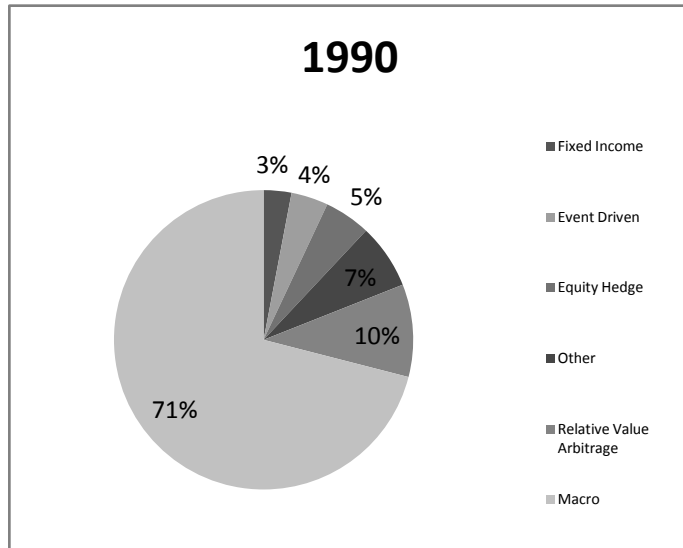


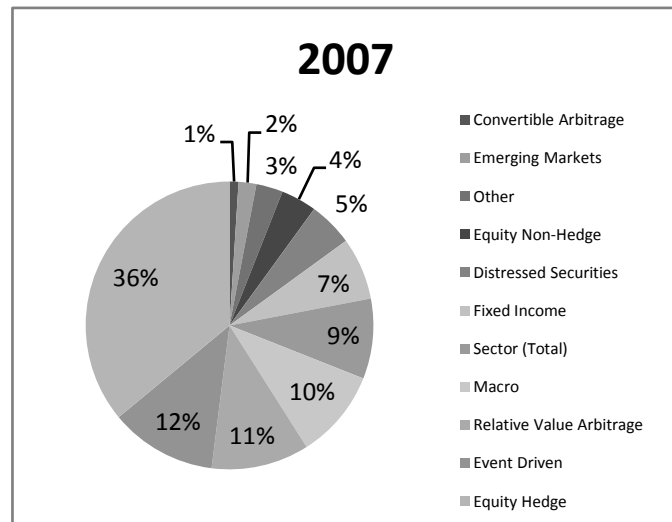
Figure 3: Composition of Hedge Fund Universe Over Time (by AuM)

This figure shows the percentage of AuM by investment objective as of December 31, 1990 and December 31, 2007.

Source: Hedege Fund Research, Q4 2007 Industry Report.



	1990
Fixed Income	3.0%
Event Driven	4.0%
Equity Hedge	5.0%
Other	7.0%
Relative Value Arbitrage	10.0%
Macro	71.0%

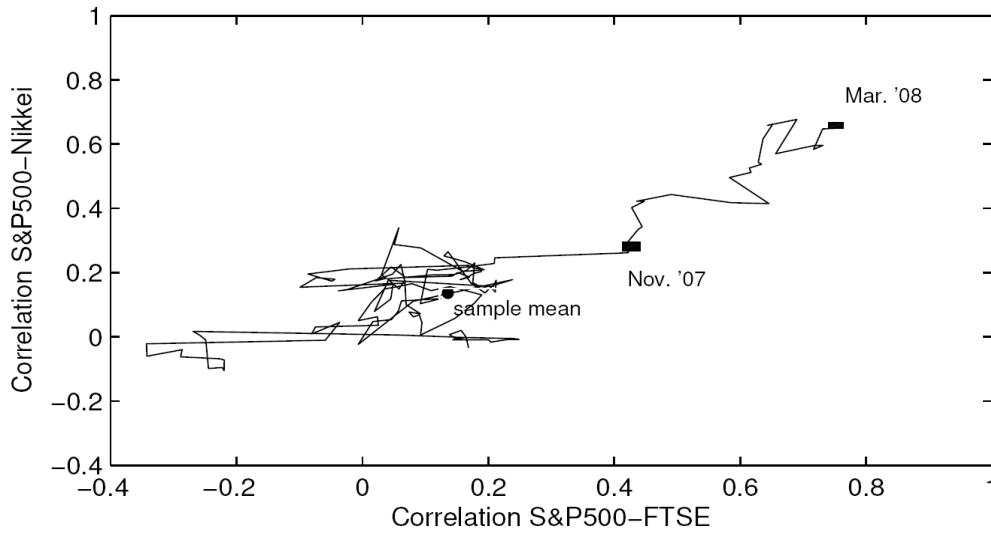


	2007
Convertible Arbitrage	0.01
Emerging Markets	0.02
Other	0.03
Equity Non-Hedge	0.04
Distressed Securities	0.05
Fixed Income	0.07
Sector (Total)	0.09
Macro	0.1
Relative Value Arbitrage	0.11
Event Driven	0.12
Equity Hedge	0.36

Figure 4: Correlation Risk and Market Events Across Equity Markets and Asset Classes

Panel A shows the S&P500-FTSE 100 correlation and S&P500-Nikkei correlation computed with weekly returns, using overlapping windows of quarterly length. Correlations reported are the last 4 years until April 08. Panel B shows the implied daily correlations on mezzanine tranches (7Y, 10-22 bp) in North America (CDX) and Europe (iTraxx). Reported correlations are from April '04 to April '08.

Panel A: S&P500-FTSE 100 correlation and S&P500-Nikkei correlation



Panel B: Implied daily correlations on mezzanine tranches in North America and Europe

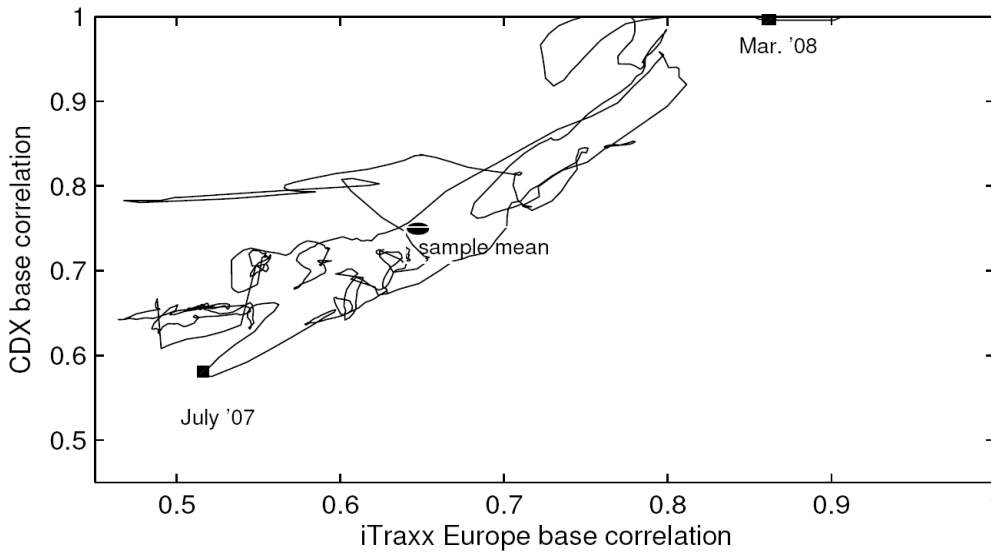
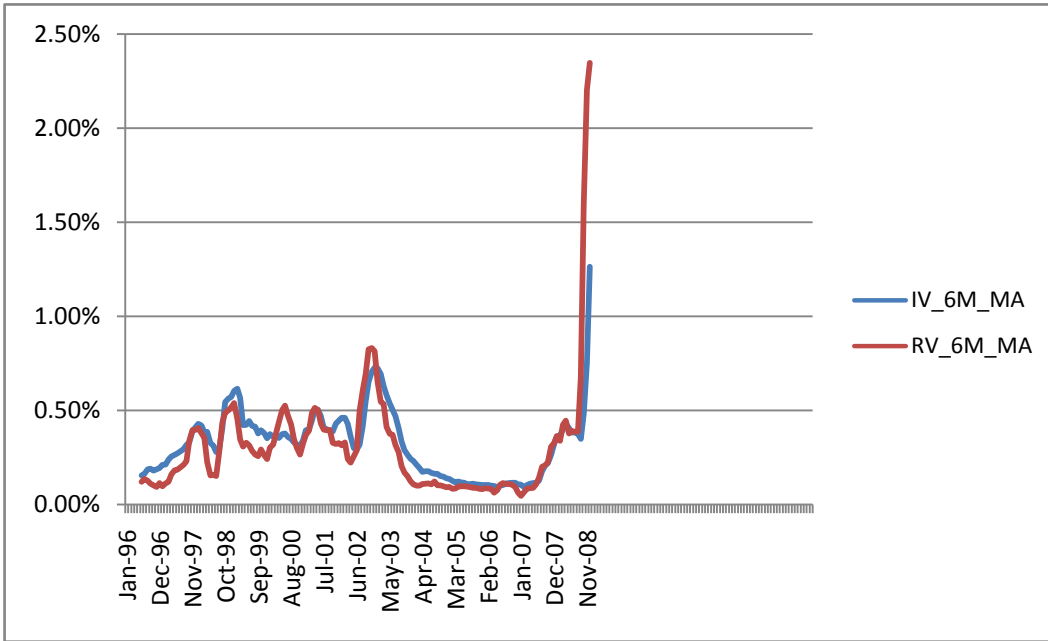


Figure 5: Implied and Realized Variance and Correlation from Variance and Correlation Swap

This figure shows implied and realized variance from variance and correlation swaps. Panel A reports the six-month moving average of implied and realized variance from variance swaps while Panel B reports the 6-month moving average of implied and realized variance from correlation swaps.

Panel A: 1-month Implied versus Realized Variance of SNP500 Index



Panel B: 1-month Implied versus Realized Correlation of SNP500 Index

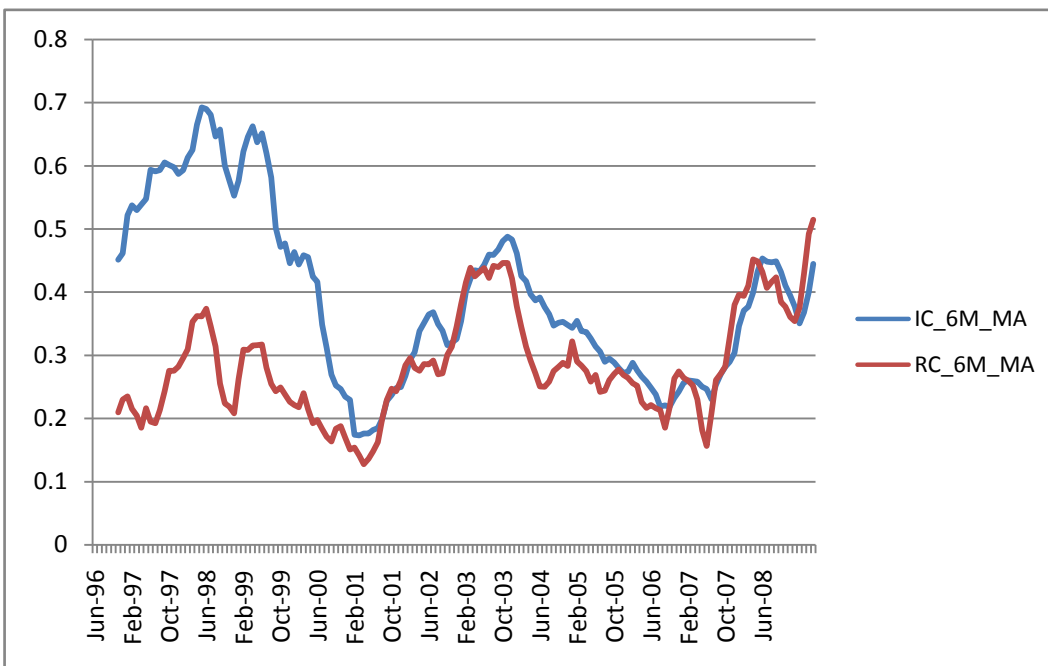


Fig 6: Moving Average Plot of Correlation Risk Premium and S&P500 Return

This figure plots the 12-month moving average of the negative of the correlation risk premium return (based on correlation swap market quotes) and S&P500 return over time. The sample period is from April 2000 to March 2008.

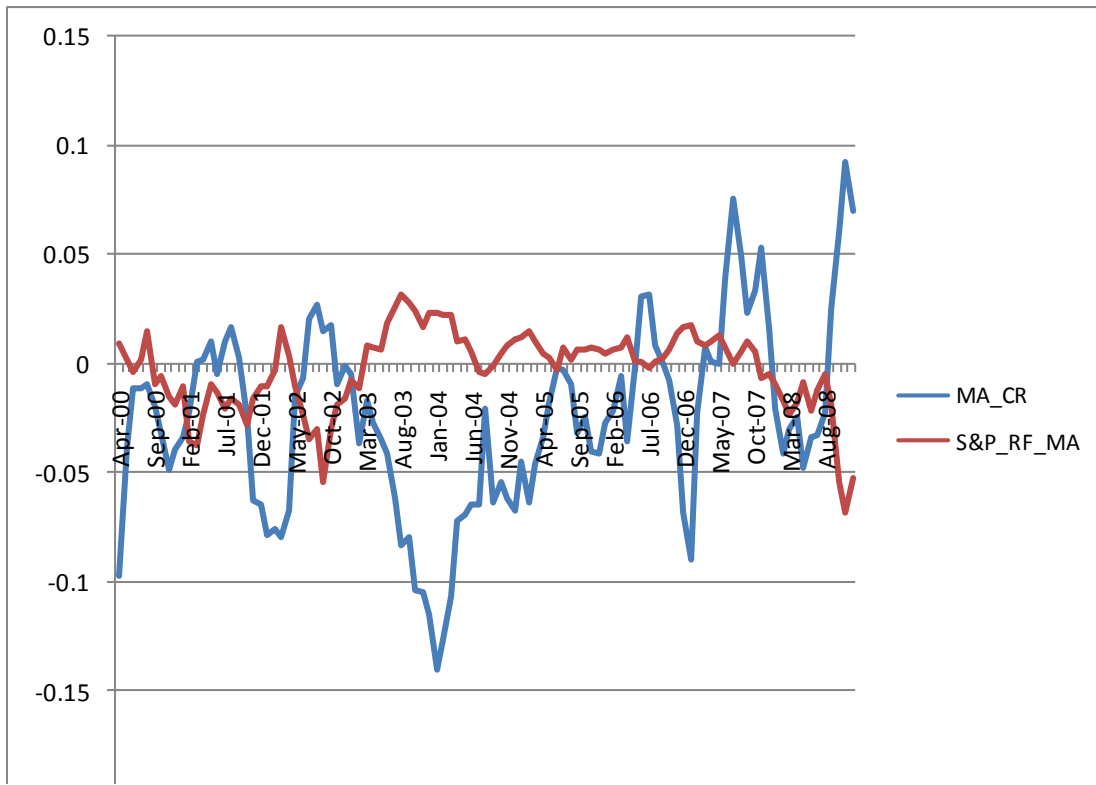


Fig 7: Maximum Drawdowns and Correlation Risk Exposure

In this figure we plot the difference between the maximum drawdowns of two portfolios over time. Portfolio H contains the decile of funds with the most extreme positive correlation risk betas while Portfolio L contains the decile with the most negative correlation risk beta. The Betas are calculated using a rolling 12-month window. The returns are reported in percent per month. The x-axis correspond to the start dates of the rolliing window which runs from January 1996 until December 2008.

