

We put forth the notion of using a Crisis Utility Ranking in lieu of more traditional approaches to defining tail risk. We argue that tail risk is generally defined too narrowly, focusing only on immediate loss potential. We feel a definition that includes both loss and resiliency better fits the effects of tail risk as it is observed in practice given that allocations are sticky and high water marks can create attractive fee structures. We then rank popular hedge fund strategies on this basis.

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Analyzing Tail Risk Using Crisis Utility Rankings

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ABSTRACT

In this paper, we put forth the notion of “Crisis Utility” as a way of estimating the tail risk of an asset or investment strategy. We believe that Crisis Utility is more functional than traditional, narrowly defined definitions of tail risk since it incorporates the concept of “resiliency,” or recovery rate, as well as the traditional concept of maximum loss potential. Our argument for the inclusion of resiliency comes from our observations of the recent credit crisis. During the depths of the crisis we observed (1) that allocations, particularly institutional allocations, were “sticky,” which is to say that investors either had trouble adjusting asset allocations or were not inclined to do so, and (2) high water marks, or the arrangement that allows investors to recoup losses before a manager can charge additional performance fees, proved to be a significant benefit for resilient strategies. In an environment of sticky allocations and high water marks, we feel that the resiliency of a strategy becomes an important allocation point, particularly for institutions seeking to make long-term, strategic allocations as opposed to short-term, tactical allocations. Our study shows that lower volatility, low correlation strategies have a demonstrably higher Crisis Utility Rating than higher volatility, high correlation strategies. Specifically, using the HFR dataset, we found the strategies with the highest Crisis Utility Ranking were Short Bias, Equity Market Neutral, our bond proxy, Relative Value (Total), Systematic Diversified, Merger Arbitrage, Convertible Arbitrage and Fund of Funds: Defensive. We anticipate that these strategies will receive a relative increase in allocations as investors adjust their allocation models to account for tail risk, all else being equal and free of constraint. We also analyze the VIX Index within our Crisis Utility framework and find that it handily outscores all other strategies in our study. Although it is currently difficult to find active long volatility managers, we conclude that this is an important area for growth.

Purpose

The investment losses incurred during the recent credit crisis have called into question many of the current asset allocation practices. Some observers have gone as far as to say that the current asset allocation process is “broken.” Although we think it is an over-reaction to call the process a failure, we do feel there is room for improvement. Specifically, it appears that many investors had been systematically underestimating tail risk. Therefore, it is not surprising that a debate has arisen around the proper way to account for tail risk in the asset allocation process. To our knowledge, this debate has not yet been resolved.

Tail risk, or the fact that we see more extreme asset price moves than the Normal Distribution would suggest, is a particularly troublesome topic for two reasons:

- (1) It creates a very awkward theoretical point. Most of the models that we use to create efficient portfolios are based upon the Normal Distribution of Returns. The acknowledgement of excess tail risk effectively invalidates the Normal Distribution, rendering many asset allocation regimes inefficient at best and possibly even invalid.
- (2) Tail risk is problematic to hedge. In order to hedge against tail risk, investors need strategies that are positively correlated with volatility or negatively correlated with the major asset markets. Unfortunately, most strategies, even alternative strategies, are either positively correlated with the major asset markets or negatively correlated with volatility. The few strategies that truly fit this description, mainly short-bias and long-volatility strategies, have relatively few investment offerings available.

Over time, we are confident that new asset allocation methodologies will emerge that adequately account for tail risk. Developing such a model is, unfortunately, beyond the scope of this paper. However, we believe we can make some predictions as to how these new models will change the average asset allocation mix with respect to individual asset classes.

It is our belief that future allocation mixes will have a higher average weighting to asset classes and strategies that exhibit higher investor utility during periods of crisis. Our reasoning is that an allocation model that explicitly or implicitly accounts for the possibility of a crisis will assign at least some higher utility to asset classes that are desirable during periods of crisis. Barring any additional portfolio constraints to the contrary, we feel this will result in higher average allocations to these strategies than would otherwise be predicted.

With that in mind, we will attempt to examine the performance of several popular hedge fund strategies during periods of crisis with an eye towards assigning a Crisis Utility Ranking to each. This Crisis Utility ranking will attempt to describe the relative desirability of each strategy in a tail event, which for all practical purposes means a financial crisis.

In this paper, we will use the terms “Tail Risk” and “Crisis Utility” somewhat interchangeably. Effectively, they can both describe the same concept except from different angles. An asset or strategy with a high Tail Risk is expected to be undesirable in a financial crisis whereas an asset or strategy with a high Crisis Utility is expected to be desirable in a financial crisis. An important distinction between the two is that some people define “Tail Risk” very narrowly. However, to our knowledge, “Crisis Utility” is a term of our own invention, which gives us the luxury of defining it a bit more broadly to fit what we see as the practical effects of a financial crisis on a portfolio.

If our theory proves sound, we hope these rankings will be of use in two general areas. For investors, these rankings might be used to institute a sort of qualitative overlay to their asset allocation process if they do not currently take into account tail risk in their primary analysis. For money managers, these rankings might give some insights into which strategies will attract more investors in the future, which may assist in their growth plans.

Method

In this paper we will examine several asset class returns during periods of financial crisis, which are typically marked by extreme price movements (tail risk). For each crisis period, we will evaluate tail risk for several strategies to establish a Crisis Utility Ranking for each strategy. This ranking will attempt to describe the relative utility of each strategy during a tail event.

Our approach to evaluating the Crisis Utility of asset classes is to look at two measures: Loss Potential and Resiliency. To evaluate the Loss Potential of a strategy, we calculate the Maximum Drawdown, or the maximum loss the strategy sustained during the crisis. This is a fairly straightforward and intuitive measure of risk as it deals with the most visible impact of a tail event: immediate monetary loss.



However, we feel that “Resiliency” is another useful, although often overlooked, metric that can help us evaluate tail risk. We define the notion of “Resiliency” to be the amount of time it takes a strategy to recover from a loss. Perhaps it is so often overlooked because we so closely associate “risk” with loss and not recovery.¹ However, when we are trying to evaluate tail risk, we are essentially trying to develop a sense of the practical effect a crisis would have on the asset class and, by extension, our portfolio. One of the things we observed during the recent credit crisis was that the ability for investors to change asset allocations during a crisis is somewhat limited. This can be due to structural/temporal redemption issues, legal constraints, redemption gates, liquidity constraints, due diligence timeframes or internal politics and policies. In an environment of sticky allocations, the time it takes to recoup the losses of a strategy can become a significant allocation point.

In addition, investors should pay particular attention to resiliency when allocating to hedge fund strategies because of the benefits of high water marks. High water marks allow investors to recoup losses before any performance fees are assessed. Investors in highly resilient strategies will benefit the most from this fee structure on the backside of a financial crisis whereas investors in minimally resilient strategies may not even recoup all their losses before the next crisis starts. It is important to note that new funds committed to a strategy during a crisis do not receive a high water mark benefit.

Data Sets

In examining crisis periods, we chose to break our analysis into two separate event types: a “minor crisis” environment and a “major crisis” environment. Our view is that there is sufficient difference in the behavior of asset classes between these two types of events as to warrant independent categories. The semantics here can get a bit messy, but we generally consider a “minor crisis” to be a market sell-off based on a narrow set of financial shocks which we can expect to occur every 7 years or so. The bursting of the tech bubble in the early 2000s would be a good example of such a crisis. The recession in the early 90s and the Russian Debt Crisis in 1998 would also be good examples, albeit those were less impactful to the general financial markets. In contrast to a minor crisis, we consider a “major crisis” to be a severe, liquidity-based sell-off prompted by a broad set of financial shocks, or one extraordinarily large shock. We would only expect a major crisis to occur every 50-100 years or so, with the last one being our recent credit crisis.

As our interests lie primarily in hedge fund strategies, we decided to focus our analysis on the Hedge Fund Research Monthly Index and its sub-strategies along with a general equity proxy (the MSCI World Gross Total Return Index) and a general bond proxy (the JPM Global Aggregate Bond Index). This puts a constraint on our data set since we are only able to access HFR Index returns going back to 1990. However, it is fortunate that this period covers three examples of minor crises and one example of a major crisis.

In an effort to limit the subjectivity of our study, we decided to use our equity proxy to define the beginning and end of each crisis period. We considered the start of the crisis to be the month the equity proxy peaked and the end of the crisis to be the month where the equity proxy showed a sustained recovery to pre-crisis levels. Our theory is that equity investors generally keep a keen eye on financial shocks and are quick to respond, although we concede that this assumption may at times seem a bit overly ambitious. As a result, we have defined the following crisis periods, which we refer to with their starting year:

Period Name	Start Month	End Month	Scenario
1990 Crisis	July 1990	December 1991	Minor Crisis
1998 Crisis	June 1998	November 1998	Minor Crisis
2000 Crisis	February 2000	January 2006	Minor Crisis
2007 Crisis	October 2007	Ongoing	Major Crisis

Minor Crisis Maximum Drawdown Rankings

First, we will analyze the drawdown data for our strategies. Table 1 shows the maximum drawdown for all the strategies in our dataset over the three minor crises and one major crisis we have identified since December 1989. Returns are gross total returns, net fees and expenses, as reported by HFR and Bloomberg. We then ranked the 35 strategies in descending order of return for each of the crisis periods so that the best performing strategy for that time period would be assigned a rank of 35 while the worst performing would be assigned a 1. We point out that several of the strategies did not have data going back to 1990 and one of the strategies did not have data in 1998. These omissions serve to lower the validity of our comparison, but we felt that there was enough benefit in including the earlier time periods to outweigh the absence of some returns.

Table 1: Maximum Drawdown from Pre-Crisis to Trough in Asset Class							
1990 Crisis – Minor		1998 Crisis – Minor		2000 Crisis - Minor		2007 Crisis - Major	
Short Bias	21.6%	Short Bias	23.0%	Short Bias	138.5%	Short Bias	46.9%
FOF: Market Defensive	4.0%	Private Issue/Reg D	2.5%	Equity Market Neutral	2.6%	FOF: Market Defensive	0.2%
FOF: Diversified	1.9%	JPM Global Agg Bond	0.3%	Merger Arbitrage	2.5%	Macro (Total)	-0.9%
Equity Market Neutral	1.8%	Systemic Diversified	0.0%	Convertible Arbitrage	1.8%	JPM Global Agg Bond	-1.1%
FoF Composite	1.6%	Equity Market Neutral	-1.9%	Relative Value (Total)	1.4%	Systemic Diversified	-4.4%
FOF: Conservative	0.7%	Convertible Arbitrage	-4.2%	Yield Alternatives	1.0%	FI-Asset Backed	-5.0%
FOF: Strategic	-0.4%	Macro (Total)	-5.7%	Sector - Energy/Mats	-0.6%	Equity Market Neutral	-6.8%
Relative Value (Total)	-0.5%	Merger Arbitrage	-6.2%	FOF: Market Defensive	-0.7%	Merger Arbitrage	-8.1%
JPM Global Agg Bond	-0.8%	FOF: Conservative	-6.3%	Multi-Strategy	-1.3%	Private Issue/Reg D	-12.2%
Equity Hedge (Total)	-1.9%	Relative Value (Total)	-6.6%	FOF: Conservative	-1.8%	Relative Value (Total)	-17.9%
Systemic Diversified	-2.1%	Multi-Strategy	-7.6%	FI-Asset Backed	-2.0%	FOF: Conservative	-20.4%
Convertible Arbitrage	-2.7%	Equity Hedge (Total)	-8.3%	Event-Driven (Total)	-2.2%	Wgt Composite GBP	-20.7%
Multi-Strategy	-2.8%	Yield Alternatives	-8.6%	JPM Global Agg Bond	-2.4%	Multi-Strategy	-21.2%
Wgt Composite GBP	-4.2%	FOF: Market Defensive	-8.7%	Distressed/Restructure	-2.5%	Wgt Composite	-21.4%
Macro (Total)	-4.7%	Wgt Composite GBP	-8.8%	FI-Corporate	-3.0%	Sector - Tech/Health	-21.4%
Wgt Composite CHF	-5.1%	EM: Asia ex-Japan	-9.2%	Systemic Diversified	-3.3%	Wgt Composite EUR	-21.5%
Wgt Composite JPY	-5.2%	Wgt Composite	-9.4%	Wgt Composite	-4.8%	FOF: Diversified	-21.8%
Merger Arbitrage	-5.4%	Wgt Composite CHF	-9.7%	FoF Composite	-4.9%	FoF Composite	-22.2%
Wgt Composite	-5.4%	Event-Driven (Total)	-10.0%	Macro (Total)	-5.2%	Wgt Composite CHF	-23.0%
Distressed/Restructure	-8.1%	Wgt Composite JPY	-10.0%	Wgt Composite GBP	-5.2%	Wgt Composite JPY	-23.4%
Event-Driven (Total)	-8.7%	FoF Composite	-11.8%	FOF: Diversified	-5.9%	Event-Driven (Total)	-24.8%
FI-Corporate	-17.1%	FI-Corporate	-12.1%	Wgt Composite EUR	-6.2%	FI-Corporate	-25.6%
EM (Total)	-18.0%	FI-Asset Backed	-12.1%	Wgt Composite CHF	-7.4%	FOF: Strategic	-26.8%
EM: Asia ex-Japan	-18.0%	FOF: Diversified	-12.5%	Equity Hedge (Total)	-8.8%	Distressed/Restructure	-27.4%
Quantitative Directional	-18.0%	Distressed/Restructure	-12.8%	Private Issue/Reg D	-9.5%	Yield Alternatives	-27.7%
MSCI World TR	-18.9%	MSCI World TR	-13.4%	FOF: Strategic	-12.2%	EM: Latin America	-30.5%
Private Issue/Reg D	NA	EM: Latin America	-14.7%	Wgt Composite JPY	-12.3%	Equity Hedge (Total)	-30.6%
Sector - Energy/Mats	NA	Quantitative Directional	-15.8%	EM: Global	-18.1%	Quantitative Directional	-31.1%
Sector - Tech/Health	NA	Sector - Tech/Health	-16.1%	EM: Russia/E Eur	-18.9%	EM: Global	-32.6%
EM: Global	NA	Sector - Energy/Mats	-17.6%	EM (Total)	-20.1%	Convertible Arbitrage	-35.3%
EM: Latin America	NA	FOF: Strategic	-17.6%	Quantitative Directional	-28.2%	EM: Asia ex-Japan	-37.6%
EM: Russia/E Eur	NA	EM (Total)	-25.2%	EM: Asia ex-Japan	-30.8%	Sector - Energy/Mats	-39.4%
Wgt Composite EUR	NA	EM: Global	-31.2%	EM: Latin America	-32.0%	EM (Total)	-39.8%
FI-Asset Backed	NA	EM: Russia/E Eur	-49.2%	MSCI World TR	-46.3%	MSCI World TR	-53.7%
Yield Alternatives	NA	Wgt Composite EUR	NA	Sector - Tech/Health	-49.6%	EM: Russia/E Eur	-62.5%

Source: Hedge Fund Research, Inc., ©2010, www.hedgefundresearch.com; Bloomberg; internal calculations

Table 2 shows the strategies ranked by return for the three minor crisis periods along with an average for the three periods, if applicable. What stands out relatively quickly is that the top 5 strategies in aggregate tend to fairly consistently rank in the top 5 for each of the crises while the bottom 5 strategies tended to rank in the bottom 5 for each of the crises. This gives us a fairly high degree of confidence when it comes to concluding which strategies are best to have in a minor crisis and which are the worst, at least from the standpoint of maximum drawdown.

Not surprisingly, Short Bias shows up as the top performing strategy for each of the crisis periods in our study due to its strong negative correlation with equity. Equity Market Neutral, Convertible Arbitrage and Relative Value (Total) take the #2 through #4 spots, respectively. These rankings also make sense to us as these strategies typically have a low correlation to equity and a low volatility profile, particularly so in the case of Equity Market Neutral. Rounding out the top five we have a Fund of Funds index, FOF: Market Defensive. We are not privy to the constituency of that index, but it does appear to live up to its billing from the standpoint of outperforming to the downside.

Table 2: Risk Rankings for Minor Crisis

Strategy	1990	1998	2000	Average	Average Dev
Short Bias	35	35	35	35	-
Equity Market Neutral	32	31	34	32	1
Convertible Arbitrage	24	30	32	29	3
Relative Value (Total)	28	26	31	28	2
FOF: Market Defensive	34	22	28	28	4
JPM Global Agg Bond	27	33	23	28	4
FOF: Conservative	30	27	26	28	2
Yield Alternatives	NA	23	30	27	4
Merger Arbitrage	18	28	33	26	6
Systematic Diversified	25	32	20	26	4
Multi-Strategy	23	25	27	25	1
Private Issue/Reg D	NA	34	11	23	12
Macro (Total)	21	29	17	22	4
FoF Composite	31	15	18	21	6
Equity Hedge (Total)	26	24	12	21	6
FOF: Diversified	33	12	15	20	9
Wgt Composite GBP	22	21	16	20	2
FI-Asset Backed	NA	13	25	19	6
Event-Driven (Total)	15	17	24	19	4
Wgt Composite	17	19	19	18	1
Sector - Energy/Mats	NA	6	29	18	12
Wgt Composite CHF	20	18	13	17	3
Distressed/Restructure	16	11	22	16	4
FI-Corporate	14	14	21	16	3
FOF: Strategic	29	5	10	15	10
Wgt Composite JPY	19	16	9	15	4
Wgt Composite EUR	NA	NA	14	14	
EM: Asia ex-Japan	12	20	4	12	5
Quantitative Directional	11	8	5	8	2
EM (Total)	13	4	6	8	4
MSCI World TR	10	10	2	7	4
EM: Latin America	NA	9	3	6	3
EM: Global	NA	3	8	6	3
EM: Russia/E Eur	NA	2	7	5	3
Sector - Tech/Health	NA	7	1	4	3

We did not feel surprised by the bottom 5 performers either. They were dominated by high volatility strategies with fairly high equity correlations such as Emerging Markets, Sector – Tech/Health and the equity index itself. The performance was fairly consistent across all three minor crisis periods.

Although many of the strategies performed consistently well or consistently poorly, it is interesting to note that such was not the case for all strategies. The Private Issue/Reg D strategy and the Sector – Energy/Mats strategy both performed quite well during one of the crises and quite poorly during another. FOF: Diversified and FOF: Strategic both performed brilliantly in the 1990 crisis and less well thereafter.

Minor Crisis Resiliency Rankings

Next, we will examine the resiliency of these strategies. As we mentioned before, in practice, asset allocation changes in the heat of a financial crisis are difficult. Against such a backdrop, strategies that recoup their losses faster are more desirable than strategies that may be a continued drag on performance. In Table 3, we have calculated the date where each strategy showed a sustained recovery from its trough during the crisis to its pre-crisis levels. To emphasize the importance of this statistic, note that some strategies were not able to recover their losses prior to the next crisis. In a world where allocations are sticky and high water marks can create attractive fee structures, this can become an important allocation point, particularly for investors looking to make infrequent, long-term allocations rather than short-term tactical allocations.

TABLE 3: Sustained Recovery Dates from Trough to Pre-Crisis Levels: HFRI Sub Indexes, JPM Global Agg Bond, MSCI World TR

1990 Crisis		1998 Crisis		2000 Crisis		2007 Crisis	
Equity Market Neutral	No Loss	Short Bias	No Loss	Merger Arbitrage	No Loss	Short Bias	No Loss
Short Bias	No Loss	Private Issue/Reg D	No Loss	Equity Market Neutral	No Loss	FOF: Market Defensive	No Loss
FOF: Conservative	Aug-90	Systematic Diversified	No Loss	Short Bias	No Loss	Macro (Total)	Dec-07
FOF: Diversified	Aug-90	JPM Global Agg Bond	No Loss	Relative Value (Total)	No Loss	Systematic Diversified	Feb-08
FOF: Market Defensive	Aug-90	Equity Hedge (Total)	Nov-98	Convertible Arbitrage	No Loss	JPM Global Agg Bond	Nov-08
FoF Composite	Aug-90	MSCI World TR	Nov-98	Yield Alternatives	Apr-00	FI-Asset Backed	May-09
FOF: Strategic	Sep-90	Sector - Tech/Health	Nov-98	Sector - Energy/Mats	May-00	Merger Arbitrage	Aug-09
JPM Global Agg Bond	Sep-90	Convertible Arbitrage	Dec-98	FOF: Market Defensive	May-00	Convertible Arbitrage	Sep-09
Relative Value (Total)	Sep-90	Equity Market Neutral	Dec-98	Event-Driven (Total)	Jun-00	Relative Value (Total)	Oct-09
Systematic Diversified	Nov-90	Merger Arbitrage	Dec-98	Multi-Strategy	Jul-00	Multi-Strategy	Jan-10
Macro (Total)	Dec-90	Quantitative Directional	Dec-98	FOF: Conservative	Aug-00	Sector - Tech/Health	Mar-10
Multi-Strategy	Dec-90	Wgt Composite GBP	Jan-99	Systematic Diversified	Aug-00	FI-Corporate	Mar-10
Equity Hedge (Total)	Jan-91	EM: Asia ex-Japan	Mar-99	FI-Asset Backed	Aug-00	Distressed/Restructure	DNR
Wgt Composite GBP	Jan-91	EM: Latin America	Mar-99	JPM Global Agg Bond	Nov-00	Private Issue/Reg D	DNR
Merger Arbitrage	Feb-91	Wgt Composite	Mar-99	Distressed/Restructure	Jan-01	Equity Market Neutral	DNR
Quantitative Directional	Feb-91	Event-Driven (Total)	Apr-99	Macro (Total)	Mar-01	Quantitative Directional	DNR
Wgt Composite	Feb-91	Macro (Total)	Apr-99	EM: Russia/E Eur	May-01	Sector - Energy/Mats	DNR
Wgt Composite CHF	Feb-91	Relative Value (Total)	Apr-99	Wgt Composite	Nov-01	EM (Total)	DNR
Wgt Composite JPY	Feb-91	Wgt Composite CHF	Apr-99	Wgt Composite GBP	Nov-01	EM: Asia ex-Japan	DNR
Convertible Arbitrage	Mar-91	Wgt Composite JPY	Apr-99	FI-Corporate	Nov-01	EM: Global	DNR
Distressed/Restructure	Mar-91	FOF: Conservative	May-99	Wgt Composite EUR	Dec-01	EM: Latin America	DNR
Event-Driven (Total)	Mar-91	Distressed/Restructure	Jun-99	FoF Composite	Jan-02	EM: Russia/E Eur	DNR
FI-Corporate	Mar-91	FOF: Diversified	Jun-99	FOF: Diversified	Jan-03	Equity Hedge (Total)	DNR
EM (Total)	May-91	FoF Composite	Jun-99	EM (Total)	Apr-03	Event-Driven (Total)	DNR
EM: Asia ex-Japan	Jul-91	Multi-Strategy	Jun-99	Private Issue/Reg D	May-03	FOF: Conservative	DNR
MSCI World TR	Dec-91	Sector - Energy/Mats	Jun-99	EM: Global	May-03	FOF: Diversified	DNR
EM: Global	NA	FOF: Strategic	Oct-99	Wgt Composite CHF	May-03	FOF: Strategic	DNR
EM: Latin America	NA	EM (Total)	Nov-99	Equity Hedge (Total)	Jul-03	FoF Composite	DNR
EM: Russia/E Eur	NA	FOF: Market Defensive	Nov-99	EM: Asia ex-Japan	Sep-03	Wgt Composite	DNR
FI-Asset Backed	NA	EM: Global	Jan-00	Wgt Composite JPY	Sep-03	MSCI World TR	DNR
Private Issue/Reg D	NA	EM: Russia/E Eur	DNR	Quantitative Directional	Oct-03	Wgt Composite CHF	DNR
Sector - Energy/Mats	NA	FI-Asset Backed	DNR	EM: Latin America	Nov-03	Wgt Composite EUR	DNR
Sector - Tech/Health	NA	FI-Corporate	DNR	FOF: Strategic	Nov-03	Wgt Composite GBP	DNR
Wgt Composite EUR	NA	Yield Alternatives	DNR	MSCI World TR	Jan-06	Wgt Composite JPY	DNR
Yield Alternatives	NA	Wgt Composite EUR	NA	Sector - Tech/Health	DNR	Yield Alternatives	DNR

Source: Hedge Fund Research, Inc., ©2010, www.hedgefundresearch.com; Bloomberg; internal calculations

TABLE 4: Resiliency Rankings for a Minor Crisis

Strategy	1990	1998	2000	Average	Average Dev
Short Bias	35	35	35	35	-
Equity Market Neutral	35	27	35	32	4
JPM Global Agg Bond	28	35	22	28	4
Systematic Diversified	26	35	24	28	4
Merger Arbitrage	21	26	35	27	5
Relative Value (Total)	27	18	35	27	6
Convertible Arbitrage	16	28	35	26	7
FOF: Conservative	33	15	25	24	6
Private Issue/Reg D		35	11	23	12
FOF: Market Defensive	31	7	28	22	10
Macro (Total)	25	19	20	21	2
Wgt Composite GBP	22	24	17	21	3
Equity Hedge (Total)	23	31	8	21	8
Multi-Strategy	24	11	26	20	6
Event-Driven (Total)	14	20	27	20	4
Sector - Energy/Mats		10	29	20	10
FOF: Diversified	32	13	13	19	8
Wgt Composite	19	21	18	19	1
FoF Composite	30	12	14	19	8
Distressed/Restructure	15	14	21	17	3
Quantitative Directional	20	25	5	17	8
Yield Alternatives		1	30	16	15
Sector - Tech/Health		29	1	15	14
Wgt Composite EUR			15	15	
Wgt Composite CHF	18	17	9	15	4
MSCI World TR	10	30	2	14	11
FOF: Strategic	29	9	3	14	10
EM: Asia ex-Japan	11	23	7	14	6
Wgt Composite JPY	17	16	6	13	5
EM: Latin America		22	4	13	9
FI-Asset Backed		1	23	12	11
EM (Total)	12	8	12	11	2
FI-Corporate	13	1	16	10	6
EM: Russia/E Eur		1	19	10	9
EM: Global		6	10	8	2

When we analyze the resiliency data for a minor crisis, we find that rankings are a bit more volatile. Like the drawdown data, the top 5 resilient strategies are fairly consistently ranked in the top 5 for each of the minor crises. However, unlike the drawdown data, the bottom 5 strategies are not particularly consistent across the three minor crises. Emerging Markets: Russia/E Europe did poorly during the 1998 crisis, which makes sense given the nature of the crisis, but did comparatively better in the 2000 crisis (no data for the 1990 crisis). A similar pattern was seen for Fixed Income Asset Backed and Fixed Income Corporate. Most notably, Yield Alternatives and Equity Sector Tech/Health had wild swings in recovery times, although neither had 1990 data.

Although there is a somewhat uncomfortable degree of variation in the data across the three minor crises, we do have some confidence in the rankings due to the consistency of the top performers. If we accept that resiliency is a desirable trait in a strategy, then it stands to reason that we would want to assign a high utility to strategies that were consistently resilient and a lower utility to strategies that recover either inconsistently or consistently poorly.

Crisis Utility Rankings: Minor Crisis Combined

After separating the notion of Crisis Utility into the concepts of Maximum Drawdown and Resiliency, we now have to re-combine our rankings to create one single Crisis Utility Ranking that describes the tail risk of a strategy in a minor crisis. A natural approach to this is to take some sort of an average of the Maximum Drawdown ranking and the Resiliency ranking. Some may wish to take a weighted average, assigning a higher weight to either Drawdown or Resiliency with many opinions abounding. Our approach is to take a straight average between the two figures as we feel that each statistic has equal import to institutional investors, who are typically interested in making strategic, long term allocations as opposed to short-term tactical allocations.

Our calculations show that the top 5 ranked strategies for Crisis Utility in a minor crisis are: Short Bias, Equity Market Neutral, JPM Global Agg Bond, Convertible Arbitrage and Relative Value (Total). We find these assignments to be reasonably intuitive. Short Bias ranked consistently and invariably at the top across all Credit Utility metrics in each of the minor crises we examined, largely because it was the only strategy to make money in each of the minor crises we examined. Equity Market Neutral also ranked consistently highly in all scenarios, which we attribute to its low volatility and low equity correlation. The JPM Global Aggregate Bond Index fared well,

TABLE 5: Crisis Utility Rankings for Minor Crisis

Strategy	Drawdown	Resiliency	Average
Short Bias	35	35	35
Equity Market Neutral	32	32	32
JPM Global Agg Bond	28	28	28
Convertible Arbitrage	29	26	28
Relative Value (Total)	28	27	28
Systematic Diversified	26	28	27
Merger Arbitrage	26	27	27
FOF: Conservative	28	24	26
FOF: Market Defensive	28	22	25
Private Issue/Reg D	23	23	23
Multi-Strategy	25	20	23
Macro (Total)	22	21	22
Yield Alternatives	27	16	21
Equity Hedge (Total)	21	21	21
Wgt Composite GBP	20	21	20
FoF Composite	21	19	20
FOF: Diversified	20	19	20
Event-Driven (Total)	19	20	20
Wgt Composite	18	19	19
Sector - Energy/Mats	18	20	19
Distressed/Restructure	16	17	17
Wgt Composite CHF	17	15	16
FI-Asset Backed	19	12	16
Wgt Composite EUR	14	15	15
FOF: Strategic	15	14	14
Wgt Composite JPY	15	13	14
FI-Corporate	16	10	13
EM: Asia ex-Japan	12	14	13
Quantitative Directional	8	17	12
MSCI World TR	7	14	11
EM: Latin America	6	13	10
Sector - Tech/Health	4	15	10
EM (Total)	8	11	9
EM: Russia/E Eur	5	10	7
EM: Global	6	8	7

although it was boosted slightly in our analysis by excellent performance during the 1998 crisis that was not fully repeated in the 1990 and 2000 crises. Convertible arbitrage also scored well, which we attribute to its low equity correlation and generally positive current income. It is interesting that convertible arbitrage turned in such a good overall performance despite a relatively poor performance in the 1990 crisis, a period where convertible arbitrage was in its infancy. Relative Value (Total) received high rankings, which we also attribute to low equity correlation.

Credit Utility Rankings: Major Crisis Combined

Armed with our rankings for Crisis Utility in a minor crisis, we now set our sights for establishing rankings for Crisis Utility in a major crisis, the 2007 crisis. Using the same methodology, we obtain the rankings seen in Table 6. Unfortunately, or fortunately in some respects, we only have one time period that qualifies as a major crisis during our analysis horizon. Although this crisis is still ongoing from the standpoint of our definitions, we can glean some conclusions from the data if we assume that the worst of the crisis is now behind us.

The first observation one is likely to make from the data in Table 6 is that many of the strategies have received the lowest resiliency rating. This is because these strategies have yet to recover to pre-crisis levels. Having so many strategies still in a loss position presents a bit of a problem for analysis. Surely, it is unfair to group all the strategies that have yet to recover in one category together. There are undoubtedly some strategies that have recovered more of their losses than others, but we also feel it is incorrect to assume that just because one strategy has recovered more of their losses than another that it will ultimately recover all their losses sooner. For example, one strategy may have encountered a higher degree of technical or forced selling than another. This would create an artificially large maximum loss and the resulting snap-back could be mis-read as higher resiliency.

Additionally, we do want to make a clear distinction between strategies that have been able to recover and strategies that have not. In fact, some of the higher resiliency strategies have not only recovered their losses, they have gone on to make reasonable gains. This highlights our point around the value of resiliency as an investment trait.

Based upon our criteria and analysis, the 5 highest ranked strategies from the standpoint of Crisis Utility in a major crisis are Short Bias, FOF Market Defensive, Macro, JPM Global Agg Bond Index and Systematic Diversified. Surprisingly, there is quite a bit of deviation between the rankings for minor and major crises, which we believe validates the practice of looking at each type of crisis separately. It appears that Relative Value drifted a few places out of the top 5 largely by displacement, but there were some interesting and dramatic shifts that warrant investigation:

TABLE 6: Crisis Utility Rankings for Major Crisis

Strategy	Drawdown	Resiliency	Average
Short Bias	35	35	35
FOF: Market Defensive	34	35	35
Macro (Total)	33	33	33
JPM Global Agg Bond	32	31	32
Systematic Diversified	31	32	32
FI-Asset Backed	30	30	30
Merger Arbitrage	28	29	29
Relative Value (Total)	26	27	27
Multi-Strategy	23	26	25
Sector - Tech/Health	21	25	23
FI-Corporate	14	24	19
Convertible Arbitrage	6	28	17
Equity Market Neutral	29	1	15
Private Issue/Reg D	27	1	14
FOF: Conservative	25	1	13
Wgt Composite GBP	24	1	13
Wgt Composite	22	1	12
Wgt Composite EUR	20	1	11
FOF: Diversified	19	1	10
FoF Composite	18	1	10
Wgt Composite CHF	17	1	9
Wgt Composite JPY	16	1	9
Event-Driven (Total)	15	1	8
FOF: Strategic	13	1	7
Distressed/Restructure	12	1	7
Yield Alternatives	11	1	6
EM: Latin America	10	1	6
Equity Hedge (Total)	9	1	5
Quantitative Directional	8	1	5
EM: Global	7	1	4
EM: Asia ex-Japan	5	1	3
Sector - Energy/Mats	4	1	3
EM (Total)	3	1	2
MSCI World TR	2	1	2
EM: Russia/E Eur	1	1	1

1. FOF Market Defensive rises to the #2 slot. Although we do not have access to the exact makeup of strategies that go into this index, it does seem more befitting the name. By removing its rather poor 1998 performance, the strategy gains significantly in Crisis Utility ranking.

2. Macro rose up from a fairly consistent mid-pack performer during the minor crises to the third highest rank. It is unclear to us why this should happen during a major crisis versus a minor. However, we believe the strategy to have low equity correlation and broad mandates, which allows for a good deal of performance variance, in our opinion.

3. Convertible Arbitrage drops to the middle of the pack and it would be a lot lower if not for its high resiliency ranking. The culprit was the maximum drawdown ranking, which was well below the rankings the strategy attained during the minor crises. In our opinion, the strategy suffered more in the 2007 crisis versus the prior crises because of factors internal to the strategy. In particular, the amount of leverage used in the strategy increased significantly from 2001 to 2007, which set up for a dramatic wave of deleveraging and technical selling in October 2008 in the face of the Lehman debacle. We believe it is unlikely that leverage providers will allow the same high leverage levels we saw in 2008 given the damage done to the convertible re-hypothecation market. While we will let the rankings stand as they are, there has been some studies that suggests that the credit crisis has lead to a lower leverage profile and greater

diversification of the convertible universe which could provide for a higher Crisis Utility Ranking in a future major crisis. ⁱⁱ

- Equity Market Neutral received high marks for its maximum drawdown rankings, similar to the minor crises. However, it has yet to recover its losses, which is a departure from the minor crises, where it showed no loss 2 out of 3 times and only a slight loss on the third, which it recovered relatively quickly. The unusually long recovery time might be due to the larger than average loss and a relatively low volatility/low expected return profile.

Crisis Utility Ranking: Total Combined Rankings

TABLE 7: Overall Crisis Utility Rankings

Strategy	Minor Crisis	Major Crisis	Weighted Average
Short Bias	35	35	35.0
Equity Market Neutral	32	15	30.8
JPM Global Agg Bond	28	32	28.3
Relative Value (Total)	28	27	27.4
Systematic Diversified	27	32	27.4
Merger Arbitrage	27	29	27.0
Convertible Arbitrage	28	17	26.5
FOF: Market Defensive	25	35	25.9
FOF: Conservative	26	13	24.8
Macro (Total)	22	33	22.8
Multi-Strategy	23	25	22.8
Private Issue/Reg D	23	14	22.0
Yield Alternatives	21	6	19.6
Wgt Composite GBP	20	13	19.6
Equity Hedge (Total)	21	5	19.2
FoF Composite	20	10	19.0
FOF: Diversified	20	10	18.8
Event-Driven (Total)	20	8	18.5
Wgt Composite	19	12	18.2
Sector - Energy/Mats	19	3	17.0
FI-Asset Backed	16	30	16.8
Distressed/Restructure	17	7	15.6
Wgt Composite CHF	16	9	15.2
Wgt Composite EUR	15	11	14.1
FI-Corporate	13	19	13.7
FOF: Strategic	14	7	13.5
Wgt Composite JPY	14	9	13.3
EM: Asia ex-Japan	13	3	11.9
Quantitative Directional	12	5	11.6
Sector - Tech/Health	10	23	10.7
MSCI World TR	11	2	9.8
EM: Latin America	10	6	9.1
EM (Total)	9	2	8.5
EM: Russia/E Eur	7	1	6.7
EM: Global	7	4	6.5

Now that we have calculated Crisis Utility rankings for both major and minor crises, we will combine them to form a total Crisis Utility Ranking. Although it may be tempting to simply average together the Minor Crisis Ranking and the Major Crisis Ranking, we feel a weighted average is more appropriate and defensible. If you consider that we have defined a minor crisis as happening every 7 years or so and a major crisis as happening every 50-100 years, we could defend a weighting of 0.91 for a minor crisis and 0.09 for a major crisis. These weightings reflect a probability that 1 out of every 11 crises will be a major crisis with the remainder being minor crises. As it is, we have identified what we feel are 16 minor crises since the Great Depression and only 1 major crisis, but we feel a bit of conservatism is appropriate in this regard, especially in light of potential differences of opinion regarding the identification of minor crises.

The result is Table 7, which shows the probability weighted overall Crisis Utility Ranking for each strategy. We see a broad theme when we examine the top and bottom quartiles with low equity correlation and/or low volatility strategies ranking best and the converse ranking worst. In the top quartile are Short Bias, Equity Market Neutral, our bond proxy, Relative Value (Total), Systematic Diversified, Merger Arbitrage, Convertible Arbitrage and FOF Market Defensive, all of which are considered low volatility or low correlation strategies. The strategies in the bottom quartile of this list are, by and large, the “high fliers” of the investment world: Emerging Markets, Tech/Healthcare and our equity proxy. Also in the bottom quartile is Quantitative Directional, which is highly correlated with our equity proxy. These results seem intuitive to us.

If our theory and methodology prove to be sound, we would expect that switching to an asset allocation regime that properly incorporates tail risk will cause a relative increase in allocation to the top quartile of this list and a relative decrease in allocation to the bottom quartile, all else being equal. This is not to say that the absolute allocation to any strategy will increase or decrease since there are many other allocation factors that may dominate tail risk

assessment such as expected return and correlation in a normalized environment as well as the changing risk tolerance and return requirements of investors.

Risking repetition for the sake of perfect clarity, just because a strategy ranks poorly here does not mean it is an inherently “bad” strategy the same way that a strategy that ranks well is not necessarily an inherently “good” strategy. We are simply trying to bring an additional descriptive element to the allocation analysis that is not necessarily incorporated into the standard allocation methods prevalently in use.

Alternative Analysis: Shortened Data Set

One immediately identifiable flaw in our analysis is our incomplete data set. Since we are relying on HFR data, and since not all of the strategies were represented in all the minor crises scenarios, it is not a particularly fair analysis

TABLE 8: Overall Crisis Utility Rankings ex-1990

Strategy	Minor Crisis	Major Crisis	Weighted Average
Short Bias	34	34	34.0
Merger Arbitrage	30	28	29.3
Equity Market Neutral	31	14	29.2
Convertible Arbitrage	30	16	29.0
JPM Global Agg Bond	27	31	27.5
Systematic Diversified	27	31	27.1
Relative Value (Total)	27	26	26.4
FOF: Market Defensive	20	34	21.5
Multi-Strategy	21	24	21.5
FOF: Conservative	22	12	21.3
Macro (Total)	20	32	21.3
Private Issue/Reg D	22	13	21.0
Event-Driven (Total)	21	7	19.7
Yield Alternatives	20	5	18.6
Wgt Composite GBP	19	12	17.9
Wgt Composite	18	11	17.5
Equity Hedge (Total)	18	4	16.5
Sector - Energy/Mats	18	2	16.0
FI-Asset Backed	15	29	15.8
Distressed/Restructure	16	6	15.0
FoF Composite	14	9	13.3
Wgt Composite CHF	13	8	12.8
FI-Corporate	12	18	12.5
FOF: Diversified	12	9	12.0
EM: Asia ex-Japan	13	2	11.5
Wgt Composite JPY	11	8	10.5
Sector - Tech/Health	9	22	9.7
Quantitative Directional	10	4	9.2
MSCI World TR	10	1	9.1
EM: Latin America	9	5	8.1
EM (Total)	7	1	6.0
FOF: Strategic	6	6	5.8
EM: Russia/E Eur	6	0	5.7
EM: Global	6	3	5.5

from the standpoint of the minor crises. That is to say, it is not statistically sound to compare strategies which have a different time series of returns. The only solution to this given our data set would be to only include crises where all strategies are represented. This either means cutting out all strategies that don't have data going back to 1990 or cutting out periods where data is not available for all the strategies. If we do the former, we lose 25% of our strategies, which we feel diminishes the analysis excessively. If we do the latter, we are left with only one minor crisis (2000), which is still descriptive, but given the variation in recovery rankings during minor crises, it would be greatly desirable to have more than one data point. However, since the 1998 data was only missing one strategy, a happy compromise might be to eliminate that one strategy and use the data from both the 1998 and 2000 minor crises.

As such, we re-ran the analysis eliminating the 1990 minor crisis, which was missing 9 strategies, but including the data for the 1998 minor crisis and the 2000 minor crisis with the exception of the one strategy that did not have data for the 1998 crisis. The results are in Table 8. As you can see, although the relative positioning of the top quartile names and the bottom quartile names changes somewhat, the names that were in the top quartile for the full data set were still in the top quartile when we exclude the 1990 data. Similarly, the strategies that were in the bottom quartile stayed in the bottom quartile. The fact that the elimination of the 1990 data does not materially alter our analysis gives us some comfort in our conclusions.

Including Volatility as a Strategy

TABLE 9: Overall Tail Risk Rankings Including VIX

Strategy	Minor Crisis	Major Crisis	Weighted Average
VIX	36	36	35.7
Short Bias	35	36	35.3
Equity Market Neutral	32	15	30.8
JPM Global Agg Bond	28	32	28.3
Relative Value (Total)	28	27	27.4
Systematic Diversified	27	32	27.4
Merger Arbitrage	27	29	27.0
Convertible Arbitrage	28	17	26.5
FOF: Market Defensive	25	35	25.9
FOF: Conservative	26	13	24.8
Macro (Total)	22	33	22.8
Multi-Strategy	23	25	22.8
Private Issue/Reg D	23	14	22.0
Yield Alternatives	21	6	19.6
Wgt Composite GBP	20	13	19.6
Equity Hedge (Total)	21	5	19.2
FoF Composite	20	10	19.0
FOF: Diversified	20	10	18.8
Event-Driven (Total)	20	8	18.5
Wgt Composite	19	12	18.2
Sector - Energy/Mats	19	3	17.0
FI-Asset Backed	16	30	16.8
Distressed/Restructure	17	7	15.6
Wgt Composite CHF	16	9	15.2
Wgt Composite EUR	15	11	14.1
FI-Corporate	13	19	13.7
FOF: Strategic	14	7	13.5
Wgt Composite JPY	14	9	13.3
EM: Asia ex-Japan	13	3	11.9
Quantitative Directional	12	5	11.6
Sector - Tech/Health	10	23	10.7
MSCI World TR	11	2	9.8
EM: Latin America	10	6	9.1
EM (Total)	9	2	8.5
EM: Russia/E Eur	7	1	6.7
EM: Global	7	4	6.5

Another analytical exercise which we feel is worthwhile is the inclusion of a long volatility strategy in our analysis. We did not include a long volatility strategy for two practical reasons: (1) there are few managers who provide a consistently positive volatility strategy and (2) there is no HFR sub-index for volatility arbitrage. However, the recent credit crisis has prompted many investors to seek a way to hedge tail risk. There have been several promising academic works that suggest that volatility, taken as an asset class, is one of the best hedges against tail risk. One of our favorite works on the topic is a paper by Kieth Black which was entitled “Improving Hedge Fund Risk Exposures by Hedging Equity Market Volatility, or How the Vix Ate My Kurtosis.”ⁱⁱⁱⁱ In his paper, Black argues that equity volatility, as measured by the CBOE Volatility Index (the “VIX”), is highly effective for hedging against tail risk because (1) it has a negative correlation to equity and (2) it increases in value at an increasing rate during large equity declines. In our opinion, this latter point sets volatility apart from and above short-biased products, which tend to increase in value at a linear rate. The distinction is an important one because tail risk is all about extreme moves, so a strategy that delivers an extra or increasing benefit during extreme moves is more desirable in this regard than one that does not.

If we include the VIX Index in our analysis as a proxy for a long-volatility strategy, we arrive at the results in Table 9. Not surprisingly, the VIX quickly takes top rank among the strategies in our study. Similar to the Short Bias strategy, the VIX showed a positive return for each of the crisis periods in our main data set. It produced higher returns than the short bias strategy in every minor crisis except 2000, where the short bias strategy showed a curiously high return relative to the other crisis

periods. However, in our major crisis scenario, the VIX turned in a significantly higher return than in our minor crises (see Table 10). This seems to support the notion that the VIX produces asymmetrically positive returns during tail events, which may make it an attractive tail risk hedge.

This analysis leads us to believe that demand for long volatility products could increase in any allocation where tail risk is incorporated into an allocation decision.

TABLE 10: VIX vs Short Bias Performance

1990 Crisis		1998 Crisis		2000 Crisis		2007 Crisis	
VIX	42.3%	VIX	124.7%	Short Bias	138.5%	VIX	223.2%
Short Bias	21.6%	Short Bias	23.0%	VIX	67.7%	Short Bias	46.9%

Source: Hedge Fund Research, Inc., ©2010, www.hedgefundresearch.com; Bloomberg

Conclusion

A fundamental premise behind our paper is that traditional definitions of tail risk are defined too narrowly and are not reflective of the practical effects of a financial crisis on an investment portfolio. We believe that the recent credit crisis highlights this point as many investors were unable or unwilling to materially alter their asset allocation during the depths of the crisis. This leads us to believe that a tail risk measurement which includes resiliency is desirable to one that just focuses on maximum loss. In an environment where asset allocations are sticky, the resiliency of a strategy can become an important allocation point.

We therefore put forth the notion of “Crisis Utility” as a more functional definition of tail risk. Our Crisis Utility metric attempts to describe the relative desirability of various strategies in the event of a financial crisis (tail risk event). As such, our Crisis Utility Rankings are made up of two separate scores: one to describe maximum loss potential (Maximum Drawdown) and one to describe resiliency (Time to Recovery). We analyze the HFR Data set along with an equity proxy and a bond proxy to rank the Crisis Utility of each strategy and conclude that (1) the methodology is workable and (2) the conclusions are intuitive.

We find that lower volatility/low correlation strategies rank significantly higher than higher volatility/high correlation strategies. As such, it is our belief that these strategies will receive increased relative allocations going forward as an increasing number of investors incorporate potential tail risk into their asset allocation decisions, all else being equal and free of constraint.

In a separate study, we also found that the CBOE Volatility Index (VIX) would have taken top rank if it were included in our main study, which now leads us down an interesting intellectual path regarding negative correlation strategies. During the course of our analysis, we examined two strategies that had a consistently negative equity correlation: Short equity, which was represented by the HFR Short Bias Index in the main part of our paper, and long volatility, which was represented by the VIX in an additional analysis section of our paper. These two strategies were the only strategies to produce positive returns in all of our crisis scenarios, which is not surprising given their negative equity correlation. This leads us to conclude that both strategies can serve as hedges for tail risk, although we note that long volatility appears preferable to short equity given its asymmetry of return in a crisis scenario.

However, in the anecdotal conversations we have had with investors, they are reluctant to allocate to these strategies because of a perceived low expected return in normalized scenarios. In an attempt to ascertain if this was true, we looked at the pre-1997 crisis returns of both strategies going back to December 1989. We calculated an annualized return of 1.83% for the VIX (not including fees and expenses) and an annualized return for the Short Bias index of 1.33% (including fees and expenses). Although we do believe that investors will increase their allocations to these strategies beyond what traditional allocation methods would predict, it is possible that these low expected returns will limit any increases on an absolute level.

Notwithstanding the foregoing, we note that volatility is being represented in this study by a passive index. In theory, an active manager willing to take a consistent long volatility position might be able to increase the expected return up to acceptable investor levels if they are able to add enough Alpha. This could potentially give investors a more attractive tail risk profile while maintaining the required expected return for the portfolio. In light of this study, we would speculate that such a strategy would have a particularly high general utility for investors, which would spark significant demand for the strategy. Although, to our knowledge, there are currently few active managers willing to take a consistently long volatility exposure, and possibly fewer still that are able to add the

required amount of Alpha, we would consider this an important area for future exploration given the potential investor utility.

¹ Presumably, investor ambivalence around resiliency stems from the belief that investors are free and willing to allocate optimally during the depths of a financial crisis. Specifically, the importance of resiliency can be assumed away if investors were free and willing to allocate away from strategies that have defended well in a crisis and into strategies that will recover quickly. In general, we have observed this not to be the case.

² Ronan Cosgrave, “The return of converts?” *Pacific Alternative Asset Management Company (PAAMCO)*, 2009

³ Keith H. Black, “Improving Hedge Fund Risk Exposures by Hedging Equity Market Volatility, or How the VIX Ate My Kurtosis” *The Journal of Trading*, Spring 2006. (Also, see our October 3, 2006, memo entitled “Article Summary: Improving Hedge Fund Risk Exposures by Hedging Equity Market Volatility”).

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