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The Value-Added of Investable Hedge Fund Indices

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Abstract

This paper empirically investigates the risk and performance of three types of alternative beta products over the January 2002 to September 2009 time period: funds of hedge funds (FHFs), investable hedge fund indices (IHFIs), and hedge fund replication strategies (HFRS). We show that IHFIs are true alternative beta products with high correlations and beta to non-investable hedge fund indices. Our results further suggest that, in a best case scenario, IHFIs outperform FHFs and HFRS on a risk-adjusted basis. However, in the worst case scenario, IHFIs underperform both investments. If we take the average of all IHFIs, we find they perform equally well as FHFs. Hence, IHFIs constitute a solid alternative to FHF investments, while costing substantially less, and offering generally more transparency and liquidity. We propose that fee-sensitive investors especially should consider taking a core-satellite approach to their hedge fund portfolio, with the core represented by cheap passive hedge fund beta through IHFIs, and the satellite represented by more expensive and actively managed alpha-generating FHFs.

Key words: Hedge funds, investable hedge fund indices, alternative beta, funds of hedge funds, hedge fund replication, Omega ratio.

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Content

1. Introduction

Although many investors think of hedge funds as a 1990s' financial innovation, it has actually been sixty years since the first hedge fund was established by Alfred Winslow Jones in 1949. Jones was a journalist and sociologist living in the U.S. who later became a fund manager. Since the beginning of this century, the popularity of hedge funds has exploded.

Hedge funds aim to generate absolute returns by using strategies such as taking advantage of mispriced securities, or pocketing non-traditional risk premiums.[1] They also profit from market inefficiencies, selling overvalued securities and buying undervalued ones. Hedge funds can be defined as private, lightly regulated investment vehicles that offer a flexible investment environment by investing in cash as well as equity, bond, derivative, and commodity instruments, often via leverage and short-selling.

As the popularity of hedge funds has increased, several alternate forms of hedge fund investments have emerged. In addition to direct investment into a single hedge fund (SHFs), investors can also choose among funds of hedge funds (FHFs), investable hedge fund indices (IHFIs), and hedge fund replication strategies (HFRS). FHFs have existed since the 1970s, and now account for more than 20% of hedge fund investments. This illustrates the increasing investor demand for more diversified hedge fund investments that will behave more similarly to conventional asset management.

IHFIs, on the other hand, are a younger investment instrument, in use only since 2002. These instruments can be attractive to investors seeking investments that are comparable to index-

[1] This is in contrast to mutual funds, who aim to beat a certain benchmark even if returns are ultimately negative. Hedge funds usually aim for positive returns, hence the term "absolute return."

tracking strategies in equity markets. IHFIs provide a transparent, cheap, and rules-based way of tracking a certain hedge fund style or strategy, or even the entire universe itself.

The theoretical foundation of this paper is the so-called alternative beta concept, pioneered by Fung and Hsieh (1997, 2001, 2002). They show that with a factor-based approach it is possible to decompose hedge fund returns into not only alpha and (traditional) beta, but also into alternative beta. Alternative beta thus represents the systematic risk exposures of hedge funds that traditional investors are not exposed to, such as volatility risks or liquidity premiums. Hence, these beta exposures are not "traditional," but "alternative."

Thus far, the term "alternative beta" has predominantly been used for investable hedge fund indices and replication strategies that try to either represent the performance of the hedge fund industry or to mimic the performance of the average hedge fund. Following Fung *et al.* (2008), who found that the number of alpha-producing FHFs is very small, we argue that most FHFs expose investors to systematic hedge fund risks, and should be included in the alternative beta discussion.

The aim of this paper is to empirically compare the risk and performance of the three main alternative beta product categories. IHFIs have not been studied as prominently yet as FHFs[2] or HFRS,[3] so we describe this category in more detail in chapter 2. Chapter 3 discusses our empirical analysis, where we compare IHFI performance against four benchmark investments: traditional equity and bond indices, non-investable hedge fund indices, FHFs, and HFRS. We focus particularly on IHFIs versus FHFs, as these two investments represent passive and

[2] See, for example, Brown *et al.* (2004), Fung *et al.* (2008), Füss *et al.* (2009), Heidorn *et al.* (2009, 2010), and Gregoriou *et al.* (2008).
[3] See, for example, Wallerstein *et al.* (2010), Gupta *et al.* (2008), Kazemi *et al.* (2008), Kat and Palaro (2005), and Amenc *et al.* (2008, 2010).

active management, respectively, of hedge fund portfolios. Chapter 4 provides a summary of our main findings and gives some conclusions.

2. Development of Hedge Fund Indices

2.1 Benchmark indices

The growing interest of private and institutional investors in hedge funds has spawned a concurrent demand for hedge fund indices. The hedge fund universe is still fairly unregulated; thus, as Crowder and Hennessee (2001) note, hedge fund indices should function as benchmarks and provide a true and fair view of overall performance.

There are numerous databases constructing hedge fund indices for different substrategies, however. And providers use their own proprietary selection criteria when choosing which funds to include. As Brooks and Kat (2002) note, this can lead to different returns for competing indices that are tracking the same hedge fund strategy.

In theory, the characteristics for judging the quality of hedge fund indices as benchmarks are transparency, investability, measurability, and adequacy. Overall transparency has increased with the evolution of the hedge fund industry and as indices have become less heterogeneous. But they are far from the homogenous benchmarks illustrated by, e.g., Amenc and Martellini (2002). The heterogeneity of hedge fund indices stems from several factors, such as the index sponsor's individual selection criteria for index components or from different index construction methods.[4]

[4] For example, Hedge Fund Research International (HFRI) requests that a single hedge fund report assets in USD, publish its returns net of fees, and have a track record of at least twelve months, or more than USD 50 million in assets under management (AuM) to be included in an index. In contrast, CS/Tremont demands both

Apart from discrepancies in methodology, there are a handful of biases inherent in hedge fund indices that can distort their validity as benchmarks. The most significant is the so-called survivorship bias. This results from the fact that index returns are calculated only on the basis of SHFs that are still in operation at the end of each reporting period (in other words, SHFs that have ceased operation are excluded). However, funds most often cease operations because they have liquidated (or merged) due to consistently negative performance. Thus, survivorship bias can lead to positively skewed performance.[5] Furthermore, standard deviation is underestimated, because defunct funds tend to be more volatile (Brown *et al.*, 1999)). To adjust for this bias, it is necessary to subtract the average performance of the "surviving" funds from the performance of the entire hedge fund universe. However, there is no official database that captures all existing SHFs, so it is impossible to fully gauge the underlying error.

USD 50 million in AuM and a minimum twelve-month track record, but none of the other criteria. Construction methodology differs as well. HFR uses equal weights, while CS/Tremont was the first index provider to use an asset-weighted approach. CS/Tremont's hedge fund indices are thus more similar to traditional market capitalization-weighted equity indices.

[5] Fung and Hsieh (2000) studied 602 single hedge funds from the TASS database that had ceased reporting. They concluded that 60% of the funds closed down, 28% decided not to provide any further data, and 4% merged with other funds. They found no explanation for the remaining 8%.

Exhibit 1: List of possible hedge fund index biases

Bias	**Definition**
Back-delete Bias	When fund managers require previously reported performance to be deleted (this is a form of survivorship bias)
Backfilling Bias	When performance is calculated backward and integrated into the index (this occurs because of the short existence of many hedge funds).
Calculation Method Bias	When mathematical models are used for illiquid asset valuation.
Classification Bias	When hedge fund strategies are misclassified.
Construction Bias	When differing methods are used for index construction.
Correlation Bias	When the correlation between hedge funds and equity indices increases due to a change from monthly to quarterly data.
Creation Bias	When high- and low-performing funds are combined.
Double-Counting Bias	When SHFs and FHFs are included in one database.
Geographical Bias	When funds from a particular region are concentrated within a database.
Liquidation Bias	When funds in the process of being liquidated cease reporting before being fully liquidated. This can lead to an upward bias.
Minimum History Bias	When a database requires a minimum track record, which can lead to excluding short-running, failed funds.
Short-History Bias	When young hedge funds are overrepresented.
Selection Bias	Can result from the use of individual selection criteria by index providers for SHFs (includes several sub-biases).
Size Bias	Can result from the use of specific size criteria chosen by an index provider.
Stop-Reporting Bias	Can result because funds may stop reporting at any given time (a form of survivorship bias).
Time Period Bias	Can result from the initiation period of an index chosen by a database.

The optional nature of hedge fund reporting leads to another bias called the self-selection or representation bias. Because there is no official hedge fund database, it is up to each SHF to report performance to external databases. Young or unknown SHFs tend to be more willing to report in hopes of obtaining marketing opportunities. However, higher-performing, established SHFs that have reached capacity often tend to stop reporting. Hence, SHFs can

often be found in one database but not in another, and some SHFs may not publish any data at all.

Research suggests that HFR has the most comprehensive database (see Agarwal *et al.* (2009)). Lhabitant (2006) found that only 3% of SHFs were included in all four major hedge fund databases (CS/TASS, HFR, CISDM, MSCI), while only 10% were found in three of the four. This can lead to a very high level of heterogeneity from the beginning of the index construction process.

Data reliability can also differ quite dramatically among databases. The result is a negative distortion of the index performance and an incomplete representation of the hedge fund universe.

Asness *et al.* (2001) suggest that the self-selection bias nets to almost zero, as the best- and worst-performing SHFs tend to be those that stop reporting and thus cancel each other out. Ackermann *et al.* (1999) argue that the survivorship bias and the self-selection bias will also cancel each other out.

In addition to the aforementioned biases, there are several other distortions that can affect the representativeness of non-investable hedge fund indices. Exhibit 1 provides a short explanation of each bias.

2.2 Investable indices

Many of the established hedge fund database providers that provide non-investable hedge fund indices as benchmarks also offer investable ones. Exhibit 2 describes the IHFI providers:

Exhibit 2: Investable hedge fund index providers

Index provider	Inception	Basis	No of indices (including Composite)
CS/Tremont Allhedge	October 2004	Hedge Funds	11 (one composite)
CS/Tremont Blue Chip	August 2003	Hedge Funds	11 (one composite)
Deutsche Bank	January 2009	Managed Accounts	5 (one composite)
Dow Jones[1]	January 2005	Managed Accounts	7 (one composite)
Edhec	May 2005	Managed Accounts	5 (no composite)
Feri	January 2002	Hedge Funds	10 (one composite)
FTSE[2]	January 2004	Managed Accounts	10 (one composite)
GAI	January 2003	Hedge Funds	14 (two composite)
HFRX	April 2003	Managed Accounts	71 (four composite)
MSCI[3]	July 2003	Managed Accounts	9 (one composite)
RBC	July 2005	Hedge Funds	10 (one composite)
S&P	October 2002	Managed Accounts	4 (one composite)

[1]Three of six indices have ceased calculation; hence, no composite is currently available.

[2]Ceased calculation as of March 2009.

[3]Ceased calculation as of January 2009.

Credit Suisse/Tremont, Deutsche Bank, Dow Jones, École des hautes études commerciales du nord (Edhec), Feri Institutional Advisors (Feri), Financial Times Stock Exchange (FTSE), Greenwich Alternative Investments (GAI), Hedge Fund Research (HFRX), Morgan Stanley Capital International (MSCI), and the Royal Bank of Canada (RBC). CS/Tremont, Feri, and RBC are based on offshore hedge fund investments, meaning that investments flow directly

into the SHFs that are underlying the index. All other providers use managed account platforms.[6]

The main difference between non-investable and investable hedge fund indices is that the latter are virtually unaffected by survivorship or backfilling biases. However, although non-investable indices can function as benchmarks, they do not fulfill what Bailey et al. (1990) has characterized as one of the primary functions of a benchmark: investability. A benchmark index tries to capture as many existing SHFs from the hedge fund universe as possible in order to be representative. At the same time, however, many of the existing SHFs are closed due to capacity constraints. Thus, hedge fund indices cannot function as perfect benchmarks because these two characteristics, being fully representative and investable, are not achievable at the same time.

IHFIs follow a slightly different methodology with regard to the underlying SHFs. They drop the goal of capturing as many SHFs as possible. Instead, the main criteria for inclusion become openness to new investments, as well as liquidity and transparency considerations. These rules apply to all the indices in Exhibit 2.

The methodologies applied when building an IHFI vary among the different providers. However, all currently existing IHFIs follow a basic construction scheme (see Exhibit 3). It begins with a large universe of SHFs that constitutes the base universe, and continues in a pyramid pattern, where the universe is narrowed stepwise until it culminates in the actual composite and strategy indices.

[6] Managed account platforms are personalized investments tailored to the needs of the accountholder. In this case, hedge fund managers run a part or all of their portfolios on an account at a third party, e.g., a broker or an investment bank. Managers have the same freedom to make decisions as in the flagship offshore fund, but they must disclose all of their positions and trades to the third party. The advantage is that all the operational risk is shifted to the third party, which is usually a reputable institution in the market and can make the fund more attractive to investors.

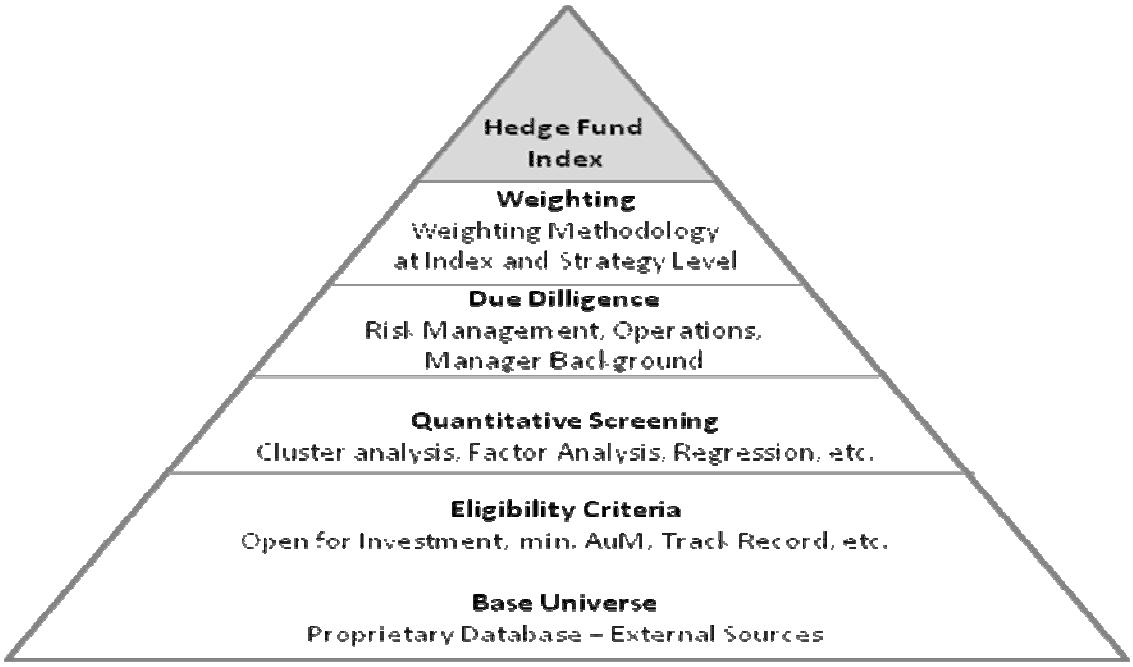
The first level is comprised of the universe of SHFs, which functions as a pool for the first step in the screening and selection process. At this level, there are already differences among index providers. Most use a proprietary database, but providers can also refer to one or more commercial hedge fund databases from external sources.

The second step involves the selection of eligible SHFs from the database. For this purpose, every IHFI provider has its own list of selection criteria. Exhibit 4 provides an overview of the main criteria: openness to new investments, minimum assets under management (min. AuM), lock-up period, track record, and redemption frequency. Index providers may also request that SHFs offer specific features according to their methodology.[7] Eligibility criteria are then applied to the subset of SHFs from the original base universe. In addition to the individual features, there is a significant difference in the amount of criteria demanded by index providers.[8]

[7] Greenwich Alternative Investment, for example, performs a quantitative analysis of SHF performance in the database, and ranks the results according to a proprietary score scheme. The aim is to generate a subdatabase consisting of the top quartile funds in terms of performance that is likely to persist.

[8] Greenwich lists twenty criteria in their eligibility catalogue, Credit Suisse/Tremont lists fourteen, and Dow Jones lists only two criteria for determining fund eligibility.

Exhibit 3: Investable index construction methodology



The third step involves the quantitative screening of potential index members. Obviously, investors are still unsure how to objectively classify SHFs. In the case of IHFIs, providers start with the self-qualification conducted by SHF managers and the qualitative information on their investment style. However, most providers also use quantitative techniques to verify a correct style allocation (e.g., clustering, factor analysis, Principal Component Analysis (PCA)). Goltz *et al.* (2007) demonstrate that it is feasible to construct a representative yet investable hedge fund strategy index with only a handful of thoroughly selected funds using PCA.[9]

[9] For example, Dow Jones applies cluster analysis to determine the strategies Convertible Arbitrage, Distressed Securities, Event Driven, and Merger Arbitrage. Volatility analysis is applied to filter Equity Market Neutral and Equity Long/Short, which must have annualized standard deviations of less than 0.1 and 0.2, respectively. For Equity Market Neutral, beta analysis also filters and preserves only those funds with a beta of less than 0.5. Finally, all funds must pass a correlation analysis against other hedge fund indices, where each fund must meet a minimum requirement depending on its strategy.

Exhibit 4: Selected eligibility criteria

Index provider	Open to investment	Min. AuM (USD)	Lock-up period	Min. track record	Redemption frequency	Total no. of criteria
CS/Tremont Allhedge	yes	100m	not allowed	N/A	one month/ quarterly (depending on strategy)	17
CS/Tremont Blue Chip	yes	250m	not allowed	N/A	one month/ quarterly (depending on strategy)	17
Deutsche Bank	N/A	N/A	not allowed	N/A	monthly	N/A
Dow Jones	yes	50m/100m (Equity l/s)	N/A	2 years	N/A	2
Edhec	yes	All criteria depend on the rules of Lyxor Asset Management, which runs the managed account platform for Edhec, which functions as the fund database.				N/A
Feri	yes	50m	maximum 25%, with 3 to 24 months hard lock-up and the rest maximum 90 days	*for 50% of constituents:* 36, 12, 3 months for 50-100m, 100m-500m, and 500m< AuM	quarterly	12
FTSE	yes	50m	N/A	2 years	N/A	5
GAI	yes (only at initial investment)	20m fund assets, 50m firm assets	maximum 6 months hard lock- up	1 year	70% monthly, remainder quarterly	20
HFRX	yes	50m	N/A	2 years	N/A	6
MSCI	yes	N/A	N/A	N/A	weekly	N/A
RBC	yes	10m	maximum 1 year	6 months	annually	20
S&P	yes	Yes, but not specified	N/A	Yes, but not specified	N/A	N/A

Correct style allocation is an important aspect of constructing a representative index, because substrategies share similar return and volatility characteristics and allow better monitoring of performance and risk. But it is an inaccurate part of index construction, because all the above-mentioned statistical methods require a non-defined number of variables as input data. Hence, each provider can choose which and how many variables to include.[10]

[10] As shown in Exhibit 3, the number of strategy indices can range from as few as five (e.g., Deutsche Bank) to as many as seventy-one (HFRX).

For example, factor analysis is used to explain a set of data by means of the factors chosen; cluster analysis is used to distinguish different strategies by the measure of distance chosen. Hence, index providers enjoy a large amount of freedom at this stage of index construction.

Apart from having different strategy amounts, the same fund may also be classified differently across databases. This classification bias can occur especially with substrategies that are not easily distinguishable from each other.[11] Although this bias is already familiar from non-investable index construction, it could be even more profound in an investable index context.[12] In fact, a single misclassification could be enough to distort the risk/return characteristics of such indices under certain market conditions without it being obvious. However, this effect may be neutralized at a composite level, when the strategies are again combined into a single index.

In the fourth step, we conduct qualitative due diligence. This process usually includes a standard questionnaire to be filled out by the potential index constituent. It provides information on topics such as accounting, risk management, and manager background, and often includes an onsite visit by the index sponsor. All SHFs that pass these final checks are considered potential index constituents. Their inclusion will depend on any constraints imposed on the maximum number of funds allowed per substrategy, or on the weighting methodology used during the final step.

The total number of SHFs included in an index is either limited by an absolute target value (as stated in the index methodology), or is allowed to float within a corridor that is capped on the

[11] For example, HFR uses Equity Hedge, Event Driven, Relative Value, and Tactical Trading as major strategies and distinguishes several substrategies for these sectors, including Equity Long/Short, Equity Long Bias, Equity Short Bias, and Equity Market Neutral. These substrategies may prove more difficult to differentiate precisely.

[12] CS/Tremont requires a minimum of ten single hedge funds per substrategy and FTSE requires only three funds in order to create a representative strategy index.

upside and has a floor on the downside.[13] In general, the tendency is to establish a minimum rule at strategy level in order to guarantee style purity and representativeness (as noted previously). The upside can be either capped or open. Hence, strategy-level indices are filled with potential SHFs up to the minimum requirement, while the SHFs are ranked based on a "best of class" method. Best of class could mean a single most important criterion, such as performance persistence (GAI), style representativeness (FTSE), or assets under management (CS/Tremont).

Exhibit 5 lists the target member funds and gives further details on weighting methodologies. It is obvious that IHFIs with a small target amount of SHFs carry greater drawdown risks for investors, because the blow-up of a constituent fund would have a much stronger impact. And because the number of SHFs per strategy index can be very small, a severe economic downturn in a certain sector might also have a strong negative impact on a strategy index.[14]

[13] For example, CS/Tremont offers two major composite indices: the CS/Tremont Allhedge Index and the CS/Tremont Blue Chip Index. The Allhedge Index requires its strategy indices to include a minimum of ten but a maximum of twenty-five single hedge funds. Because there are ten strategy indices comprising the composite index, the total number of funds will be between 100 and 250. In contrast, the Blue Chip Index has a fixed amount of sixty member funds in the composite index, and the Royal Bank of Canada (RBC) has a fixed amount of 250 member funds.

[14] This was the case with three Dow Jones hedge fund strategy indices that suspended calculation during 2009. As a result, the composite index also had to cease calculation, because it was based on a total of six strategy indices.

Exhibit 5: Number of constituents and weighting methodology

Index provider	No. of funds in composite index	Weighting methodology		Single fund weight cap	Rebalancing
		Strategy level	Composite level		
CS/Tremont Allhedge	100 - 250	asset-weighted	according to CS Hedge Fund Index	15% of strategy index	semiannually
CS/Tremont Blue Chip	60	asset-weighted	asset-weighted	8% of composite	semiannually
Deutsche Bank	Variable; 39 as of September 2009	equally	according to HFRI composite	N/A	quarterly
Dow Jones	min. 35	equally	equally	N/A	quarterly
Edhec	40 - 60	according to the highest correlation to PCA	N/A	between 5%-20% of strategy index per fund	weights every 3 months, funds every 6 months
Feri	min. 32; 62 as of September 2009	asset-weighted	equally; strategy may deviate up to 40%	4*(NAVt/nt) > w*t* > 1/4 * (NAVt/nt)[15]	quarterly
FTSE	40	investability-weighted	investability-weighted	Max. 40% of trading strategy (trading strategy -> strategy index -> comp. index)	monthly
GAI	min. 45	equally	according to Greenwich Global Hedge Fund Index (equally weighted)	max. 10% of composite index; aggregate of funds larger than 5% must be < 40% of constituents	annually
HFRX	N/A	equal weights for HFRX Equal index; low vol. & correl. weights for HFRX absolute return; high vol. & correl. weights for HFRX directional	asset-weighted for HFRX Global Hedge Fund Index	N/A	quarterly
MSCI	23 - 50 (calculated from fund cap; official value n/a)	equally	according to MSCI Hedge Fund Composite Index	2% - 4.5%	quarterly
RBC	250	asset-weighted; max. 120% of average AuM in strategy over preceding 12 months;	asset-weighted	max. approx. 1% of composite	monthly
S&P	40	equally weighted	equally weighted	N/A	annually

[15] w_t = weight in time t, NAV_t = net asset value in time t, n_t = number of composite index constituents in time t.

At a strategy level, SHFs are usually equally weighted or weighted by assets under management. Additional proprietary methods exist as well, such as weighting by investability of a fund. At the composite index level, weighting can take place according to assets, equality among strategies, or by replicating the sector weights of non-investable composite indices (e.g., inheriting the weighting method of the non-investable index).[16]

Finally, every IHFI must be rebalanced periodically in order to comply with the index methodology. During rebalancing, which takes place either monthly, quarterly, semiannually, or annually, the entire construction methodology is repeated so as to refresh the indices. Quarterly rebalancing is the most common frequency.[17]

In addition to scheduled rebalancing dates, as stated in the index methodology documents of each provider, there can be unscheduled rebalancing dates as well. These can occur under several circumstances that again differ among providers, such as liquidation or gating of index constituents, large redemptions in tracking vehicles, or breach of eligibility criteria by index constituents. The aim of rebalancing is to remain as close as possible to the defined index rules, which guarantee investability, liquidity, and representativeness.

For IHFIs, fees can occur at three levels: a SHF level, an index provider level, and an issuer level. Investors' net performance can be obtained by subtracting all of these fees. Most of the fees are common to all types of hedge fund investments, but specific charges can occur at an index level and especially at an issuer level, depending on the derivative structure used to make the index investable.

[16] CS/Tremont Allhedge uses its own non-investable hedge fund composite index as a role model, as do MSCI, GAI, and Deutsche Bank. Asset weighting is used by RBC, HFRX, and CS/Tremont Blue Chip. Dow Jones and Feri use equal weighting; FTSE uses the investability criterion.

[17] Greenwich is the only provider cited in this article that uses annual rebalancing; Credit Suisse is the only one cited here that uses semiannual rebalancing.

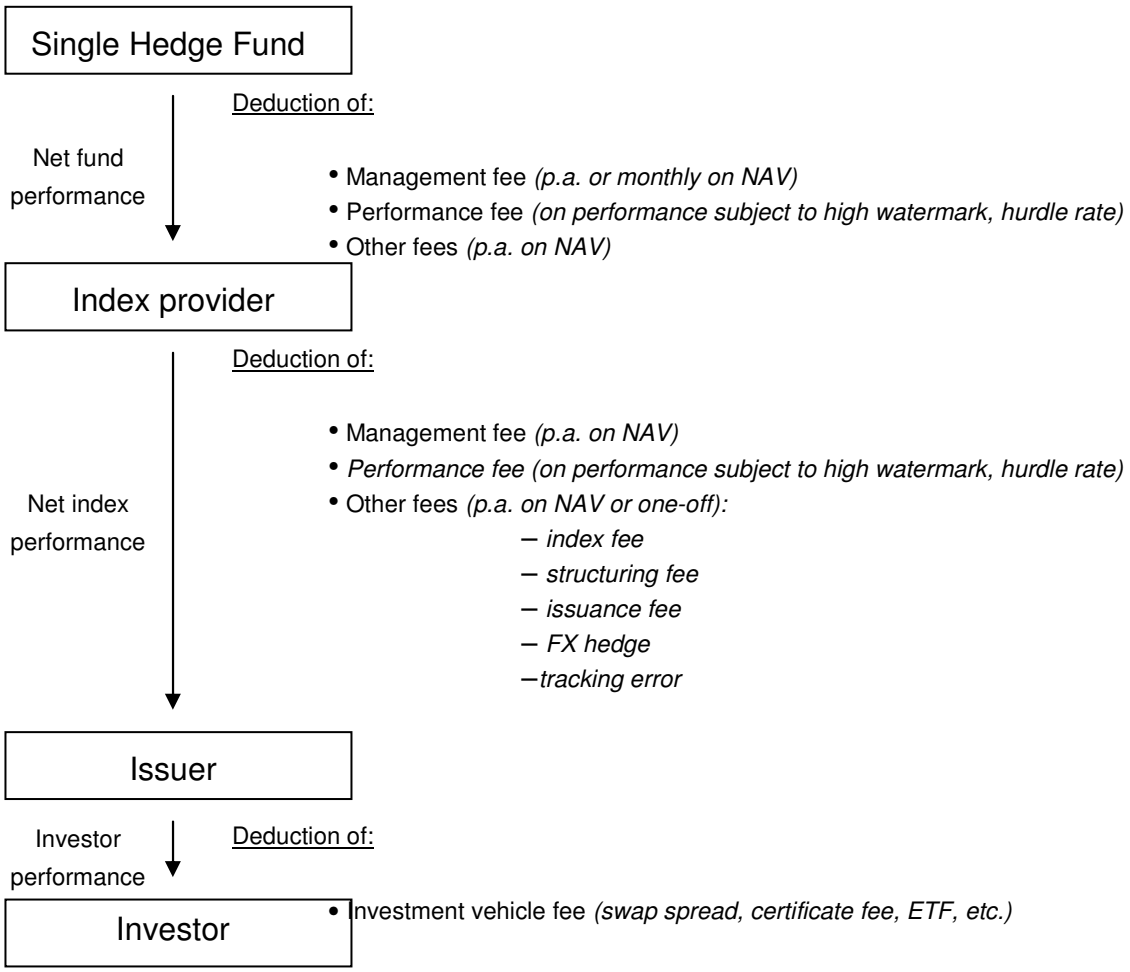
The SHF level of fees consists mainly of management and performance fees. Other types may exist, however, depending on fund strategy, instruments used, and the complexity of the investment process. The management fee is normally around 1% to 2% per annum, and is charged on the notional amount of the fund's assets. The performance fee averages about 20%, and is charged on the positive performance generated by the fund. Performance fees are also generally subject to a high watermark and possibly hurdle rates.

After deducting these fees, the net SHF performance flows into the index. There, all SHF performance is captured by the overall index gross performance. From this gross performance, index providers deduct their own expenses (in the form of management fees) and others such as FX hedging fees. The main difference between IHFIs and FHFs is that FHFs charge an additional performance fee for active management. Exhibit 6 illustrates fee deductions.

Index providers pass on the net index performance to the issuer, who finally deducts the fee for the investment or tracking vehicle. Most structures are either funds of hedge funds, or they use an asset swap as an investment vehicle. Other issuers build so-called delta-one certificates that track the index. However, these are more complex and bear the risk of counterparty default for investors, which can be avoided when using a funded swap.[18] After the issuers deduct their share of fees, the final net index performance can flow to the investor.

[18] The newest development in the market comes from Deutsche Bank, which offers the first exchange-traded fund (ETF) on a hedge fund index. As its name implies, this type of instrument is exchange-traded and provides intraday liquidity. The price for this liquidity is higher fees in contrast to swaps or certificates. There is also a tracking error, accounted for in this example as fees because on average it generates costs for investors.

Exhibit 6: Fee Structure



3 Empirical Analysis

3.1 Database and methodology

The investable composite indices we used in the first and second sections come from the following indices: CS/Tremont AllHedge Index, CS/Tremont Blue Chip Index, ARIX Composite Index, Greenwich Investable Hedge Fund Index, HFR Global Hedge Fund Index, and RBC Hedge 250 Index. The criteria for inclusion were a minimum twenty-four-month track record (to obtain a meaningful statistic), and full functionality of the composite index as of the end of October 2009.[19]

The RBC 250 index is the youngest in terms of performance history, and thus marks the starting point of our sample period here, July 2005 through October 2009. Note that the last third of this period includes the peak of the financial crises. Hence, our results may be biased because of a structural break during this crisis. All investable indices are net of fees.

We create three artificial monthly indices out of an existing investable index universe in order to obtain a broader picture over a longer time horizon and using a larger database. This index universe includes functional as well as defunct indices. For the latter, we include only those periods for which the index was accessible for investors. Furthermore, we drop the minimum track record requirement. The only criterion necessary is the provision of a true investable track record. This means no backtested performance will be included even if the indices existed longer than the investability tracking vehicle.

[19] This led to the exclusion of Deutsche Bank, Dow Jones, and the FTSE and MSCI indices.

Note also that our analysis includes investable strategy indices as well as composite indices. According to these changes in inclusion criteria, the new database numbers 111 indices from eleven different providers. We construct the three artificial indices as follows.

We split the database into three identical percentiles for each month in our sample period: a top percentile, a middle percentile, and a bottom percentile. Accordingly, the best in class index consists of the median monthly return across all investable indices within the top percentile at each point in time. The median index consists of the median performance across all indices in the middle percentile for each month; the worst in class index consists of the median performance of indices in the bottom percentile at each point in time. Taking the median instead of the arithmetic mean allows us to smooth extreme returns, and it provides a better representation of the return distribution. Our three sample indices begin in January 2002, which is the point at which data is available for investable indices. We also compute a fourth index, which takes the average performance at each point in time across all investable indices.

In order to compare the performance of the passive investable hedge fund indices to the actively managed FHFs, we use the Lipper TASS Hedge Fund Database. According to Heidorn *et al.* (2010), this is the most popular database for empirical hedge fund studies. The database at the end of September 2009 consisted of 6,114 hedge funds, of which 1,341 were classified as FHFs.[20]

In order to cleanse the dataset, we performed the following adjustments: 1) We removed all share classes for the same FHF (e.g., the same fund denominated in different currencies),

[20] The Lipper TASS Hedge Fund Database provides such information as legal domicile, domicile of fund management, fee structure, assets under management, and monthly performance.

while retaining the class with the longest performance track record, 2) we converted the performances of foreign currency-denominated funds into U.S. dollars, and 3) we removed all funds with a track record of twenty-four months.

Our FHF sample ultimately consisted of 525 members. In order to compare performance against investable hedge fund indices, we again split the performance of the FHF sample into three percentiles, using the same procedures as for the investable indices. We again created four different indices: best, median, worst, and average. All FHF returns are net of fees.

The sample of the hedge fund replicators consists of nineteen different replication funds or indexes, of which twelve are based on factor analysis, four are rules-based, two are a combination of factor analysis and rules-based, and two are based on dynamic trading. We constructed this sample using the same replication products used in Wallerstein *et al.* (2010). We also create four different indices for the hedge fund replicators: best, median, worst, and average index. All hedge fund replication returns are net of fees.[21]

Finally, the non-investable hedge fund indices and the traditional indices function as our benchmarks. The group of non-investable indices includes CS/Tremont Hedge Fund Index, Greenwich Global Hedge Fund Index, and HFRI Fund Weighted Composite Index. These are three of the most widely used benchmarks, and are based on large, industry-leading databases.

For the traditional indices, we choose the MSCI World and the Barclays Aggregate Bond Index. Both are well established among investors, and have global exposure and exceptionally broad constituent bases within their asset classes.

[21] Note that we include HFRS in the empirical section because they are widely considered an alternative beta product. However, academic research has shown that the correlation of these products to the broad hedge fund market has dropped significantly, particularly since they have been managed with real money. The performance achieved by HFRS is systematically inferior to that of actual hedge funds (see, e.g., Hasanhodzic and Lo (2007) and Amenc *et al.* (2010).

The risk and return measures applied in the empirical section include mostly well-known measures, such as skewness, kurtosis, and the Sharpe, Sortino, Calmar, or Sterling ratios. For space considerations, we do not repeat these formulas here. We also calculate Keating and Shadwick's (2002a) Omega ratio.

According to Schneeweis *et al.* (2004), the Omega ratio is especially well suited for alternative investment valuation because it considers all moments of the return distribution, rather than simply the first and second moments (return and volatility). While the Sharpe and other ratios view volatility as a negative effect, the Omega ratio allows investors to account for the positive side of standard deviation, the rationale being that positive returns are driven by higher volatility, positive skewness, and negative kurtosis. These three performance drivers are positively correlated with the value of omega, but would not affect (or would negatively affect) conventional risk/return ratios. Only when returns are normally distributed do both the omega and traditional risk-adjusted measures lead to the same preference ranking. But when return distributions are non-normal, omega provides a different ranking (see Keating and Shadwick (2002b) for elaboration on the Omega ratio).

Mathematically, omega provides a probability-weighted measure of gains to losses depending on a chosen return threshold. The numerator is 1 minus the integral of the cumulative distribution function, beginning from the threshold to the upper boundary b. The denominator is the integral of the cumulative distribution function from the lower boundary a to the threshold. a and b constitute the minimum and maximum returns of the cumulative distribution function. This can be implemented effortlessly for discrete distributions, but can be complex for theoretic constructs with infinite boundaries.

$$\Omega(r) = \frac{\int_{r}^{b} (1 - F(x))dx}{\int_{a}^{r} F(x)dx}$$

$F(x) = cumulative\ distribution\ function$
$a = lower\ boundary$
$b = upper\ boundary$
$r = threshold$

3.2 Results

3.2.1 Representativeness of IHFIs

There is a high correlation among IHFIs, ranging from 0.88 to 0.98, which indicates good representation of this asset class among investable indices. The same level of correlation is found between investable and non-investable hedge fund indices, ranging here from 0.88 to 0.96 (see Exhibits 7 and 8). This shows that, as benchmarks, investable hedge fund composite indices are truly representative of the overall hedge fund universe when measured against non-investable indices.

Exhibit 7: Correlation matrix IHFIs

Correlation	CS/T Blue	CS/T All	Feri	GAI	HFRX	RBC
CS/T Blue	1					
CS/T All	0.98	1				
Feri	0.88	0.90	1			
GAI	0.92	0.92	0.89	1		
HFRX	0.96	0.97	0.91	0.94	1	
RBC	0.90	0.93	0.92	0.88	0.94	1

Period: July 2005-October 2009.

Exhibit 8: Correlation between IHFIs and benchmarks

Correlation	CS/Tremont Hedge Fund Index	HFRI Fund Weighted Composite Index	Greenwich Global Hedge Fund Index	MSCI World	Barclays Aggregate Bond Index
CS/T Blue	0.94	0.91	0.89	0.79	0.20
CS/T All	0.96	0.95	0.94	0.84	0.22
Feri	0.91	0.88	0.88	0.65	0.04
GAI	0.90	0.89	0.88	0.73	0.11
HFRX	0.96	0.95	0.94	0.78	0.12
RBC	0.96	0.96	0.96	0.79	0.13

Period: July 2005-October 2009.

The correlations between IHFIs and equities as represented by the MSCI World index range from 0.65 to 0.84. The correlations fall, to a range of 0.04 to 0.22, if we compare IHFIs to bonds. This indicates that IHFI returns clearly do not depend on bond returns.

The correlation to equities is relatively high. This is due to the fact that the composite indices contain a high degree of equity strategies. Note also that, because composite indices are composed of all the existing strategies, they can begin to resemble broad market developments. But the correlation is still below 0.8, except for one index, which indicates some diversification potential for both equity pure portfolios, and particularly for bond portfolios or a mix of equities and bonds. IHFIs may thus help diversify portfolios consisting of traditional asset classes.

We performed a linear regression with each IHFI against the three non-investable indices. We found beta values ranging from 0.81 to 1.12, with an average beta of 0.98, which indicates an almost parallel development of returns. The R^2 values are between 0.77 and 0.93, which indicate clear significance of all betas. Hence, regression analysis further supports the findings from the correlation analysis.

The alpha values range from -0.60% to -0.11%, with an average of -0.36%. We can interpret this as the price investors must pay for the investability of hedge fund indices. Exhibit 9 shows the results.

Exhibit 9: Linear regression of IHFIs against non-investable indices

Linear regression	CS/Tremont Hedge Fund Index			HFRI Fund Weighted Composite Index			Greenwich Global Hedge Fund Index		
	α	*β*	*R²*	*α*	*β*	*R²*	*α*	*β*	*R²*
CS/Tremont Blue Chip Index	-0.57%	1.08	0.89*	-0.51%	1.00	0.82*	-0.60%	1.05	0.80*
CS/Tremont AllHedge Index	-0.46%	1.11	0.93*	-0.42%	1.05	0.91*	-0.51%	1.12	0.89*
Feri	-0.15%	0.90	0.83*	-0.11%	0.84	0.78*	-0.19%	0.89	0.77*
GAI	-0.37%	0.87	0.82*	-0.33%	0.81	0.78*	-0.41%	0.86	0.78*
HFRX	-0.44%	1.03	0.92*	-0.40%	0.97	0.90*	-0.49%	1.03	0.88*
RBC	-0.16%	1.02	0.92*	-0.13%	0.98	0.93*	-0.22%	1.05	0.93*

Period: July 2005-October 2009.
*Denotes significance at the 99% confidence interval (*t*-test).

The linear regression of IHFIs against the Barclays aggregate bond index shows insignificant results. The R² values range from 0.00 to 0.05, indicating high independence from bond returns and good diversification potential. For equities, the R² ranges from 0.43 to 0.71. However, the beta is low, with all values below 0.4. This means that only a small percentage of IHFI variance can be explained by equity returns, and IHFIs could significantly add to portfolio diversification. Exhibit 10 gives the results.

Exhibit 10: Linear regression of IHFIs against non-investable indices

	Barclays Aggregate Bond Index			MSCI World Index		
	α	*β*	*R²*	*α*	*β*	*R²*
CS/Tremont Blue Chip Index	-0.24%	0.46	0.04	-0.07%	0.36	0.62*
CS/Tremont AllHedge Index	-0.14%	0.50	0.05	0.05%	0.39	0.71*
Feri	0.19%	0.08	0.00	0.21%	0.26	0.43*
GAI	-0.04%	0.22	0.01	0.03%	0.28	0.53*
HFR	-0.05%	0.25	0.01	0.03%	0.33	0.62*
RBC	0.21%	0.28	0.02	0.31%	0.33	0.62*

Period: July 2005-October 2009.
*Denotes significance at the 99% confidence interval (*t*-test).

3.2.2 Risk and return analysis

The risk and return analysis encompasses IHFIs, non-investable hedge fund indices, and traditional equity and bond indices for the July 2005-October 2009 period. The results are in Exhibit 11. Note that the MSCI World equity index had the best performance during the last twelve months of the sample period. All non-investable hedge fund indices, as well as the HFRS and the Barclays bond index, delivered double-digit positive returns, while the FHFs were flat. However, when looking at results from a twenty-four- and a thirty-six-month perspective, the MSCI World was clearly the worst-performing index.[22] All non-investable benchmarks reverted to positive returns for the thirty-six-month time frame. In terms of

[22] Among the investable indices, the CS/Tremont Blue Chip was clearly the worst-performing. It lost 21.7% over the last twenty-four months of our sample, and 12.6% over the last thirty-six months. The only investable index generating positive results during that period was the RBC index, with 3%.

average monthly returns and annualized returns, the non-investable indices are the best-performing.[23]

Overall, it is obvious that IHFI returns underperformed non-investable indices, as the latter are prone to several biases (e.g., survivorship bias, backfilling bias). But investable indices managed to perform better than equity markets for both for the twenty-four- and the thirty-six-month periods, as well as for the entire investment period. This fulfills the promise of hedge fund investments to provide stable returns even during turbulent market phases.

[23] The only investable indices that achieved significantly positive returns are RBC and Feri. All others were rather flat at around zero. The MSCI index is clearly negative, and hence the worst-performing index for the entire observation period. When we examine the results for the best and worst months, the MSCI actually performed the best and the worst, due to the equity market turbulence during the financial crisis.

Exhibit 11: Return analysis of IHFIs versus benchmarks

Returns	r12	r24	r36	r monthly	r annually	Best month	Worst month
CS/Tremont Blue Chip Index	2.7%	-21.7%	-12.6%	-0.08%	-0.9%	2.6%	-11.4%
CS/Tremont AllHedge Index	5.9%	-19.7%	-8.8%	0.05%	0.6%	3.2%	-10.5%
Feri	5.1%	-11.9%	-0.5%	0.21%	3.2%	3.7%	-6.8%
GAI	1.5%	-17.6%	-9.6%	0.03%	0.3%	2.4%	-8.5%
HFR	6.3%	-16.9%	-8.3%	0.03%	0.4%	3.2%	-9.3%
RBC	14.0%	-8.6%	3.0%	0.30%	3.7%	6.8%	-8.1%
CS/Tremont Hedge Fund Index	10.3%	-7.5%	9.0%	0.46%	5.6%	4.1%	-6.6%
HFRI Fund Weighted Composite Index	13.7%	-7.1%	7.6%	0.44%	5.4%	5.2%	-6.8%
Greenwich Global Hedge Fund Index	15.0%	-3.5%	12.3%	0.51%	6.3%	5.1%	-6.0%
Median FHF	0.3%	-7.4%	5.2%	0.28%	3.4%	3.0%	-5.5%
Median HFRS	14.6%	5.5%	7.3%	0.08%	1.0%	3.2%	-6.7%
MSCI World	15.6%	-34.5%	-22.4%	-0.08%	-0.9%	10.9%	-19.0%
Barclays aggregate bond index	13.8%	14.1%	20.3%	0.42%	5.2%	3.7%	-2.4%

Period: July 2005-October 2009.

Moving on to risk measures, we see from Exhibit 12 that annualized standard deviation is relatively equal among all hedge fund indices and remains in the single digits. Besides the Barclays bond index with 3.7%, the IHFI standard deviation ranges from 7.1% to 8.5%. This is slightly higher on average than the 7.2%-7.7% range for non-investable indices, but significantly below the 18.6% found for the MSCI World. However, the lowest standard deviations are achieved by the FHFs and the replication indices.

Another symptom of the financial crisis is found in the large difference between loss and gain volatility. Non-investable indices, FHFs, and HFRS maintained an approximately 2:1 ratio of loss to gain volatility. But the average for IHFIs was 3:1. Also, in absolute terms, IHFIs have a higher loss and a lower gain volatility, meaning they were affected by greater swings in losses than their benchmarks, but had less upside exposure.

Semivolatility tells a similar story. Because of the financial market turmoil, returns falling below the mean had a higher volatility than overall returns. And just as we saw previously, IHFIs had higher values than their non-investable benchmarks. The MSCI World has the highest values across all volatility classes. Overall, if excluding bonds, risk-averse investors would opt for hedge fund investments over equities. This shows that equity returns are less stable than IHFI returns.

Thus far, we see that IHFIs provide a useful tool for reducing risk in contrast to traditional equity market indices, especially under severe market disruptions. However, the index construction methodology seems to take a toll by increasing risk in these extreme situations compared to other hedge fund investments.

Exhibit 12: Risk analysis of IHFIs versus benchmarks

Risk analysis	σ	σ_{loss}	σ_{gain}	σ_{semi}	Skew-ness	Kurto-sis	Average drawdown	Maximum drawdown
CS/Tremont Blue Chip Index	8.5%	10.7%	2.6%	13.5%	-2.91	10.63	-10.5%	-27.6%
CS/Tremont AllHedge Index	8.5%	9.9%	3.1%	12.1%	-2.41	7.87	-10.6%	-28.4%
Feri	7.3%	7.0%	2.8%	10.3%	-1.54	2.87	-8.5%	-22.5%
GAI	7.1%	7.6%	2.5%	10.5%	-2.07	5.86	-9.2%	-22.9%
HFR	7.9%	8.0%	2.9%	10.3%	-1.94	5.51	-9.8%	-25.1%
RBC	7.8%	7.4%	4.3%	10.2%	-1.10	4.50	-8.2%	-22.0%
CS/Tremont Hedge Fund Index	7.4%	7.3%	3.6%	9.7%	-1.44	2.86	-7.3%	-19.7%
HFRI Fund Weighted Composite Index	7.7%	6.7%	4.1%	9.8%	-1.09	2.19	-7.9%	-21.4%
Greenwich Global Hedge Fund Index	7.2%	6.1%	3.9%	9.1%	-1.02	1.99	-6.6%	-17.8%
Median FHF	6.1%	5.3%	4.0%	8.2%	-1.27	1.94	-6.3%	-16.3%
Median HFRS	6.0%	5.8%	3.9%	8.2%	-1.63	4.77	-5.7%	-15.8%
MSCI World	18.6%	17.6%	9.0%	22.4%	-1.15	2.55	-22.7%	-55.5%
Barclays aggregate bond index	3.7%	2.4%	2.8%	3.7%	0.41	1.54	-2.0%	-3.8%

Period: July 2005-October 2009.

But aside from volatility measures, it is worth examining additional risk measures. We find a similar picture for skewness as we did earlier for return and volatility. Again due to the financial crisis, we find that the return distribution is skewed toward negative returns for all indices, except for the Barclays bond index. Only one IHFI is within the range of non-investable indices, with -1.10. In terms of kurtosis, all IHFIs have positive values, which

indicates a leptokurtic distribution with a high concentration around the mean return but with broad tails.[24]

We find that the MSCI World has the largest drawdown, at -55.5%, which is twice as much as any other index. The maximum drawdown for non-investable hedge fund indices is about -20%, while IHFIs perform somewhat worse in the mid-twenties. The average drawdown, which is the average of the maximum drawdowns for three consecutive twelve-month periods, exhibits similar results.

Exhibit 13 focuses on risk-adjusted ratios. Starting with the Sharpe ratio, it is obvious that non-investable indices beat IHFIs and equity indices. The MSCI World even exhibits a negative Sharpe ratio due to its negative return for that period. Among IHFIs, RBC and Feri are the only two indices that deliver significantly positive ratios (0.47 and 0.43, respectively).

The Sortino ratio produces exactly the same ranking. Apart from Barclays Bond Index, the non-investable indices are most preferable, followed by RBC and Feri. The Calmar and Sterling ratios also return the same ranking. Thus, for risk-adjusted performance, it does not seem to matter which volatility measure is used, as they all return exactly the same ranking.

The only difference we find results from using the Omega ratio, which includes the attributes of several return distributions. The best-performing index remains the non-investable CS/Tremont index. But the other two non-investable indices (the Feri IHFI and GAI) and the CS/Tremont AllHedge all share second place. Surprisingly, CS/Tremont Blue Chip also rises

[24] The Feri index is the only investable index that has a value in the same region as non-investable and traditional indices. All the other investable indices have values that are at least twice as high for kurtosis. The CS/Tremont index values are four to five times as high.

two places from its last place position under the other risk-adjusted ratios. The MSCI World is now ranked last.

Exhibit 13: Risk-adjusted ratios of IHFIs versus benchmarks

Risk-adjusted ratios	Sharpe ratio (0%)	Sortino ratio (0%)	Calmar ratio	Sterling ratio	Omega ratio (0%)
CS/T Blue	-0.11	-0.07	-0.16	-0.22	1.74
CS/T All	0.06	0.05	-0.11	-0.15	1.89
Feri	0.43	0.30	-0.04	-0.04	2.06
GAI	0.05	0.03	-0.14	-0.17	1.89
HFR	0.05	0.03	-0.11	-0.14	1.36
RBC	0.47	0.36	0.04	0.05	1.74
CS/Tremont Hedge Fund Index	0.74	0.57	0.15	0.17	2.25
HFRI Fund Weighted Composite Index	0.69	0.54	0.11	0.14	2.06
Greenwich Global Hedge Fund Index	0.84	0.67	0.22	0.24	2.06
MSCI World	-0.05	-0.04	-0.15	-0.25	1.26
Barclays Aggregate Bond Index	1.36	1.38	1.66	0.53	1.89

Period: July 2005-October 2009.

In summary, when excluding bonds, we can rank the investable composite indices under traditional risk-adjusted measures in the following order of preference: 1) non-investable indices, 2) IHFIs, and 3) equities. When using the Omega ratio, however, the picture changes. Non-investable indices tend to remain dominant, but investable indices close the gap somewhat. Hence, investors should avoid making blanket judgments of single indices, and

instead should judge each on a case-by-case basis. As for equities, they underperform IHFIs in each case in our sample period.

3.2.3 Best, worst, median, and average scenarios

Exhibits 14-17 show the results of performing linear regressions of investable indices against FHFs and HFRS for the best, median, worst, and average indices. Note that R^2 is significant for all regressions except the best replication index, which explains only 31% of the volatility in the best investable index returns.[25]

Regarding betas, IHFIs achieve values greater than 1 against all indices, except for the insignificant best replication index. This implies that investable indices tend to be more volatile than the other indices.

Exhibit 14: Linear regression of best-performing indices

	Best FHF			Best HFRS		
	α	**β**	**R^2**	**α**	**β**	**R^2**
Best IHFI	0.25%	1.12	0.83*	0.64%	0.70	0.31

Period: January 2002-September 2009.

*Denotes significance at the 99% confidence interval (*t*-test).

[25] We verified these results by regressing the replication indices against the non-investable hedge fund indices and the FHF indices. We do not provide the results here, because they are not directly related to investable index performance measurement. They are, however, available from the authors upon request.

Exhibit 15: Linear regression of worst-performing indices

	Worst FHF			Worst HFRS		
	α	***β***	***R²***	***α***	***β***	***R²***
Worst IHFI	-0.34%	1.19	0.92*	0.11%	1.37	0.81*

Period: January 2002-September 2009.

*Denotes significance at the 99% confidence interval (*t*-test).

Exhibit 16: Linear regression of median indices

	Median FHF			Median HFRS		
	α	***β***	***R²***	***α***	***β***	***R²***
Median IHFI	-0.13%	1.10	0.91*	-0.11%	1.02	0.79*

Period: January 2002-September 2009.

*Denotes significance at the 99% confidence interval (*t*-test).

Exhibit 17: Linear regression of average indices

	Average FHF			Average HFRS		
	α	***β***	***R²***	***α***	***β***	***R²***
Average IHFI	-0.09%	1.11	0.93*	-0.14%	1.38	0.80*

Period: January 2002-September 2009.

*Denotes significance at the 99% confidence interval (*t*-test).

As an additional verification of alternative beta, Exhibit 18 shows the results of regressing the best, median, and worst FHF and replication indices against the non-investable hedge fund indices, which represent the hedge fund universe. Again, all indices except the best replicator index have R^2 values ranging from 0.60 to 0.91, indicating a significant beta. The best

replicator index has values ranging from 0.20 to 0.27, which are not statistically significant. Hence, the following performance analysis will not include these results.

Exhibit 188: Linear regression of FHFs and HFRS against non-investable HFI

	CS/Tremont Hedge Fund Index			HFRI Fund Weighted Composite Index			Greenwich Global Hedge Fund Index		
	alpha	**beta**	**R^2**	**alpha**	**beta**	**R^2**	**alpha**	**beta**	**R^2**
Best FHF	-1.05%	1.20	0.79*	-1.20%	1.30	0.75*	-1.10%	1.24	0.78*
Median FHF	0.11%	1.17	0.91*	0.08%	1.24	0.82*	0.13%	1.17	0.83*
Worst FHF	1.07%	0.91	0.90*	1.08%	0.96	0.81*	1.07%	0.90	0.80*
Best Replication	-0.42%	0.62	0.20	-0.72%	0.80	0.27	-0.63%	0.76	0.27
Median Replication	0.15%	1.06	0.76*	0.05%	1.26	0.87*	0.11%	1.17	0.85*
Worst Replication	1.32%	0.94	0.63*	1.09%	1.04	0.63*	1.35%	0.95	0.60*

Period: January 2002-September 2009.

*Denotes significance at the 99% confidence interval (*t*-test).

Regarding the returns of the best in class indices, we see that the IHFI outperforms both the other indices during all periods. This is particularly obvious when compared to the FHF index. All indices posted positive returns during all periods. However, the results for the worst-performing indices are exactly the opposite. Here, the IHFI is the worst-performing, followed by HFRS and led by the FHF index. All indices had negative returns during all periods. This supports our observation that IHFIs have a beta higher than 1 against HFRS and FHFs, as these two extreme scenarios clearly show. Exhibit 19 shows all the results.

Exhibit 19: Return analysis of IHFIs, FHFs, and HFRS

Return analysis		12 months	24 months	36 months	Monthly average	Annual-ized	Best month	Worst month
Best	IHFI	33.4%	51.9%	104.5%	1.74%	23.0%	6.8%	-2.2%
	HFRS	25.6%	49.8%	84.3%	1.59%	20.9%	5.3%	-3.3%
	FHF	17.8%	27.8%	61.1%	1.34%	17.4%	4.4%	-2.8%
Worst	IHFI	-25.3%	-46.4%	-46.8%	-1.01%	-11.5%	1.2%	-14.1%
	HFRS	-18.5%	-35.0%	-36.4%	-0.81%	-9.3%	1.4%	-8.9%
	FHF	-16.4%	-35.4%	-33.2%	-0.56%	-6.5%	1.9%	-8.3%
Median	IHFI	-1.5%	-11.1%	-0.9%	0.29%	3.5%	2.8%	-8.1%
	HFRS	14.6%	5.5%	7.3%	0.14%	1.7%	3.2%	-6.7%
	FHF	0.3%	-7.4%	5.2%	0.38%	4.7%	3.0%	-5.5%
Average	IHFI	-0.4%	-9.6%	3.4%	0.35%	4.2%	3.7%	-8.2%
	HFRS	1.0%	-4.2%	5.4%	0.36%	4.4%	2.4%	-5.3%
	FHF	-1.5%	-9.7%	3.6%	0.39%	4.8%	3.1%	-5.4%

Period: January 2002-September 2009.

Note that the median returns show an interesting trend. During the last twelve-, twenty-four-, and thirty-six-month periods, HFRS was clearly the outperformer. It was the only index that achieved positive returns for all three periods. However, in terms of average monthly returns over the entire sample period, HFRS was the worst performer, with 0.14%, followed by the IHFI (0.29%) and the FHF (0.38). If we measure average rather than median returns, the HFRS remains the best-performing index for the twelve-, twenty-four-, and thirty-six-month periods. But the IHFI slightly outperforms the FHF index for the twelve- and twenty-four-month periods. On an average monthly return basis, we see that all three average indices are

almost equal. The FHF is the best performer, achieving 3 basis points more than the HFRS, and 4 basis points more than the IHFI.

Further relating to the scenario analysis on an index basis, we can measure the IHFIs against each fund from the FHF database. We can compute the average monthly returns of each FHF over the entire observation period, and compare them to the average monthly performance of the four investable index scenarios. The results are in Exhibit 20.

The best case scenario beats each single FHF, while the worst beats 3% of all FHFs. This shows that investable indices clearly dominate FHFs on the upside, while managing to retain a small 3% buffer to the downside. The median index slightly underperforms FHFs, while the average IHFI beats slightly more than half of all FHFs. This implies that the return distribution is slightly in favor of FHFs, but the average performance shows that IHFIs are preferred.

Exhibit 20: IHFIs versus each FHF in the sample

% of FHFs beaten by IHFIs			
best	**worst**	**median**	**average**
100.0%	3.0%	40.0%	50.5%

Period: January 2002-September 2009.

Overall, we conclude that IHFI returns have a larger range, as illustrated by the best and worst case scenarios and as already assumed by the regression analysis. Also, average returns show that the three investment choices performed almost equally over the observation period. If we

compare IHFIs directly to FHFs, it seems that IHFIs have a broader and on average stronger performance, but a less preferable return distribution.

We now move on to risk measures. Beginning with the best-performing index scenario, we see that IHFI exhibits the highest standard deviation, and has the lowest loss deviation and the highest gain deviation of the three indices. As we would expect, two of the three indices have positive skewness, meaning they are skewed to the right, and their median is larger than their mean return. Only the FHF index exhibits negative skewness, which indicates tail extension to the left with the mode being greater than the average return.

The FHF index is also the only one where the semideviation is larger than the standard deviation. Kurtosis indicates slightly leptokurtic return distributions for the IHFI and the FHF, and a clear leptokurtic distribution for HFRS. Both maximum and average drawdowns are negligible. Exhibit 21 illustrates the results.

The worst-performing index results are similar. Standard deviation and loss deviation are again highest for the IHFI. Semideviation is higher than standard deviation for all three indices. Accordingly, all three indices clearly exhibit negative skewness. Kurtosis is much more elaborate here, however, than for the best case. Values range from 6.43 for FHFs to 16.13 for IHFIs, which exhibit the strongest leptokurtic distribution among all scenarios.

The median index results are also similar. The IHFI has the highest standard deviation and loss deviation, while the gain deviation is almost equal among indices. All indices are skewed to the left and leptokurtic. For the average scenario, the IHFI again leads all deviation categories. All indices are skewed to the left and leptokurtic. However, they are slightly less so than in the median case.

Exhibit 21: Risk analysis of IHFIs, FHFs, and HFRS

Risk analysis		σ	σloss	σgain	σsemi	Skew-ness	Kur-tosis	Average Draw-down	Max. Draw-down
Best	IHFI	5.3%	2.3%	5.4%	4.6%	0.47	0.70	-1.4%	-3.7%
	HFRS	4.2%	5.9%	4.0%	3.8%	0.21	3.03	-1.4%	-3.3%
	FHF	4.4%	2.6%	4.1%	4.6%	-0.27	0.69	-2.1%	-5.5%
Worst	IHFI	7.6%	8.3%	2.4%	12.0%	-3.44	16.13	-19.7%	-61.2%
	HFRS	5.0%	5.3%	1.5%	8.3%	-3.02	12.39	-14.2%	-53.3%
	FHF	6.1%	6.3%	3.1%	8.8%	-2.13	6.43	-15.2%	-41.5%
Median	IHFI	5.5%	6.5%	3.3%	7.5%	-2.58	10.60	-8.3%	-21.3%
	HFRS	4.9%	4.9%	3.4%	6.3%	-1.71	6.86	-5.7%	-15.8%
	FHF	4.8%	4.7%	3.3%	6.3%	-1.46	3.92	-6.3%	-16.3%
Average	IHFI	6.0%	6.3%	4.0%	8.2%	-2.08	8.12	-8.3%	-21.6%
	HFRS	3.9%	3.9%	2.8%	5.0%	-1.70	6.33	-4.8%	-13.3%
	FHF	5.2%	4.7%	3.8%	6.7%	-1.31	3.13	-7.0%	-18.1%

Period: January 2002-September 2009.

The risk-adjusted returns included in Exhibit 22 complete our analysis. We begin again with the best-performing scenario. We see that the HFRS has the highest values across all measures. However, linear regression has shown that the beta of this replication index is insignificant, and does not offer true hedge fund investment exposure. Thus, it makes sense to compare only the IHFI with the FHF index. Here, the investable index beats the FHF index across all ratios.

For the worst-case scenario, we find negative values for all traditional risk-adjusted measures due to the negative performance of all indices over our sample period. Thus, we cannot

provide interpretations. However, we can measure the Omega ratio because it is based on the return distribution. We find that the FHF is the best-performing, with a ratio of 0.82, followed by the IHFI and the HFRS, with ratios of 0.52 and 0.39, respectively.

For the median scenario, the FHF index exhibits the highest values for the Sharpe and Sortino ratio, followed by the IHFI and then the HFRS. According to the Calmar and Sterling ratios, the HFRS are the best-performing, due to the strong results over the past three years. The Omega ratio gives the same value for FHFs and HFRS, 2.72, and gives 2.44 for the IHFI.

Exhibit 22: Risk-adjusted ratios of IHFIs, FHFs, and HFRS

Risk-adjusted ratios		Sharpe ratio (0%)	Sortino ratio (0%)	Calmar ratio	Sterling ratio	Omega ratio (0%)
Best	IHFI	3.92	4.08	7,35	2,36	8.30
	HFRS	4.50	4.43	6,86	1,99	30.00
	FHF	3.70	3.00	3,13	1,42	7.45
Worst	IHFI	-1.60	-0.95	-0,31	-0,64	0.52
	HFRS	-1.96	-0.89	-0,26	-0,58	0.39
	FHF	-1.10	-0.63	-0,30	-0,50	0.82
Median	IHFI	0.62	0.42	-0,01	-0,02	2.44
	HFRS	0.35	0.22	0,15	0,15	2.72
	FHF	0.95	0.60	0,11	0,10	2.72
Average	IHFI	0.70	0.48	0,05	0,06	2.21
	HFRS	1.11	0.61	0,13	0,12	2.58
	FHF	0.91	0.60	0,07	0,07	2.21

Period: January 2002-September 2009.

Finally, if we focus on the average scenario, we see that the replication index dominates across all ratios. While FHFs slightly beat investable indices from a traditional return standpoint, the Omega ratio is the same for both. Also, in contrast to the median case scenario, FHFs and replication indices achieve smaller ratios across almost all measures, and HFRS manage to increase all their ratios.

We conclude that IHFIs dominate the best-performing index scenario across all ratios, but are themselves dominated in the worst-case scenario. In the median scenario, IHFIs perform better than HFRS, but are beaten slightly by FHFs. In the average scenario, IHFIs and FHFs perform exactly equally, according to the Omega ratio.

4 Conclusion

We argue that most funds of hedge funds (FHFs) expose their investors to systematic hedge fund risks, and hence should be considered as alternative beta products. In this paper, we empirically investigate the risk and performance of three types of alternative beta products over the January 2002-September 2009 period: FHFs, investable hedge fund indices (IHFIs), and hedge fund replication strategies (HFRS).

Empirical performance analysis of investable composite indices shows that they are representative of the hedge fund universe when measured as a correlation to non-investable hedge fund indices. Regression analysis between investable and non-investable indices supports this finding, and shows that average beta across all indices is 0.98. This implies almost parallel development to non-investable indices.

Note, however, that alpha is negative across all funds, which may be interpreted as the performance that must be sacrificed to gain investability. From performing correlation and regression against equities and bonds, we found that IHFIs offer diversification benefits.

The risk-adjusted return analysis produced the following order of performance across all ratios: 1) Non-investable indices, followed by 2) investable indices, and 3) equities. Because our sample period included the financial crisis and the corresponding market turbulence, it was a good test of the stability of investable hedge fund index performance. Most indices passed this test successfully.[26]

[26] However, note that three providers partially or completely ceased index calculation during spring 2009, due to either defunct underlying funds or missing prices for illiquid instruments (this makes it impossible to value certain strategy indices). The indices were: Dow Jones Convertible Arbitrage, Dow Jones Distressed Securities, Dow Jones Equity Market Neutral, FTSE Hedge, and MSCI Hedge Invest.

Our empirical analysis of a broad IHFI database of both strategy and composite indices shows that, in a best case scenario, investable indices outperform FHFs and HFRS on a risk-adjusted basis. However, in the worst case scenario, they underperform both investments. Taking the average of all IHFIs, they perform equally to FHFs. For investors, IHFIs constitute a solid alternative to established FHF investments in terms of return characteristics. They also cost substantially less than actively managed FHFs, and they offer more transparency and generally higher liquidity.

Based on these findings, we propose that fee-sensitive investors should especially consider taking a core-satellite approach to their fund of hedge funds portfolio, with the core represented by cheap passive hedge fund beta through IHFIs, and the satellite represented by more expensive and actively managed alpha-generating FHFs.

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