Edhec Investable Hedge Fund Indices

Construction methodology & management principles

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Executive summary

In spite of the recent advances in hedge fund indexing, designing good hedge fund indices remains a particularly challenging task in the face of challenges that are specific to the alternative investment industry. Two distinct purposes have to be distinguished: i) an index can be used as a *benchmark* for investments in specific styles, instruments or locations; or ii) it can be used as an *investment vehicle*. Each of these two purposes is associated with some challenging construction requirements. In particular, indices that act as benchmarks have to be *representative*, i.e., they should accurately reflect the whole universe of hedge funds following a particular style. On the other hand, indices that act as investment vehicles are obviously required to be investable in addition to being representative.

In 2003, EDHEC proposed an original solution to the challenge of representativity by introducing a set of alternative indices (known as the EDHEC Alternative Indexes[1]), which can be thought of as the most representative possible portfolio of hedge fund returns for a given style, based on factor analysis of competing indices.

In 2005, EDHEC has adapted the methodology behind the EDHEC Alternative Indexes to propose a solution to the challenge of investability and offer a set of investment vehicles (known as the EDHEC Investable Hedge Fund Indices) while maintaining a focus on representativity. These indices, which are made up of a limited number of single hedge funds, can be thought of as the best possible one-dimensional summaries of information conveyed by a variety of hedge funds following a given style, in the sense of the largest fraction of the variance explained. Since they are both representative and investable, these indices are ideal tools for constructing asset allocation benchmarks.

The EDHEC Investable Hedge Fund Indices are invested in funds that are managed on the Lyxor (Société Générale group) managed accounts platform, which allows them to benefit from a secure and liquid investment context. Their performances will be calculated every week and their liquidity is also weekly.

The EDHEC Investable Hedge Fund Indices are not funds of funds and as a result are not marketed as such. They are allocation supports that allow asset management firms or institutional investors to implement value creation strategies based on dynamic allocation between the hedge fund styles. Up until now, the stumbling block for implementing an effective allocation policy in the alternative universe has been the lack of investment supports that are liquid and genuinely representative of the risks of each strategy.

To date, five EDHEC Investable Hedge Fund Indices have been created, covering five popular strategies, namely, Convertible Arbitrage, Equity Market Neutral, Long/Short Equity, CTA Global and Event Driven. These strategies not only represent the bulk of assets managed in the alternative arena (i.e. 65%[2]) but they also deliver betas that are representative of the hedge fund universe.

1. The Edhec Alternative Indexes are indices of non-investable hedge fund indices, which are consequently non-investable themselves. More details on these indices can be found on the Edhec-Risk website at the following page: http://www.edhec-risk.com/indexes/pure_style.
2. According to major hedge fund database providers (e.g. TASS, HFR) Convertible Arbitrage, Equity Market Neutral, Long/Short Equity, CTA Global and Event Driven represent respectively 8%, 7%, 32%, 5% and 13% of the hedge fund universe, as of the end of 2004.

The Evolution
of Hedge Fund Indexing

The lack of transparency has long been a hurdle to the development of the alternative investment industry. Hedge funds used to be extremely secretive about their performance and their investment strategy, making it very difficult for investors to differentiate between returns explained by the style of the fund (i.e., beta drivers) and returns generated by the skill of the manager (i.e., alpha drivers).

In this respect, the development of hedge fund indices in the 1990s was a useful response to investors' need for a better understanding of hedge fund performance. A multitude of "boutiques" specialised in hedge funds (HFR, CSFB/Tremont, CISDM, etc.) launched their own indices which relied on different databases (HFR, TASS, CISDM, etc.), following varying construction methodologies (e.g. equally weighted versus value weighted) and diverse management principles (quarterly versus annual rebalancing, no backfilling versus full history backfilling, etc.). In a second wave, the traditional large players in the index industry such as MSCI, S&P, Dow Jones, etc., also entered the field of hedge fund indexing, where they leveraged their brand name to promote investable solutions.

In spite of the recent advances in hedge fund indexing, designing good hedge fund indices remains a particularly challenging task in the face of challenges that are specific to the alternative investment industry. Two distinct purposes have to be distinguished: i) an index can be used as a benchmark for investments in specific styles, instruments or locations; or ii) it can be used as an *investment vehicle*. Each of these two purposes is associated with some construction requirements. In particular, indices that act as benchmarks have to be *representative*, i.e., they should accurately reflect the whole universe of hedge funds following a particular style. On the other hand, indices that act as investment vehicles are obviously required to be *investable* in addition to being representative (see Kündig, Lodeiro, Meier and Ruckstuhl (2004) for more details).[3] As we now explain, both of these requirements appear to be very challenging in the hedge fund universe.

The Challenge of Representativity in Hedge Fund Indexing

There are some serious challenges one has to face when attempting to provide a detailed picture of the hedge fund universe, the most serious of which is the challenge of representativity.

Due to the lack of regulation on hedge fund performance disclosure, existing databases only cover a relatively small fraction of the hedge fund population. Probably only a little more than half of existing hedge funds choose to report their performance to one of the major hedge fund databases themselves. As simple evidence of the fact that existing indices are not fully representative of the universe, it perhaps suffices to note that one of the most popular hedge fund indices, the EACM 100, only accounts for a tiny percentage of all existing hedge funds (100 out of more than 7,000 funds).

Moreover, because hedge fund indices are built from databases of individual fund returns, they inherit the databases' shortcomings in terms of scope and quality of data, which vary a lot among various data vendors, because of the presence of several biases.

3. An investable vehicle that is not representative would be called a fund of funds rather than a hedge fund index.

The Evolution of Hedge Fund Indexing

The Biases of Hedge Fund Indices

A fund's participation in a database is voluntary, which poses a real problem in terms of the reliability of the data published **("self reporting bias").** The voluntary nature of the act presupposes that only some of the funds will decide to register. Since the funds that have refused to report to one or other of the databases are, by definition, unobservable, it is not possible to evaluate the impact of this bias. In addition, since some refuse to display their performance because of poor results and others because they have already reached their critical size, it is even difficult to know whether this bias has a positive or negative impact on the performances announced.

Depending on the date at which the database began, the quality of past information will vary (notably for funds that ceased their activity before the database began). This affects the performance of the index to a greater or lesser degree, depending on the number of funds that stop communicating their results each year (referred to as the attrition rate) and the average performance differential observed between those funds and the remaining funds. This is known as **"survivorship bias".**

The funds have selection criteria that can be very diverse, and the data provided will not be representative of the same management universe. This is referred to as **"selection bias"**. For instance, HFR excludes managed futures from its databases while TASS and MAR take them into account. Most funds are present in one but not the other: of the 1,162 HFR funds and the 1,627 TASS funds, only 465 are common to both databases. 59% of the funds that are still in activity and 68% of the funds that no longer report to HFR are not part of the TASS database (cf. Liang (2000)).

The Performance Heterogeneity of Hedge Fund Indices

A number of competing indices can be used by investors for benchmarking purposes (see Illustration 1).

Illustration 1:
Overview of Major Non-Investable Hedge Fund Indices as of December 2004

Index Provider	Launch Date	Base Date	Index Weighting	Nbr of Funds in the Database	Nbr of Funds in the Indices	Rebalancing Frequency
Altvest	2000	1993	E.W.*	+2600	+2600	Monthly
Barclay Group	2003	1997	E.W.*	3580	+2100	Monthly
CISDM	1994	1990	Median	+2300	+1280	Monthly
CSFB/Tremont	1999	1994	V.W.**	+4500	389	Quarterly
EACM	1996	1996	E.W.*	100	100	Annual
EDHEC	2003	1997	P.C.A.***	n.a.	n.a.	Quarterly
Hennessee	1987	1987	E.W.*	+3000	+690	Annual
HF Net	1998	1976-1995[1]	E.W.*	+4500	+3180	Continual
HFR	1994	1990	E.W.*	2300	+1400	Monthly
MSCI	2002	2002	E.W.* & V.W.** [2]	2050	+1500	Quarterly [3]
Van Hedge	1994	1988	E.W.*	+6000	+1300	Monthly

* E.W. stands for Equally Weighted.
** V.W. stands for Value Weighted.
*** P.C.A. stands for Principal Component Analysis.

1. Depends on the strategy.
2. For the global indices.
3. For inclusion and Monthly for the "reranking" of funds.

Source: EDHEC Risk.

The Evolution of Hedge Fund Indexing

Since the various indices have different compositions, they will not be affected in the same way by the different biases to which we have referred and significant performance differences for the same style are commonly observed between the different competing indices.

This phenomenon is particularly noticeable in periods of crisis (between August 1998 and October 1998, cf. table below). The level of heterogeneity of the information supplied by the different index providers is actually spectacularly high, as can be seen from illustration 2.

Illustration 2:
Performance Differential for Competing Hedge Fund Indices

Investment Styles		Max differences (with dates and indices)
Convertible Arbitrage	7.55%	(Dec 01: EACM (-6.93%) / Hennessee (0.62%))
CTA Global	8.28%	(Apr 04: S&P (-8.06%) / Barclay (0.22%))
Distressed Securities	7.75%	(Aug 98: CSFB (-12.45%) / Van Hedge (-4.70%))
Emerging Markets	19.45%	(Aug 98: CISDM (-26.65%) / Altvest (-7.20%))
Equity Market Neutral	5.00%	(Dec 99: Hennessee (0.20%) / Van Hedge (5.20%))
Event Driven	5.37%	(Aug 98: CSFB (-11.77%) / S&P (-6.40%))
Fixed Income Arbitrage	7.96%	(Oct 98: Hennessee (-8.56%) / Van Hedge (-0.60%))
Funds of Funds	8.01%	(Dec 99: CISDM (2.41%) / Altvest (10.42%))
Global Macro	14.17%	(Oct 98: CSFB (-11.55%) / Altvest (2.62%))
Long/Short Equity	9.51%	(Feb 00: Altvest (3.50%) / CSFB (13.01%))
Merger Arbitrage	3.18%	(Jan 99: CSFB (-1.51%) / Altvest (1.67%))
Relative Value	13.34%	(Oct 98: S&P (-6.90%) / HF Net (6.44%))
Short Selling	21.13%	(Feb 00: Van Hedge (-24.30%) / EACM (-3.17%))

Source: EDHEC Risk — From January 1998 through December 2004

The fact that the different indices available on the market are impacted in various ways by performance measurement biases is largely reflected in the heterogeneity of their returns. Investors are thus provided with a somewhat confusing picture of alternative investment strategies.

EDHEC's Response to the Challenge of Representativity

To reconcile the apparently conflicting information provided by the different indices, EDHEC proposed a construction methodology based on factor analysis techniques aimed at maximising the representativity dimension of a series of indices of hedge fund indices. As a result, these indices of indices respond to investors' need for a "true and fair" representation of the performance of alternative investment strategies. Given that it is impossible to come up with an objective judgment on what the best existing index is, a natural idea consists of using some combination of competing indices to reach a better understanding of what the common information about a given investment style would be. One straightforward method for obtaining a composite index based on various competing indices would involve computing an equally-weighted portfolio of all competing indices. This would obviously provide investors with a convenient one-dimensional summary of the contrasted information contained in competing indices. In particular, because competing hedge fund indices are based on different sets of hedge funds, the resulting portfolio of indices would be more exhaustive than any of the competing indices it is extracted from. We can push the logic one step further and use factor analysis techniques to extract the best possible one-dimensional

The Evolution of Hedge Fund Indexing

summary of a set of competing indices, and design what can be called "pure style" indices. This method is thus a natural generalisation of the idea of taking a portfolio of competing indices. The refinement involves relaxing the assumption of an equally-weighted portfolio.

We suggest using factor analysis techniques to generate a set of alternative indices that can be thought of as the best possible one-dimensional summaries of information conveyed by competing indices for a given style, in the sense of the largest fraction of the variance explained. Here, we are looking for the portfolio weights that make the combination of competing indices capture the largest possible fraction of the information contained in the data from the various competing indices. Technically speaking, this amounts to using the first component of a Principal Component Analysis of competing indices as a candidate for a pure style index. Note that the first component typically captures a large proportion of cross-sectional variations because competing styles tend to be at least somewhat positively correlated.

The EDHEC Alternative Indexes generated as the first component in a factor analysis have an appealing built-in element of optimality, since there is no other linear combination of competing indices that implies a lower information loss. By construction, they are designed to be as representative as possible of the investment universe, given inherent difficulties specific to the hedge fund universe, and increasing numbers of investors and managers have started using them for benchmarking purposes (the returns of these indices can be downloaded from the EDHEC Risk and Asset Management Research Centre's website: www.edhec-risk.com).

The benefits of the EDHEC Alternative Indexes in terms of improvement of the representativity dimension have been examined in two formal studies led by F.S. Lhabitant (Lhabitant (2002)) with data up to December 2002, and Lhabitant (2004) with updated data up to December 2003). The methodology and results of these studies are as follows:

Lhabitant first collected information from different providers: Altvest, MAR, HFR, TASS, MSCI and EACM. He also collected fund returns from UBP's host system, as well as from SYZ Bank and HSBC's client reports. He finally collected some information via Bloomberg. He thus ended up with a database made up of 7,422 hedge funds, of which 2,317 were not included in any of the commercially available databases (henceforth "ghost" funds). It should be noted that these "ghost" funds include funds with assets under management exceeding $10bn, as well as start-up funds.

The resulting database covers the following 9 strategies: Convertible Arbitrage, Long/Short Equity (Global, US, Europe, Asia, Sector), Merger Arbitrage (or Risk Arbitrage), Distressed Securities (Credit Trading, Restructuring), Emerging Markets (Global, Latin America, Europe, Asia), Equity Market Neutral (including Statistical Arbitrage), Fixed Income Arbitrage (Arbitrage, Trading), Global Macro (Global Macro, CTA) and Short Selling (Short Bias, Dedicated Short Bias). It is worth noting that 1,211 funds did not fall into any of the categories corresponding to the classification of the EDHEC hedge fund indices. This was mainly due to one of the following reasons: 1/ lack of information, 2/ a significant shift in the strategy, 3/ the exotic nature of the strategy. These funds were thus classified under the sub-type "Multi strategy".

The Evolution of Hedge Fund Indexing

In order to avoid any double counting, Lhabitant implemented qualitative as well as quantitative filters. He first sorted the funds by alphabetical order and eliminated funds with identical or very similar names. He then eliminated funds that were very highly correlated (i.e., coefficient greater than 0.95).

Once he could avail of a comprehensive database, Lhabitant proceeded as follows to measure the degree of representativity of the different indices, depending on the investment strategy. He first constructed an equally weighted portfolio made up of all funds contained in the database for the strategies corresponding to the classification of the EDHEC indices (henceforth representative portfolios). He then calculated the correlation coefficient of these representative portfolios with the EDHEC Alternative Indexes. The higher the coefficient, the better the level of representativity.

As can be seen from Illustration 3, EDHEC indices exhibit a very high level of correlation with the representative portfolios. Lhabitant (2002, 2004) has also shown that EDHEC indices are systematically better correlated with the representative portfolios than the average of the indices they are made up of. These results confirm the benefits of the construction methodology of the EDHEC indices. The use of a factor analysis approach (i.e. Principal Component Analysis) clearly leads to a maximisation of the representativity dimension.

However, the EDHEC Alternative Indexes, like most of the peer indices they are based upon, are partially made up of funds that are closed to new investment or do not provide investors with sufficient extra capacity. It is thus technically difficult for investors to replicate the performance of these indices with a satisfying tracking error. Consequently, those indices do not offer a viable alternative to existing investment vehicles (e.g., hedge funds or funds of hedge funds), and since investors are generally reluctant to use indices that are not investable as benchmarks, they cannot qualify as quality benchmarks. They are therefore of little help for investors who want to gain exposure to hedge fund strategies, or measure their relative returns properly.

Illustration 3:
Correlation coefficient with representative portfolios

	EDHEC Indices (1998-2000)	EDHEC Indices (1998-2003)
Convertible Arbitrage	0.84	0.90
Long/Short Equity	0.98	0.93
Merger Arbitrage	0.86	0.84
Distressed Securities	0.94	0.83
Emerging Markets	0.98	0.97
Equity Market Neutral	0.41	0.65
Fixed-Income Arbitrage	0.81	0.70
Global Macro	0.77	0.85
Short Sellers	0.73	0.92

The Challenge of Investability in Hedge Fund Indexing

To satisfy the need of investors for hedge fund benchmarks in which they can invest, some of the aforementioned index providers (CSFB/Tremont, HFR, etc.) and well-known traditional financial institutions (S&P, MSCI, Dow Jones, FTSE, etc.) have launched investable hedge fund indices. Like their non-investable counterparts, investable hedge fund indices rely on different investment universes, following varying construction methodologies (e.g. equally weighted versus value or investability weighted) and diverse management principles (quarterly versus semi-annual or annual rebalancing).

The Evolution of Hedge Fund Indexing

Presentation of Investable Hedge Fund Indices

Generally based on platforms of separated accounts (Lyra Capital, PlusFund Group, Lyxor AM, MSS Capital, etc.) rather than on hedge fund databases, this new generation of indices has been able to provide investors with improved liquidity (up to weekly) and increased transparency (i.e. managed accounts allow for full transparency and daily pricing). In addition, for all these indices, the composition, construction methodology and management principles are overseen by an independent committee and disclosed to the public. The success of these indices was almost immediate and assets managed by investment vehicles linked to these indices rapidly reached substantial levels of assets under management (i.e. 10 billion dollars).

This success might be explained by the appealing value proposition of investable hedge fund indices, which is significantly different from that of actively managed funds of hedge funds (FoHF). It consists of: 1/ full transparency, 2/ initial and ongoing due diligence and 3/ investability (i.e. low entry level and high redemption frequency). It is worth noting that traditional houses like S&P, MSCI and Dow Jones have signed partnerships with separated account platform managers and other third parties (e.g. due diligence consultants) to make up for their lack of experience in the alternative arena. As a result, with investable hedge fund indices, investors can take advantage of the diversification potential of hedge fund strategies at relatively low cost without being concerned by the lack of transparency in the alternative arena, or their lack of understanding of alternative investment strategies.

Illustration 4:
Overview of Major Investable Hedge Fund Indices as of March 2004

Index Provider	Base date	Launch date	Nbr of indices	Strategy / Fund Weighting	Nbr of Funds in Database / Eligible Universe	Nbr of Funds in the Index	Rebalancing Frequency
CSFB/Tremont	Jan.-00	Aug-03	10 + composite	V.W. / V.W.	>4500 / 440	60	Semi annually
Dow Jones	Jan.-02	Nov-03	6	n.a. / E.W.	300 / 100	40	Quarterly [1]
FTSE	Jan.-98	Apr-04	11 + composite	I.W. / I.W.	6000 / 75	40	Annual [2]
HFRX	Jan.-00	Mar-03	8 + composite	V.W / *	8000 / 1600	n.a.***	Quarterly
MSCI	Jan.-00	Jul-03	1	Adj. Median Asset Weighted / E.W.	>150 / n.m.**	120	Quarterly
S&P	Jan.-98	May-02	5 + composite	E.W. / E.W.	3500 / 300	41	Annual [3]

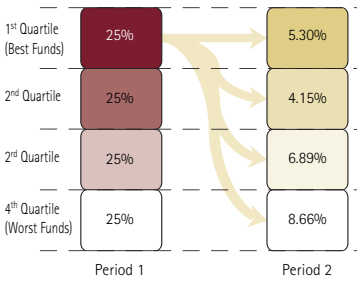
* Fund weightings are optimised to maximise correlation with their group.
** n.m. stands for not mentioned.
*** Optimal number of funds for strategy replication is determined through Monte Carlo simulation.
1. Additions or deletions can occur without notice at the complete and absolute discretion of Dow Jones.
2. Funds may be added/deleted more frequently in response to changing market conditions or fund-specific events.
3. Annual at the strategy level and periodically on the fund level.

Source: EDHEC Risk.

The Evolution of Hedge Fund Indexing

Investable hedge fund indices give investors an opportunity to obtain relatively low-cost[4] exposure to alternative investment strategies. Consequently, unlike non-investable indices, they offer a viable alternative to hedge fund or fund of hedge fund investing. Nevertheless, in most cases, investability is the primary objective of the index construction process. Funds are selected by the index providers, or more often by the managed account platform teams, for their extra capacity, liquidity, good infrastructure, high level of transparency or track record, and not for any criteria related to representativity (CSFB/Tremont indices are an exception since they are generally composed of the 6 largest funds in the eligible universe). Similarly, indices are equally weighted (e.g., Dow Jones, S&P), weighted according to their level of "investability" (e.g., FTSE Index) or at best value weighted (e.g. CSFB/Tremont indices). Except for the HFR indices (the weights are chosen so as to maximise the correlation with the corresponding non-investable index) and perhaps for the CSFB/Tremont indices, which are value weighted, there is generally no explicit reference to representativity.

Illustration 5:
Do Winners Repeat?



Breakdown of 283 funds belonging to the CISDM database, which were classified in Quartile 1 (i.e. top-performing funds) over period 1 (i.e. from 12/1999 through 12/2000), in period 2 (i.e. from 12/2000 through 12/2001). Similar results are found for subsequent periods.

Problems with Investable Hedge Fund Indices

Unfortunately, one of the by-products of this search for investability is the loss in terms of representativity. Focusing on funds' liquidity leads to the exclusion of numerous funds (especially funds closed to new investments, with small additional capacity, or investing in illiquid securities). As a result, the different investable hedge fund indices available on the market fail to capture the actual betas of hedge fund strategies, and thus fail to satisfy a basic criterion for representativity. They should thus be referred to as passively managed funds of hedge funds rather than indices. They cannot *ipso facto* qualify as quality benchmarks.

On the other hand, these indices are also subject to biases such as the selection and backfilling biases. Funds are often selected so as to magnify *pro forma* returns, but nothing guarantees that these funds will continue to post appealing performance in the future (as can be seen from Illustration 5, winners do not repeat). Investors should not therefore take hedge fund indices' *pro forma* returns at face value, but should handle them with *caveats*.

EDHEC's Response to the Challenge of Investability

Our contribution is to investigate from an academic perspective whether designing sound (i.e., both representative and investable) hedge fund indices is a feasible task given the specific features of that industry, in particular the lack of capacity and transparency. To test whether or not investability should necessarily come at the cost of representativity, we use hereafter a well-known methodology in asset pricing literature based on the concept of *factor replicating portfolios* (see for example Huberman, Kandel and Stambaugh (1987). More specifically, our results suggest that it is actually possible to construct representative indices based on a limited number of funds, provided that i)

4. License, management and entry and/or exit fees must generally be paid.

The Evolution of Hedge Fund Indexing

these funds are suitably selected and ii) an optimally designed portfolio is set up with the objective of replicating the common trend in hedge fund returns for a given strategy.

In what follows, we use an approach similar to that developed by Fung and Hsieh (1997) to form, for each hedge fund strategy, an investable portfolio replicating the performance of the common component in the funds' returns.[5] Following the logic behind the construction of its indices of hedge fund indices, EDHEC suggest using factor analysis techniques (i.e. Principal Component Analysis) to extract the best possible one-dimensional summary of a set of competing individual funds following a given strategy, and design replicating portfolios for the factor explaining the largest amount of information *(PC1)*. The resulting indices can be thought of as the best possible one-dimensional summaries of information conveyed by a variety of hedge funds following a given style, in the sense of the largest fraction of the variance explained.

More specifically, our methodology is based on the concept of *factor replicating portfolios (FRP),* which are designed to replicate the common component in a set of asset returns.

Factor analysis techniques have been extensively used in finance, both in the context of term structure analysis (a classic reference is Litterman and Scheinkman (1991)) as well as in the time-series analysis of equity portfolios (e.g., Chan, Karceski and Lakonishok (1998) or Alexander and Dimitriu (2004) for a recent reference). In the context of empirical testing of the Arbitrage Pricing Theory (Ross (1976)), replicating portfolios are extracted in an attempt to track the performance of unobserved implicit factors that drive asset returns (see Huberman, Kandel and Stambaugh (1987)).

At the intuitive level, the aim of the methodology is to use a small sample of funds to design a replicating portfolio for the return on a given strategy. To this end, the natural selection criterion is the loading of individual funds on the *first principal component* (see below for a formal definition). The higher the loading of a fund on the first principal component, the higher its contribution will be to the common trend in hedge fund returns following a given strategy. Given that the first *eigenvector* corresponding to the first principal component is determined so as to maximise the variance of the corresponding linear combination of fund returns, high factor loadings will be allocated to funds which have been highly correlated with their group over the calibration period. Such funds should be the most representative of their group. This allows us to achieve a satisfactory level of representativity, while respecting the constraint of investability based on a small number of funds.

A detailed presentation of the construction methodology follows.

5. One difference with Fung and Hsieh (1997) is that they perform a factor analysis on a sample of hedge fund returns covering a mix of strategies, while we perform a separate factor analysis on each strategy sample.

Construction Methodology
and Management Principles

Construction Methodology

Selection Stage

Starting with a database of hedge fund returns, we extract the combination of individual funds that captures the largest possible fraction of the information contained in the data. Technically speaking, this amounts to using the first component of a Principal Component Analysis (PCA) of funds' returns as a candidate for a pure style index. Note that the first component typically captures a large proportion of cross-sectional variations because various hedge funds following a given strategy tend to be at least somewhat positively correlated.

The PCA of a time-series involves studying the correlation matrix of successive shocks. Its purpose is to explain the behaviour of observed variables using a smaller set of unobserved implied variables. From a mathematical standpoint, it involves transforming a set of K correlated variables into a set of orthogonal variables, or implicit factors, which reproduces the original information present in the correlation structure. Each implicit factor is defined as a linear combination of original variables. Define R as the following matrix:

$$R = (R_{tk})_{\substack{1 \le t \le T \\ 1 \le k \le n}}$$

R actually contains standardised, as opposed to raw, returns. It is better to conduct PCA on standardised returns (so that they all have mean zero and variance one) because this removes differences in variances caused by leverage differences (see Fung and Hsieh (1997)). For example, two funds employing the exact same trading strategy but different leverage will have different return variances.

We have n variables, i.e. returns for n different individual funds, and T observations of these variables, where T is the number of months in our case.

$$R_{tk} = \sum_{i=1}^{n} \sqrt{\lambda_i}\, U_{ik}\, V_{ti} \quad (1)$$

where:

$(U) = (U_{ik})_{1 \le i,k \le n}$ is the matrix of the n eigenvectors[6] of R'R.

$(U^T) = (U_{ki})_{1 \le k,i \le n}$ is U transposed.

$(V) = (V_{ti})_{\substack{1 \le t \le T \\ 1 \le i \le n}}$ is the matrix of the n eigenvectors RR'

Note that these n eigenvectors are orthogonal. $\lambda\{i\}$ is the eigenvalue (ordered by degree of magnitude) corresponding to the eigenvector U_i. Denoting $S_{ik} = \sqrt{\lambda_i}\, U_{ik}$ the principal component sensitivity of the k^{th} variable to the i^{th} factor, and $V_{ti} = F_{ti}$, one can equivalently write equation (1).

$$R_{tk} = \sum_{i=1}^{n} S_{ik}\, F_{ti}$$

where the n factors F_i are a set of orthogonal variables. One may use the method to describe each variable as a linear function of a reduced number of factors. To that end, one needs to select a number of factors I such that the first I factors capture a large fraction of asset return variance, while the remaining part can be regarded as statistical noise

$$R_{tk} = \sum_{i=1}^{I} \sqrt{\lambda_i}\, U_{ik}\, V_{ti} + \varepsilon_{tk} = \sum_{i=1}^{I} S_{ik}\, F_{ti} + \varepsilon_{tk} \quad (2)$$

6. An eigenvector is a vector that is scaled by a linear transformation, but not moved. The scaling factor is the eigenvalue.

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where some structure is imposed by assuming that the residuals ε_{tk} are uncorrelated one to another. The percentage of variance explained by the first I factors is given by $\frac{\sum_{i=1}^{I}\sqrt{\lambda}_i}{\sum_{i=1}^{n}\sqrt{\lambda}_i}$.

By taking $I = 1$ in equation *(2)* this method can be used to generate "the best one-dimensional" summary of a set of individual funds.

For each strategy, we form a portfolio using the 8-12 hedge funds in the corresponding category, and belonging to the eligible universe, that are most correlated with the first principal component in the calibration period (e.g. January 1998 to December 2000). The eligible universe of the EDHEC Investable Hedge Fund Indices is made up of the funds represented on the managed account platform that is managed by Lyxor AM. As a result, all these funds present significant extra capacity and high levels of liquidity, which allows the EDHEC Investable Hedge Fund Indices to offer high levels of liquidity in turn.

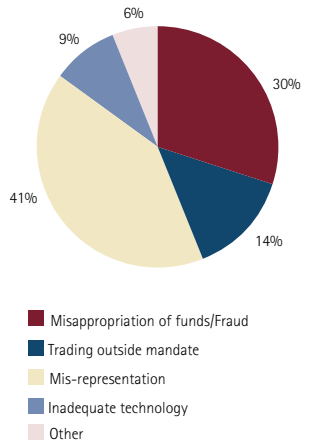
Furthermore, it should be noted that the funds represented on the managed account platform managed by Lyxor AM have been selected after proper initial due diligence and are then submitted to ongoing due diligence. Positions are valued independently and the terms of the investment mandate (e.g. risk limits) are checked daily. As a result, operational risks – which are not rewarded by the markets – are mitigated (as can be seen from Illustration 6, around 85% of the causes of operational failures are circumvented thanks to the managed account platform[7]). This allows us to focus on the risks that are rewarded by the market (i.e. betas are captured through the PCA performed in the fund selection process) and in turn to maximise the representativity dimension.

Optimisation Stage

In an attempt to further improve the efficiency of the EDHEC Investable Hedge Fund Indices, the weights of the selected funds are then determined through an optimisation procedure that explicitly aims to maximise the representativity dimension. By doing this, we avoid specifying an arbitrary weighting scheme (e.g. equal weighting) and thus ensure optimality. In other words, the portfolio weights are chosen so that the EDHEC Investable Hedge Fund Indices' returns have maximal correlation with the corresponding principal component (PC1).

Portfolios that maximise correlation might make use of extreme weights in a few highly correlated funds, which may yield concerns over taking on unnecessary fund-specific risk. We therefore impose weight constraints so that weights lie between 5% and 20% of the EDHEC Investable Hedge Fund Indices. It is worth stressing that an appealing side effect of imposing weight constraints is to allow one to achieve a better trade-off between specification error and sampling error. This is similar to what can be achieved by statistical shrinkage techniques (see Jagannathan and Ma (2003)). It should be noted that weight constraints implicitly prohibit short sales, which is consistent with operational constraints.

Illustration 6:
Details on Operational Failures



Source: Capco, 2002, Understanding and Mitigating Operational Risk in Hedge Fund Investments, Working Paper.

7. For more details, please refer to "Mitigating Hedge Funds' Operational Risks, Benefits and Limitations of Managed Account Platforms", Working Paper, Edhec Risk and Asset Management Research Centre, 2005.

Construction Methodology and Management Principles

$$\max_{w_i} \rho_{FRP,\,PC1} \; s.t. \begin{cases} 5\% \leq w_i \leq 20\% \\ \sum_i w_i = 1 \end{cases} \qquad for\ i = 1\ to\ n \qquad with\ 8 \leq n \leq 12$$

where w_i is the weight of fund i and $\rho_{FRP,\,PC1}$ is the correlation coefficient between the EDHEC Investable Hedge Fund Indices and the 1st Principal Component.

Management Principles

Selection Stage

To ensure that constituents are representative of their investment universe on an ongoing basis, the selection procedure is repeated every 6 months i.e. we perform a Principal Component Analysis on the past 3 years of normalised returns, and we select the 8-12 funds with the highest correlation. The "Fund Selection" will take place on the last Friday before the end of the quarter and be effective on the first Tuesday of the new quarter. The current composition of the EDHEC Investable Hedge Fund Indices and recent composition changes are available upon request for information purposes (investableindices@edhec-risk.com).

If a fund has to be dropped from the index between two portfolio rebalancing dates (e.g. failure, capacity limit, style drift[8]), no new fund will be included until the next "Fund Selection" date (i.e. the end of the 6-month period). By doing this, we ensure the stability of the characteristics of the EDHEC Investable Hedge Fund Indices.

Optimisation Stage

As we go through the selection process every 6 months, the composition changes and we have to terminate some funds, invest in new funds and more generally adjust the weight allocated to each fund. The optimisation stage should therefore take place at least every 6 months. However, since the representativity of the selected funds might change through time due to style shifts, weights will be optimised every 3 months. We thus expect to improve the out-of-sample robustness of the EDHEC Investable Hedge Fund Indices. "Portfolio Optimisation" will take place on the last Friday before the end of the quarter. Changes are effective on the first Tuesday of the new quarter.

If a fund has to be dropped from the index between two portfolio rebalancing dates (e.g. failure, style drift), the weights of the remaining funds are re-optimised following the optimisation procedure presented above, to maintain a high level of representativity. If a fund reaches its capacity limit, the excess weight that could not be invested in the fund is reallocated to the other funds on a *pro rata* basis.

Number of Constituent Funds

The EDHEC Investable Hedge Fund Indices are made up of a limited number of funds, namely 8 to 12. It should be noted that despite the fact that an increase in the number of funds would have increased the degree of

8. Adherence to investment guidelines (investment style, risk constraints, etc.) is monitored by Lyxor on an ongoing basis.

Construction Methodology and Management Principles

representativity of the EDHEC Investable Hedge Fund Indices, the maximum number of constituent funds was voluntarily fixed at 12. The reasons are twofold.

On the one hand, improving representativity by increasing the number of underlying funds is not a free lunch. As shown in Learned and Lhabitant (2002), the volatility of the portfolio decreases when the number of funds increases (i.e. > 15 funds), but in parallel its skewness tends to decrease and its kurtosis tends to increase. Furthermore, this degradation of third order and fourth order moments comes hand in hand with a beta dilution effect, leading to an increase in the correlation with traditional asset classes (especially with stock markets).

On the other hand, the rationale behind increasing the number of funds is essentially to reduce the sensitivity of the fund of hedge funds to the risk of default of one of its constituents. However, since the EDHEC Investable Hedge Fund Indices are made up of managed accounts (as opposed to hedge funds), the risk of default is already largely mitigated. Firstly, the manager of the managed account platform (i.e., Lyxor AM) conducts initial and ongoing due diligence to identify funds that not only display sound investment strategies but also dispose of reliable infrastructures. Secondly, NAV are not calculated by fund managers but delegated to external administrators to ensure the independency of position valuations. Finally, sophisticated risk monitoring techniques derived from proprietary trading desk practices are used. In the end, around 85% of the operational risks causing bankruptcies are mitigated (see Illustration 6).

As a result, from both a practical and a theoretical perspective, the optimal number of funds lies between 8 and 12.

Index Governance

The fund selection and optimisation processes are implemented by EDHEC following the methodology presented in this document. The performance of the EDHEC Investable Hedge Fund Indices is calculated by EDHEC, based on the constituent fund valuations made by Lyxor AM. Proper implementation of the construction methodology and management principles is overviewed by the scientific director of the EDHEC Risk and Asset Management Research Centre. Improvements to the construction methodology are submitted by the scientific director of the EDHEC Risk and Asset Management Research Centre and approved by a committee of experts chaired by the director of the EDHEC Risk and Asset Management Research Centre.

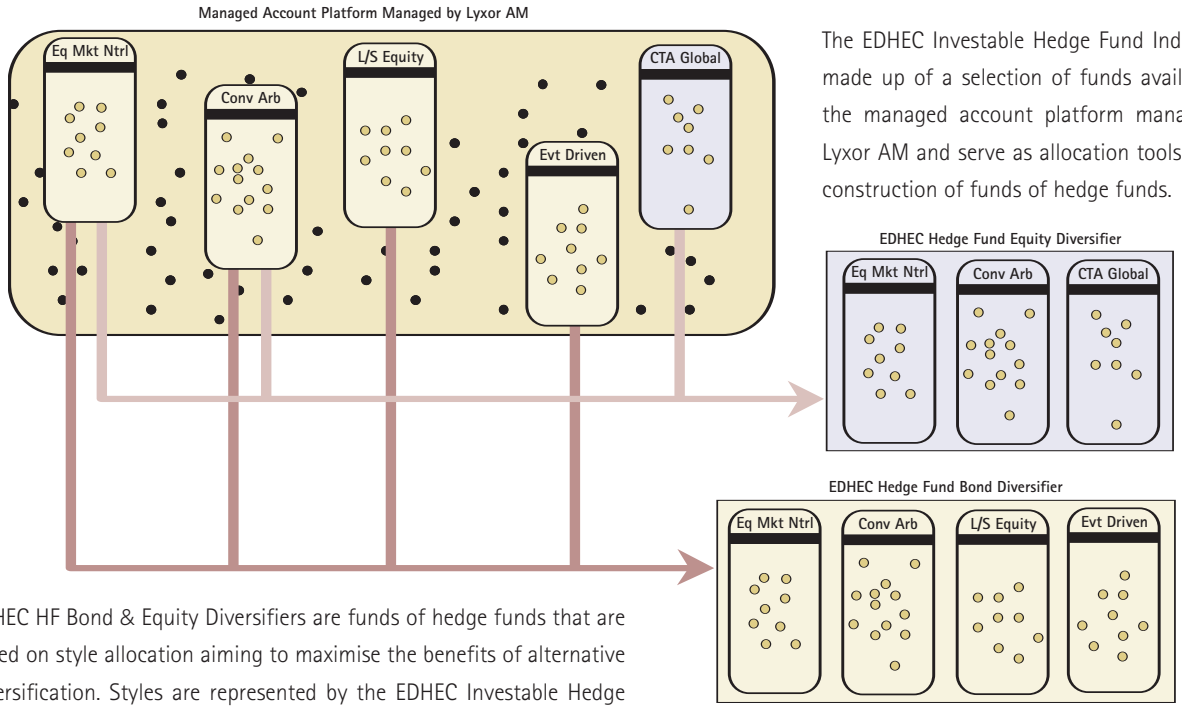
Communication

The performance of the EDHEC Investable Hedge Fund Indices is published on a monthly basis at www.edhec-risk.com. The composition of the EDHEC Investable Hedge Fund Indices is available, for information purposes and upon request at investableindices@edhec-risk.com.

The Use of
the EDHEC Investable Hedge Fund Indices

The EDHEC Investable Hedge Fund Indices are portfolios of managed accounts available on the platform managed by Lyxor AM. The EDHEC Investable Hedge Fund Indices are not intended to be used as standalone investment vehicles. Instead, the EDHEC Investable Hedge Fund Indices are intended to serve as allocation tools for the construction of funds of hedge funds following a dynamic style allocation across hedge fund strategies. For example, the EDHEC Investable Hedge Fund Indices can be used to construct benchmarks that allow for maximisation of the benefits of alternative diversification, such as the EDHEC HF Bond & Equity Diversifiers[9] (see Illustration 7).

Illustration 7:
Using the EDHEC Investable Hedge Fund Indices to construct optimal benchmarks



The EDHEC Investable Hedge Fund Indices are made up of a selection of funds available on the managed account platform managed by Lyxor AM and serve as allocation tools for the construction of funds of hedge funds.

EDHEC HF Bond & Equity Diversifiers are funds of hedge funds that are based on style allocation aiming to maximise the benefits of alternative diversification. Styles are represented by the EDHEC Investable Hedge Fund Indices.

9. The EDHEC Hedge Fund Diversifier Benchmarks are made up of an optimised selection of EDHEC Investable Hedge Fund Indices. This selection is carried out in accordance with the diversification objective of an equity or bond portfolio. The proportions between each of the indices are the fruit of a dynamic reallocation that aims to optimise the benchmarks' diversification capacity not only in terms of volatility but also in terms of extreme risks. For more information on the EDHEC Hedge Fund Diversifier Benchmarks, please refer to the Construction Method of the EDHEC Hedge Fund Diversifier Benchmarks document.

Testing the Representativity
of the EDHEC Investable Hedge Fund Indices

Statistical Properties of the EDHEC Investable Hedge Fund Indices

Investable hedge fund indices are primarily aimed at providing investors with a viable passive alternative to actively managed funds of hedge funds. Unfortunately, to satisfy investors' need for liquidity many index providers have sacrificed the representativity dimension. As a consequence, most investable hedge fund indices available on the market are nothing but passively managed funds of hedge funds and cannot therefore qualify as quality benchmarks.

To assess the extent to which the construction methodology of the EDHEC Investable Hedge Fund Indices allows these two conflicting objectives of investability and representativity to be reconciled, we calculated the coefficient correlation of the EDHEC Investable Hedge Fund Indices with the EDHEC Alternative Indexes. As recalled above, the representativity of the latter indices was tested in Lhabitant (2002, 2004) with a meta-database. The results clearly indicated that the EDHEC Alternative Indexes are unarguably the most representative indices available on the market. We therefore decided to use them in our representativity test.

As can be seen from Illustration 8, despite the fact that the EDHEC Investable Hedge Fund Indices are made up of a limited number of funds (i.e., 8 to 12), they are highly correlated with the EDHEC Alternative Indexes. This is particularly true for directional strategies (e.g. CTA Global, Long/Short Equity), semi-directional strategies (i.e. Event Driven) and Convertible Arbitrage, which present correlation coefficients that are higher than 0.90. In the case of Equity Market Neutral, the correlation coefficients, though lower, are still higher than 0.75. This confirms that even when alpha accounts for a substantial part of hedge funds' performance, as is the case for Equity Market Neutral funds, the methodology used to construct the EDHEC Investable Hedge Fund Indices still allows the behaviour of the population to be replicated properly.

Alternatively, the representativity of the EDHEC Investable Hedge Fund Indices can be measured as the extent to which the first four moments of their return distribution functions (i.e., mean, standard deviation, skewness and kurtosis) match those of the EDHEC Alternative Indexes.

Illustration 8:
Correlation coefficient of the EDHEC Investable Hedge Fund Indices* with the (non-investable) EDHEC Alternative Indexes – Monthly data from April 2002 through March 2005

	Correlation Coefficients
Convertible Arbitrage	0.96
CTA Global	0.97
Event Driven	0.93
Equity Market Neutral	0.79
Long/Short Equity	0.95

* Based on monthly returns gross of fees for Edhec Investable Hedge Fund Indices

Testing the Representativity of the EDHEC Investable Hedge Fund Indices

Illustration 9:
Comparison of EDHEC Investable Hedge Fund Indices* and (non-investable) EDHEC Alternative Indexes' return distribution functions – Based on monthly return data from April 2002 through March 2005

	Convertible Arbitrage		CTA Global		Event Driven		Equity Market Neutral		Long Short Equity	
	Non-Investable	Investable	Non-Investable	Investable	Non-Investable	Investable	Non-Investable	Investable	Non-Investable	Investable
Monthly Average	0.43%	0.40%	0.82%	1.12%	0.82%	0.47%	0.45%	0.50%	0.58%	0.67%
Monthly Volatility	1.08%	1.05%	3.09%	4.18%	1.35%	0.98%	0.44%	0.69%	1.68%	2.02%
Skewness	0.01	-0.08	-0.11	-0.12	-0.92	-0.31	-0.26	-0.35	-0.47	-0.22
Excess Kurtosis	-0.43	-0.80	-0.80	-0.98	1.75	0.78	0.80	0.74	0.17	-0.52

* Based on monthly returns gross of fees for Edhec Investable Hedge Fund Indices

As can be seen from Illustration 9, the first four moments of the return distribution functions of the EDHEC Investable Hedge Fund Indices are generally very close to those of the non-investable EDHEC Alternative Indexes, which is further evidence of their high degree of representativity.

Diversification Properties of the EDHEC Investable Hedge Fund Indices

Hedge fund strategies present appealing properties when analysed on a standalone basis. However, if an increasing number of institutional investors are now considering them for integration in their global asset allocation, it is rather for their diversification properties. As a result, the representativity of the EDHEC Investable Hedge Fund Indices should be assessed in light of their behaviour relative to traditional asset classes (e.g., stocks, bonds). Since the construction methodology of the EDHEC Investable Hedge Fund Indices aims to maximise the representativity dimension, we expect them to deliver an exposure to risk factors that are representative of the investment style under consideration, and in turn, to offer the same diversification properties as representative indices (e.g., EDHEC Alternative Indexes). This allows investors to avoid the pitfalls of unstable and unreliable risk exposure of portfolios of individual fund managers selected on the basis of their performance.

It is actually likely that the best performing managers on a given sample are the ones with risk exposures that are very different from that of the population of managers following a given style. For example, most long/short equity funds maintain a long bias. However, if the objective is to select the funds showing the best in-sample performance, it is likely that in the case of bear markets the selection screen might lead one to pick funds with a short bias, as they will have performed strongly under such circumstances. As a result, the investor will gain exposure to funds that are not representative of their investment universe. The resulting index would therefore present diversification properties that do not resemble those of the

Testing the Representativity of the EDHEC Investable Hedge Fund Indices

long/short equity strategy, with potentially serious consequences in terms of optimal allocation decisions.

This problem is circumvented when the objective is to select funds that are most representative of the investment universe (i.e. showing the highest correlation coefficient with the PC1). In this case, only funds presenting similar behaviours and, as a result, comparable risk factor exposures, are selected. The resulting index would thus offer diversification properties that are similar to those of the average long/short equity fund. Obviously, this observation holds true for all hedge fund strategies.

Since higher order moments matter when analysing the performance of hedge fund strategies, we not only paid attention to their "covariance" beta but also to "coskewness" and "cokurtosis" betas with respect to traditional asset classes. These measures were estimated with the method proposed in Martellini and Ziemann (2005).

Illustration 10:
Comparison of EDHEC Investable Hedge Fund Indices* and (non-investable) EDHEC Alternative Indexes' Higher Moment Betas – Based on monthly return data from April 2002 through March 2005[10]

	Convertible Arbitrage		CTA Global		Event Driven		Equity Market Neutral		Long Short Equity	
	Non-Investable	Investable	Non-Investable	Investable	Non-Investable	Investable	Non-Investable	Investable	Non-Investable	Investable
With Stocks										
Covariance Beta	0.02	0.00	-0.20	-0.23	0.24	0.15	0.02	0.03	0.34	0.41
Coskewness Beta	-0.14	-0.18	-0.51	-0.86	0.29	0.14	0.03	0.02	0.32	0.34
Cokurtosis Beta	0.02	0.00	-0.28	-0.37	0.22	0.13	0.02	0.02	0.29	0.35
With Bonds										
Covariance Beta	0.31	0.44	2.02	2.36	-0.32	-0.07	0.14	0.23	-0.52	-0.69
Coskewness Beta	0.23	0.47	1.50	1.07	0.04	0.20	0.30	0.33	0.05	-0.24
Cokurtosis Beta	0.36	0.54	1.66	1.81	-0.15	0.10	0.21	0.25	-0.24	-0.40

* Based on monthly returns gross of fees for Edhec Investable Hedge Fund Indices.

As can be seen in Illustration 10, the EDHEC Investable Hedge Fund Indices, as a result of their high degree of representativity, have a diversification profile that is similar to that of the non-investable EDHEC Alternative Indexes in terms of both beta covariance and beta coskewness / beta cokurtosis. They therefore enable investors to gain exposure to hedge fund strategies and tap their diversification potential in an optimal way.

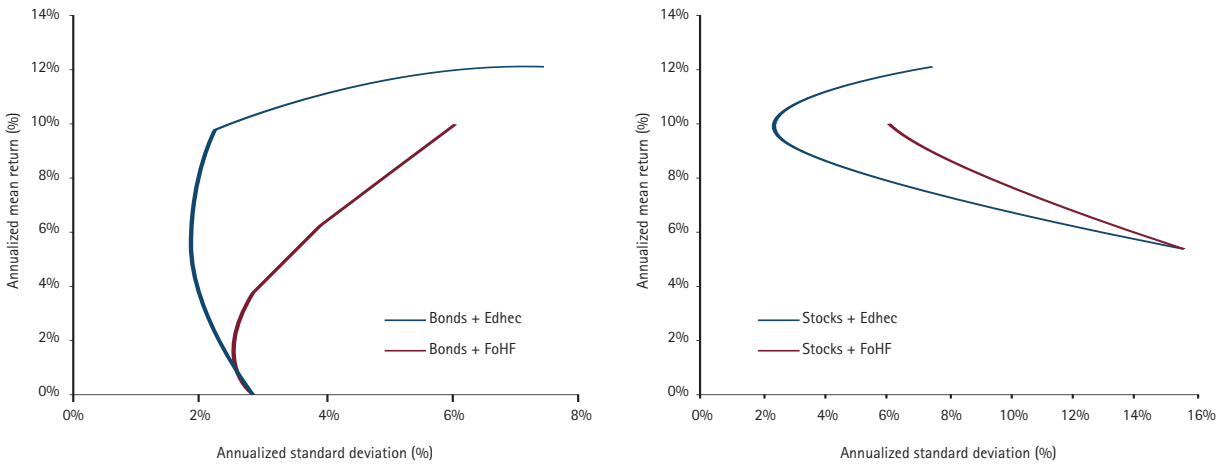
Since the EDHEC Investable Hedge Fund Indices have representative and contrasted exposures with respect to stock and bond portfolios, they can usefully be included in an optimal allocation exercise. In particular, it can be shown that a customised portfolio based on hedge fund strategy indices dramatically outperforms a one-size-fits-all funds of hedge funds solution in terms of diversification benefits (see Illustration 11 below).

10. Stock and bond markets are proxied by the MSCI World Equity Index and the Lehman Global Treasury Bond Index.

Testing the Representativity of the EDHEC Investable Hedge Fund Indices

In other words, existing investment in hedge fund portfolios, typically done through multi-strategy funds of hedge funds based on the selection of high performance funds, does not allow investors to access the full benefits of active allocation in the hedge fund universe. Given the low allocation typically made to alternative investment strategies (i.e., generally 5% to 15% of the global allocation), investors must try to maximise the benefits of their hedge fund portfolios. This can be done by customising an optimal hedge fund portfolio and by taking into account the investor's original allocation to stocks and bonds. The promising results obtained by optimally designed hedge fund portfolios clearly plead in favour of pure style indices, as opposed to composite portfolios such as funds of hedge funds, as investment vehicles for institutional investors.

Illustration 11:
Efficient Frontiers based on style indices[11]
vs. Funds of Hedge Funds – from
January 1997 through December 2004



11. The stock and bond markets are proxied by the MSCI World Index and the Lehman Global Treasury Bond Index. We used the historical returns of the (non-investable) Edhec Alternative Indexes to dispose of a longer observation period. Similar results are obtained with the Edhec Investable Hedge Fund Indices from April 2002 through March 2005.

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Appendices

Appendix 1: Definition of Hedge Fund Styles

Convertible Arbitrage

Convertible bonds, like any other convertible securities, tend to be undervalued due to the fact that stock and bond markets are not closely integrated. They thus present significant arbitrage opportunities for hedge funds. Convertible arbitrage funds generally take long positions in the convertible bond and short positions in the underlying stock. As a result of their bond holding, they tend to be negatively impacted by a steepening of the yield curve. Conversely, since companies that issue convertible bonds are often rated below investment grade, they mechanically benefit from a decrease in the credit spread. Convertible bonds are hybrid securities and as a result they also embed exposure to stock markets. Thanks to their long option position, convertible arbitrage funds are gamma long, and can benefit from stock market increases despite their short equity position. Finally, thanks to their short positions, they can benefit from an increase in short-term interest rates, via higher short rebates, and more directly through a decrease in stock prices.

CTA Global

CTA Global funds try to exploit equity/bond/foreign exchange market trends, generally through systematic technical trading systems. They thus perform particularly well in equity markets that present a moderate but increasing level of volatility. Since trends tend to be more pronounced in down markets than up markets, CTA Global fund returns are negatively correlated with the stock market performance, and in turn positively correlated with changes in credit spreads. Conversely, they tend to post poor performance when bond markets are falling and exhibiting a relatively high level of volatility. Finally, they take advantage of increases in the commodity markets.

Equity Market Neutral

Equity Market Neutral funds basically identify mispricing in stock valuations and bet on the convergence between the market price and the intrinsic value. They thus generally take long positions in stocks that are considered to be undervalued and short positions in stocks that are considered to be overvalued. This strategy is successful in relatively stable market conditions. As a result, these funds are averse to regime switches. They generally perform well in bullish markets, especially when the size spread is relatively large and widening due to their long positions in small caps and/or short positions in large caps. Similarly, Equity Market Neutral funds generally hold long positions in assets that are exposed to default risk and short positions in investment grade companies; they consequently benefit from low and decreasing levels of credit spread. They finally tend to benefit from increases in short term interest rates – in part thanks to higher short rebates –, and more generally from a flattening of the yield curve (since small cap and non-investment grade companies are generally more sensitive to a steepening of the yield curve than large cap and investment grade companies).

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Event Driven

Event driven funds try to take advantage of events that affect companies, such as mergers/acquisitions or bankruptcies. The performance of these funds generally depends on either the completion of a transaction or the success of a restructuring plan. Event driven funds thus tend to post good performance in low-volatility markets and also when there is no regime switch or when markets are upwardly oriented. For liquidity issues, event driven funds generally hold long positions in small caps and short positions in large caps; they thus benefit from relatively wide size spreads. Similarly, they generally hold long positions in companies rated below investment grade; they thus benefit from a relatively low and narrowing credit spread.

Long/Short Equity

Long/short equity funds not only try to capture mispricing in stock valuations, but also try to take advantage of market trends. They thus benefit from relatively low levels of volatility and are negatively impacted by regime switches. Given the fact that long/short equity funds generally maintain a long net exposure to stock markets, they are strongly exposed to market risk. They generally take long positions in small caps and short positions in large caps, and on average take long positions in growth stocks and short positions in value stocks (for liquidity reasons); they thus take advantage of decreases in the value spread and increases in the size spread. Conversely, they suffer from increases in the credit spread and perform well when the credit spread is at a moderate level. Similarly, they post their best performance when the yield curve is relatively flat and short-term interest rates are at a moderate level.

Appendix 2: Higher Moment Betas

In the mean/variance framework that is inherited from Modern Portfolio Theory, the definition of the risk dimension boils down to volatility, and diversification effects are measured by a decrease in volatility. In the alternative arena, however, returns are non-Gaussian (see for example Brooks and Kat (2002)); it is therefore necessary to measure hedge fund strategies' diversification potential in an extended framework that accounts for the presence of fat tails.

Building on Martellini and Ziemann (2005) we will measure the diversification potential of hedge fund strategies with higher moment betas. Higher moment betas allow for a straightforward estimation of the extent to which the introduction of hedge fund strategies in a traditional portfolio may lead

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to a reduction in normal risk (i.e. volatility), in the risk of asymmetry (i.e. skewness), and in the risk of fat tails (i.e. kurtosis). Higher moment betas are defined as follows:

As in Martellini and Ziemann (2005), we define the following co-moments (co-variance, co-skewness and co-kurtosis):

$$\mathrm{CoV}\left(R_i, R_j\right) = \mathrm{E}\left[\left(R_i - \mathrm{E}\left(R_i\right)\right)\left(R_j - \mathrm{E}\left(R_j\right)\right)\right]$$
$$\mathrm{CoS}\left(R_i, R_j\right) = \mathrm{E}\left[\left(R_i - \mathrm{E}\left(R_i\right)\right)\left(R_j - \mathrm{E}\left(R_j\right)\right)^2\right]$$
$$\mathrm{CoK}\left(R_i, R_j\right) = \mathrm{E}\left[\left(R_i - \mathrm{E}\left(R_i\right)\right)\left(R_j - \mathrm{E}\left(R_j\right)\right)^3\right]$$

If we define the initial Portfolio as P, and the new portfolio as $P' = (1 - \varepsilon)\, P + \varepsilon A$, the marginal impact of the introduction of some small amount ε invested in a new asset A, on the second moment of portfolio distribution is, as a first order approximation:

$$\mathrm{Var}\left(R_{p'}\right) - \mathrm{Var}\left(R_p\right) \approx 2\varepsilon\mathrm{Var}\left(R_p\right) + 2\varepsilon\mathrm{CoV}\left(R_A, R_P\right)$$

From this, we obtain the following condition, which states that the introduction of the new asset A has led to a decrease in portfolio variance if and only if the beta of this asset with respect to the initial portfolio is less than one.

$$\mathrm{Var}\left(R_{p'}\right) \leq \mathrm{Var}\left(R_p\right) \Longleftrightarrow \beta^{(2)}_{A/P} = \frac{\mathrm{CoV}\left(R_A, R_P\right)}{\mathrm{Var}\left(R_p\right)} \leq 1$$

Similarly, we obtain that the marginal impact of the introduction of some small amount ε invested in a new asset A on the third moment of portfolio distribution is, as a first order approximation:

$$\mu^{(3)}\left(R_{p'}\right) - \mu^{(3)}\left(R_p\right) = \mu^{(3)}\left((1-\varepsilon)R_p + \varepsilon R_A\right) - \mu^{(3)}\left(R_p\right) \underset{\varepsilon \to 0}{\approx}$$
$$- 3\varepsilon\mu^{(3)}\left(R_p\right) + 3\varepsilon\mathrm{CoS}\left(R_A, R_P\right)$$

- which leads to the following conditions:

$$\text{If } \mu^{(3)}\left(R_p\right) > 0, \mu^{(3)}\left(R_{p'}\right) \geq \mu^{(3)}\left(R_p\right) \Longleftrightarrow$$
$$\beta^{(3)}_{A/P} \equiv \frac{\mathrm{CoS}\left(R_A, R_P\right)}{\mu^{(3)}\left(R_p\right)} \geq 1$$

$$\text{If } \mu^{(3)}\left(R_p\right) < 0, \mu^{(3)}\left(R_{p'}\right) \geq \mu^{(3)}\left(R_p\right) \Longleftrightarrow$$
$$\beta^{(3)}_{A/P} \equiv \frac{\mathrm{CoS}\left(R_A, R_P\right)}{\mu^{(3)}\left(R_p\right)} \leq 1$$

Finally, we obtain that the marginal impact of the introduction of some small amount ε invested in a new asset A on the fourth moment of portfolio distribution is, as a first order approximation:

$$\mu^{(4)}\left(R_{p'}\right) - \mu^{(4)}\left(R_p\right) = \mu^{(4)}\left((1-\varepsilon)R_p + \varepsilon R_A\right) - \mu^{(4)}\left(R_p\right) \underset{\varepsilon \to 0}{\approx}$$
$$- 4\varepsilon\mu^{(4)}\left(R_p\right) + 4\varepsilon\mathrm{CoK}\left(R_A, R_P\right)$$

- which leads to the following condition:

$$\mu^{(4)}\left(R_{p'}\right) \leq \mu^{(4)}\left(R_p\right) \Longleftrightarrow \beta^{(4)}_{A/P} = \frac{\mathrm{CoK}\left(R_A, R_P\right)}{\mu^{(4)}\left(R_p\right)} \leq 1$$

Hence, a low or negative second, third, and fourth moment beta indicates good diversification potential, in the sense of a potential for a decrease in the overall portfolio average risk (i.e. volatility), in the bias toward lower than average returns (i.e. skewness), and in fat-tails (i.e. kurtosis), respectively.

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Appendix 3: EDHEC Investable Hedge Fund Indices in Figures

Illustration 12:
EDHEC Investable Hedge Fund Indices' Performance Statistics as of March 2005

	Return Dimension		Risk Dimension			Risk-Adjusted Performance	
Strategies***	Average Return over the last 3 years*	Maximum Drawdown	Volatility*	Downside Risk*/**	Value-at-Risk (95%)	Sharpe Ratio*/**	Sortino Ratio*/**
Convertible Arbitrage	4.9%	3.4%	3.6%	1.6%	1.4%	0.8	1.9
CTA Global	14.3%	15.6%	14.5%	7.5%	6.0%	0.8	1.6
Event Driven	5.8%	3.5%	3.4%	2.3%	1.2%	1.1	1.6
Equity Market Neutral	6.1%	1.8%	2.4%	1.5%	0.7%	1.7	2.7
Long Short Equity	8.3%	7.5%	7.0%	4.1%	2.8%	0.9	1.5
Stocks	1.0%	30.2%	14.6%	11.6%	7.5%	-0.1	-0.1
Bonds	0.4%	6.0%	2.9%	2.3%	1.5%	-0.5	-0.7

* Monthly indicator annualised.
** Calculated with a reference rate of 2% (for downside threshold, riskfree rate, minimum acceptable return).
*** Based on monthly returns gross of fees for Edhec Investable Hedge Fund Indices. Stocks are proxied by the MSCI World index and bonds are proxied by the Lehman Global Treasury index.

In view of the sensitivity of investors to the third and fourth order moments of return distribution functions (cf. Scott and Horvath (1980)), the mean/variance framework is not sufficient to analyse hedge fund performance. Therefore, we not only look at risk-adjusted performance in terms of the Sharpe ratio, but also at measures that take the presence of fat tails into account. These include the Modified Value-at-Risk and the Sortino ratio, which divides the excess return of an asset over a pre-specified threshold (the minimum acceptable return is equal to 2% in our case), by the downside risk of this asset. Finally, the Omega functions of the EDHEC Investable Hedge Fund Indices are given in Illustration 13. The Omega measure involves dividing the probability weighted average return of an asset over a threshold return by the probability weighted average return of this asset below the same threshold (see Keating and Shadwick (2002) for further details). Illustration 14 summarises the performance of EDHEC Investable Hedge Fund Indices by showing the time series of cumulative returns over the period April 2002 to March 2005.

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Illustration 13:
EDHEC Investable Hedge Fund Indices' Omega function – Based on monthly return data from April 2002 through March 2005

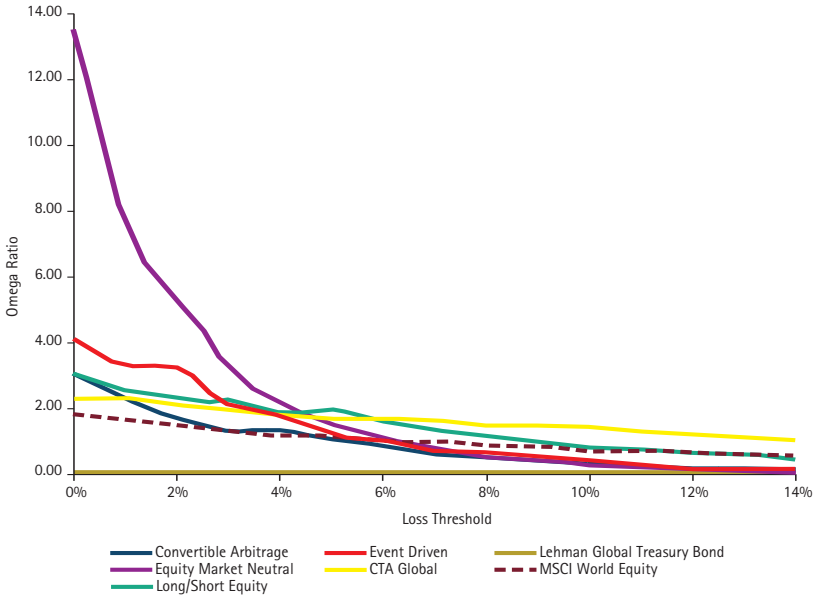
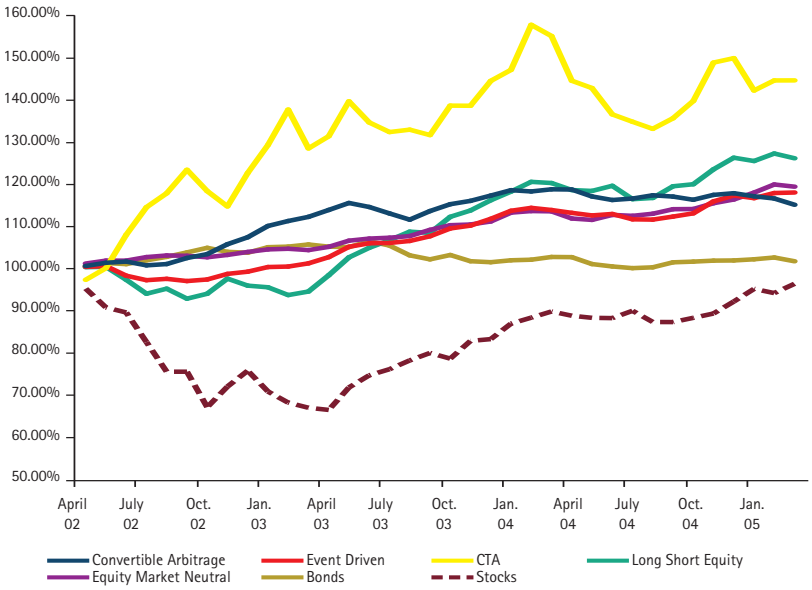


Illustration 14:
Cumulative Returns for EDHEC Investable Hedge Fund Indices from April 2002 to March 2005. Stocks are proxied by the MSCI World index and bonds are proxied by the Lehman Global Treasury index.



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Appendix 4: About the Edhec Risk and Asset Management Research Centre

Edhec is one of the top five business schools in France owing to the high quality of its academic staff (over 100 permanent lecturers from France and abroad) and its privileged relationship with professionals that the school has been developing since it was established in 1906. Edhec Business School has decided to draw on its extensive knowledge of the professional environment and has therefore concentrated its research on themes that satisfy the needs of professionals. Edhec is one of the few business schools in Europe to have received the triple international accreditation: AACSB (US-Global), Equis (Europe-Global) and AMBA (UK-Global). Edhec pursues an active research policy in the field of finance. Its "Risk and Asset Management Research Centre" carries out numerous research programmes in the areas of asset allocation and risk management in both the traditional and alternative investment universes.

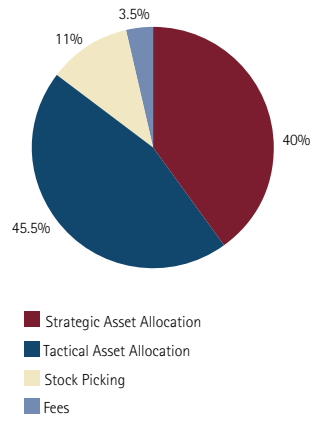
The choice of asset allocation

The Edhec Risk and Asset Management Research Centre structures all of its research work around asset allocation. This issue corresponds to a genuine expectation from the market. On the one hand, the prevailing stock market situation in recent years has shown the limitations of active management based solely on stock picking as a source of performance. On the other, the appearance of new asset classes (hedge funds, private equity), with risk profiles that are very different from those of the traditional investment universe, constitutes a new opportunity in both conceptual and operational terms. This strategic choice is applied to all of the centre's research programmes, whether they involve proposing new methods of strategic allocation, which integrate the alternative class; measuring the performance of funds while taking the tactical allocation dimension of the alphas into account; taking extreme risks into account in the allocation; or studying the usefulness of derivatives in constructing the portfolio.

An applied research approach

In a desire to ensure that the research it carries out is truly applicable in practice, Edhec has implemented a dual validation system for the work of the Risk and Asset Management Research Centre. All research work must be part of a research programme, the relevance and goals of which have been validated from both an academic and a business viewpoint by the centre's advisory board. This board is made up of both internationally recognised researchers and the centre's business partners. The management of the research programmes respects a rigorous validation process, which guarantees both the scientific quality and the operational usefulness of the programmes.

Percentage of variation between funds



Source: Edhec (2002) and Ibbotson, Kaplan (2000).

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To date, the centre has implemented six research programmes:

Multi-style/multi-class allocation

This research programme focuses on the benefits, risks and integration methods of the alternative class in asset allocation. From that perspective, Edhec is making a significant contribution to the research conducted in the area of multi-style/multi-class portfolio construction.

Performance and style analysis

The scientific goal of the research is to adapt the portfolio performance and style analysis models and methods to tactical allocation. The results of the research carried out by Edhec thereby allow portfolio alphas to be measured not only for stock picking but also for style timing.

Indices and benchmarking

Edhec carries out analyses of the quality of indices and the criteria for choosing indices for institutional investors. Edhec also proposes an original proprietary style index construction methodology for both the traditional and alternative universes. These indices are intended to be a response to the critiques relating to the lack of representativity of the style indices that are available on the market. Edhec was the first to launch composite hedge fund strategy indices as early as 2003.

Asset allocation and extreme risks

This research programme relates to a significant concern for institutional investors and their managers– that of minimising extreme risks. It notably involves adapting the current tools for measuring extreme risks (VaR) and constructing portfolios (stochastic check) to the issue of the long-term allocation of pension funds. This programme has been designed in co-operation with Inria's Omega laboratory. This research programme also intends to cover other potential sources of extreme risks such as liquidity and operations. The objective is to allow for better measurement and modelling of such risks in order to take them into consideration as part of the portfolio allocation process.

Asset allocation and derivative instruments

This research programme focuses on the usefulness of employing derivative instruments in the area of portfolio construction, whether it involves implementing active portfolio allocation or replicating indices. "Passive" replication of "active" hedge fund indices through portfolios of derivative instruments is a key area in the research carried out by Edhec.

ALM and asset management

This programme concentrates on the application of recent research in the area of asset-liability management for pension plans and insurance companies. The research centre is working on the idea that improving asset management techniques and particularly strategic allocation techniques has a positive impact on the performance of Asset-Liability Management programmes. The programme includes research on the benefits of alternative investments, such as hedge funds, in long-term portfolio management. Particular attention is given to the

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institutional context of ALM and notably the integration of the impact of the IFRS standards and the Solvency II directive project.

Research for business

In order to facilitate the dialogue between the academic and business worlds, the centre has recently undertaken four major initiatives:

- Opening of a web site that is entirely devoted to the activity of international research into asset management. **www.edhec-risk.com** is aimed at a public of professionals who wish to benefit from Edhec's analyses and expertise in the field of applied portfolio management research such as detailed summaries, from a business perspective, of the latest academic research on risk and asset allocation as well as the latest industry news assessed in the light of the results of the Edhec research programme. www.edhec-risk.com is also the official site for the Edhec Indices.
- Launch of **Edhec-Risk Advisory,** the consulting arm of the research centre focusing on risk management issues within the buy-side industry, and offering a wide range of services aimed at supporting fund managers and their service providers in the fields of operational risk, best execution, structured products, alternative investment due diligence and risk management system implementation.
- Launch of **Edhec Investment Research,** in order to support institutional investors and asset managers in implementing the results of the Edhec Risk and Asset Management Research Centre's research. Edhec Investment Research proposes asset allocation services in the context of a "core-satellite" approach encompassing alternative investments.
- Launch of **Edhec Alternative Investment Education,** which is the exclusive official CAIA association course provider for Europe.

Disclaimer

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