

Hedge Fund Alpha: Cycle or Sunset?

Rodney N. Sullivan, CFA, CAIA†

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Abstract

The hedge fund industry has grown from \$200 billion in assets under management around the turn of the millennium to now over \$3 trillion. Many reports have criticized hedge funds for poor performance, particularly since the 2008 global financial crisis (GFC). In this paper, I seek to demystify hedge fund strategies by evaluating fund performance that can be attributed to the markets as well as other well-known systematic factors with an emphasis on outcomes prior to and following the 2008 GFC. When adjusted for risk to stock/bond markets, the evidence shows that, after fees and costs, hedge fund managers as a group have shown a marked decline in risk-adjusted alpha in the 10 years following the GFC. To aid in a better understanding of the decline in alpha, I further investigate equity hedge fund returns against a suite of well-known systematic risk/return factors documented in the literature beyond traditional market factors. In all, the model explains around 90 percent of the variation in returns. Equity hedge funds show meaningful and consistent exposures to many of these factors over time, but whether intended or otherwise, significant changes also occurred (including a significant decline in active risk) following the GFC, in turn influencing their performance. Armed with this information, investors are better positioned to make more informed decisions in deciding manager allocations.

†Executive Director, Richard A. Mayo Center for Asset Management, Darden Graduate School of Business. Email: sullivanr@darden.virginia.edu. I thank participants of the University of Virginia Finance Seminar, Richard Ennis, Luis Garcia-Feijoo, Antti Ilmanen, Jimmy Fortin, Michele Gambera, and Nick Sargen for helpful comments.

The hedge fund industry has grown quite rapidly from its nascent early years at the turn of the millennium with around \$200 billion in assets under management to now over \$3 trillion in assets under management.¹ With that growth has come increased scrutiny with many reports criticizing hedge funds for poor performance particularly since the 2008 global financial crisis (GFC). I review the empirical evidence for performance and risk exposures of hedge fund managers over the past 25 years with an emphasis on comparing outcomes prior to and following the 2008 global financial crisis (GFC), adjusting for market risk and additional well-known risk factors documented in the literature. I review hedge funds as a group overall as well as hedge fund managers focused on equities.

Hedge funds have drawn much attention in recent years especially from critics pointing to how hedge funds managers as a group have strongly underperformed the stock market since the GFC. The commentary has not been kind, with many suggesting that hedge funds managers have destroyed considerable capital and that investors should shed all their hedge fund managers.² Criticism of hedge fund performance most often compares them incorrectly against an all-equity benchmark. However, as we know, any measure of the value of active management must account for risk or factor exposures—hedge funds create value when they deliver a return greater than a passive benchmark of similar risk. As such, commentary about hedge fund performance that use an incorrect benchmark (most often assuming 100 percent equity exposure as the benchmark) lack merit (see for e.g., Asness, Krail and Liew, 2001).

The aim of this paper is to demystify hedge fund performance by understanding the determinants of active hedge fund returns and whether hedge fund managers in aggregate (as well as those funds focusing only on equities) have “alpha” — the ability to generate positive active returns after adjusting for passive exposures to both traditional markets and other risk premia.³ I examine how hedge funds have performed over the 25 year period from 1994 to 2019 (June), the full period for which we have available data. Specifically, I investigate to what extent systematic risk exposures and the level of alpha have changed, especially in the 10-years since the GFC whereby, as we’ll see, hedge fund managers have experienced a meaningful decline in

¹ Source, BarclayHedge website <https://www.barclayhedge.com/solutions/assets-under-management/hedge-fund-assets-under-management/hedge-fund-industry/>

² See for instance, https://www.wsj.com/articles/twilight-of-the-stock-pickers-hedge-fund-kings-face-a-reckoning-11572197217?mod=hp_lead_pos5, <https://www.marketwatch.com/story/be-like-calpers-dump-your-hedge-funds-2014-09-18> and <https://www.bloomberg.com/opinion/articles/2018-02-15/hedge-funds-underperform-yet-keep-attracting-pension-fund-money>

³ Investors should be wary of paying active management fees for exposures that can be obtained passively and at low cost.

risk-adjusted excess returns. I seek to decompose manager returns into the components driven by exposures to traditional market risk, other non-traditional factor premia, and the component that cannot be explained by these risk premia — alpha. That is, to what extent are hedge fund returns influenced by systematic risk factors that have been shown in the literature to impact returns of active managers; and after adjusting for those exposures do we still see outperformance, and how have these factor exposures influenced returns pre- and post-GFC? With an understanding of the risk factors and alpha driving hedge fund returns, investors are better equipped to consider the expected returns associated with these factors and whether they believe that the factors they are exposed (either long or short) to will deliver associated excess returns over the long-term.

Hedge Fund Performance and Market Risk

To adjust for hedge fund market risk, I'll start with a regression that measures hedge fund alpha and traditional market betas over the full 25 year sample period beginning in 1994, when data for hedge funds has been deemed more reliable, and ending June 2019. This can be seen by estimating Equation 1, shown below, which adjusts for the stock market using the S&P 500 and for the bond market using the Bloomberg/Barclays U.S. Bond Aggregate, and follows the approach of Dimson (1979) and Asness, Krail, and Liew (2000). For hedge fund returns, I create a hedge fund composite using the monthly after-fee returns of the overall Credit Suisse Hedge Fund Index and the HFRI Fund Weighted Composite Index (weighted 50/50).

Equation 1

$$R_t = \alpha_1 + \beta_1 S\&P500_t + \beta_2 S\&P500_{t-1} + \beta_3 BAgg_t + \varepsilon_t$$

1.7%	0.30	0.07	0.14
(1.65)*	(12.11)***	(4.19)***	(2.01)*

$R^2 = 0.52$

Where

R_t is the monthly excess of cash return of the hedge fund composite, net of fees, in month t

$S\&P500_t$ is the excess of cash return of the S&P500 in month t

$B\&A_{agg}$ is the excess of cash return of the Bloomberg Barclays US Aggregate in month t

α_1 is the average annualized alpha, β are the regression coefficients, and ε is the error term.

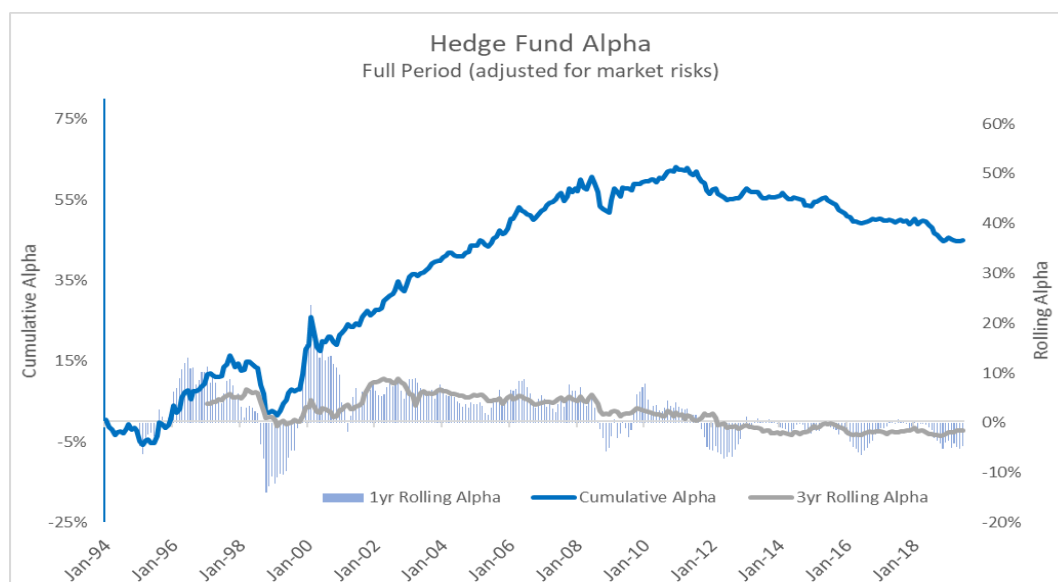
t statistics shown in parenthesis. ***, **, * represent 99 percent, 98 percent and 95 percent confidence, respectively (using a Newey-West adjustment with one lag).

With this model, the total hedge fund beta with the stock market is the sum of the betas ($\beta_1 + \beta_2$). Consistent with other researchers (Asness 2018a), over the full 25 year period, I find a small statistically significant annual alpha, a strongly significant total stock market beta of 0.37, and mildly significant bond market beta of 0.14. This means that hedge funds have on average

a 37 percent long exposure to stocks and 14 percent long exposure to bonds and thus should not be compared to 100 percent stock exposure.

Next, using this equation, I calculate the cumulative hedge fund alpha over the full sample which is simply the difference between each month's unadjusted hedge fund return and the return attributed to the average market risks and add this to the prior month (I do not compound alpha). The cumulative market-adjusted alpha is shown as the solid line in Exhibit 1. I also show here the one-year and three-year rolling alpha to allow an easier comparison of the average level of hedge fund manager excess return over time. Taken together, we see how much total market-adjusted alpha an investor would have received by investing in the average hedge fund over the 25 year period and how that alpha varies over time. As we know from Equation 1, the average alpha is 1.7% per year over the full period, but now we can also see how the level of alpha has changed over time as visualized in Exhibit 1.

Exhibit 1



Source: Author analysis using data from Bloomberg, Hedge Fund Research Institute and Credit Suisse. Hedged funds are defined as a blend of 50 percent HFRI and 50 percent CS HFFW returns each month.

Specifically, although hedge fund managers have added market risk-adjusted alpha cumulatively after fees over the full period, their performance has clearly meaningfully declined since the GFC. Hedge fund manager performance was in general stronger in the pre-GFC period, though underperforming during the internet bubble period of the late 90s and strongly out-performing following its bursting in early 2000, but then weakening following the GFC. This downward trend can be seen in both the flattening of the cumulative alpha curve (actually a slight downward sloping curve since 2009) and also in the low to negative rolling 1-year alpha

(bars) beginning in 2008 with negative rolling 12-month performance over the latter part of the most recent decade. The 3-year rolling alpha makes this downward trend even more evident with mostly small negative alpha for hedge funds over the prior 36 months since the beginning of 2013.

By making a minor modification to Equation 1, I next quantify the magnitude of the observed decline in risk-adjusted alpha for hedge funds in the period since the 2008 GFC. To do this, I add a binary intercept “dummy” variable to Equation 1 in order to separate the estimated alpha for the 15 years ending in 2008 from the 10 years since.⁴ Results are reported in Equation 2 and Exhibit 2.

Equation 2

$$R_t = \alpha_1 + \beta_1 S\&P500_t + \beta_2 S\&P500_{t-1} + \beta_3 BAGG_t + \alpha_2 D09 + \varepsilon_t$$

3.4%	0.30	0.08	0.15	-4.2%
(2.30)*	(11.90)***	(4.35)***	(2.13)*	(-2.43)**

$$R^2 = 0.53$$

Where

R_t is the monthly excess of cash return of the hedge fund composite, net of fees, in month t

$S\&P500_t$ is the excess of cash return of the S&P500 in month t

$BAGG_t$ is the excess of cash return of the Bloomberg Barclays US Aggregate in month t

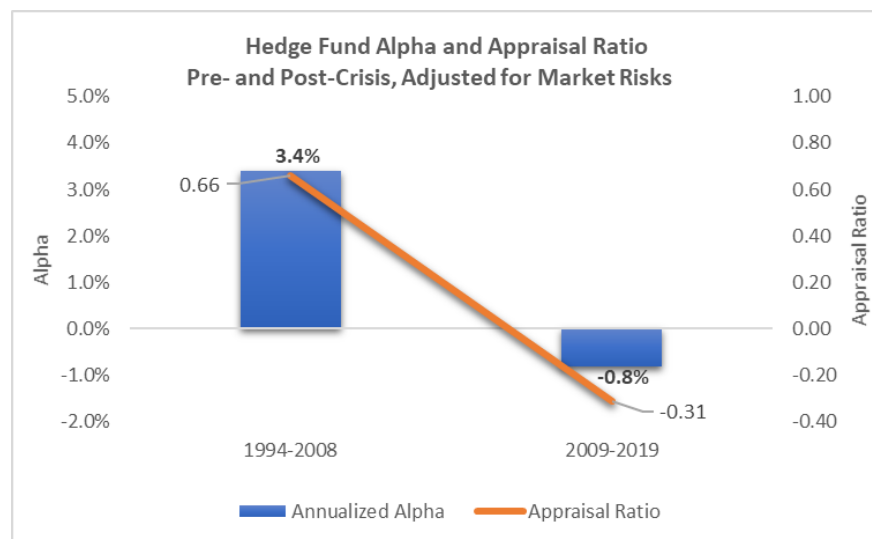
$D09$ is a dummy variable equaling zero from 1/1994 to 12/2008 and 1 otherwise (1/2009-6/2019)

t statistics shown in parenthesis. ***, **, * represent 99 percent, 98 percent and 95 percent confidence respectively, (using a Newey-West adjustment with one lag).

α_1 is the average annualized alpha for the pre-crisis period (1/1994 to 12/2008). Average annualized alpha for the post-crisis period (1/2009-6/2019) is the sum of the two alphas ($\alpha_1 + \alpha_2$).

β are the regression coefficients, and ε is the error term.

Exhibit 2



⁴ Upon visual inspection, in hindsight we can see the inflection point in alpha occurred during the GFC in 2008. I've chosen to begin the post-GFC period subsequent to the crisis (beginning in Jan 2009) to more clearly distinguish that any post-GFC results are not being driven by the market turbulence of 2008.

Source: Author analysis using data from Bloomberg, Hedge Fund Research Institute and Credit Suisse. Hedged funds are defined as a blend of 50 percent HFRI and 50 percent CS HFFW returns each month.

As expected, the results from this regression show a marked decline for both annualized market-adjusted alpha (from 3.4% per year to -0.8% per year on average) and appraisal ratio (from 0.66 to -0.31) for the collective group of hedge funds in the 10 years following the GFC when adjusted versus the market. Note that the estimated dummy parameter of -4.2 percent represents the change in alpha over the post-crises period relative to the pre-crisis period, so that the average realized risk adjusted annualized alpha over the post-crisis period equals -0.8 percent (3.4 percent plus -4.2 percent).⁵

As we will see later, I find similar results when focusing on equity hedge fund managers. Traditional market equity betas for equity funds are largely unchanged over the two periods while bond market exposure has declined (turning from a positive to negative exposure). For the group of equity hedge fund managers, the result is a decline in risk-adjusted alpha post-crisis when performance is adjusted for market exposures as well as when further adjusted for exposures to additional well-known systematic risk factors beyond traditional markets.

Even though reports pointing to poor hedge fund performance often incorrectly compare them to an all-equity benchmark, as we've seen, the more accurate market-risk-adjusted performance of hedge fund managers as a group over the past ten years is also clearly not good (comparing hedge funds to 100 percent equity makes their performance, of course, appear much worse). This has led some to question whether hedge fund alpha, after ten years of low to no alpha, has disappeared altogether. We return to explore this issue in detail later.

Quantifying Hedge Fund Impact on Invested Capital

To evaluate claims of capital destruction by hedge fund managers, we need to quantify the degree to which hedge fund managers have added (or destroyed) value for investors over the past 25 years. The impact on invested capital can be quantified by using the market-risk adjusted alpha model above combined with the hedge fund industry assets under management (AUM) shown in Exhibit 3 and applying the approach of Berk and van Binsbergen (2015). To do this, I simply multiply the average quarterly hedge fund AUM at the end of each quarter times the average after-fee risk-adjusted alpha (by taking the 3 month average, not compounded)

⁵ Another approach to estimate the change in alpha over the two periods by simply running two separate regressions (one for each sub-period) yields similar results. I use this approach later when including additional systematic factors.

over the following quarter. The result is the risk-adjusted dollar value added by hedge funds for investors after fees (how much value did hedge managers, on average, add for their clients after costs and fees) during each quarter from 2000 to 2019 (June). I then calculate the rolling 1-year total value add to smooth the results and show all this in Exhibit 4.

Exhibit 3

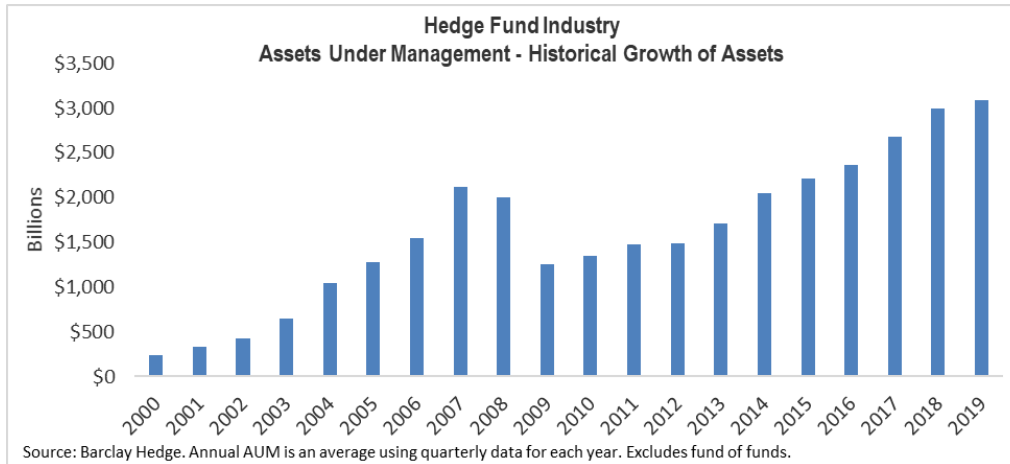
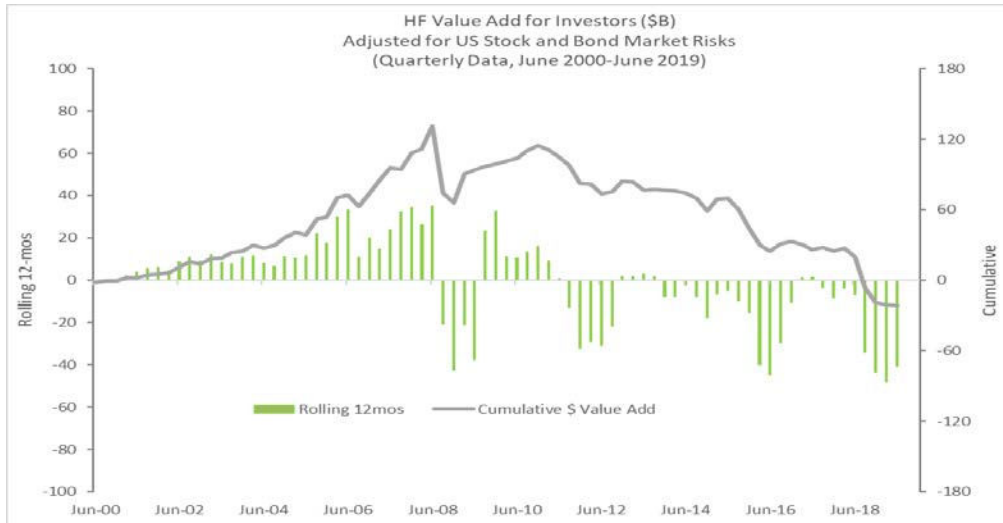


Exhibit 4



As consistent with our above discussion, after adding value for their clients in the early period, hedge fund value added has since witnessed a marked decline, with the rolling 12-month value add falling below zero in 2012 and mostly remaining negative since. Albeit a short period for evaluating results, we can see that when applying the above alpha model, the most recent 12 months ending June 2019, hedge fund managers as a group subtracted \$40.6 billion in value on an average asset base of \$3.1 trillion. Also shown in Exhibit 4 is the cumulative dollar value added over the full period. Cumulatively, over the full 19 year period after accounting for risk and costs, hedge funds have subtracted a cumulative \$21.1 billion in value for investors.

Though these findings intuitively follow from our earlier discussion of hedge fund alpha, it is nonetheless important to quantify the impact on invested capital.

The evidence thus far paints a picture of a greatly reduced ability of hedge fund managers as a group to deliver risk-adjusted alpha. So perhaps, as some have suggested, the forces of arbitrage have driven alpha to zero after fees implying that the sun has indeed set on hedge fund alpha and the future is grim for them. On the other hand, hedge fund managers may be experiencing a period of temporary (in statistical terms) weak performance but over the longer-term, the strategies and risk premiums that many managers pursue are truly positive (e.g., Asness 2018). If so, hedge fund alpha may move back into positive territory in future years.

In order to understand the source of the change in hedge fund performance, a deeper dive is needed into some of the key drivers behind hedge fund strategies. This information will aid in gauging to what extent hedge fund returns can be explained through various risk factors, and how much of it has been due to the random (idiosyncratic) nature of hedge fund alpha (or some combination of both). The idea being to gain useful insight into historical drivers of performance and the possible persistence of future returns be it from factors or alpha. Next, we'll make a closer inspection of this issue. I reveal an interesting set of factors that describe, in part, hedge fund performance, but that a nuanced picture of the world of hedge fund performance remains. Armed with this information, investors are better positioned to make more informed decisions in deciding manager allocations.

Empirical Analysis of Equity-Focused Hedge Funds

I next seek to decompose risk and return for equity-focused hedge funds in order to gauge the degree to which risk factors beyond traditional markets have historically driven their performance. As all funds analyzed in this section focus on equities, and the research factors used tend to be equity-centric, the resulting analysis and any conclusions drawn may be considered more informative versus an analysis of the more heterogeneous group of all hedge funds.

As mentioned, conclusions about hedge fund performance must account for their traditional market risk exposures. In evaluating fund performance, the literature commonly goes beyond relying solely on market exposures to include factor exposures Carhart (1997). While informative, these models have important limitations and there is no broad agreement on which

set of factors to employ. For instance, the literature has identified hundreds of potential pricing factors that could be used in attributing returns, and using systematic factors also runs the risk of overfitting (Harvey, Liu, and Zhu (2016), Harvey and Liu (2014), and Hou, Xue, and Zhang (2017)). The choice of factors to include in the modeling exercise will have a significant effect on any conclusions drawn and is subject to data snooping, hindsight bias and so forth. For these reasons, in evaluating alpha and value add, the market risk-adjusted model that compares hedge fund returns adjusted for their degree of risk to traditional passive market exposures is perhaps most appropriate; whenever hedge fund returns beat that risk-adjusted passive index return, then they add alpha and value.

Regardless of whether performance comes from idiosyncratic alpha or factor betas, investors today have awareness of sources of systematic returns beyond market risk. These “research factors” may be valuable from a return and risk standpoint and so should not be ignored altogether. In other words, while historically the main ways for a fund to outperform was via idiosyncratic alpha or by simply taking more market risk, managers now have access to a suite of other risk/return factors allowing for a variety of ways to potentially add value. So while there are limitations to using factors to evaluate manager alpha, it’s nonetheless important to go beyond a market-adjusted estimate of alpha in order to more fully demystify hedge fund strategies. Evaluating performance that can be attributed to select systematic factors enables a better understanding of the various risk exposures of managers over time.

In selecting these systematic factors, I use those that employ a rules-based approach to investing, have been tested over time by many researchers, across markets, and are well-known. I note importantly here that any such analysis is backward looking and employs factors that are well-known today but may not have been well-known over the full study period. Nonetheless, a better understanding of which investment styles (if any) are part of a typical fund manager’s process will help to provide clear implications for evaluating the sources and risks of fund manager performance both past and future. Taken together, it’s useful to understand how fund managers may seek to add value even when their returns are below any performance that can be attributed to systematic factors whether or not these factors are known in advance.

Before discussing the building blocks of the systematic risk-factor model used to evaluate equity-hedge fund managers, I first describe the equity hedge fund composite. For equity hedge fund returns, I use an equity hedge fund composite constructed with a 50/50 allocation of a Credit Suisse Equity Composite and the HFRI Equity Hedge Index. I construct the Credit Suisse Equity Composite with an equal one-third weighting to each of the three equity-oriented Credit

Suisse hedge funds: Emerging Markets Index, Equity Market Neutral Index, and Long-Short Equity Index. Exhibit 5a reports the average correlations, beta and appraisal ratios (versus the S&P 500) over the full period for the equity hedge fund composite and the individual categories comprising it. The correlations, beta and appraisal ratios for all equity hedge fund categories are positive over the full period with emerging market managers having the lowest appraisal ratio and equity market neutral having the highest.

Exhibit 5a

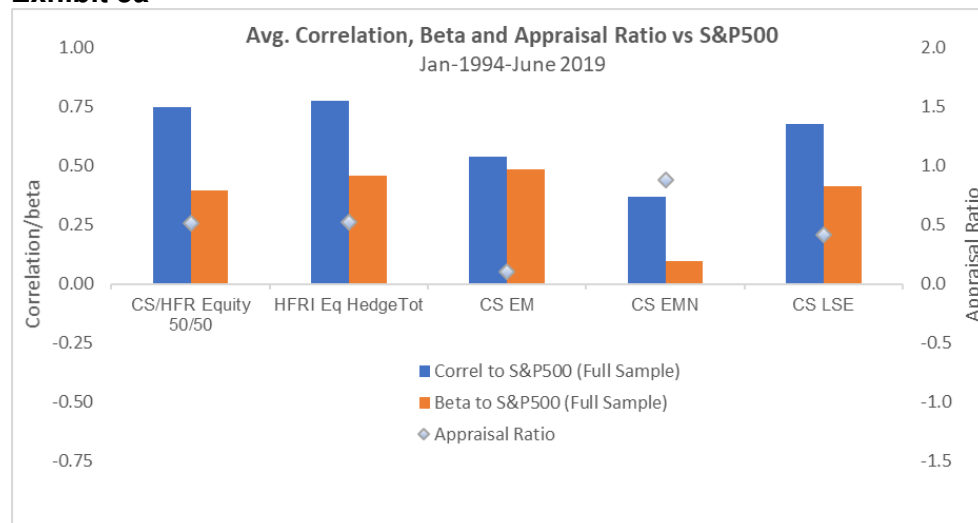
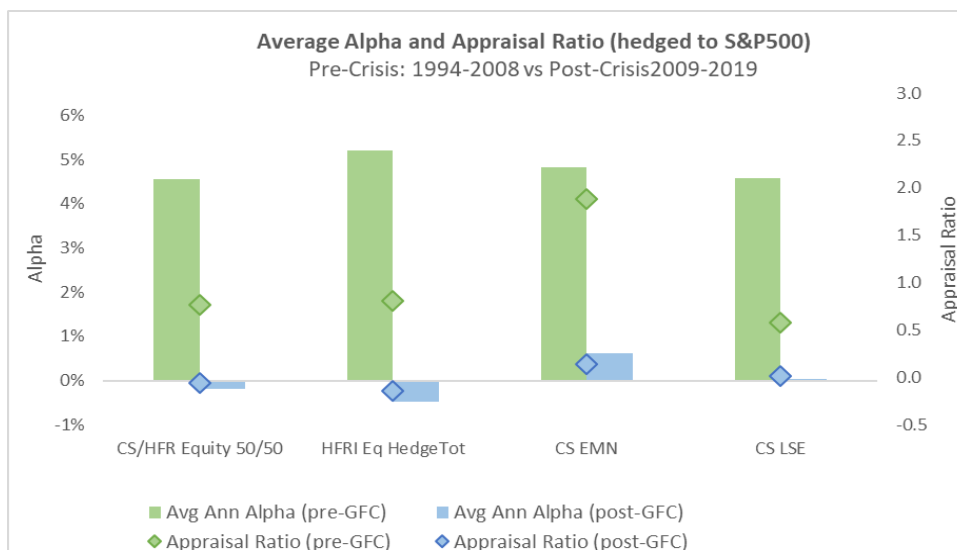


Exhibit 5b reports the market risk-adjusted alphas and appraisal ratios (versus the S&P500) for the periods prior to and since the GFC again for each of the equity hedge fund categories and the equity composite itself. A noticeable decline in both alphas and appraisal ratios across the board post-GFC can be seen with the largest decline coming from equity market neutral. Furthermore, the alphas and appraisal ratios for the equity fund categories post-GFC are all close to zero (and even slightly negative) except for EMN which registers a small positive.

Exhibit 5b



I now add to the earlier traditional market risk-premia model by including additional systematic risk factors that have been shown in the literature to impact performance of equity-focused managers over time. The factors used here are most similar to those used in Fung, Hsieh, Naik, and Teo (2019), Blitz (2018), and Harvey, Rattray, Sinclair, and Van Hemert (2017). The “factor zoo” of possibilities is thus narrowed down to include a few factors shown in the literature to possess positive risk premium over the long run for active equity managers, are well-known and researched, and are independent (very low to no correlations to one another). The factors were chosen also to be broad (equity hedge fund strategies represent an array of strategies) and intuitive from an economic standpoint. Exhibit 6 defines the variables and systematic investment factors considered in the analysis. There may be additional risk premia employed by equity hedge fund managers, but parsimony is also an important consideration in considering which factors to include.

Exhibit 6: Variable Descriptions

Category	Name	Instruments
Hedge Fund	Equity hedge fund composite	A Credit Suisse Equity Composite and the HFRI Equity Hedge Index (50/50 weighted, see text for detail)
Traditional	US Equity market	S&P 500 Index
	Emerging Market Equities	MSCI Emerging Markets Index
	US Bond market	Bloomberg Barclays US Bond Aggregate
Research Factors	Size (stocks)	Small-minus-big US stocks (SMB) (Ken French)
	Value (stocks)	High-minus-low book value US stocks (HMLdevil) (AQR)
	Momentum (stocks)	Winner-minus-loser US stocks (UMD) (Ken French)
	Quality (stocks)	Quality-minus-junk US stocks (QMJ) (AQR)

	Momentum (equity index time series)	Indices for global stocks (TSMOM^EQ) (AQR)
	Equity Volatility	Return on stock index lookback straddle (Equity Vol) (David Hsieh)

Following Harvey, Rattray, Sinclair, and Van Hemert (2017), I scale all research factors to have 10 percent volatility which allows for an easier comparison of betas to different factors; larger beta suggests that more variance is explained by that factor. The traditional factors include the main large and easily investable asset classes, U.S. stocks (S&P500 Index), emerging market stocks (MSCI Emerging Market Index), and U.S. bonds (Bloomberg Barclays US Aggregate Index).⁶

As for the research factors, there are two Fama-French (1993) factors: size (small-minus-big US stocks) and cross sectional momentum (winner-minus-loser US stocks). Jegadeesh and Titman (1993) and Carhart (1997) report on cross-sectional momentum. The returns for these two factors can be obtained from Kenneth French’s website.⁷ There are four factors from AQR Capital Management: value (high-minus-low book value US stocks adjusted for more recent book value per Asness and Frazzini (2013)), quality (quality-minus-junk, Asness, Frazzini, and Pedersen (2019))⁸, and global equity time series momentum (recent outperforming indexes from nine developed equity markets, Moskowitz, Ooi and Pedersen (2011)).⁹ Finally, for the equity volatility factor, I use the approach of Fung and Hsieh (2001, 2002) which is long an option straddle (long both a put and call stock option with the same strike price).¹⁰

The empirical analysis includes explanatory variables that are tradable assets which my analysis assumes are costless to access. However, not all of the factors themselves can be produced for zero cost, and so a manager implementing these factor exposures would have a cost associated with doing so. While zero cost may be a reasonable assumption for liquid traditional risk premia (e.g., traditional market risk), it is arguably less appropriate for the riskier

⁶ Bloomberg tickers: SPX for S&P 500, NDUEEGF for MSCI Emerging Markets (for 1999-2019 and Global Financial Data, MSCI Emerging Markets Free for prior years), and LBUSTRUU for Barclays U.S. Aggregate.

⁷ see Ken French’s website for the returns data for these factors:
http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

⁸ Others discuss low volatility or low beta (betting against beta, or low beta minus high beta, (see Blitz (2017), and Frazzini and Pedersen (2013)) as an important factor in describing returns. Given that BAB and QMJ are quite similar, at least conceptually, for parsimony, I use only QMJ.

⁹See AQR website for the returns data and construction detail for these factors:
<https://www.aqr.com/Insights/Datasets>.

¹⁰ See David Hsieh’s website for the returns data for this factor:
<http://faculty.fuqua.duke.edu/~dah7/DataLibrary/TF-FAC.xls>

spectrum of systematic factor premia such as (HML, SMB, MOM). All returns are determined on an unfunded basis, which is done by using futures, a dollar-neutral long-short portfolio, or using returns in excess of the 3-month T-Bill rate.

As mentioned, these factors were not all necessarily well-known over the entire sample period. Some have arguably been well-understood over the study period, like the Fama-French factors, while others, TSMOM^{EQ} and QMJ, for instance were not published on until later.¹¹

Regardless, my primary purpose here is to evaluate risk and return factors contributing to historical performance, not to judge value add or minimize the importance of manager innovation. Put differently, the main point here is not to negate any value add from these factors should a manager employ them, but instead to better understand ex-post the risk factors that managers have been exposed to over the study period and how these influenced hedge fund returns.

Exhibit 7 Panel A shows the cumulative returns of the traditional markets, the hedge fund composite, and the systematic research factors over 1994-2019(June). Returns shown are compound, excess of cash, returns. Exhibit 7 Panel B shows the average annualized excess returns over the same period. The hedge fund composite, US and emerging market stocks, US bonds, and research factors have positive returns over the period, with the exception of the value factor (HMLdevil) which has a slight negative excess return of -1.2 percent, and the equity volatility factor returning -15.5 percent (being short volatility has a large negative excess return due to the volatility risk premium, see Israelov and Nielsen (2015)).¹²

Exhibit 7

Panel A

¹¹ Although some factors may not have been well understood in the academic literature over the study period, the ideas behind them have likely been well-known in practitioner circles for many years. Consider Benjamin Graham (1934) discussed the importance of value and quality, Fischer Black (1972) evaluated how the capital market line was unexpectedly flat, and the idea that the “trend is your friend” was formally documented by Brock, Lakonishok, and LeBaron (1992) and has been [understood](#) long before then.

¹² The related Fama-French HML factor (not reported here) has a slight positive risk premium over the study period and reported results are similar whether using the HML devil or more traditional Fama-French HML factor.

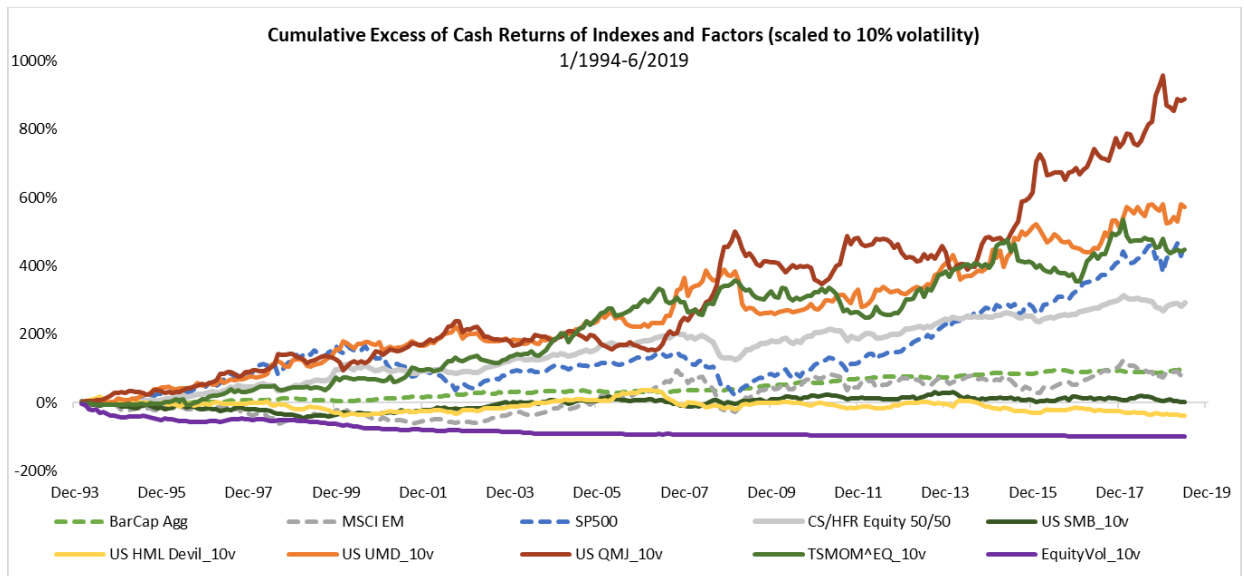


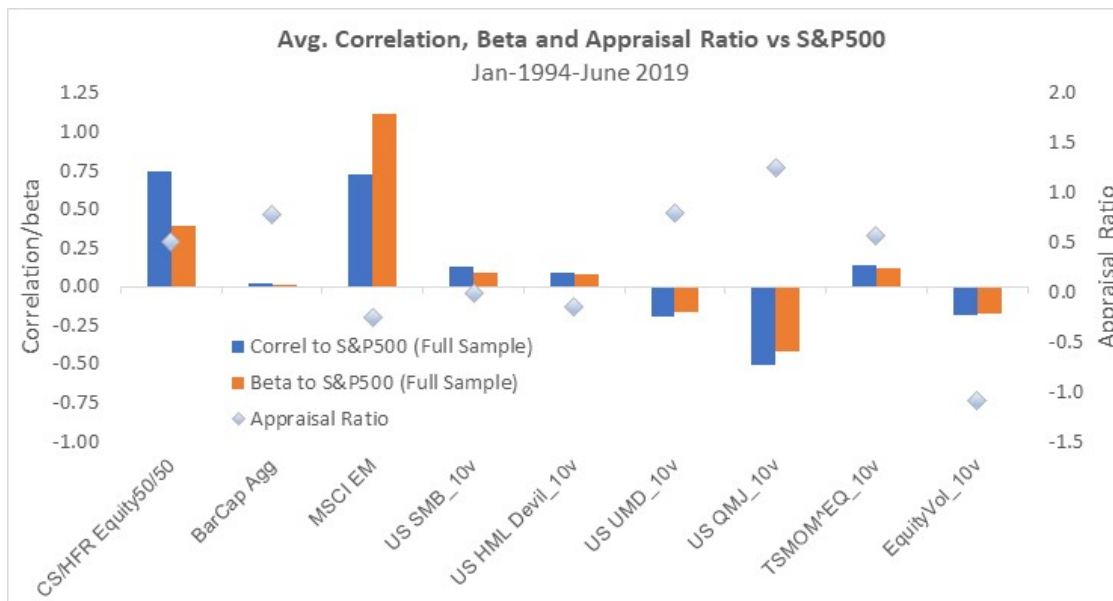
Exhibit 7

Panel B: Average Monthly Excess Returns (annualized) Jan1994-Jun 2019

CS/HFR										
Equity	BarCap	US	US HML	US	US	TSMOM^	EquityVol			
50/50	SP500	MSCI EM	Agg	SMB_10v	Devil_10v	UMD_10v	QMJ_10v	EQ_10v	_10v	_10v
5.7%	7.9%	5.1%	2.8%	0.7%	-1.2%	8.3%	9.7%	7.4%	-15.5%	

In Exhibit 8, I plot the correlations, betas, and appraisal ratios (diamonds) for the different traditional markets, research factors, and the equity hedge fund composite versus the S&P 500 over the full sample period. The equity hedge fund composite has an average beta of around 0.4 and correlation of 75 percent versus the S&P 500. Emerging market equities has a beta of 1.1 and correlation of 73 percent to the S&P 500 and a negative -0.25 appraisal ratio. The research factors all have low to negative correlations with the S&P 500, with QMJ having the strongest negative correlation and beta, and the highest appraisal ratio. The research factors not only have low correlation to stocks, it's worth noting that they also have low to negative correlations to one another, meaning that they are unlikely to be redundant in my model. Furthermore, their risk premiums are potentially diversifying, creating a strong case for including those factors with a positive expected return in a portfolio.

Exhibit 8



Equity-Focused Hedge Funds: Regression and Performance

I now employ linear regression to examine the performance of equity hedge fund managers as a group while adjusting for exposures to market and other well-known risk factors. Here, I decompose manager returns into the components driven by factor exposures (to traditional market risk and other non-traditional factor premia) and the component that cannot be explained by these risk premia — alpha. As evident from Equation 2 and Exhibit 2 earlier, a meaningful change in performance occurred following the GFC for hedge fund managers as a group. For this reason, I separate the empirical analysis into the pre- and post-crisis periods identified earlier. This will allow the alphas and the factor exposures to vary across each of the two periods so that we can observe to what extent changes in these exposures, whether intended or otherwise, may have contributed to the observed decline in alpha following the GFC. For instance, perhaps fund managers have altered their approach to how they seek to add value for investors.

In Panel A of Exhibit 9, I report the results for the following regression separately for the pre-crisis period (January 1994 through December 2008) and the post-crisis period (January 2009 through June 2019):

Equation 3

$$R_t = \alpha + \sum_i \beta^i F_t^i + \varepsilon_t$$

Where

R_t is the monthly excess return of the equity hedge fund composite, net of fees, in month t
 F are factor excess returns, α is the annualized alpha, β are the regression coefficients, and ε is the error term.

In the first column of Exhibit 9 Panel A, I list the regression variables with the equity hedge fund composite portfolio being the dependent variable. In the remaining columns I report the respective coefficients for each regression equation with the second row reporting the annualized alpha for each regression. I begin by showing in the second column the “markets only” model similar to Equation 1, but now add emerging market equities given that a one of the hedge fund categories is focused on emerging market equities (see also Blitz 2018). Next in column 3, I report a 5-factor model employing traditional markets, size, and value (but again replacing the traditional HML with HMLdevil); in column 4, a 7-factor model that adds cross-sectional momentum (UMD) and quality (QMJ); then in column 5 I create a 9-factor model by adding equity-related time-series momentum (TSMOM^{EQ}) and equity volatility (EquityVol). I run the same regression models separately for the pre-crisis (left hand panel) and post-crisis (right hand panel) periods.

Regarding the pre-crisis period, the empirical results (judging by t-values exceeding the usual 2.0 threshold)¹³ show that the alphas are large and significant across all four models. Traditional market equity betas for both S&P 500 and emerging markets are also strongly significant, but BarCap Agg is small and insignificant for the market only model (and only weakly significant for the remaining models). The research factors are almost all statistically significant across all four models with one exception, TSMOM^{EQ} is slightly below the required level of significance in the 9 factor model.

Focusing on column 5 that employs all of our risk factors, I first note that the estimated alpha is higher for the 9-factor model (both pre- and post-crisis) than for the market-only model. We will discuss this more below, but in the pre-GFC period, this is due primarily to the negative loading on QMJ (managers prefer junkier stocks) and to a lesser degree a preference for being long equity volatility. In the post-GFC period, the higher alpha reported for the 9-factor model versus the markets only model comes from the same preferences but also being short US bonds. The net result is that after adjusting returns for exposure to stocks/bonds and the 6 research factors, the 9-factor model leaves more residual alpha remaining versus adjusting for the market alone. This result is also reflected in the higher appraisal ratio shown for the 9-factor model versus the market-only model.

From Exhibit 9 column 5, we can also see that in the pre-crisis period equity hedge fund managers prefer securities that are smaller, more growth oriented (not value), have positive

¹³ Using a Newey-West adjustment with one lag as done earlier. The significance levels are only suggestive. As mentioned, many factors have been tested by the literature. See Harvey, Liu and Zhu (2016) and Hou, Xue, and Zhang (2017).

relative momentum, and have lower quality (junkier). Finally, they are also long absolute (time series) momentum and equity market volatility (but not statistically so).

The last row reports the R^2 statistic (the proportion of return variance explained by each model). In the pre-GFC period, we see that traditional markets explain 70 percent of the return variation, and each successive model explains an increasing proportion of return variation with the 9-factor model explaining 87 percent of the return variation. Taken together, we see that the market and academic factors appear to be rather impactful in helping us to better understand the systematic drivers of monthly returns of hedge funds as a group.

In comparing the pre-crisis and post-crisis results, we see some similarities as well as important changes in the alphas and the various factor exposures between the two periods. When accounting for only exposure to traditional markets, the residual alpha in the post-GFC period is now very small (statistically no different from zero), falling from 4.6 percent per year in the pre-crisis period to 0.8 percent per year in the post-crisis period. The alphas for the models that further include research factors remain statistically significant for the 7 factor and 9 factor models, but all alphas are smaller by about 4 percent per year versus the pre-crisis period. All together, the results suggest that alpha declines markedly for equity hedge fund managers in the post-GFC period. This stands in contrast to the pre-crisis period wherein all alphas are large and statistically different from zero.¹⁴

Focusing on the 9-factor model results shown in column 5, we see that for the post-crisis period manager exposures to traditional market equities remain positive and significant, but they interestingly now have a significant negative exposure to bonds. Other changes versus the pre-GFC period, we now see more systematic factors being statistically insignificant as exposures to small caps stocks (SMB), cross-sectional momentum (UMD), time series momentum (TSMOM^{EQ}), and equity volatility (EquityVol) all weaken. As before, managers still significantly prefer growth oriented (not value) and junkier (lower quality) stocks.

Finally, it is worth noting that the models describe a greater proportion of return variance post-GFC than pre-GFC. The markets-only model R^2 increases from 70 percent to 85 percent and the 9-factor model now describes 91 percent of return variation post-GFC, up from 87 percent in the pre-crisis period. For the post-crisis period, we see that the market and academic factors are

¹⁴ In an appendix, I report the regression model results for the broad hedge fund composite discussed earlier, finding similar declines in alpha during the post-GFC period versus the earlier period.

again helpful to our understanding of the systematic drivers of monthly returns of equity hedge funds as a group.

Exhibit 9

Panel A: Regression Coefficients: Equity Hedge Fund Composite

Jan-1994-Dec-2008					Jan-2009-Jun-2019				
Regressions:	MKTS Only	5 Factor (MKTS+SMB, HML)	7 Factor (5Factor+UM D,QMJ)	9Factor (7Factor+TSMOM,EQ Vol)	Regressions:	MKTS Only	5 Factor (MKTS+SMB, HML)	7 Factor (5Factor+UM D,QMJ)	9Factor (7Factor+TSMOM,EQ Vol)
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Alpha (Ann.)	4.58%	4.09%	6.05%	6.21%	Alpha (Ann.)	0.82%	0.66%	2.36%	2.14%
<i>T-Stat</i>	3.50	4.05	6.49	6.44	<i>T-Stat</i>	0.64	0.60	2.24	2.22
SP500	0.15	0.20	0.17	0.17	SP500	0.20	0.18	0.16	0.16
<i>T-Stat</i>	4.34	7.97	6.82	7.66	<i>T-Stat</i>	5.07	5.03	5.09	4.97
SP500(t-1)	0.06	0.07	0.05	0.05	SP500(t-1)	0.05	0.05	0.03	0.04
<i>T-Stat</i>	2.69	3.17	3.04	3.06	<i>T-Stat</i>	2.67	3.02	2.47	2.56
MSCI EM	0.21	0.16	0.13	0.13	MSCI EM	0.18	0.20	0.18	0.18
<i>T-Stat</i>	8.74	7.93	7.41	7.53	<i>T-Stat</i>	8.21	8.77	9.53	9.33
BarCap Agg	0.10	0.20	0.14	0.12	BarCap Agg	(0.20)	(0.22)	(0.30)	(0.29)
<i>T-Stat</i>	1.20	2.98	2.47	2.24	<i>T-Stat</i>	(2.08)	(2.14)	(3.28)	(3.26)
US SMB_10v		0.18	0.10	0.10	US SMB_10v		0.06	0.02	0.02
<i>T-Stat</i>		4.54	3.91	4.05	<i>T-Stat</i>		3.56	1.22	1.41
US HML Devil_10v		(0.14)	(0.14)	(0.13)	US HML Devil_10v		(0.07)	(0.11)	(0.11)
<i>T-Stat</i>		(5.02)	(5.46)	(5.12)	<i>T-Stat</i>		(3.14)	(4.30)	(4.30)
US UMD_10v			0.09	0.08	US UMD_10v			(0.01)	(0.01)
<i>T-Stat</i>			3.17	3.15	<i>T-Stat</i>			(0.44)	(0.65)
US QMJ_10v			(0.20)	(0.20)	US QMJ_10v			(0.13)	(0.13)
<i>T-Stat</i>			(8.06)	(7.47)	<i>T-Stat</i>			(6.73)	(6.61)
TSMOM^EQ_10v				0.04	TSMOM^EQ_10v				0.02
<i>T-Stat</i>				1.52	<i>T-Stat</i>				0.83
EquityVol_10v				0.04	EquityVol_10v				(0.00)
<i>T-Stat</i>				2.03	<i>T-Stat</i>				(0.00)
<i>R²</i>	0.70	0.81	0.86	0.87	<i>R²</i>	0.85	0.87	0.91	0.91

Exhibit 9

Panel B: Cumulative Alpha: Equity Hedge Fund Composite

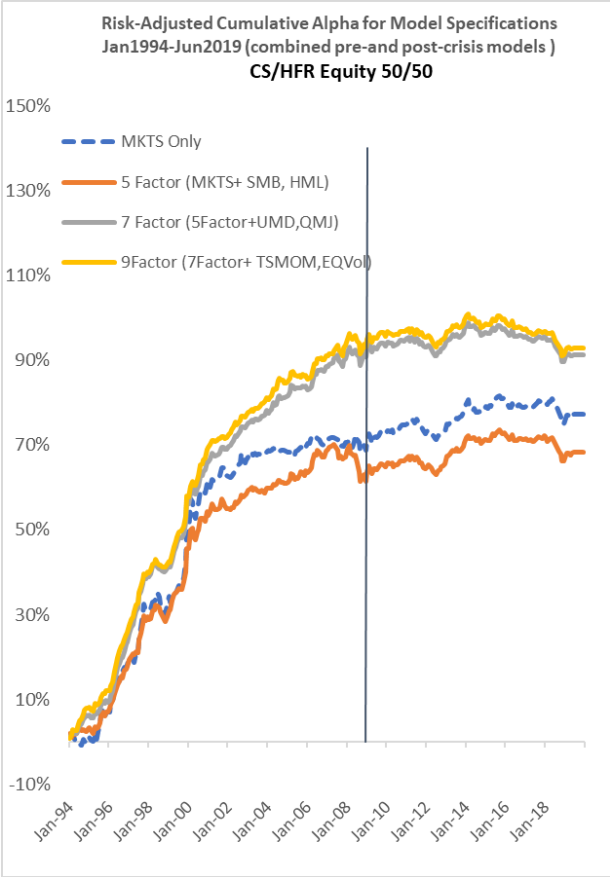


Exhibit 9

Panel C: Performance (Annualized): Equity Fund Composite

Jan-1994-Dec-2008					Jan-2009-Jun-2019				
Performance	MKTS Only	5 Factor (MKTS+SMB, HML)	7 Factor (5Factor+UM D,QMJ)	9Factor (7Factor+TSMOM,EQ Vol)	Performance	MKTS Only	5 Factor (MKTS+SMB, HML)	7 Factor (5Factor+UM D,QMJ)	9Factor (7Factor+TSMOM,EQ Vol)
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
HF Avg Rtn	5.99%	5.99%	5.99%	5.99%	HF Avg Rtn	5.28%	5.28%	5.28%	5.28%
SP500	0.57%	0.74%	0.61%	0.61%	SP500	2.76%	2.51%	2.25%	2.20%
SP500(t-1)	0.23%	0.24%	0.19%	0.18%	SP500(t-1)	0.62%	0.66%	0.46%	0.48%
MSCI EM	0.39%	0.30%	0.24%	0.24%	MSCI EM	1.75%	1.96%	1.78%	1.77%
BarCap Agg	0.22%	0.46%	0.32%	0.29%	BarCap Agg	-0.67%	-0.73%	-1.01%	-0.98%
US SMB_10v		0.13%	0.08%	0.08%	US SMB_10v		0.04%	0.01%	0.01%
US HML Devil_10v			0.02%	0.02%	US HML Devil_10v		0.19%	0.29%	0.29%
US UMD_10v			1.00%	0.94%	US UMD_10v			-0.04%	-0.06%
US QMJ_10v			-2.51%	-2.44%	US QMJ_10v			-0.82%	-0.81%
TSMOM^EQ_10v				0.46%	TSMOM^EQ_10v				0.05%
EquityVol_10v				-0.60%	EquityVol_10v				0.00%
Attrib to Markets	1.41%	1.74%	1.35%	1.32%	Attrib to Markets	4.46%	4.39%	3.48%	3.47%
Attrib to Factors	0.00%	0.13%	-1.42%	-1.54%	Attrib to Factors	0.00%	0.23%	-0.55%	-0.52%
Alpha	4.58%	4.11%	6.05%	6.21%	Alpha	0.82%	0.66%	2.36%	2.33%
Active Risk	4.6%	3.7%	3.1%	3.1%	Active Risk	2.4%	2.2%	1.9%	1.9%
Appraisal Ratio	0.99	1.11	1.93	2.04	Appraisal Ratio	0.34	0.30	1.22	1.21

Average Monthly Excess Returns (annualized)

	CS/HFR									
	Equity 50/50	SP500	MSCI EM	BarCap Agg	US SMB_10v	US HML Devil_10v	US UMD_10v	US QMJ_10v	TSMOM^EQ_10v	EquityVol_10v
Pre-GFC	5.99%	3.67%	1.84%	2.34%	0.74%	-0.13%	11.15%	12.24%	10.66%	-16.72%
Post-GFC	5.28%	13.92%	9.68%	3.41%	0.66%	-2.69%	4.11%	6.12%	2.65%	-13.77%

Exhibit 9, Panel B plots the cumulative alpha (not compounded) for the various model specifications from Exhibit 9, Panel A, combining the results for the pre-crisis and post-crisis periods. As a starting point, I plot the traditional markets-only model (the dashed line). The pattern is similar to that shown in Exhibit 1 for all hedge funds, although the flattening of the cumulative alpha curve begins a few years earlier, around 2002. In unreported results, I find that when excluding emerging market equities, the shape of the cumulative alpha curve for equity managers follows quite closely that of hedge fund managers as a group.¹⁵

The cumulative alpha from the 5-factor model follows closely that of the market model. The cumulative alpha for the 9-factor model, that adjusts for the risk of all of our systematic research factors, has the same overall pattern as the other models but results in a slightly higher level of

¹⁵ When adjusting for US stock and bond market risk only (S&P 500 and US BarCap Agg), equity hedge fund manager alpha pre-GFC equals 4.2% and -1.2% post-GFC.

alpha versus the market-only model. As we'll see more clearly in the following paragraphs, this is due mostly to the fact that the 9-factor model has a higher annualized residual alpha due to the negative loading on QMJ which negatively influences manager returns.¹⁶ To better understand this and other drivers behind the estimated alphas for the various models, I next turn attention to annualized performance attribution statistics for each of the models estimated above.

Panel C of Exhibit 9 reports annualized performance statistics for each of the models, again separating the pre- and post-crisis periods. I include the annualized return attributed to factor exposures, annualized alpha, active risk, and appraisal ratio, each as defined below. The return attributed to each of the research factors is shown individually and then combined together in the row titled "Attrib to Factors." The alpha for each model is what remains after subtracting the return attributed to the three traditional markets and to the combined research factors from the average hedge fund return. Specifically, the return contribution to any factor (Equation 4) shown in Panel C is the product of its regression coefficient from Panel A and the historic risk premium (excess return) shown in the bottom of Panel C (e.g., return attribution in the pre-GFC period for QMJ = $-0.2 \times 12.2\% = -2.4\%$).

Equation 4: $Avg[R] = \alpha + \sum_i \beta^i Avg[F^i]$

Equation 5: $Active Risk = \sigma(\alpha) * \sqrt{12}$

Equation 6: $Appraisal Ratio = \frac{\alpha}{Active Risk} * \sqrt{12}$

I next explore the impact of the factor exposures and changes to them on equity hedge fund manager performance. As shown in Exhibit 9, Panel C, equity hedge funds reported similar average unadjusted annualized excess returns (first row) in each of the two periods; 5.99 percent over the pre-GFC period and 5.28 percent post-GFC. Although the total return of equity hedge funds is only slightly higher in the pre-GFC period, the attribution of those returns differs importantly between the two periods. Recall that from the earlier regression model betas to the S&P 500 and emerging markets remain roughly unchanged. So when adjusting for stock/bond market risk only, I note that the much higher returns to US stocks and emerging market equities during the post-crisis period (for US stocks, 3.7 percent annually in pre-crisis period vs 13.9 percent per year post-crisis crisis, and 1.8 percent and 9.7 percent per year for emerging market equities pre- and post-crisis, respectively) leads to higher proportions of total equity hedge fund

¹⁶ In short the alpha is higher for the 9-factor model as managers are doing "other things" to add idiosyncratic alpha to absorb, or compensate, for the drag of being short quality.

returns coming from US and emerging market stocks in the post-crisis period (about 3 percent per year return coming from traditional markets in the post-GFC period). This higher return from stocks is offset by a decline in idiosyncratic alpha in the post-crisis period and a negative contribution from US bonds (annualized residual alpha declines from 4.1 percent to 0.8 percent for the markets-only model). Regarding bonds, from Table 9 Panel A, we see that equity hedge fund manager exposure to US bonds has changed from a small (insignificant) positive 0.1 percent pre-GFC to a mildly statistically significant, but negative, -0.2 percent post-GFC resulting in a negative drag on total return of -0.7 percent annually for equity hedge fund managers in that period.

I now turn attention to return attribution for equity hedge funds as based on the 9-factor model shown in column 5 for each period. Within each respective period, I first note that as compared to the market-only-model, the 9-factor model attributes roughly similar amount of returns coming from each of the three traditional market exposures. The one exception is that for the pre-GFC period, the lower beta estimated for emerging market stocks (falling from 0.21 to 0.13) resulted in a slight decline attributed to emerging markets for the 9-factor model versus the markets-only model in that period.

Comparing the two periods, when combining the traditional factors in the 9-factor model altogether, on net, leads to a 1.3 return annually pre-GFC as compared to 3.5 percent annually coming from traditional markets post-GFC (again, the negative exposure to US bonds detracts roughly 1 percent return per annum). For the systematic research factor exposures combined for the 9-factor model subtracts -1.5 percent of return annually in the pre-crisis period and -0.5 percent in the post-crisis period (again, largely due to the preference for underperforming junkier stocks in both periods).

I noted the decline in alpha for equity hedge fund managers post-GFC and the associated decline in the appraisal ratio. An important and notable change also evident from the results is that equity hedge fund managers also meaningfully reduced their active risk in the post-GFC period versus the earlier period. For the markets-only model, annualized active risk in the pre-GFC period equaled 4.6 percent as compared to 2.4 percent in the post-GFC period. Active risk as measured by the 9-factor model also declined, from 3.1 percent to 1.9 percent in the pre- and post-GFC periods, respectively. Given this decline in risk taking, it is perhaps not surprising to see a decline in idiosyncratic alpha following the GFC (though, of course, given that the appraisal ratio falls over the latter period, the decline in alpha post-GFC exceeds the decline in active risk).

It is not clear why active risk of hedge fund managers has declined so dramatically, but there are at several possibilities. One relates to our earlier discussion regarding the rise in the number of hedge fund firms and assets under management. Clearly, the manager universe has grown and so the decline in active risk could be the result of greater diversification across a wider array of managers. Adding managers with uncorrelated idiosyncratic returns could drive active risk lower. Related to this, the forces of arbitrage from more managers and assets seeking opportunities may also be a key driver behind the observed decline in industry alpha. Another possibility for the decline in active risk is that hedge funds identified fewer alpha opportunities in the post-GFC period (as also the lower ex-post alpha suggests). That is, there would be little reason for a manager to take active risk absent the concomitant benefit of active return, so both active risk and active return decline. Finally, perhaps clients of hedge funds post-GFC simply sought lower active risk from their active managers, and in turn asset managers obliged. This possibility could be due to asset owners being stung by the market turbulence associated with the GFC and so desired less active risk taking on the part of their managers. Alternatively, a lower desired active risk could be a result of the demands of changing clientele. For instance, the growth in hedge funds could be driven, in part, from clients with a lower than typical risk appetite (i.e., from high net worth individuals and pension plans), requesting lower active risk from their managers. Future research could explore these hypotheses in more detail.

It is interesting to further note how the return attribution for equity hedge funds coming from the various risk factors changed meaningfully following the GFC. A review of the individual contributions of factors as shown in Exhibit 9, Panel C provides interesting insight into the systematic return drivers of active equity hedge-fund managers (this is merely suggestive especially, as mentioned, many of the exposures in the post-GFC period are not statistically different from zero). To summarize, equity hedge fund managers in the **pre-crisis period**:

- Added excess return by being long stock markets (US stocks and emerging markets) and by being long US bonds;
- Added excess return by preferring smaller growth stocks with positive momentum (recall that equity hedge funds dislike value stocks and the value factor has a slightly negative return over the full period);
- Detracted from excess return by going long underperforming junkier stocks and being long market volatility or long straddles;
- Added return by going long (short) global equity indexes with recently positive (negative) returns.

In the **post-crisis period** we see some consistency with the pre-crisis period but also came some notable changes in exposures for both traditional and research factors:

- Once again added excess return by being long stock markets (US stocks and emerging markets), but now managers subtracted value by having negative exposure to US bonds:
 - Beta exposure to US bonds changed from a weak 0.1 pre-GFC to a strongly significant negative -0.3 post-GFC resulting in a 1.0 percent drag on annual total return in the latter period;
- Beta exposure to small-cap stocks (SMB) weakened meaningfully in the post-crisis period though still adding slight value, and exposure to growthier stocks remained strong adding value in both periods but even more so in the post-GFC period;
- Cross-sectional momentum (UMD) changed from being a strong positive influence on returns in the pre-GFC period to being a small but negative impact post-GFC, resulting in a slight drag on returns in the latter period.
- Once again detracted from excess return by going long underperforming junkier stocks resulting in a notable drag on returns in both periods, but especially so in the earlier period due to both a higher factor loading and higher positive returns to QMJ pre-GFC versus post-GFC.
- Exposure to equity market time series momentum (TSMOM^{EQ}), and market volatility (long straddles) both weakened such that neither had much influence on overall return in the latter period.

Exhibit 10 summarizes the differences between regression and performance results between the pre- and post- GFC.

**Exhibit 10
Impact of Risk Exposures on Equity Hedge Fund Manager Performance Pre- and Post-GFC (9-Factor Model)**

Factor	Pre-Crisis	Post-Crisis
Residual Alpha	6.2% (annualized)	2.1% (annualized)
Market (S&P500)	Beta of 0.22 (+0.8%/yr)	Beta 0.20 (+2.7%/yr)
Market (Emerg Mkts)	Beta of 0.13 (+0.24%/yr)	Beta 0.18 (+1.8%/yr)
Market (US Bonds)	Beta of 0.12 (+0.3%/yr)	Beta of -0.3 (-1.0%/yr)
Size (US stocks)	Prefer small stocks (+0.1%/yr)	Same (+0.01%/yr)
Value (US stocks)	Prefer growth (+0.0%/yr)	Same (+0.3%/yr)
Momentum (US stocks)	Long momentum (+0.9%/yr)	Prefer opposite (-0.1%/yr)
Quality (US stocks)	Prefer lower quality (-2.4%/yr)	Same (-0.8%/yr)
Momentum (equity index time series)	Long outperforming indexes, short underperformers (+0.5%/yr)	Same (+0.1%/yr)
Equity Volatility	Long straddles (-0.6%/yr)	No exposure (+0.0%/yr)

Conclusions

This paper has explored to what extent hedge fund performance over the past 25 years can be explained through various systematic risk factors, and how much of it is due to the random (idiosyncratic) nature of hedge fund alpha. The findings help investors gain insight into the various historical drivers of performance and how these may have changed following the GFC. I explore hedge funds as a group and also fund managers focusing only on equities, with findings for the two groups being generally consistent with one another.

Results show that in the 15 years leading up to the 2008 GFC, hedge fund manager performance was quite strong, with the average hedge fund manager adding 3.4 percent per year in net risk-adjusted return, or alpha, on average when adjusting for market risk. However, in the 10 years following the GFC, hedge funds have witnessed a strong decline in their risk-adjusted excess returns with the typical hedge fund contributing -0.8 percent per year on average net of fees and costs. Appraisal ratios have also declined post-GFC even as manager active risks are much lower.

To aid a fuller understanding of what might be driving hedge fund returns beyond stocks/bonds, I further seek to decompose returns of equity-focused hedge fund managers into the components of their return driven by exposure to other non-traditional factor premia beyond market risk — what return remains after adjusting for passive exposures to both traditional markets and other risk premia? I find that while exposure to stock market risks were roughly unchanged pre- and post-crisis, meaningful changes in exposures to bond markets and other factor premia occurred following the GFC in turn influencing their performance. I review the differences in exposures and highlight how, whether intended or otherwise, hedge funds have clearly altered the way they drive performance including a considerable decline in active risk taken.

It's important to further note that my results are for hedge funds overall and a subset of equity-focused managers. As would be expected, within the universe of hedge funds there certainly will be a subset of managers that have delivered alpha over the periods discussed here. It would be useful for future research to analyze manager-level performance in detail to better understand performance and persistence within managers.

In sum, hedge fund managers as a group in the years following the GFC, whatever active strategies they pursue, have maintained a relatively consistent exposure to market risks, reduced active risk and exposures to many systematic research factors (and in some cases, reversed their exposures), and have added little to no idiosyncratic alpha. Regardless of the

outlook for hedge fund alpha— whether it remains grim or the poor recent performance turns the corner— this paper maps out a methodology and approach to understanding specific hedge fund risk exposure to markets and other factors as well as their attribution to returns. Hopefully these results shed important light for investors who allocate to hedge funds as part of their investment portfolio.

Appendix A

Empirical Analysis of Hedge Funds

This appendix examines the performance of hedge fund managers as a group using, as before, linear regression to decompose manager returns into the components driven by systematic risk exposures (to traditional market risks and other non-traditional factor premia) and the component that cannot be explained by these risk premia — alpha. Once again, I separate the empirical analysis into the pre-crisis period (January 1994 through December 2008) and the post-crisis period (January 2009 through June 2019). Results are reported in Exhibit A1.

For consistency and to avoid “data snooping” across the hundreds of potential factors that have been studied, I make just two changes to the factors included in the earlier analysis applied to equity hedge fund managers. I replace the equity-focused time-series-momentum factor (TSMOM^{EQ}) with a broader measure (TSMOM) that incorporates five asset classes (stocks, bonds, foreign exchange, commodities).¹⁷ Also, following Harvey, Rattray, Sinclair, and Van Hemert (2017), I add currency carry (FX Carry) using data from Deutsche Bank.¹⁸ As with all systematic research factors, both of these variables are scaled to 10 percent volatility.

In the first column of Exhibit A1, Panel A, I list the regression variables with the hedge fund composite portfolio being the dependent variable as defined in Equation 1 earlier. In the remaining columns I report the respective coefficients for each regression equation with the second row reporting the annualized alpha for each regression. Columns 2 through 4 report the results for the same models defined earlier. In column 5, I create a 10-factor model by using TSMOM in place of TSMOM^{EQ} and add FX Carry. I run the same regression models separately for the pre-crisis (left hand panel) and post-crisis (right hand panel) periods.

The regression results are quite similar to those for equity-focused managers discussed earlier. Regarding the pre-crisis period, the empirical results show that the alphas, market and research factors are almost all statistically significant (judging by t-values exceeding the usual 2.0 threshold)¹⁹ across all of the models with only a few exceptions; the BarCap Agg and FX Carry in column 5 are not significant. Focusing on column 5 that employs all 9 of our risk factors, in the pre-crisis period hedge fund managers prefer securities that are smaller, more growth oriented (not value), have positive relative momentum, and are of lower quality (junkier). Finally,

¹⁷ See Moskowitz, Ooi and Pedersen (2011) and the AQR website for the returns data for this factor: <https://www.aqr.com/Insights/Datasets>.

¹⁸ Bloomberg ticker: DBHTG10U.

¹⁹ Again, the significance levels are only suggestive. As mentioned, many factors have been tested by the literature. See Harvey, Liu and Zhu (2016) and Hou, Xue, and Zhang (2017).

they are also long absolute (time series) momentum, equity market volatility, and currency carry (but not statistically so).

The market and academic factors together are impactful in helping us to better understand the systematic drivers of monthly returns of hedge funds as a group. Judging by the R^2 statistic in the pre-GFC period, we see that the markets-only model explains nearly two-thirds of the return variation, and each successive model explains an increasing proportion of return variation with the 10-factor model explaining 81 percent of the return variation.

In comparing the pre-crisis and post-crisis results, we see some important changes in the alphas and factor exposures between the two periods. Across all models, when accounting for exposure to markets and research factors, the residual alphas in the post-GFC period are much smaller and weaker. This stands in contrast to the pre-crisis period wherein all alphas are large and statistically different from zero. Also, from column 2, we see that for the post-crisis period exposures to emerging market equities and US bonds are now smaller and statistically weaker while exposure to US stocks is slightly larger but much stronger.

Focusing on the 10-factor model results shown in column 5, small caps stocks (SMB) and cross-sectional momentum (UMD) are now statistically insignificant (and SMB is now negative suggesting that managers post-crisis slightly preferred large cap stocks versus small caps). Also notable are insignificant exposures to EquityVol (also now negative suggesting that managers tend to be short equity volatility) and FXCarry in the post-crisis period. It is also worth noting that the markets-only model describes a much greater proportion of return variance post-GFC than pre-GFC (R^2 increases from 63 percent to 77 percent) while the 10-factor model describes once again 85 percent of return variation post-GFC versus 81 percent in the pre-GFC period.

Exhibit A1

Panel A: Regression Coefficients: Hedge Fund Composite

Jan. 1994-Dec. 2008

Jan. 2009-Jun. 2019

<i>Regressions:</i>	MKTS Only	5 Factor (MKTS+SMB, HML)	7 Factor (5Factor+UM D,QMJ)	10Factor (7Factor+TSMOM,EQ Vol,FXCarry)	<i>Regressions:</i>	MKTS Only	5 Factor (MKTS+SMB, HML)	7 Factor (5Factor+UM D,QMJ)	10Factor (7Factor+TSMOM,EQ Vol,FXCarry)
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Alpha (Ann.)	3.65%	3.29%	4.36%	4.09%	Alpha (Ann.)	0.72%	0.59%	2.05%	2.17%
<i>T-Stat</i>	3.11	3.14	4.07	3.78	<i>T-Stat</i>	0.03	0.74	2.68	2.81
SP500	0.13	0.17	0.14	0.15	SP500	0.17	0.16	0.15	0.13
<i>T-Stat</i>	4.10	5.70	5.31	5.91	<i>T-Stat</i>	11.50	7.07	6.99	6.41
SP500(t-1)	0.07	0.07	0.06	0.05	SP500(t-1)	0.06	0.06	0.05	0.04
<i>T-Stat</i>	3.17	3.51	3.15	2.74	<i>T-Stat</i>	3.30	4.01	3.40	2.96
MSCI EM	0.16	0.12	0.10	0.09	MSCI EM	0.10	0.12	0.10	0.11
<i>T-Stat</i>	8.13	6.72	5.63	5.52	<i>T-Stat</i>	1.41	6.90	6.50	6.73
BarCap Agg	0.20	0.28	0.21	0.13	BarCap Agg	0.03	(0.01)	(0.08)	(0.13)
<i>T-Stat</i>	2.30	3.54	3.06	1.91	<i>T-Stat</i>	0.39	(0.11)	(1.16)	(1.88)
US SMB_10v		0.14	0.08	0.07	US SMB_10v		0.02	(0.02)	(0.01)
<i>T-Stat</i>		4.88	2.73	2.56	<i>T-Stat</i>		0.99	(0.89)	(0.56)
US HML Devil_10v		(0.10)	(0.07)	(0.06)	US HML Devil_10v		(0.06)	(0.09)	(0.09)
<i>T-Stat</i>		(4.32)	(2.24)	(2.32)	<i>T-Stat</i>		(2.91)	(3.72)	(4.03)
US UMD_10v			0.13	0.10	US UMD_10v			(0.01)	(0.04)
<i>T-Stat</i>			4.42	3.35	<i>T-Stat</i>			(0.43)	(1.67)
US QMJ_10v			(0.17)	(0.18)	US QMJ_10v			(0.11)	(0.11)
<i>T-Stat</i>			(5.59)	(6.09)	<i>T-Stat</i>			(5.42)	(5.42)
TSMOM_10v				0.10	TSMOM_10v				0.06
<i>T-Stat</i>				3.71	<i>T-Stat</i>				3.49
EquityVol_10v				0.05	EquityVol_10v				(0.01)
<i>T-Stat</i>				2.30	<i>T-Stat</i>				(0.61)
FX Carry_10v				0.04	FX Carry_10v				0.01
<i>T-Stat</i>				1.82	<i>T-Stat</i>				0.42
<i>R²</i>	0.63	0.71	0.78	0.81	<i>R²</i>	0.77	0.79	0.83	0.85

Exhibit A1

Panel B: Cumulative Alpha: Hedge Fund Composite

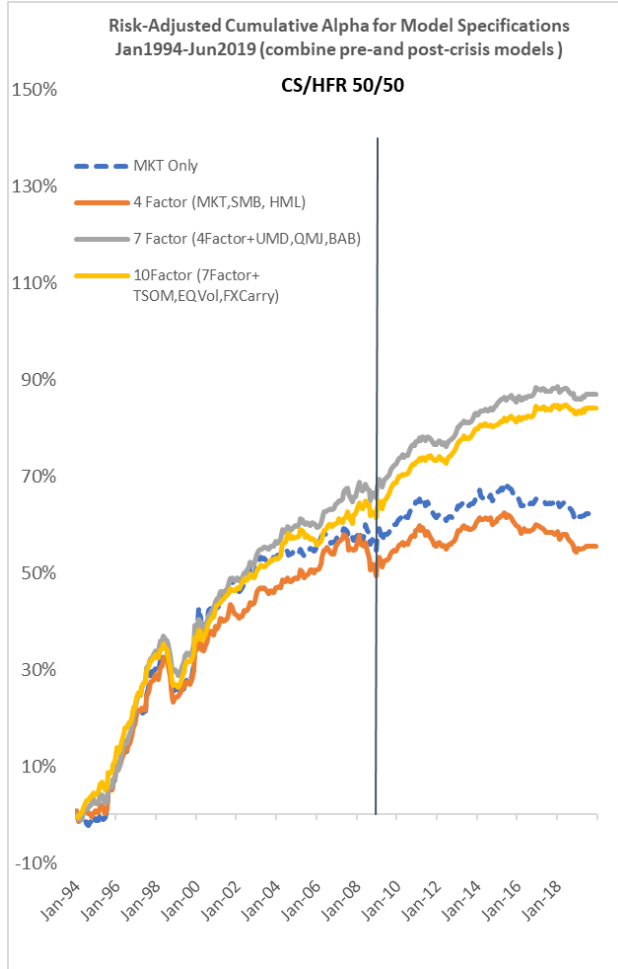


Exhibit A1

Panel C: Performance (annualized): Hedge Fund Composite

Performance	MKTS Only	5 Factor (MKTS+SMB, HML)	7 Factor (5Factor+UM D,QMJ)	10Factor (7Factor+TSMOM,EQ Vol,FXCarry)	Performance	MKTS Only	5 Factor (MKTS+SMB, HML)	7 Factor (5Factor+UM D,QMJ)	10Factor (7Factor+TSMOM,EQ Vol,FXCarry)
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
HF Avg Rtn	5.15%	5.15%	5.15%	5.15%	HF Avg Rtn	4.95%	4.95%	4.95%	4.95%
SP500	0.48%	0.61%	0.52%	0.55%	SP500	2.39%	2.28%	2.05%	1.86%
SP500(t-1)	0.26%	0.27%	0.21%	0.18%	SP500(t-1)	0.74%	0.78%	0.61%	0.52%
MSCI EM	0.29%	0.23%	0.18%	0.17%	MSCI EM	1.00%	1.16%	1.01%	1.03%
BarCap Agg	0.47%	0.65%	0.50%	0.30%	BarCap Agg	0.10%	-0.03%	-0.27%	-0.44%
US SMB_10v		0.10%	0.06%	0.05%	US SMB_10v		0.01%	-0.01%	-0.01%
US HML Devil_10v			0.01%	0.01%	US HML Devil_10v		0.15%	0.24%	0.25%
US UMD_10v			1.41%	1.06%	US UMD_10v			-0.04%	-0.15%
US QMJ_10v			-2.10%	-2.16%	US QMJ_10v			-0.70%	-0.70%
TSMOM_10v				1.47%	TSMOM_10v				0.30%
EquityVol_10v				-0.78%	EquityVol_10v				0.12%
FX Carry_10v				0.21%	FX Carry_10v				-0.01%
Attrib to Markets	1.50%	1.75%	1.41%	1.20%	Attrib to Markets	4.23%	4.19%	3.41%	2.98%
Attrib to Factors	0.00%	0.10%	-0.62%	-0.14%	Attrib to Factors	0.00%	0.17%	-0.51%	-0.20%
Alpha	3.65%	3.30%	4.36%	4.09%	Alpha	0.72%	0.59%	2.05%	2.17%
Active Risk	4.4%	3.9%	3.4%	3.2%	Active Risk	2.2%	2.1%	1.9%	1.8%
Appraisal Ratio	0.83	0.85	1.28	1.29	Appraisal Ratio	0.33	0.28	1.08	1.20

Average Monthly Excess Returns (annualized)

	CS/HFR 50/50	SP500	MSCI EM	BarCap Agg	US SMB_10v	US HML Devil_10v	US UMD_10v	US QMJ_10v	TSMOM_10v	EquityVol_10v	FX Carry_10v
Pre-GFC	5.15%	3.67%	1.84%	2.34%	0.74%	-0.13%	11.15%	12.24%	14.97%	-16.72%	6.06%
Post-GFC	4.95%	13.92%	9.68%	3.41%	0.66%	-2.69%	4.11%	6.12%	4.84%	-13.77%	-2.00%

Exhibit A1, Panel B plots the cumulative alpha (not compounded) for the various model specifications from Exhibit 1A, Panel A, combining the results for the pre-crisis and post-crisis periods. The results follow pretty closely those shown in Exhibit 1. To better understand the drivers behind the estimated alphas for the various models, I next turn attention to annualized performance attribution statistics for each of the models estimated above.

Panel C of Exhibit A1 reports annualized performance statistics for each of the models, again separating the pre- and post-crisis periods. I include the annualized return attributed to factor exposures, annualized alpha, active risk, and appraisal ratio, each as defined earlier. Hedge funds reported an average unadjusted annualized excess return (first row) of 5.15 percent during the pre-GFC period, and a very similar 4.95 percent for the post-crisis period. As we discussed earlier regarding equity-focused managers, the attribution of manager total returns differs markedly between the two periods and are summarized below. The individual contributions of factor exposures provides interesting insight into the drivers of active hedge-

fund manager returns. Exhibit A2 summarizes the differences between the pre- and post- GFC periods. Also evident from the results, hedge fund managers as a group, like equity-fund managers, reduced active risk by roughly 50 percent over the post-GFC period, perhaps due to the reasons discussed.

**Exhibit A2
Impact of Risk Exposures on Hedge Fund Manager Performance Following the GFC (10-Factor Model)**

Factor	Pre-Crisis	Post-Crisis
Residual Alpha	4.1% (annualized)	2.2% (annualized)
Market (S&P500)	Beta of 0.20 (+0.8%/yr)	Beta 0.17 (+2.4%/yr)
Market (Emerg Mkts)	Beta of 0.10 (+0.20%/yr)	Beta 0.11 (+1.0%/yr)
Market (US Bonds)	Beta of 0.13 (+0.3%/yr)	Beta of -0.1 (-.40%/yr)
Size (US stocks)	Prefer small stocks (+0.1%/yr)	Prefer larger stocks (-0.01%/yr)
Value (US stocks)	Prefer growth (+0.0%/yr)	Same (+0.3%/yr)
Momentum (US stocks)	Long momentum (+1.0%/yr)	Prefer opposite (-0.2%/yr)
Quality (US stocks)	Prefer lower quality (-2.2%/yr)	Same (-0.7%/yr)
Momentum (index time series)	Long outperforming indexes, short underperformers (+1.5%/yr)	Same (+0.3%/yr)
Equity Volatility	Long straddles (-0.8%/yr)	Short straddles (+0.1%/yr)
FX Carry	Long currency carry (+0.2%/yr)	Weakly short currency carry (-0.0%/yr)

To summarize, in the post-crisis period, hedge fund managers as a group, whatever active strategies they pursue, have maintained relatively consistent exposures to market risks, reduced active risk and exposures to systematic research factors (and in some cases, reversed their exposures), and have added little to no idiosyncratic alpha.

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