JOIM
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Journal Of Investment Management, Vol. 12, No. 3, (2014), pp. 5–18


# INSIGHTS

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## HEDGE FUND BETA REPLICATION: A FIVE-YEAR RETROSPECTIVE*

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*During the past few years, hedge fund beta replication strategies have become more common. At the same time, questions about the relevance, performance, and applicability of these strategies have been raised in response to the rapidly shifting landscape in the hedge fund industry. We present a review of the growing beta replication industry with particular emphasis on the ASG Global Alternatives Fund. We discuss the motivation for its existence and the logic of its absolute and relative performance over time and across different market environments. We also explain why these strategies are complements to, and not substitutes for, direct investments in hedge funds, and provide examples of their value-added in investors' portfolios.*

*Past performance of the ASG Global Alternatives Fund (the "Fund") should not be construed as an indicator of future performance. Any projections, market outlooks, or estimates in this document are forward-looking statements and are based upon certain assumptions. Other events which were not taken into account may occur and may significantly affect the returns or performance of the fund. This document shall not constitute an offer to sell or the solicitation of an offer to buy any securities or other financial instruments from AlphaSimplex Group, LLC ("AlphaSimplex"). While all the information presented in this document is believed to be accurate, and historical data were obtained from sources believed to be reliable, AlphaSimplex makes no express warranty as to the completeness or accuracy of the document, nor can it accept responsibility for errors appearing in the document.

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## 1 Introduction

On September 30, 2008, Natixis Global Asset Management launched the ASG Global Alternatives Fund (GAFYX), a mutual fund that implements a hedge fund beta replication strategy based on published research by Hasanhodzic and Lo (2006, 2007) and proprietary research conducted by AlphaSimplex. Since then, hedge fund beta replication has grown in popularity among investors who now have several products and managers from which to choose.[1] However, the hedge fund industry has experienced tremendous change over this same five-year period in the wake of the Financial Crisis of 2008, with many funds earning lower returns than their historical averages, and many funds closing down and fewer new ones starting up. Not surprisingly, skeptics have questioned the value proposition of hedge funds and funds of funds, especially in light of their high fees and lackluster performance. These concerns, and the growing interest in beta replication, provide a natural occasion to review the brief history of this young product category, explore the costs and benefits of these strategies, and examine the performance of the ASG Global Alternatives Fund since its inception.

Before turning to this review, we should first consider the underlying motivation for hedge fund beta replication—why should we expect to earn positive returns on average by investing in the betas of the hedge fund industry? The answer is the same as for any other asset with risks that cannot easily be diversified away: a positive expected return is the required reward for compensating investors for bearing systematic risk. In other words, in the absence of a positive expected return, no investor would have any incentive to hold such an asset, in which case the asset would be universally shunned and become worthless. This incentive is known as a "risk premium," of which the best-known—but not the only—example is the aggregate stock market such as the S&P 500.

The innovation of hedge fund beta replication is the recognition that there are many other types of undiversifiable risks in addition to equities—currencies, commodities, and certain investment strategies such as trend-following and relative-value trades also possess such risks.[2] And each of these undiversifiable risks has a risk premium associated with it, which often varies over time and across market conditions. By measuring and investing in these risk factors, hedge fund managers can garner the corresponding risk premia, in the same way that an investor in an S&P 500 index fund garners the equity risk premium without engaging in stock-picking. Hedge fund beta replication strategies seek to profit from the same broad variety of risk premia that are captured by hedge fund managers. And in much the same way that we believe investment capacity is not a constraint for equity index funds (at least not yet), we believe there is tremendous capacity in hedge fund replication strategies despite the fact that the hedge fund industry may be capacity-constrained.

## 2 Intellectual history

The research that led AlphaSimplex to develop its beta replication strategy originated in 1999 with the company's first two investment mandates: an equity market neutral strategy and a global tactical asset allocation (GTAA) overlay.[3] In designing its enterprise risk management system, AlphaSimplex ran into a conundrum: none of the commercially available risk management systems, e.g., BARRA, Northfield, and Sungard, could accommodate these two non-traditional investment strategies. The only risk models available at the time were standard U.S. and developed-market individual exchange-traded equity factor models, which were updated only monthly, not

daily as required by AlphaSimplex's strategies. Therefore, AlphaSimplex's research team, led by Dr. Andrew W. Lo, constructed its own linear-factor risk models for its statistical arbitrage and GTAA portfolios.

As part of this research, Lo and his team applied their risk models to a commercially available database of hedge fund returns (TASS) to compare the risk exposures of their portfolios with those of other managers in the two respective investment categories. The team was surprised to learn that many hedge funds had significant exposures to factors such as the aggregate stock market (S&P 500), the bond market (the Lehman Bond Aggregate), currencies (the U.S. dollar index), and commodities (oil, gold, and copper). As the repository for unique investment skills, i.e., "alpha," the hedge fund industry had a reputation for generating returns that were uncorrelated with traditional investments so the statistical significance of these common factors was unexpected.

Of course, there was considerable heterogeneity across hedge funds in how important these factors were. Categories such as fixed income arbitrage had relatively little factor exposure, whereas managed futures and long/short equity had large exposures. The type of exposure also varied—long/short equity funds had significant equity betas that changed relatively slowly, whereas managed futures funds had more exotic betas (currencies, commodities, and spreads within these asset classes) that varied more quickly across time and market conditions. These surprising research findings motivated AlphaSimplex to publish three articles, two documenting the common-factor exposures of the hedge fund industry (Hasanhodzic and Lo, 2006, 2007), and a third applying these results to help institutional investors manage their risk exposures dynamically despite the illiquidity of hedge fund investments (Healy and Lo, 2009).

This research agenda was not merely academic—AlphaSimplex implemented these ideas almost immediately in actively managing the risks of its two portfolios. In the case of its statistical arbitrage portfolio, S&P 500 futures contracts were used to seek to eliminate any remaining equity beta exposures from this market-neutral strategy. In the case of its GTAA strategy, the portfolio was managed using liquid futures contracts. From these applications, AlphaSimplex developed methods for using futures to both replicate and hedge betas for various purposes.

## 3 Other approaches to beta replication

Although Hasanhodzic and Lo (2006, 2007) were the first to propose using liquid futures contracts as factors to estimate and replicate hedge fund betas, other approaches have been advanced. Perhaps the most prominent of these alternatives is the replication of the statistical distribution of hedge fund returns using options and other derivative securities. In a series of papers, Harry Kat and his student Helder Palaro (2005, 2006a, 2006b)[4] argued that sophisticated dynamic trading strategies involving liquid futures contracts can replicate many of the statistical properties of hedge fund returns.[5] They launched a fee-based commercial service in which clients could select individual hedge funds whose return distributions they wished to replicate, and the service would provide the corresponding trading strategy. While their empirical results were encouraging for the hedge fund replication problem, thus far this approach has not achieved the popularity of others, perhaps because Kat and Palaro's replication strategies are quite involved and not easily implemented by the typical institutional investor. Indeed, some of the derivatives-based replication strategies may be more complex than the hedge

fund strategies they intend to replicate, counter to the very purpose of replication.[6]

The motivation for the AlphaSimplex approach came not from derivatives, but from Sharpe's (1992) asset-class factor models in which he proposed to decompose a mutual fund's return into two distinct components: asset-class factors such as large-cap stocks, growth stocks, and intermediate government bonds, which he interprets as "style," and an uncorrelated residual that he interprets as "selection." Fung and Hsieh (1997) applied this approach to hedge funds, but the factors were derived statistically from a principal components analysis of the covariance matrix of their sample of 409 hedge funds and commodity trading advisors. While such factors may yield high explanatory power (as measured by in-sample $R^2$'s), they suffer from significant overfitting bias and also lack economic interpretation, which is one of the primary motivations for Sharpe's (1992) decomposition.

Several other authors have estimated factor models for hedge funds using more easily interpretable factors such as fund characteristics and indexes (Schneeweis and Spurgin, 1998; Liang, 1999; Edwards and Caglayan, 2001; Capocci and Hubner, 2004; Hill *et al.*, 2004), and the returns to certain options-based strategies and other basic portfolios (Fung and Hsieh, 2001, 2004; Agarwal and Naik, 2000a, 2000b, 2004). In addition, a number of the world's largest banks have created hedge fund beta replication indexes based on factor models, including Barclays, Credit Suisse, Deutsche Bank, Goldman Sachs, Merrill Lynch, and Société Générale.

The most direct application of Sharpe's (1992) analysis to hedge funds was by Ennis and Sebastian (2003). They provided a thorough style analysis of the HFR Fund of Funds Index, and concluded that funds of funds are not market neutral and although they do exhibit some market-timing abilities, "…the performance of hedge funds has not been good enough to warrant their inclusion in balanced portfolios. The high cost of investing in funds of funds contributes to this result."[7] This conclusion is one of the primary motivations for Hasanhodzic and Lo's (2006, 2007) construction of lower-cost linear "clones."

Finally, some academics have proposed mechanical trading rules to create "plain vanilla" versions of certain types of hedge fund strategies such as risk arbitrage, long/short equity, and the currency carry trade.[8] For example, a carry-trade portfolio can be automatically managed by defining an investment universe of 15 currencies and a simple rule that buys bonds in the currencies with the three highest yields over a trailing three-month window and shorts bonds in the currencies with the three lowest yields over the same window.

The potential benefit of such an approach over factor-based strategies is that even a plain-vanilla implementation may be able to capture more of the risk factors associated with this strategy, thereby garnering more of the expected returns associated with those factors. The potential cost of this approach is the complexity and illiquidity involved in implementing even a plain-vanilla version of the strategy, and the higher management fees and risks associated with it. How an investor balances these potential costs and benefits should be determined by the nature of the strategy to be replicated, i.e., how well the strategy's returns can be replicated by liquid futures contracts, how much of the overall returns are explained by the illiquidity premium, and how challenging it is to manage the risks of the plain-vanilla strategy as compared to a liquid futures portfolio.

It should be emphasized that certain strategies involving highly illiquid assets may not be amenable to replication by any means. For example, replication of venture capital, private

equity, infrastructure, real estate, and distressed debt strategies using liquid instruments such as exchange-traded futures contracts is likely to yield unacceptably large deviations or "tracking error." In these cases, an inverse replication strategy—one designed to hedge out unintended exposures to liquid risk factors—may be of more interest to investors. Because of their dissimilarity, these illiquid strategies may be a natural complement to allocations to liquid beta replication strategies.

## 4 Unique aspects of AlphaSimplex's replication technology

AlphaSimplex has sought to refine its approach to hedge fund beta replication over the course of many applications and it believes its approach is distinct in several respects. AlphaSimplex believes that perhaps the most significant aspect is the investment philosophy on which the Fund's current strategy and ongoing research are based: the Adaptive Markets Hypothesis (AMH).[9] According to this philosophy, financial markets are not always and everywhere efficient but they are highly competitive and adaptive. Therefore, under the AMH, investment opportunities come and go, with alpha constantly being transformed into beta and new alphas emerging from behavioral reactions, institutional frictions, and macroeconomic policy. Because hedge funds operate with relatively few constraints in a highly competitive environment that requires them to adapt quickly to changing market dynamics, their broad market exposures can sometimes offer a window into the leading edge of market behavior.

This perspective leads to differences in how AlphaSimplex approaches hedge fund beta replication, and we highlight four of the most important differences for the ASG Global Alternatives Fund:

(1) **Emphasis on liquidity.** Because financial markets are adaptive, risk premia are not constant over time or circumstances; hence harvesting risk premia requires a nimble portfolio. By definition, it is only possible for a portfolio to be nimble if its underlying securities are liquid. Exotic over-the-counter derivatives contracts such as bilateral swaps, caps, collars, and look-back straddles may yield benefits during normal times, but when markets dislocate, these contracts can be subject to severe pressures such as fire-sale liquidations. For this reason, the ASG Global Alternatives Fund uses exchange-traded futures and currency forward contracts. This emphasis on liquidity may allow the ASG Global Alternatives Fund to maintain a slightly higher target volatility than that of funds with less liquid investments. These less liquid funds are often characterized by lower volatility during normal market conditions but their net-asset values can drop even more precipitously than long-only equity funds when markets dislocate.

(2) **Factor construction and estimation.** As market participants adapt to changing economic conditions, the betas of individual hedge funds can vary significantly from month to month. Therefore, any linear factor model of hedge fund returns must address these shifts by adapting as well. AlphaSimplex uses several techniques that seek to capture these changes more quickly, including Kalman filtering, genetic algorithms, statistical factor-selection methods, and momentum in industry betas.

(3) **Volatility control.** Another implication of the AMH is the fact that risks can vary dramatically over time. While most individual investors accept that they will experience some volatility in their investment returns, many are unprepared for the "volatility of volatility" that seems to have become the

status quo since 2007. To reduce the surprise factor in the overall risk level of the ASG Global Alternatives Fund, AlphaSimplex rebalances its portfolio every day to target an annualized volatility less than or equal to the maximum annualized volatility target of 9%. Of course, there is no guarantee that this daily rebalancing will result in any particular realized volatility because historical measures are imperfect forecasts of future volatility; nevertheless, we believe that this process generally yields a more stable level of risk than less frequent rebalancing (see Figure 2).

(4) **Stop-loss control.** In an efficient market, stop-loss policies only subtract value by causing investors to pull money out of higher expected-return assets in favor of cash. However, under the AMH, there are periods where risk premia can be negative because of market dislocation and flights-to-safety. During these periods, stop-loss policies can help avoid some of the losses and allow investors to stay invested longer, eventually reaping the benefits of the long run. For this reason, the ASG Global Alternatives Fund employs a drawdown control mechanism (i.e., stop-loss policy) that reduces its positions as cumulative losses grow and then reinstates those positions as the Fund becomes profitable again.

We believe that these differences have added value to the ASG Global Alternatives Fund in several ways over the course of its five-year history, and we provide illustrations of this value-added in the next section.

## 5 Historical performance[10]

Since inception through September 30, 2013, Table 1 shows that Class Y of the ASG Global Alternatives Fund has returned 4.66% per annum with an annualized volatility of 7.62%, implying a Sharpe ratio of 0.60 relative to the three-month T-bill risk-free rate. Over the same period, the Fund's benchmark, the Barclay Hedge Fund of Funds Index, generated a return of 1.28% per annum with 5.32% volatility, implying a Sharpe ratio of 0.22. The Fund's cumulative outperformance of its benchmark is substantial: since inception the Fund has earned a cumulative return of 25.60% while the Barclay Hedge Fund of Funds Index has generated a return of only 6.56%. Funds of hedge funds are the most popular way to obtain diversified exposure to hedge funds; hence they constitute the most natural comparison group for the Fund.

Table 1 also reports the correlation of the ASG Global Alternatives Fund to the S&P 500, an important measure given the role that alternative investments are expected to play in diversifying portfolios of traditional investments. The Fund's correlation to stocks is comparable to those of the benchmark: 70% correlation to the S&P 500 since inception compared to 78% for the Barclay Hedge Fund of Funds Index.[11]

These statistics appear to confirm that during the time period examined, hedge fund beta replication did achieve its objective of providing investors with the liquid portion of the expected returns and the diversification benefits of hedge funds without the complexities and fees of hedge fund investments. In addition to outperforming its benchmark on both a relative and an absolute basis during this particular period, the ASG Global Alternatives Fund is investable, with daily liquidity and multi-billion-dollar capacity, unlike any current hedge fund index (see "Issues with Hedge Fund Indexes" below for details).[12]

## 6 Volatility and stop-loss controls[13]

To develop further intuition about the performance of beta replication strategies, Figure 1 displays the annual returns of the Fund and its fund of

**Table 1** Performance comparison of ASG Global Alternatives Fund (GAFYX) with benchmark and S&P 500 Index from inception (September 30, 2008) through September 30, 2013. Year-to-date statistics are based on daily data; all other statistics are based on monthly data. Data are from Bloomberg with the exception of the Barclay Hedge Fund of Fund return for September 2013, which was obtained from the Barclay Hedge website on October 15, 2013.

| Statistic | GAFYX | Barclay FoF index | S&P 500 total return | GAFYX | Barclay FoF index | S&P 500 total return |
|---|---|---|---|---|---|---|
| | Trailing five-year/inception (through September 30, 2013) | | | Trailing three-year (through September 30, 2013) | | |
| Cumulative return | 25.60% | 6.56% | 61.18% | 13.71% | 6.70% | 57.16% |
| Annualized geometric RoR | 4.66% | 1.28% | 10.02% | 4.38% | 2.19% | 16.27% |
| Volatility | 7.62% | 5.32% | 18.08% | 7.93% | 4.09% | 12.41% |
| Sharpe ratio | 0.60 | 0.22 | 0.55 | 0.54 | 0.52 | 1.31 |
| Worst DD | −11.22% | −10.58% | −36.13% | −11.22% | −8.05% | −16.26% |
| S&P 500 correlation | 0.70 | 0.78 | 1.00 | 0.73 | 0.82 | 1.00 |
| Skewness | −0.70 | −1.73 | −0.82 | −0.84 | −0.69 | −0.14 |
| Kurtosis | 3.56 | 8.35 | 4.12 | 3.88 | 3.09 | 3.70 |
| Autocorrelation | −0.07 | 0.34 | 0.13 | −0.08 | 0.15 | −0.09 |
| | Trailing one-year (through September 30, 2013) | | | Year-to-date (through September 30, 2013) | | |
| Cumulative return | 10.75% | 6.50% | 19.34% | 9.61% | 4.94% | 19.79% |
| Annualized geometric RoR | — | — | — | — | — | — |
| Volatility | 5.75% | 3.23% | 9.04% | 7.09% | — | 11.32% |
| Sharpe ratio | 1.86 | 1.99 | 2.13 | — | — | — |
| Worst DD | −1.89% | −1.47% | −2.90% | −4.72% | — | −5.58% |
| S&P 500 correlation | 0.66 | 0.83 | 1.00 | 0.70 | — | 1.00 |
| Skewness | −0.04 | −0.63 | −0.20 | −0.35 | — | −0.49 |
| Kurtosis | 2.59 | 3.10 | 2.03 | 4.32 | — | 4.41 |
| Autocorrelation | −0.33 | −0.19 | −0.49 | 0.03 | — | −0.10 |

*Note*: Past performance is no guarantee of future results.

funds benchmark. The relative performance during the fourth quarter of 2008 and during 2009 is particularly instructive, highlighting the impact of illiquidity and volatility targeting. In the fourth quarter of 2008, the Fund's volatility targeting and stop-loss mechanisms led it to pare down its portfolio, limiting losses. During that time, many hedge funds lost considerable value because of the failure of Lehman Brothers and the subsequent flight to quality in the wake of the Financial Crisis, and the Fund reflected this industry-wide shock. However, the Barclay Hedge Fund of Funds Index lost −10.58% during the fourth quarter of 2008 whereas the ASG Global Alternatives Fund (Class Y) lost −2.60%.

A demonstration of the effectiveness of the Fund's volatility and stop-loss control mechanisms is the

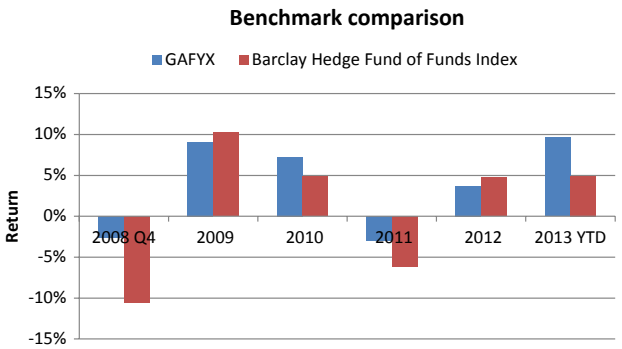


**Figure 1** Performance of the Fund and its benchmark over annual periods. 2008 and 2013 are partial periods, from October 2008 through December 2008 and from January 2013 to September 2013, respectively. Data are from Bloomberg with the exception of the Barclay Hedge Fund of Fund return for September 2013, which was obtained from the Barclay Hedge website on October 15, 2013. (*Note*: Past performance is no guarantee of future results.)

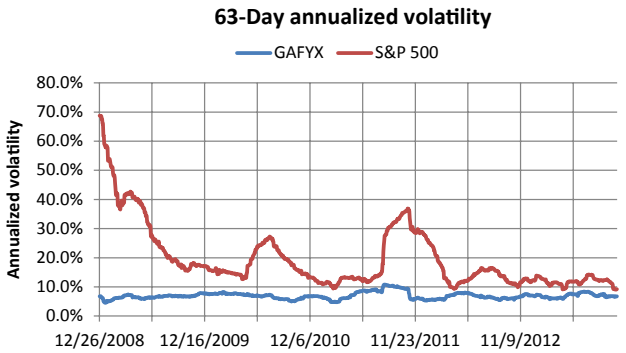


**Figure 2** The annualized volatility (standard deviation) of ASG Global Alternatives Fund (GAFYX) and the S&P 500 are calculated over 63-day rolling periods from October 1, 2008 to September 30, 2013. Data source: Bloomberg. (*Note*: Past performance is no guarantee of future results.)

annualized volatility of its daily returns during the fourth quarter of 2008, which was 6.64% despite the fact that the VIX Index reached its all-time intraday high of 89.53 on October 24, 2008[14]. The accuracy of the Fund's volatility targeting mechanism—recall that the Fund targets a volatility of up to 9%—is especially notable in light of the fact that one of the Fund's assets was S&P 500 futures contracts. Despite the sharp spike in equity volatility, we believe that the liquidity of the futures markets allowed the ASG Global Alternatives Fund to adapt to rapidly shifting market conditions. The resulting reduction in risk-taking helped limit the Fund's Q4 2008 losses to −2.60% while the S&P 500 lost −21.94% over the quarter.

Figure 2 provides a more direct comparison by displaying the 63-day rolling-window volatility of the Fund and the S&P 500 total return index; the impact of the volatility control mechanism is apparent. Due to its volatility and stop-loss control mechanisms and the liquidity of its constituents, the Fund has exhibited a relatively steady level of volatility while avoiding inordinately large losses—in fact, the Fund's worst quarterly return, −7.42% in the third quarter of 2011, represents a loss of 1.65 standard deviations with respect to the 9% maximum target volatility.

When compared to a traditional core holding such as the S&P 500, Table 1 shows that from inception to September 30, 2013, the Fund generated slightly less than half the return of the S&P 500 but with less than half of the volatility, implying a slightly higher Sharpe ratio of 0.60 for the Fund versus 0.55 for the S&P 500.

But more significant is the maximum drawdown—a measure of the worst peak-to-subsequent-trough decline of the Fund's net asset value. This statistic measures the worst-case scenario of an investor with impeccably poor timing, who buys into the fund at its peak and exits at its bottom. Since inception (September 30, 2008) to September 30, 2013, the Fund experienced a maximum monthly drawdown of −11.22%, whereas the comparable figure for the S&P 500 was −36.13%. Moreover, the fact that the Fund has a historical monthly correlation with the Barclay U.S. Aggregate Bond Index of just 9% may be especially relevant for

investors who anticipate a period of rising interest rates that would render bonds—the traditional tool for taming the volatility of equities as a core holding—less appealing than they have been historically.

## 7 The impact of the illiquidity premium

In 2009, as financial markets and liquidity returned to a "new normal," the hedge fund industry recovered and the Barclay Hedge Fund of Funds Index generated a return of 10.24%, whereas the Fund's return was 9.10%. This lower return reflects the fact that during normal times, beta replication strategies may underperform the hedge fund industry because, by construction, beta replication omits two components of hedge fund returns: the managers' alphas, and the illiquidity premium. While the alpha component may vary from one fund of funds to another due to variation in manager-selection ability, many funds of funds and hedge funds benefit from the fact that illiquid assets earn a higher expected rate of return to compensate investors for bearing the illiquidity risk.

However, it follows from the AMH that the illiquidity premium varies over time and across markets—for example, it was quite small just prior to August 1998, and became extremely large in the wake of Long Term Capital Management's demise as investors became much more risk averse, requiring a much greater incentive to hold any type of risky asset. Using a large sample of hedge funds, mutual funds, and individual U.S. stocks and serial correlation as a proxy for illiquidity, Khandani and Lo (2011) have estimated the average illiquidity premium of the hedge fund industry to be 3.93%. The alternative investments advisory firm Cliffwater LLC (2013) compared the net-of-fee returns of several hundred hedge funds with those of similar strategies in liquid vehicles offered by the same manager, and estimated an average annual illiquidity premium of 0.98% for hedge funds across style categories and over the past 10 years. It is important to note that both studies document considerable variation in the illiquidity premium over time, style categories, and market conditions, with Khandani and Lo's estimates ranging as high as 9.9% for fixed-income arbitrage strategies during market dislocations. This suggests that when liquidity is plentiful or increasing and equity markets are operating normally, beta replication strategies will underperform the hedge fund industry, as in 2009 and 2012, and when liquidity is scarce and equity markets are in turmoil, beta replication strategies should outperform the hedge fund industry, as the Fund did in the fourth quarter of 2008 and in 2011.

Of course, there are many other factors that can cause beta replication returns to deviate from those of the hedge fund industry. For example, the higher kurtosis of less liquid hedge funds means highly liquid beta replication funds can be managed to a slightly higher volatility (and expected return) target without a higher maximum drawdown during times of market stress. In addition, because beta replication strategies employ more liquid assets, they can be repositioned more quickly and cheaply to respond to changing market conditions, outperforming their hedge fund counterparts in some circumstances. The 2013 year-to-date performance of the Fund is a case in point. Equity markets have been strong and liquidity seems normal, yet the ASG Global Alternatives Fund has a year-to-date return through September 30, 2013 of 9.61%, compared to a return of 4.95% for the Barclay Hedge Fund of Fund Index. Both the fund and its benchmark benefited from rising stock prices. However, we believe that the Fund's ability to reduce its bond positions relatively quickly and to establish long-dollar and short-gold positions provided an important contribution to its performance.

## 8 Issues with hedge fund indexes

Whereas we believe that the performance of the ASG Global Alternatives Fund with respect to its benchmark has benefited investors, the comparison should nevertheless be interpreted with caution because hedge fund indexes are different from their traditional long-only equity counterparts. We believe investors have come to expect three things from an index: (1) it is passive and rules-based; (2) it is constructed with mechanical rules that are fully disclosed and transparent to the public; and (3) it is investable in the sense that the index return over any holding period can be realized, even for large amounts of capital. The motivation for these three characteristics comes from how indexes are used by investors—if managers cannot beat an index over time, investors have a viable and lower-fee alternative in which to invest. For this reason, index funds have grown into a multi-trillion-dollar industry in which indexes such as the S&P 500 are closely tracked by index funds, exchange traded funds, futures, and swaps, and each of these vehicles can provide investors with returns that are within basis points of the S&P 500 index return.

This is not the case with the most popular monthly hedge fund indexes, which are simply performance composites of multiple hedge funds. Even so-called "investable" indexes do not have the same capacity as traditional equity indexes. For example, we believe it is possible to invest $1 billion in the S&P 500 over the course of the next three trading days, hold this portfolio for a month, then liquidate it entirely, and be assured that the realized rate of return on the $1 billion over that monthly holding period is within a few basis points of the index return; hedge funds simply do not have this kind of capacity or liquidity.

Apart from issues of capacity and liquidity, hedge fund indexes may also contain several well-known biases. For example, funds that experience large losses often stop all public reporting and remove themselves from indexes and databases rather than have to report their bad returns, resulting in "exit bias." Some indexes include funds that are closed to new investors, making them non-investable by definition. And because hedge fund indexes have limited transparency into their constituent funds, there is likely no way to tell whether their returns on paper can be achieved by new investors. An extreme example is the fact that Fairfield Sentry, a private investment fund that invested with Bernard Madoff, was included in at least one prominent hedge fund index, hence a portion of the historical returns of this index will always contain an unrealistically high-performing component.

Some hedge fund industry indexes are composed of hundreds or even thousands of individual hedge funds. This breadth of diversification reduces the volatility of that index and increases its Sharpe ratio relative to the average hedge fund. While the benefits of such broad diversification are available to investors, they are not available without the expense of a fund of funds manager or swap fees which would reduce the return available to investors by 1% or 2% per annum.

Indexes that are composites of funds of hedge funds are less susceptible to some of these problems. Funds of funds often have access to many closed funds, they invest in funds that do not report to databases or indexes, and they are immune to the individual manager exit bias phenomenon (though they may generate some by themselves). However, they still suffer from capacity constraints. Because they are less affected by biases and because they are the traditional means by which investors obtain diversified hedge fund exposure, fund of funds indexes are currently the most appropriate benchmarks for hedge fund replication strategies.

In the long run, however, we believe that a liquid, transparent, and scalable portfolio of common factors associated with the returns of the hedge fund industry, i.e., beta replication strategies, may become the de facto benchmarks for funds of hedge funds and hedge funds. The current practice of comparing hedge funds and beta replication funds to uninvestable single-manager composite indexes—with returns and Sharpe ratios that are literally incredible—likely does a disservice to both investors and managers.

## 9 Hedge fund industry outlook

Since the motivation for hedge fund beta replication is based on the ability of the hedge fund industry to generate attractive risk-adjusted returns, the perceived underperformance of the industry in the post-Crisis period is an important concern. Specifically, the average annualized returns of single-fund managers (which excludes funds of funds) in our database dropped from 16.10% during the pre-Crisis period (1996–2006) to 5.04% during the post-Crisis period (2010–2012).

However, a closer look reveals that this drop in reported performance was likely exaggerated by two factors. First, returns in the pre-Crisis period were subject to more survivorship and backfill biases than those in the post-Crisis period. Our estimates suggest that, while in the pre-Crisis period the average annual return was upwardly biased by 8.57%, in the post-Crisis period the average annual return was upwardly biased by just 1.91%. Second, the risk-free rate dropped from an average of 3.80% pre-Crisis to just 0.08% post-Crisis.[15] When these two factors are taken into account, the average bias-adjusted excess net average return declined only modestly, from 3.73% to 3.05% (see Figure 3).

Moreover, on a risk-adjusted basis, this decline can likely be explained by decreased risk-taking—hedge funds' average returns (the

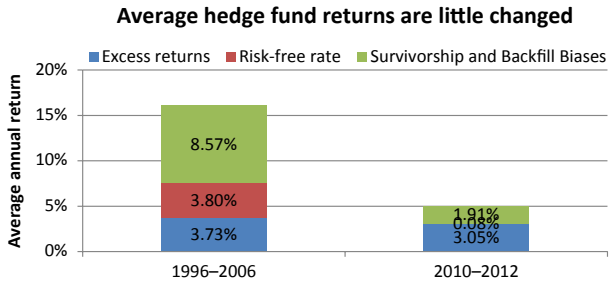


**Figure 3** The average rate of return of hedge funds is decomposed into three elements: (1) Reporting bias due to survivorship and backfill effects, (2) returns attributable to the risk-free rate rather than manager skill, and (3) net excess returns. The underlying data for this study consisted of the returns of the thousands of hedge funds in the Morningstar and TASS hedge fund databases.

average return each month of the single-fund managers in our database) exhibited a volatility of 6.64% in the pre-Crisis period but only 5.37% in the post-Crisis period, likely because of reduced leverage. While the aggregate skill of thousands of fund managers can be gauged in many ways, this simple analysis suggests that the risk-adjusted returns of the hedge fund industry have not changed appreciably, but the macroeconomic environment in which hedge funds operate is now quite different.

In light of the issues with hedge fund indexes discussed above, it is natural to ask how closely should we expect hedge fund beta replication to track the hedge fund industry in the future? In particular, might state-of-the-art beta replication strategies be employed not only to track, but actually to improve upon, the performance of the hedge fund industry as a whole? Indeed, an emphasis on liquid instruments already allows for dynamic portfolio management techniques (e.g., volatility control and stop-loss control, described above) that are not readily available to traditional hedge fund or fund-of-funds managers. Similarly, the liquid replication approach can generate

"replication portfolios" that: (1) eliminate the sector/style biases of hedge fund indexes; (2) engage in more robust portfolio optimization than is practical in a fund of funds portfolio; and (3) give more weight to the characteristics of hedge fund returns that are more likely to add value (e.g., tactical changes in position in response to a change in macroeconomic regime) and downweight the characteristics that are less likely to add value to investors seeking diversification (e.g., the hedge fund industry's bias toward long stock exposure). Only time will tell how the landscape of beta replication products will evolve, but there is no reason to believe that the most sophisticated of these strategies will be constrained by the weaknesses of hedge fund indexes or the biases of the hedge fund industry.

## 10 Conclusion

The ASG Global Alternatives Fund was designed with adaptation in mind. We believe that its ability to adapt via risk control and stop-loss policies, and its slightly higher volatility which is facilitated by the use of liquid securities, have contributed to the Fund's performance. Nevertheless, the AlphaSimplex research team is constantly seeking ways to improve the Fund. Two examples of improvements that have been implemented since inception are: an increase in the speed of adjustment for betas to reflect changes in the industry and the addition of two new assets (the Australian dollar and the Hang Seng Index futures) to improve diversification[16] and the fidelity of replication.

Hedge fund beta replication offers investors a new set of choices that fill a gap between traditional and alternative investments. While it is difficult to specify a single criterion for assessing the success of hedge fund beta replication, we can describe qualitatively what successful hedge fund beta replication looks like: a liquid, low-fee fund that generates attractive risk-adjusted returns by capturing the most significant drivers of the hedge fund industry and actively managing its risk. As financial markets become broader in scope, deeper in liquidity, and more highly interconnected, we believe that replication techniques can enhance risk-sharing and capital formation while enabling investors to stay invested for the long run.

## Acknowledgement

We thank Bev Bearden, Jerry Chafkin, Matt Connors, Arnout Eikeboom, David Giunta, Alex Healy, Peter Martin, Pierre Servant, Duncan Wilkinson, and Xiru Zhang for their helpful comments and discussion.

## Notes

1 See, for example, the recent reviews by Tuchschmid *et al.* (2010) and Bruno and Whitelaw (2012).

2 There are several theoretical justifications for the existence of risk premia other than the market portfolio, e.g., Merton's (1973) intertemporal Capital Asset Pricing Model and Ross's (1976) Arbitrage Pricing Theory. Empirical evidence for multiple risk premia has been documented in both equities (Fama and French, 1992) and hedge funds (Fung and Hsieh, 2001, 2004).

3 The strategies described above were only available for qualified investors and are no longer being offered.

4 See also the technical reports listed at http://helderpalaro.com.

5 More generally, Bertsimas *et al.* (2001) have shown that securities with very general payoff functions (like hedge funds, or complex derivatives) can be synthetically replicated to an arbitrary degree of accuracy by dynamic trading strategies—called "epsilon-arbitrage" strategies—involving more liquid instruments.

6 Nevertheless, derivatives-based replication strategies may still serve a useful purpose: risk attribution, with the ultimate objective of portfolio risk management. Even if an underlying hedge fund strategy is simpler than its derivatives-based replication strategy, the replication strategy may be used to measure the broader risk exposures of the hedge fund which can serve as the basis of an integrated hedging policy for a portfolio of hedge fund investments.

[7] Ennis and Sebastian (2003, p. 111).

[8] For example, see Mitchell and Pulvino (2001) for a mechanical risk arbitrage strategy, and Lo and Patel (2008) and Hasanhodzic *et al.* (2009) for a mechanical 130/30 U.S. large-cap equity strategy.

[9] See Lo (2004, 2005, 2012) and a video of Lo's 2013 Clarendon Lecture at www.youtube.com/watch?v=Dq6pwRhico.

[10] Past performance should not be construed as an indicator of future performance. There is a risk of loss associated with investing in the fund, including the loss of all or a portion of an investor's investment.

[11] The S&P 500 Index is a stock market index based on market capitalization weights for 500 leading companies that are publicly traded in the U.S. stock market. The Barclay Fund of Funds Index is a measure of the average return of all funds of funds included in Barclay's database. The indexes have been included to show the general trend in the equity markets and in funds of funds during the periods indicated and is not intended to imply that the Fund's portfolio is comparable to the S&P 500 Index or the funds of funds included in the Barclay Fund of Funds Index either in composition or element of risk.

[12] Past performance should not be construed as an indicator of future performance.

[13] No investment strategy or risk management technique can guarantee returns or eliminate risk in all market environments.

[14] The VIX is a measure of the implied volatility of S&P 500 Index options and generally increases during times of greater volatility.

[15] The three-month T-bill is used as the risk-free rate for this application.

[16] Diversification does not guarantee a profit or protect against a loss.

## References


Agarwal, V. and Naik, N. (2000a). "Generalised Style Analysis of Hedge Funds," *Journal of Asset Management* **1**, 93–109.

Agarwal, V. and Naik, N. (2000b). "On Taking the Alternative Route: Risks, Rewards, and Performance Persistence of Hedge Funds," *Journal of Alternative Investments* **2**, 6–23.

Agarwal, V. and Naik, N. (2004). "Risk and Portfolio Decisions Involving Hedge Funds," *Review of Financial Studies* **17**, 63–98.

Baquero, G., Horst, J., and Verbeek, M. (2005). "Survival, Look-Ahead Bias, and Persistence in Hedge Fund Performance," *Journal of Financial and Quantitative Analysis* **40**, 493–517.

Bertsimas, D., Kogan, L., and Lo, A. (2001). "Hedging Derivative Securities and Incomplete Markets: An $\varepsilon$-Arbitrage Approach," *Operations Research* **49**, 372–397.

Bruno, S. and Whitelaw, R. (2012). "Selecting a Hedge Fund Replication Approach: Some Factors to Consider," *Journal of Indexes* May/June, 41–47.

Capocci, D. and Hubner, G. (2004). "Analysis of Hedge Fund Performance," *Journal of Empirical Finance* **11**, 55–89.

Carpenter, J. and Lynch, A. (1999). "Survivorship Bias and Attrition Effects in Measures of Performance Persistence," *Journal of Financial Economics* **54**, 337–374.

Cliffwater LLC (2013). *Performance of Private versus Liquid Alternatives: How Big a Difference?* June 19. Marina Del Rey, CA: Cliffwater LLC.

Edwards, F. and Caglayan, M. (2001). "Hedge Fund Performance and Manager Skill," *Journal of Futures Markets* **21**, 1003–1028.

Ennis, R. and Sebastian, M. (2003). "A Critical Look at the Case for Hedge Funds: Lessons from the Bubble," *Journal of Portfolio Management* **29**, 103–112.

Fama, E. and French, K. (1992). "The Cross-section of Expected Stock Returns," *Journal of Finance* **47**, 427–465.

Fung W. and Hsieh, D. (1997). "Empirical Characteristics of Dynamic Trading Strategies: The Case of Hedge Funds," *Review of Financial Studies* **10**, 275–302.

Fung, W. and Hsieh, D. (2001). "The Risk in Hedge Fund Strategies: Theory and Evidence from Trend Followers," *Review of Financial Studies* **14**, 313–341.

Fung, W. and Hsieh, D. (2004). "Hedge Fund Benchmarks: A Risk-Based Approach," *Financial Analysts Journal* **60**, 65–80.

Hasanhodzic, J. and Lo, A. (2006). "Attack of the Clones," *Institutional Investor's Alpha*, June, 54–61.

Hasanhodzic, J. and Lo, A. (2007). "Can Hedge-Fund Returns Be Replicated?: The Linear Case," *Journal of Investment Management* **5**, 5–45.

Hasanhodzic, J., Lo, A., and Patel, P. (2009). *The Credit Suisse 13/30 Index*: *A Summary and Performance Comparison*, New York: Credit Suisse.

Healy, A. and Lo, A. (2009). "Jumping the Gates: Using Beta-Overlay Strategies to Hedge Liquidity Constraints," *Journal of Investment Management* **7**, 1–20.

Hill, J., Mueller, B., and Balasubramanian, V. (2004). "The 'Secret Sauce' of Hedge Fund Investing—Trading Risk Dynamically," Goldman Sachs Equity Derivatives Strategy, November 2.

Ibbotson, R., Chen, P., and Zhu, K. (2011). "The ABCs of Hedge Funds: Alphas, Betas and Costs," *Financial Analysts Journal* **67**, 15–25.

Kat, H. and Palaro, H. (2005). "Who Needs Hedge Funds? A Copula-Based Approach to Hedge Fund Return Replication," Alternative Investment Research Centre Working Paper No. 27, Cass Business School, City University, London.

Kat, H. and Palaro, H. (2006a). "Replication and Evaluation of Fund of Hedge Funds Returns," Alternative Investment Research Centre Working Paper No. 28, Cass Business School, City University, London.

Kat, H. and Palaro, H. (2006b). "Superstars or Average Joes?: A Replication-Based Performance Evaluation of 1917 Individual Hedge Funds," Alternative Investment Research Centre Working Paper No. 30 Cass Business School, City University, London.

Khandani, A. and Lo, A. (2011). "Illiquidity Premia in Asset Returns: An Empirical Analysis of Hedge Funds, Mutual Funds, and U.S. Equity Portfolios," *Quarterly Journal of Finance* **2**, 205–264.

Liang, B. (1999). "On the Performance of Hedge Funds," *Financial Analysts Journal* **55**, 72–85.

Lo, A. (2004). "The Adaptive Markets Hypothesis: Market Efficiency from an Evolutionary Perspective," *Journal of Portfolio Management* **30**, 15–29.

Lo, A. (2005). "Reconciling Efficient Markets with Behavioral Finance: The Adaptive Markets Hypothesis," *Journal of Investment Consulting* **7**, 21–44.

Lo, A. (2012). "Adaptive Markets and the New World Order," *Financial Analysts Journal* **68**, 18–29.

Lo, A. and Patel, P. (2008). "130/30: The New Long-Only," *Journal of Portfolio Management* **34**, 12–38.

Merton, R. (1973). "An Intertemporal Capital Asset Pricing Model," *Econometrica* **41**, 867–887.

Mitchell, M. and Pulvino, T. (2001). "Characteristics of Risk and Return in Risk Arbitrage," *Journal of Finance* **56**, 2135–2175.

Ross, S. (1976). "The Arbitrage Theory of Capital Asset Pricing" *Journal of Economic Theory* **13**, 341–360.

Schneeweis, T. and Spurgin, R. (1998). "Multi-factor Analysis of Hedge Fund, Managed Futures, and Mutual Fund Return and Risk Characteristics," *Journal of Alternative Investments* **1**, 1–24.

Sharpe, W. F. (1992). "Asset Allocation: Management Style and Performance Measurement," *Journal of Portfolio Management* **18**, 7–19.

Tuchschmid N., Wallerstein, E., and Zaker, S. (2010). "Hedge Fund Clones are Still to Count on," Working Paper, Social Science Research Network, doi: 102139/ssrn.1729109.

*Keywords*: Hedge funds; liquid alternatives; beta replication; exotic beta; smart beta