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RISK MEASUREMENT OF INVESTMENTS IN THE SATELLITE RING OF A CORE-SATELLITE PORTFOLIO: TRADITIONAL VERSUS ALTERNATIVE APPROACHES

HILARY TILL*,†
Premia Risk Consultancy, Inc., Chicago

This paper provides a risk framework for fiduciaries by considering using a core-satellite approach to investing. While the article mainly covers the additional risk measurement techniques, which are needed when investing in hedge funds, its recommendations are also relevant for other investments that have default, devaluation, and/or liquidity risks associated with them. Also, while the article's focus is on quantitative techniques, we note that a fiduciary must also understand the economic basis for each investment's returns.

Keywords: Sharpe ratio; Hedge funds; Risk measurement; Asymmetric risk.

1. Introduction

This article mainly focuses on risk measurement issues for hedge funds. However, most of the issues covered here will also apply to other satellite investments in a core-satellite portfolio, especially those that have default, devaluation, and liquidity risk associated with them. This article will also help fiduciaries understand the return-to-risk trade-offs that may be present in the satellite ring.

Ideally the return-to-risk trade-off could be summarized with one number. One candidate for such a metric is the Sharpe ratio, which is defined as:

$$\text{Sharpe Ratio} = \frac{\text{Average returns} - \text{T-bill returns}}{\text{Standard deviation of returns}}$$

The higher the Sharpe ratio, the better the reward per unit of risk.

Unfortunately as Nobel Laureate William Sharpe himself has noted in Lux (2002), "the Sharpe ratio is oversold." This article will specifically discuss the following topics:

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†Address for Correspondence: Hilary Till, Premia Risk Consultancy, Inc., 505 N. Lake Shore Drive, Suite 402, Chicago, IL 60611, USA; E-Mail: till@premiacap.com.

- Why the Sharpe ratio has become the main performance evaluation metric for investments;
- A number of shortcomings with this approach;
- Several alternative metrics; and finally,
- The need to understand the source of returns for a satellite investment strategy rather than solely relying on summary performance numbers.

2. The Sharpe Ratio

William Sharpe introduced the *reward-to-variability ratio* in 1966 to evaluate the performance of mutual funds. Other authors later referred to this ratio as the *Sharpe ratio*. Sharpe came up with this ratio to provide a way for investors to take into consideration the risk they were incurring to earn an investment's return. He believed that the use of such a ratio was far better than solely evaluating an investment's return.

Until recently it was fine to use the Sharpe ratio to summarize the attractiveness of an investment. The reason for the measure's acceptance is that the predominant investment has been portfolios of large capitalization equities. And by and large, the statistical properties of diversified portfolios of equities have met the restrictive assumptions that should be met before using the Sharpe ratio.

The Sharpe ratio has also been widely used by the alternative investment industry to evaluate their strategies. Because the hallmark of such strategies is the use of leverage, a strategy's returns can be arbitrarily restated, according to the amount of leverage allowed. Exhibit 1 shows how returns can differ solely as a function of their leverage (e.g., Event Driven and Merger Arbitrage have the same levered return but, because of differences in leverage, different delevered returns). These alternative strategies depend on leverage for their double-digit returns. Therefore, to get a clearer picture of the trade-off between return and risk in a leveraged investment, many investors have turned to the Sharpe ratio.

One has to make a number of restrictive assumptions when using the Sharpe ratio to compare investments. Drawing from Sharpe (1994), these assumptions are as follows:

- Historic results have at least some predictive ability;
- The mean and standard deviation of the investment's returns are sufficient statistics for evaluating a portfolio;
- The investment's returns are not serially correlated; that is, they do not trend; and
- The candidate investments have similar correlations with the investor's other assets.

Sharpe cautions that the use of historic Sharpe ratios as the basis for making predictions "is subject to serious question."

3. Shortcomings of the Sharpe Ratio

The key problem with the Sharpe ratio is that an investment has to meet very restrictive assumptions before its use is appropriate, as Sharpe himself has noted. Some authors even advocate that if the Sharpe ratio is used as the evaluation metric for a portfolio's investments, then certain strategies should be disallowed. In other words, only those investments

Exhibit 1. Levered and Delevered Returns by Hedge Fund Strategy 1997–2001

Style	Average Levered Return (%)*	Average Delevered Return (%)*
Short Biased	13.7	9.3
Global Macro	16.8	8.9
Emerging Markets	16.9	8.8
Event Driven	14.7	8.3
Merger Arbitrage	14.7	7.0
Long/Short Equity	14.0	6.3
Fixed Income	9.6	4.8
Convertible Arbitrage	10.6	4.2
Managed Futures	10.5	4.2
Distressed Securities	n/a	n/a

*Leverage analysis was done for funds with 5 year Historical Leverage and performance data.
Author's source: Altvest, CSFB/Tremont, EACM, HFR, Institutional Investor (June 2002), CMRA
Source: Rahl (2002).

that meet the restrictive assumptions underlying the Sharpe ratio should be included in a portfolio. This article takes the opposite point of view: fiduciaries should have complete freedom in deciding amongst investments in their satellite ring, but they should make sure that their evaluation metric is appropriate for their chosen investments.

3.1. *Predictive ability in question*

Does a Sharpe ratio calculated from historical data provide any meaningful information for expected future results? Exhibit 2 indicates that the answer may be "no," especially if one were evaluating investments at the beginning of 2000.

In Exhibit 2, for example, Fidelity Aggressive Growth starts out at the end of 1999 with a relatively high Sharpe ratio. Note, though, that it suffers serious losses in 2000, 2001, and through the summer of 2002, at which point it has a negative Sharpe ratio. The other funds,

Exhibit 2. Historical Risk-Adjusted Returns Are Not Predictive of Future Results

Mutual Fund	Sharpe Ratio 12/30/99	2000 Return	2001 Return	2002 Return*	Sharpe Ratio 8/31/02
Fidelity Aggressive Growth	1.26	−27.1%	−47.3%	−43.6%	−1.07
Janus Twenty	1.47	−32.4%	−29.2%	−21.2%	−0.99
Firsthand Technology Value	0.89	−10%	−44.0%	−56.1%	−0.67
Amerindo Technology	0.74	−64.8%	−50.7%	−42.1%	−1.19
Van Wagoner Emerging Growth	0.70	−11.8%	−47.8%	−42.5%	−0.70

*through August
Author's Data Source: Morningstar.
Source: Lux (2002).

chosen to illustrate this point, demonstrate that Sharpe ratios have not been predictive of future results.

In viewing Exhibit 2, fiduciaries should note that a high Sharpe ratio might indicate that an investment is nearing the end of a successful momentum-based strategy. Further, most asset allocation strategies rely on the principle of mean reversion and rebalance a portfolio whenever investments attain extremely attractive returns. In this context a high Sharpe ratio may be a warning signal to consider allocating away from a manager or fund.

Another example concerns the prominent hedge fund, Long Term Capital Management (LTCM). In September 1996, after 31 months of operation, LTCM reportedly had a Sharpe ratio of 4.35 (after fees). Subsequently LTCM nearly went broke, helping to deepen an international financial crisis. With the benefit of hindsight, we can say that LTCM's realized Sharpe ratio after two and a half years of operation did not give a meaningful indication of how to evaluate its investments.

Another problem with assuming that the Sharpe ratio has predictive ability is that one is assuming that the investment manager's style will not change going forward. Harding (2003) warns that among hedge fund managers:

> "It is common for a manager's early track record to differ significantly from later performance, due to his [or her] ability . . . to exploit a particularly good anomaly with a small amount of money, or because when . . . [the manager] had little to lose . . . [the manager] could afford [to engage in risky investment practices.]"

Harding notes that given how dynamic markets are, it is probably unreasonable to expect no style drift.

3.2. *The mean and standard deviation may not be sufficient*

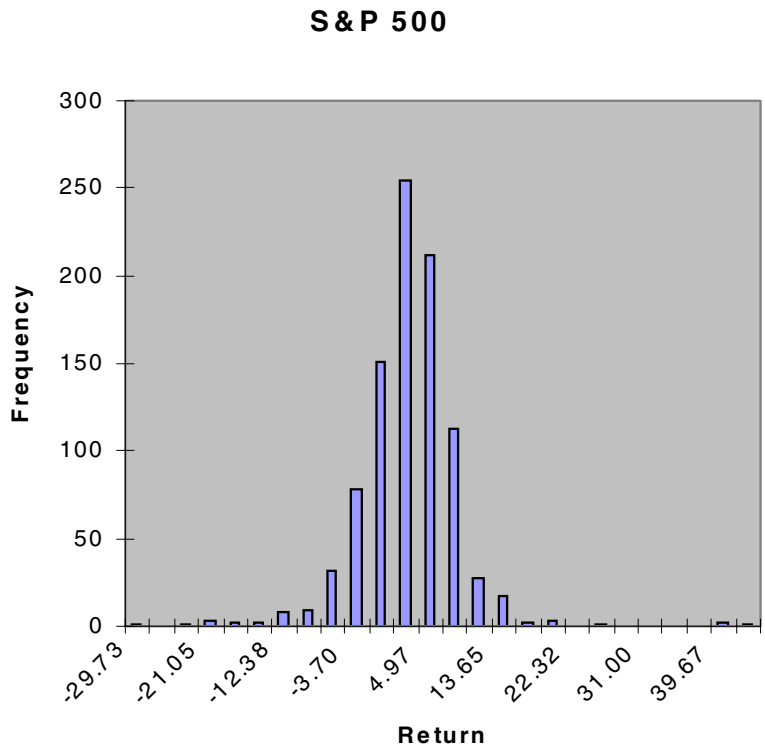
Should one evaluate an investment by solely examining the mean and standard deviation of its returns? The short answer is no, especially if one's investments have highly asymmetric outcomes or contain illiquid securities as with a number of hedge fund strategies.

3.2.1. *Asymmetric outcomes*

The Sharpe ratio identifies risk as the standard deviation of returns around the investment's mean. This approach is appropriate only if the investment's return distribution is symmetric. Because empirical studies from the 1970's showed that diversified large capitalization equity portfolios had returns that appeared to be distributed in a symmetric fashion, the Sharpe ratio became widespread in investment evaluation.

Negatively skewed outcomes

But if an investment's returns are very skewed as with highly leveraged or option-like strategies, the Sharpe ratio is inappropriate. As Leland (1998) points out, one can increase the Sharpe ratio of an investment by selling fairly valued options: in this case, an investor is accepting the possibility of negatively skewed outcomes in exchange for improving the investment's average return.



Source: Hirt and Singleton (2004).

Exhibit 3. Histogram of U.S. Stock Market Returns 1926–2002

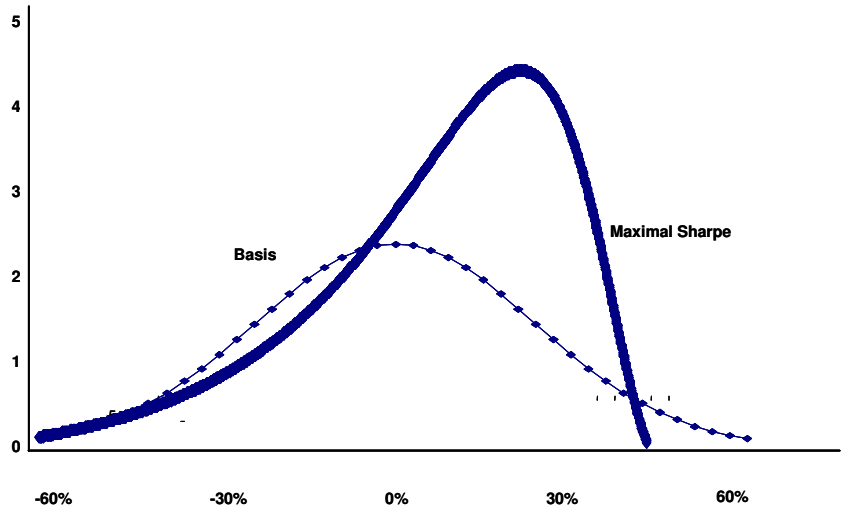
Exhibit 3 provides an example of an investment return distribution that is symmetrically distributed; that is, it is not skewed. This exhibit shows the histogram of U.S. large capitalization stock market returns from 1926 to 2002.

Exhibit 4 illustrates a portfolio whose return distribution is "negatively skewed." It is a portfolio whose return distribution maximizes the Sharpe ratio, which will be discussed further below. The exhibit refers to this distribution as "Maximal Sharpe."

The fact that investors have a preference for positively skewed outcomes and an aversion to negatively skewed outcomes is not captured by variance-based risk measures because they all weight the two types of outcomes equally.

Goetzmann *et al.* (2002) have pursued this line of argument to its logical conclusion in a working paper entitled, "Sharpening Sharpe Ratios." They mathematically derive a strategy for maximizing the Sharpe ratio. The resulting strategy has limited upside returns and the possibility of very large losses, as illustrated in Exhibit 4. By undertaking a maximum Sharpe ratio strategy, an investor may be accepting negatively skewed returns in exchange for improving the mean or standard deviation of the investment.

Goetzmann *et al.* (2002) further show that one can achieve a maximum Sharpe ratio portfolio by selling certain ratios of calls and puts against a core equity market holding. The authors conclude that:



Source: Goetzmann *et al.* (2002).

Exhibit 4. The Distribution of the Sharpe Ratio Maximizing Portfolio

> "expected returns being held constant, high Sharpe ratio strategies are, by definition, strategies that generate modest profits punctuated by occasional crashes."

The experience of the Art Institute of Chicago's endowment supports the Yale professors' concern. One of the endowment's hedge fund managers noted in their marketing material that their fund had "the highest Sharpe ratio in the industry," according to Dugan *et al.* (2002).

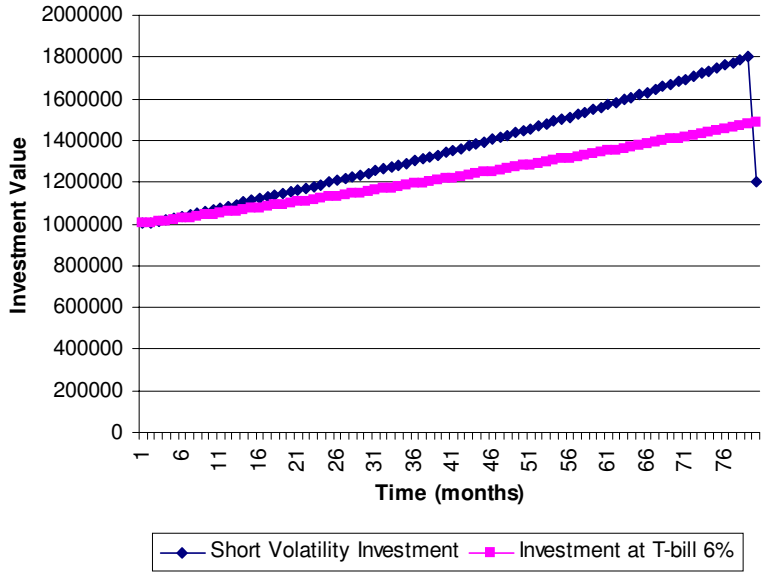
The hedge fund noted it would combine "cash holdings with stocks and riskier index options" in such a way that they:

> "could guarantee profits of 1% to 2% a month in flat or rising markets. The fund . . . could lose money only if the stocks to which the options were tied dropped more than 30%."

This fund reportedly had large losses in late 2001.

Anson (2002) provides an informative, hypothetical example. Anson illustrates the problem with using symmetric performance measures like the Sharpe ratio for evaluating trading strategies with asymmetric outcomes. In Anson's hypothetical example, an investment manager leverages his or her initial investment capital by selling out-of-the-money puts and calls on the S&P 500 to achieve a certain performance objective above T-bills.

Exhibit 5 illustrates the superior performance of the strategy until a "volatility event" or large move occurs in the stock market. What is striking about Anson's simulated examples is that on average, it takes about seven years for the volatility event to occur and leave the investor with sub-T-bill returns. This event could occur in one month, or it could take as long as twenty years.



Source: Anson (2002).

Exhibit 5. Simulated Short Volatility Investment Strategy

Exhibit 6. Performance Statistics for Short Volatility Investment Strategy

	Pre-Volatility Event	Post-Volatility Event
Average Annual Return	9.00%	2.85%
Excess Return	3.00%	−3.15%
Standard Deviation	0.42%	3.71%
Sharpe Ratio	7.14	−0.85

Source: Anson (2002).

Exhibit 6 shows Anson's example where the strategy will have a superior Sharpe ratio until the volatility event occurs and reveals the underlying riskiness of the strategy. Fiduciaries with long time horizons should not be misled by short-term (pre-volatility event) performance.

After reviewing the examples above, one can understand the statement of City University (London) Professor Harry Kat in Lux (2002):

> "I would probably only trust . . . [Sharpe ratios] for large diversified portfolios investing in large [equity] names."

Positively skewed outcomes

Even though it is intuitively obvious that all things being equal, investors would prefer investments that have the possibility of large gains, this feature of an investment is not rewarded by the Sharpe ratio.

An extreme example of this is given in Bernardo and Ledoit (2000). The authors provide an extreme example of how a superior investment can have a low Sharpe ratio. They note that a lottery where a ticket costs one cent today, and where winners pocket fifty billion dollars next year with probability 10%, and nothing otherwise, has a Sharpe ratio of 0.33.

Questioning the mean-variance paradigm

As Sharpe notes in his 1994 paper, the Sharpe ratio builds on the Markowitz mean-variance paradigm, which assumes that the mean and standard deviation are sufficient for evaluating an investment. Other authors have noted that only taking into consideration the first and second moments of a distribution may not be enough to characterize the attractiveness of an investment. The first moment of a distribution is the mean; the second moment is its variance. The standard deviation is the square root of the variance.

A number of researchers have suggested that one should also take into consideration the skewness and kurtosis of an investment's distribution. Skewness is the third moment, which describes how asymmetric a distribution is; and kurtosis is the fourth moment, which is linked to the existence of extreme returns. Further, one should also take into consideration how the addition of a candidate investment to a portfolio will impact the overall portfolio's skewness and kurtosis.

In financial applications, negative skewness refers to an investment having a higher probability of a very large loss and a lower probability of a high positive return than one with equally balanced probabilities of gains and losses. The higher the kurtosis is, the more likely extreme observations are. For given levels of mean return and variance, one would expect most investors to like positive skewness and dislike high kurtosis.

Brooks and Kat (2002) reported to have found among individual hedge fund indices a strong relationship between their Sharpe ratio and their skewness and kurtosis properties. In their empirical study, they find that:

> "High Sharpe ratios tend to go together with negative skewness and high kurtosis. This means that the relatively high mean and low standard deviation offered by hedge fund indices is no free lunch."

Kat and Amin (2003) further found evidence that when one uses mean-variance optimization to construct portfolios that include a sufficiently large number of hedge funds, one ends up with portfolios that have lower skewness as well as higher kurtosis in the overall portfolio's return distribution. In other words, they find that there is a trade-off between improving a portfolio's mean-variance characteristics and taking on more risk of rare, but large losses.

For many investment practitioners, it does not come as a surprise that improving a portfolio's mean-variance ratio may come at the cost of taking on the possibility of extreme loss. Anecdotally, one fund-of-hedge-funds manager has stated that he will not invest in a manager with a Sharpe ratio of over 1.5, figuring that such a ratio is unsustainable in efficient markets. Instead, it may be the result of earning risk premiums for a catastrophic event that has not occurred yet.

3.2.2. *Illiquid holdings*

Fiduciaries should use performance measures that indicate a manager's skill in providing superior returns per unit of risk. If a manager can adopt a passive strategy that inflates the performance measure, then that performance metric is flawed. Our earlier discussion noted how a skewness-inducing strategy that requires no managerial skill (e.g., by selling options) could produce a superior Sharpe ratio. Unfortunately, there is another way to increase a Sharpe ratio, which also does not require skilled management.

Required return premium

One way to produce a higher average return is to invest in equity proxies that are illiquid. Naturally the market will demand a liquidity premium when pricing such investments. The Sharpe ratio, however, does not penalize illiquidity. But investors do value flexibility; this is the basis of real option theory. In real options theory, one explicitly values the optionality associated with decision-making flexibility. In essence, with illiquidity, the portfolio is short real options, and the investor gives up the flexibility to readily liquidate their investments.

Artificially stable returns

A portfolio's investments may contain illiquid securities for which one may have trouble obtaining current prices, so there may be a lag in investments being revalued. This would give the false impression of stable returns and, therefore, would result in an artificially low standard deviation. This factor would then tend to inflate the investment's Sharpe ratio. Hedge funds are typical targets of empirical studies because they tend to have illiquid investments. Other assets like high yield bonds, venture capital, and small-capitalization stocks also can be quite illiquid.

The principals of AQR Capital Management, LLC address a related issue in Asness *et al.* (2001). They question the reported lack of relationship between hedge fund indices and the S&P 500. When they regress a hedge fund index's returns versus lagged returns of the equity market, they find a strong relationship between the hedge fund index and the S&P using data from January 1994 to September 2000. Because there is such a strong relationship once they compare the hedge fund index's returns to dated returns in the stock market, they infer that hedge funds making up the index have been using stale pricing in evaluating their holdings.

Fiduciaries might consider hedge funds for their satellite portfolios because they would like to diversify away some of their equity market exposure. If this were one's investment rationale, then the AQR procedure would be useful in evaluating potential hedge fund strategies. The AQR researchers recalculate the Sharpe ratio of a number of hedge fund styles as if each style's true equity market exposure had been hedged away. Their measure of true equity market exposure takes into consideration the probable stale pricing of hedge funds.

Exhibit 7 shows an excerpt from the authors' results. "Monthly Unhedged Sharpe Ratio" is the unadjusted Sharpe ratio of the hedge fund style. "Monthly Beta Hedged Sharpe Ratio" is the Sharpe ratio of the hedge fund style if it were hedged according to its relationship with the stock market based on regressing contemporaneous returns. "Summed Beta Hedged

Exhibit 7. Annual Sharpe Ratios of Unhedged and Hedged Hedge Fund Returns January 1984 to September 2000

Portfolio	Monthly Unhedged Sharpe Ratio	Monthly Beta Hedged Sharpe Ratio	Summed Beta Hedged Sharpe Ratio
Aggregate Hedge Fund Index	0.80	0.31	−0.40
Convertible Arbitrage	1.07	0.95	−0.11
Event Driven	1.05	0.55	−0.27
Equity Market Neutral	1.85	1.55	1.06
Fixed Income Arbitrage	0.35	0.28	−0.56
Long/Short Equity	0.94	0.39	−0.23
Emerging Markets	0.11	−0.47	−0.82
Global Macro	0.54	0.18	−0.40
Managed Futures	−0.10	−0.12	0.14
Dedicated Short Bias	−0.38	0.61	0.89

Source: Asness *et al.* (2001).

Sharpe Ratio" is the Sharpe ratio of the hedge fund style if it were hedged according to its relationship with the stock market plus an adjustment for the stale-pricing effect.

With several noteworthy exceptions, the exhibit above illustrates that once market exposure is taken into consideration, the attractiveness of a number of hedge fund strategies declines fairly dramatically. Further, the adjusted Sharpe ratios shown in the last column of Exhibit 7 (Summed Beta Hedged Sharpe Ratios) are mostly negative, indicating that at least over the period January 1994 to September 2000, there is no evidence that most categories of hedge funds were able to add value after taking into consideration their actual equity market exposure.

One caveat to AQR's empirical findings is that these results are valid for indices of hedge fund manager results. They do not provide us with information on the *exposures* of individual manager results, which can be widely varying even within categories, as noted in Ross and Oberhofer (2002).

The fourth section of this article will provide other performance metrics that researchers have proposed as alternatives to the Sharpe ratio.

As Weisman and Abernathy (2000) note, if one uses the Sharpe ratio for evaluating hedge fund investments, one may be inadvertently maximizing risk (due to taking on negatively skewed investments) and illiquidity (due to these investments giving the appearance of stable, superior returns).

3.3. *Some investments' returns do trend*

Sharpe notes in his 1994 article that the returns of an investment strategy should not be serially correlated if one is going to use simple adjustments to "annualize" the Sharpe ratio. It is common practice to calculate an investment strategy's standard deviation based on monthly data and then annualize the statistic by multiplying by the square root of 12.

Brooks and Kat (2002) report that the monthly returns of hedge fund indices show significant serial correlation. Serial correlation is the correlation of something with itself over time and indicates a trend in the underlying data. Specifically, these researchers find that:

> "All of the Convertible Arbitrage [hedge fund] indices have a first order serial correlation of at least 0.4, which are also statistically significant at the 1% level. A similar feature is observed for Distressed Securities and some of the Risk Arbitrage, Emerging Markets and Equity Market Neutral [hedge fund] series. It is also reflected in the Fund of Funds results . . ."

Finding serial correlation is not surprising in investments that suffer from stale pricing. Other investments that exhibit stale pricing, like high yield bonds, venture capital, and small capitalization stocks, also exhibit serial correlation in their prices.

Similarly, when Lo (2002) examines twelve hedge funds, he finds that most of the funds exhibit meaningful serial correlation. Lo shows that:

> "the annual Sharpe ratio can be overstated by as much as 65% due to the presence of serial correlation in monthly returns, and once this serial correlation is properly taken into account, the rankings of hedge funds based on Sharpe ratios change dramatically."

Lo notes that hedge funds and mutual funds have different return characteristics. Fiduciaries should not naively compare investments using Sharpe ratios without an appropriate statistical adjustment for each return history.

3.4. *The candidate investments may not have similar correlations with the investor's other assets*

Sharpe (1994) notes that the Sharpe ratio does not take into consideration an investment's correlation with other investments. Therefore, the ratio:

> "will not by itself provide sufficient information to determine a set of decisions that will produce an optimal combination of asset risk and return, given an investor's tolerance for risk."

This issue is particularly relevant for alternative investments because, for some fiduciaries, their attractiveness relies on these investments being diversifiers for existing equity portfolios. One would prefer a performance metric that would incorporate the degree of diversification that the investment could provide.

Researchers at Kenmar Global Investment have found that diversified portfolios of hedge funds are highly correlated to the equity market, mirroring the concerns of the AQR researchers. In Goodman *et al.* (2002a), they note that the Sharpe ratio "does not differentiate between risk that is correlated with the equity market — to which most investors have significant exposure via traditional investments — and risks that are not correlated with the equity market."

As a result, the Kenmar researchers devise a new risk-adjusted return measure, which adjusts returns for correlation to the equity market. This measure will be discussed in Section 4 of this paper, which covers "Alternative Metrics."

3.5. *Business risks are not taken into consideration*

Koh *et al.* (2002) recommend including a penalty function to adjust returns downwards to account for additional business risks associated with hedge fund investing. The authors recommend including the following sources of risk in computing the penalty function: style purity, asset growth, leverage, liquidity, and asset concentration. By extension this advice would apply to other satellite investments that have some or all of these characteristics. The details are beyond the scope of this article, but the point is that the researchers advise against taking most satellite investments' historical returns at face value. The next section introduces some alternatives.

4. Alternative Metrics

During the discussion of the shortcomings of the Sharpe ratio, the previous section touched upon enhanced risk-adjusted return methodologies that have been published in the *Journal of Portfolio Management*, the *Financial Analysts Journal*, the *Singapore Economic Review*, and *Risk* magazine. This section will discuss several additional approaches. Basically there are two fundamentally different ways to address the shortcomings of the Sharpe ratio. One way is to come up with a better summary risk-adjusted return number, given the demand for having one number with which to compare all kinds of investments. The second way is to summarize an investment by deriving its primary "asset-based style factors." If one is allowed more than one number to summarize an investment, this is the preferred approach.

4.1. *Better summary metrics*

A number of researchers have advocated improvements in risk-adjusted return metrics and risk measures.

4.1.1. *Risk-adjusted return metrics*

Stutzer index

One alternative measure is the Stutzer index, which is described in Stutzer (2000). For Professor Michael Stutzer of the University of Colorado-Boulder, the main concern for investors is the probability of underperforming a benchmark on average. Stutzer's performance measure, therefore, rewards those portfolios that have a lower likelihood of underperforming a specified benchmark on average. This measure penalizes negative skewness and high kurtosis (for given levels of mean returns and variance.)

Bernardo-Ledoit Gain-Loss ratio

Another performance measure is the Bernardo-Ledoit Gain-Loss Ratio, which is described in Bernardo and Ledoit (2000). This measure is the ratio of the expectation of the positive part of the returns divided by the expectation of the negative part. If an investment's expected returns are large, and the potential loss is low, then this measure would reward such an investment in a way that the Sharpe ratio would not. So, for example, this ratio would very much reward the lottery mentioned previously.

Excess Downside Deviation as an Adjustment to the Sharpe Ratio

In Johnson *et al.* (2002), researchers from Financial Risk Management note that many hedge fund strategies appear to be in effect "short option" strategies that bear overpriced risks associated with rare events. This brings up the problem with using the Sharpe ratio when there are "asymmetric outcomes," as noted in a previous section.

The authors advocate examining the downside deviation of an investment strategy's return distribution. The downside deviation measures the degree to which the overall return distribution is due to returns below a threshold level.

Given that the Sharpe ratio is so prevalent as a performance measure, the authors propose making an adjustment to this ratio to incorporate the extra information from the downside deviation calculation.

Their "adjusted Sharpe ratio" is defined as:

> "the Sharpe ratio that would be implied by the fund's observed downside deviation if returns were distributed normally."

The authors show one example of a hedge fund strategy where this adjustment can be quite dramatic:

> "a Sharpe ratio of over 2.50 is reduced to 0.79 [for one particular fund.]"

The researchers conclude that their framework has the benefit of being sensitive to rare events, which might otherwise go undetected when using standard measures.

Bavar (beta and volatility adjusted returns) ratio

A previous section of this article had noted that researchers at Kenmar had devised a performance metric to explicitly take into consideration an investment's correlation with the stock market. Their metric shares the spirit of the AQR authors' adjustments shown in the second column of Exhibit 7.

The Kenmar researchers propose in Goodman *et al.* (2002a) that investors use the Bavar (Beta and Volatility Adjusted Returns) ratio. This ratio:

> "adjusts the beta of various investments to be equivalent, so that a fund that has a lower return but is uncorrelated to the market can be appropriately compared with a fund that achieves a higher return but is highly correlated with the market."

The authors note that investing in hedge funds that are not market neutral is acceptable as long as the higher correlation to the stock market is sufficiently compensated with higher returns.

4.1.2. *Risk metrics*

Conditional Value-at-Risk

Agarwal and Naik (2004) recommend applying the Conditional Value-at-Risk (CVaR) framework to satellite asset classes like hedge funds. They advocate replacing Value-at-Risk (VaR), which has been popular among traditional asset managers. The authors explain that:

> "[Whereas] VaR measures the maximum loss for a given confidence interval, . . . CVaR corresponds to the expected loss conditional on the loss being greater than or equal to the VaR."

By using CVaR, the authors are able to capture the left-tail risk of those hedge fund strategies that have short put option-like exposures. (Exhibit 4 above shows an example of a return distribution that has noteworthy "left-tail risk.")

They additionally show that the application of the mean-variance framework for some hedge fund strategies can underestimate tail risk by as much as 50%.

The authors conclude that if a fiduciary's goal is to create portfolios for which the magnitude of extreme losses is kept under control, then that fiduciary should consider using CVaR as their risk constraint during portfolio construction.

Modified value-at-risk

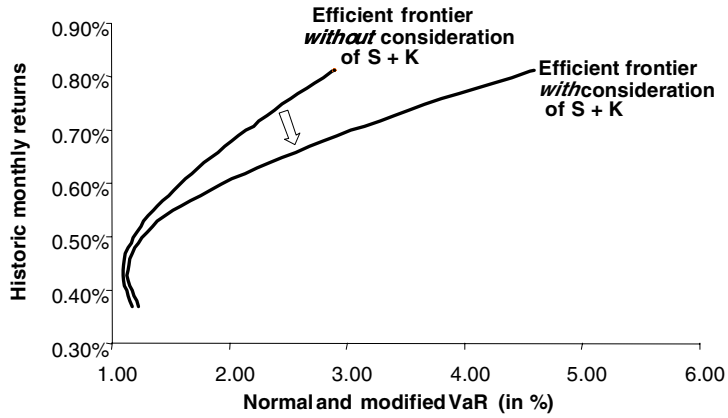
When one cannot assume that an investment's returns are distributed normally (or at least symmetrically distributed), Signer and Favre (2002) propose a risk measure that also incorporates the third and fourth moments of an investment's distribution. They describe a statistical method for adjusting VaR to incorporate skewness and kurtosis; the authors refer to this new measure as "modified VaR."

The authors advocate using modified VaR as the risk constraint for portfolios that include hedge funds because:

> "nearly all hedge fund strategies show negatively skewed return distributions with positive excess kurtosis."

The authors provide an example that shows how the efficient frontier is affected when using modified VaR rather than VaR as the risk constraint. Exhibit 8:

> "shows the degree to which [a] . . . sample portfolio with a hedge fund portion of maximum 10% is represented too positively (in the sense of returns being too favorably risk-adjusted) by not taking account of the skewness and kurtosis of the return distributions."



Source: Signer and Favre (2002).

(S refers to skewness, and K refers to kurtosis.)

Exhibit 8. Sample Portfolio with a Maximum Investment in Hedge Funds of 10%

The authors conclude that an evaluation of the benefits of hedge funds needs to incorporate the higher moments of the investment strategies' return distributions.

Not all hedge fund strategies can be characterized as exhibiting negative skewness. It is mainly the event driven and fixed-income arbitrage strategies that have been characterized as having disadvantageous skewness and kurtosis properties (for given levels of average returns and variance).

One should also add that the cautionary notes on taking into consideration an investment strategy's skewness and kurtosis properties do not only pertain to hedge funds. It also pertains to investments with default risk (like high-yield bonds) and investments with potential liquidity problems (like small-capitalization stocks).

For example, as noted by Goetzmann *et al.* (2002):

> "... some assets in the U.S. market, primarily small cap stocks, behave as if they are short a[n] [out-of-the-money] put [on the overall stock market.]"

This latter point will be revisited in Section 5 of this article, "The Need for Understanding the Source of Returns of an Investment Strategy."

A last qualifying remark is that to be more precise, the important statistical characteristics are co-skewness and co-kurtosis rather than skewness and kurtosis, *per se*. Co-skewness (co-kurtosis) refers to the component of an asset's skewness (kurtosis) related to the market portfolio's skewness (kurtosis.)

Co-skewness and co-kurtosis provide an investor with information on how an investment will perform during times of overall market stress. Negative skewness, as with a hurricane bond, which results from factors unrelated to market stress, is not as undesirable an investment as one that does very poorly during times of equity market stress and so has negative co-skewness. This is because it is during times of market stress that one is

particularly worried about having a portfolio of seemingly diversified investments that all perform poorly at the same time.

Brooks and Kat (2002) show how this qualification matters in portfolio construction. They note that:

> "in most cases where the skewness of the hedge fund index is lower (higher) than that of the portfolio to which it is added . . ., the skewness of the new portfolio tends to be less (more) attractive than that of the original portfolio comprising only stocks and bonds. The Equity Market Neutral indices are an exception, though. Although the latter do not exhibit much skewness themselves, adding them still causes portfolio skewness to deteriorate. This strongly suggests that the correlation between the Equity Market Neutral indices and the S&P 500 is higher in down markets than in up markets."

4.2. *Asset-based style factors*

The current academic thinking on how to evaluate alternative investment strategies, which may have short-option-like risk and brief track records, is to use "asset-based style factors" to characterize an investment.

Ideally, financial economists would prefer to come up with the universe of fundamental risk factors that can explain the time-series behavior of an investment's returns rather than just explain an investment's return based on other asset's returns. In other words, if an investment's return cannot be entirely explained by its exposure to the market, what are the additional underlying risk factors of special concern to investors (that give rise to the investment's excess return)? But that effort has not been fruitful as yet. Instead, linking a portfolio, whether it is a fiduciary account, mutual fund, or a hedge fund, to a limited set of investment styles has been a lot more successful empirically.

William Sharpe, the creator of the Sharpe ratio, originally used this approach in Sharpe (1992) to model mutual fund risk. A current effort by academics is to extend this approach to hedge funds. This effort has been spearheaded by William Fung of the Center for Hedge Fund Research and Education, London Business School and David Hsieh of Duke University and also by Vikas Agarwal of Georgia State University and Narayan Naik of London Business School. In addition to including various asset classes and rule-based investment styles, they also explicitly include options as explanatory factors of a hedge fund's returns.

The idea is if an investor can link a hedge fund's returns to its underlying "style factors," then one can use the style factor's longer history of returns to evaluate the specific hedge fund. Presumably the return history of the style factor would be long enough so that if the hedge fund incorporates a short-event-risk-type strategy, the magnitude of the losses that have occurred (and perhaps could occur) would be apparent from the long-term data.

The asset-based style factor approach provides more useful information about alternative investments and their unique risk exposures than purely relying on the summary metrics covered above.

The following section provides examples of the asset-based style factor approach.

4.2.1. *Example: equity arbitrage strategies*

A number of arbitrage strategies have been characterized as implicitly including short put options.

For example, in the merger arbitrage strategy, a merger candidate is bought by a hedge fund at a discount to what its intended buyer has announced it will pay for the company. These investors assume the risk that a merger deal will fail. This strategy tends to earn consistent returns but sustains very large losses in the event that a deal is not consummated.

A historical analysis of merger arbitrage deals conducted in Mitchell and Pulvino (2001) shows that this strategy's return is correlated to the overall market during severe market downturns, giving a return profile similar to short index put options.

Agarwal and Naik (2004) take into consideration the option-like features inherent in a number of arbitrage strategies. The authors find, for example, that the following risk factors are significant in explaining the returns of the Hedge Fund Research (HFR) Event Arbitrage strategy: a short out-of-the-money put on the S&P 500 along with two equity style factors: size and value.

These researchers find that in addition to Event Arbitrage, the payoffs of the Restructuring, Event Driven, Relative Value Arbitrage, and Convertible Arbitrage hedge fund strategies resemble those from selling a put option on the market index.

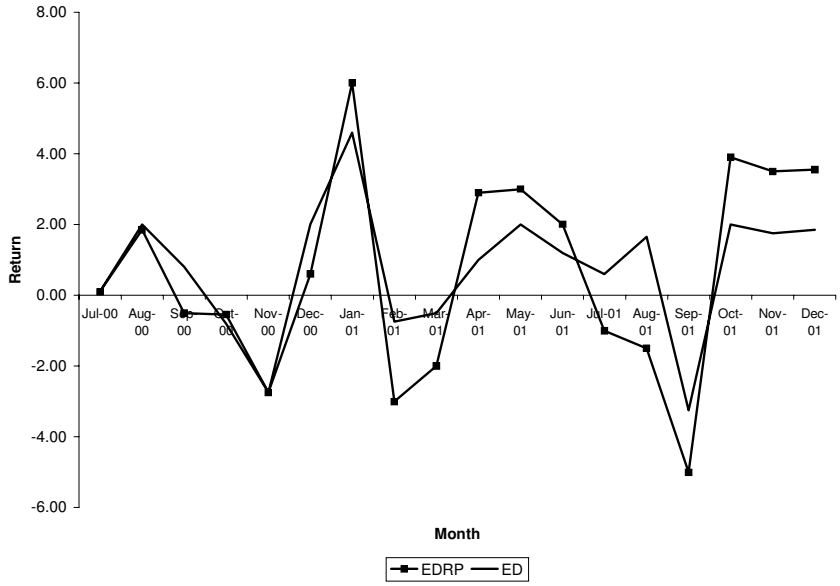
The authors create replicating portfolios for each hedge fund strategy based on their respective significant risk factors. They do so using out-of-sample data. The authors wanted to make sure that their results were not mere statistical artifacts of the data. If the replicating portfolios resemble their hedge fund index's results using out-of-sample data, this is highly suggestive evidence that the risk factors represent the true risks of the particular hedge fund strategy. With only one exception, the replicating portfolios and their respective indices are statistically indistinguishable.

Exhibit 9 illustrates the out-of-sample results for the Event Driven Index. (EDRP is the Event Driven Replicating Portfolio, and ED is the actual Event Driven Index results.)

The authors go one step further. They look into whether the superior performance of arbitrage strategies is unique to the decade of the 1990s. There has not been an obvious way to determine this because the return history of hedge funds only goes back to 1990.

If the authors' replicating portfolios, which are constructed using buy-and-hold and option-based risk factors, are accurate models for describing the returns of arbitrage strategies, one can use the replicating portfolios as proxies for the strategies and therefore look into the past to see how these strategies would have performed.

The authors examine the period from 1927 to 1989 to find the long-run returns and volatility of the hedge funds' replicating portfolios. In the main, they find that the returns are smaller, and the long-run volatilities are higher compared to their performance in the 1990s. Their conclusion is that the performance of the arbitrage strategies "during the recent period appears significantly better compared with their potential long-run performance."



Source: Agarwal and Naik (2004).

Exhibit 9. Out-of-Sample Performance of a Replicating Portfolio versus the Event Driven Hedge Fund Strategy

4.2.2. *Example: fixed-income arbitrage strategies*

Fung and Hsieh (2002) advocate extracting common risk factors from groups of fixed-income funds. Their procedure then links the extracted factors to market observable prices, which have longer price histories.

The authors find that fixed-income hedge funds primarily have exposure to fixed-income related spreads, including the convertible/Treasury spread, the high yield/Treasury spread, the mortgage/Treasury spread, and the emerging market bond/Treasury spread.

The authors also construct a one-factor model with a corporate credit spread as the factor. Their goal is to examine how sensitive a particular fixed-income hedge fund strategy is to changes in credit spreads. They find a strong correlation using recent data. They show that if one extrapolates this relationship using a longer price history, one would find losses that are double the worst loss experienced in the brief history of this category of hedge fund. The researchers conclude that the returns for bearing the added sources of risk identified in their study need to be balanced against the additional tools needed to manage the attendant tail risk of the strategies.

4.2.3. *Example: Generic model decomposition*

A practical application of the "asset-based style factor" approach is given in Weisman and Abernathy (2000).

Based on a qualitative review of an individual hedge fund, the authors classify the fund's exposure to different asset classes and option types. They then use an optimization

technique that fits the hedge fund's returns to these exposures. The particular non-parametric, non-linear optimization technique they choose is based on their experience with which characteristics are most important in evaluating a manager. They try to capture the manager's large winning and losing months, the manager's use of leverage, and the inflection points of the manager's returns.

One of their examples emphasizes why such an approach is needed. The authors reference a mortgage-backed securities manager who had a historical Sharpe ratio of 4.99 using performance data from July 1995 to August 1998. A Sharpe ratio of greater than 1.0 is considered quite good. A decomposition of the exposures in this portfolio revealed that the pattern of reported returns could have similarly been achieved with substantial leverage and short option exposure. After August 1998, this manager reported a very large loss during a time of large dislocations in the fixed-income markets.

The authors take the investment performance produced by the likely exposures driving a portfolio's return and compare it with the manager's reported performance. They notice a tendency for hedge fund manager performance to be less volatile than the performance produced by their optimization. They hypothesize that because certain over-the-counter securities are difficult to value because they are illiquid, their owners may underestimate the periodic changes in the value of these holdings. With their derived performance figures, the authors are in a position to evaluate the real underlying volatility of a portfolio and adjust the risk measure used in evaluating a manager.

This approach is helpful as a forensic tool in determining the implicit short options risk of any manager or investment style, especially if one only has a short track record to analyze.

4.2.4. *Example: systematic style biases*

Besides determining a hedge fund's exposure to the equity market, researchers at Kenmar advocate in Goodman *et al.* (2002b) that fiduciaries should evaluate the structural or systematic risks assumed by their hedge fund allocation. These systematic or factor risks could include:

> "sector exposures (e.g., technology, banking), style exposures in equities (e.g., small/large cap, growth/value and financial leverage), and style exposures in fixed income (e.g., credit, yield curve and prepayment)."

That way when an investor is creating a portfolio with a number of hedge funds, one can ensure that their overall portfolio will not be inadvertently exposed to too much of any one risk factor. The researchers note that diversified portfolios of hedge funds currently have a structural bias towards the small-capitalization and value equity styles. Fiduciaries who are considering adding these asset classes to the satellite ring of their portfolio should consider the possibility they would be double counting existing asset class exposures.

5. The Need for Understanding the Source of Returns of an Investment Strategy

5.1. *Bismarck's advice*

When hedge funds were solely of interest to high net worth individuals, the need to understand the types of exposures taken on by these investment vehicles was practically non-existent.

A hedge fund manager who now has over a billion dollars under management once told the author of this article that his prospective investors were only interested in receiving a one-page summary of performance numbers. The ensuing discussions would then focus on the nuances of how the performance numbers were calculated. There was no interest in discussing the underpinnings of his investment process, he said.

It was as if hedge fund investors were applying Baron von Bismarck's advice on sausages and legislation to their investments. ("Anyone who likes legislation or sausage should watch neither one being made," Bismarck was quoted as saying.)

But now that U.S., European and Asian fiduciaries are actively adding alternative investments to their satellite rings, there is tremendous academic and practitioner interest in accurately characterizing the risk exposures of these investments.

The following section will briefly discuss the risk exposures of a number of investment strategies that provide superior returns (whether these returns are due to manager skill or not.)

5.2. *St. Petersburg paradox*

Weisman (2002) warns that an investor should be aware of investment strategies that require no investment skill and yet for long periods of time seem to provide superior returns. Anson (2002) provided one example of such a strategy, which was cited earlier in this article. Weisman provides a further example.

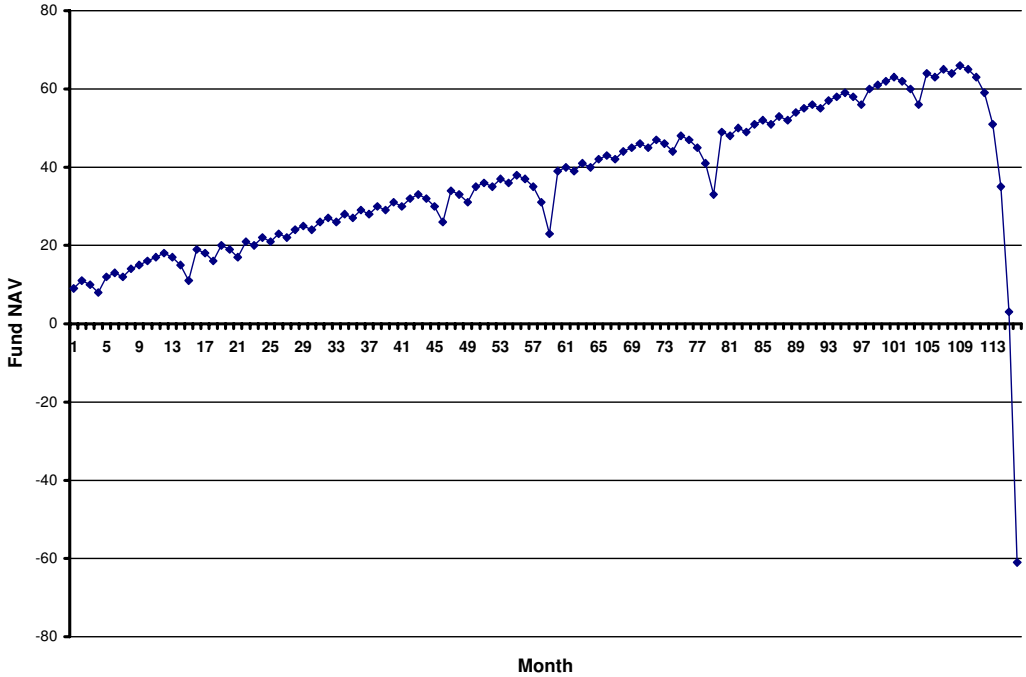
The key point is that these strategies have large occasional losses, much like hedge funds and other more traditional asset classes. Weisman simulates an investment strategy where one makes a bet on a single coin toss. If the bet is successful, one bets again with the bet size being the same size as before. If one loses, one doubles up: increasing the bet size by a factor of two in the next trial. This strategy is named after the paradoxical St. Petersburg coin toss game that was originally solved by Bernouli in 1738.

Exhibit 10 illustrates the monthly performance of a hypothetical manager who elects to follow this strategy.

In Weisman's particular simulation, he found that:

> "Monthly reporting tends to obscure much of the fund's volatility, the 'draw-downs' (losses of capital) have a very limited duration, and the returns are consistently positive. In fact, right up until [the strategy fails] . . ., such a fund would generate approximately a 15% annualized rate of return with about a 12% annualized standard deviation and would be profitable approximately 78% of all months."

Weisman's example illustrates the importance of understanding the underlying return-generating process of a manager's strategy.



Source: Weisman (2002).

(This chart was created by Professor J. Clay Singleton of Rollins College (USA) using the algorithm in Weisman's article.)

Exhibit 10. Performance of St. Petersburg-Like Investment Strategy

5.3. *Risk premia strategies*

Another way of earning superior returns besides Weisman's "informationless" approach is to implement risk premia strategies. A number of diverse traditional and alternative investment strategies appear to earn their returns due to assuming risk positions in a risk-averse financial world. The investors in these strategies are in effect taking on risks that others would prefer not to hold; in some cases, one can see a direct analogy between particular risk premia strategies and the provision of insurance, as will be covered below.

Selling insurance is the essence of a short put position. While insurance is socially useful, insurance companies are widely diversified to spread the risk of any one local disaster. Investment managers who follow short put strategies, either explicitly or implicitly, are typically not diversified enough to avoid catastrophic losses. Prudent fiduciaries that invest with these managers should do so knowingly and with sufficient diversification in other asset classes to withstand the occasional disaster. One benefit of the core-satellite approach is that it potentially allows fiduciaries to invest in these satellite higher-return short option-like strategies without taking extraordinary risk.

The following section gives examples of investment strategies where it appears that the investor earns a risk premium. Most of these examples are drawn from Cochrane (1999a and 1999b).

5.4. *Relative-value bond funds*

A relative-value bond fund earns its returns by taking on the illiquid assets that international banks desire to sell when they need to reduce risk. The fund hedges this risk by shorting liquid assets. A relative-value bond fund thereby provides a reinsurance function for financial institutions, but it also exposes the fund to liquidity crises. As a result, an examination of empirical data shows that relative-value bond funds have short put option-like returns. An investor in such funds assumes the risk of infrequent systemic financial distress and provides other investors with the flexibility of being able to readily liquidate their investments. A relative-value bond fund is in essence providing real options to financial institutions.

5.5. *Value vs. growth equity strategy*

One market anomaly identified by Rosenberg *et al.* (1985) was that an investor could earn returns beyond that predicted by CAPM by investing in stocks that have high book-value-to-price ratios. This value-based strategy has historically had twice the Sharpe ratio of the overall market.

Cochrane (1999a) notes that value stocks may earn premium returns because of the risk associated with distressed stocks all going bankrupt during a financial panic. This is precisely the time that investors would not like to find their equity portfolio doing poorly. Therefore, investors pursuing a value-based equity strategy may be in effect earning a risk premium for assuming the risk of a "credit crunch, liquidity crunch, flight-to-quality or similar financial event" that other investors would prefer not to take on. By assuming these risks, the value investor may in effect be providing financial-distress insurance to other investors.

To further understand why value investing may require excess returns, we need to emphasize that most individual investors have larger economic worries than just the performance of their investment portfolios. The main source of income is from their jobs. In the event of systemic financial distress, individuals whose jobs are tenuous would not want their portfolios to be particularly at risk. This means avoiding stocks of companies that could be threatened with bankruptcy. One indication of a weak company is one in which its price-to-book ratio is low.

An investor who systematically buys stocks based on "value" considerations such as a low price-to-book ratio and sells stocks based on "growth" considerations may be taking on risks that most individual investors desire to avoid.

5.6. *Small capitalization stocks*

Cochrane (1999a) notes that small-capitalization stocks seem to have abnormally high returns, even after accounting for this style's market "Beta." (Beta provides a measure of how much a portfolio's performance varies with respect to the overall stock market).

In two studies, which will be discussed below, researchers have found that small capitalization stocks do particularly poorly when the stock market does poorly. Investors may require a return premium for taking on this risk. This premium may be a contributing

explanation for why, over very long periods of time, small cap stocks have historically had superior returns.

Lux (2002) discusses one of the risks associated with small-capitalization stocks:

> "Illiquidity is one of the biggest hazards with investments that are outside the mainstream, such as small capitalization stocks. . . . small-cap fund managers are betting that liquidity won't dry up in thinly traded stocks, causing their prices to plunge."

Lux notes that "taking such a gamble to earn excess returns is not unreasonable," but fiduciaries should take this risk into consideration when investing.

5.6.1. *Negative co-skewness*

Harvey and Siddique (2000) note that the smallest market capitalization stocks are amongst the assets with the most negatively skewed return profiles.

As noted in the "Alternative Metrics" section of this article, one would expect negative skewness to be an undesirable investment property, especially negative co-skewness. Therefore, one might expect that an investor would need to be compensated to take on investments with these properties. In confirmation of this expectation, Harvey and Siddique find that a portfolio that is long equities with undesirable co-skewness properties and short equities with desirable co-skewness properties on average made 3.6% per year over the time period July 1963 to December 1993.

Harvey and Siddique's article was the first paper to show empirically that skewness is priced; in other words, that investors are compensated for taking on this undesirable distributional property. As Harvey notes, if investors did not need a return premium for skewness, then it would be acceptable to continue to represent investors' preferences in terms of mean/variance trade-offs — even when an investment's distribution is highly skewed.

Fiduciaries who do not consider the systematic skewness properties of a portfolio of investments might be misled into thinking they have discovered a "free lunch" by incorporating certain types of negatively skewed investments in their portfolio, as discussed in Kat and Amin (2003).

5.6.2. *Beta-gap*

Low (2000) finds that small-capitalization stocks tend to have a different response to bullish and bearish equity market conditions when compared to large capitalization stocks. He captures this differential response through a measure called "Beta-gap," which is described below.

Low calculates an investment's Beta during bearish market conditions, a measure he refers to as Beta-negative, and a Beta during bullish market conditions, a measure which he refers to as Beta-positive. He then constructs a composite risk measure called Beta-gap, which is defined as Beta-positive minus Beta-negative. Beta-gap is positive when an investment's relationship to the overall market is stronger during bullish times than bearish times. Low characterizes a portfolio with a positive Beta-gap measure as convex with respect to

the overall equity market. Conversely, Beta-gap is negative when an investment's relationship to the overall market is stronger during bearish times than bullish times. He defines a portfolio with a negative Beta-gap measure as concave.

Using data from 1963 to 1998, Low finds a positive correlation between Beta-gap and the size of a portfolio's equity capitalization; the return profiles of small-capitalization stocks tend to be more concave than those of large stocks.

One might expect low Beta-gap portfolios to be regarded as undesirable and investors would require a return premium to hold such a portfolio. In fact Low found that a low Beta-gap portfolio outperformed a high Beta-gap portfolio by 6.1% per year over the time period 1967 to 1998.

A concluding remark on Beta-gap is similar to the concluding remark on co-skewness. Unless one takes into consideration the asymmetric response of an investment to bullish and bearish market conditions, one may again believe that they have found a "free lunch" by investing in assets or strategies that have undesirable (but as yet unrealized) responses to market conditions.

5.7. *High-yield currency investing*

Another strategy that seems to have the hallmarks of a risk premia strategy is high-yield currency investing. In this strategy, one invests in currencies with relatively high interest rates and funds this purchase in a currency with relatively low interest rates. On average this kind of strategy has proven profitable; the forward rate of currencies is not predictive of where future currency spot rates will be. Particularly in cases where a currency pair has an extreme interest-rate differential, one could argue that this devaluation risk increases with global financial panics and, therefore, that this strategy has a short-option-type payoff profile.

One example concerns investing in the Thai Baht. The Sharpe ratio for investing in Thai Baht deposits that were funded by U.S. dollar denominated loans was 2.55 over the period 1980 to 1996, according to data in Shimko and Reider (1997). Given the unexpected devaluation of the Bhat in 1997, it appears that an investment in Baht carried a well-deserved risk premium over this period.

6. Conclusions

One purpose of this article is to suggest that a number of the candidate investments in a fiduciary's satellite ring may have asymmetric return distributions. Investments will have these return features when they are earning returns due to in effect selling insurance or providing liquidity to other investors. One result is that a fiduciary should not exclusively rely on traditional risk-adjusted return measures like the Sharpe ratio for evaluating investments. Also, because a number of alternative investment strategy managers provide minimal transparency to their investors, the burden is on the fiduciary to understand the economic basis of their manager's returns.

This article has focused on quantitative solutions to the risk measurement of satellite ring investments. An emerging alternative view is that investors, and for that matter regulators, should not press for more transparency of hedge fund investments or require more elaborate summaries of an investment's significant risk factors. Instead, regulators and investors should focus on verifying the quality and independence of an alternative investment firm's risk management function.

This author's view is that this solution is not sufficient for fiduciaries. The fiduciary must receive enough information about a manager's strategies and key risk factors so that the fiduciary is in a position to properly understand how the satellite ring's investments interact with the risks of their core portfolio. This article provides some examples of alternative performance and risk measures that a fiduciary might take into consideration when investing in the satellite ring.

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