European Investment Bank

Economic and Financial Report 2006/02

Does the hedge fund industry deliver *alpha*?

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JEL Classification codes:

G11 – Portfolio Choice
G12 – Asset Pricing
G23 – Private Financial Institutions

Notes

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The author would like to thank Paul Arthur, Marc Buhlig, Fang Liu, Eric Perée, Armin Riess and Christian Schmieder for constructive comments.

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Abstract

We measure the total-risk-adjusted (as opposed to factor-risk-adjusted) performance of hedge fund indices in well-diversified portfolios. *Alpha* is defined as the difference between, on the one hand, the average return on a mean-variance efficient portfolio containing exclusively traditional market assets (such as stocks and bonds) and, on the other hand, the average return on a mean-variance efficient portfolio containing traditional market assets and the new asset (such as a hedge fund index), where both portfolios carry the same risk. *Alpha* is conditioned on this risk level. Outlier-robust mean-variance efficient portfolios are constructed by using Minimum Volume Ellipsoid (MVE) estimates of location and scatter. We find that, between July 1995 and December 2005, the broad Credit Suisse/Tremont hedge index did not deliver statistically significant *alpha*.

1. Introduction

Hedge funds are sometimes described as “unregulated and opaque investment partnerships that engage in a variety of active investment strategies” (Chan et al. 2005, p. 1). In this definition, the distinction between hedge funds and traditional investment companies, such as mutual funds, pension funds etc., is basically reduced to two features: Firstly, hedge funds are lightly regulated and, as a consequence, lightly supervised. Secondly, hedge funds are opaque because they seldom report their investment strategies and positions to investors, not even to investors in their own fund, let alone to the general public. So far, hedge funds have largely avoided regulatory oversight by targeting mainly high net worth individuals and institutional investors. Yet, this has not prevented the industry from growing. Between 2000 and 2005, assets under management of hedge funds have doubled and now exceed $ 1 trillion. The seminal article of Ackermann, McEnally and Ravenscraft (1999) provides a full description of hedge fund characteristics.

Interestingly, the definition above does not make any reference to what hedge funds themselves advocate; that their alternative investment approach leads to superior returns, which are little correlated to the traditional markets such as the stock market. Superiority is broadly defined by the ability to generate a higher return than expected on traditional long only stock and bond investment strategies, while not taking more risk.

It is common practice to measure excess performance of hedge funds by *alpha*, which is a constant added to the traditional Capital Asset Pricing Model (CAPM) of Lintner (1965), Mossin (1965) and Sharpe (1964) or a constant in a multi-factor model based on the Arbitrage Pricing Theory (APT) introduced by Ross (1976). Under the CAPM assumptions, additional expected return on a portfolio could only be obtained by additional risk taking, i.e. by choosing portfolios with a higher *beta*, i.e. a higher sensitivity to the market portfolio. Similarly, in exact factor pricing models, the expected return is determined by the multiple risk factors only. *Alpha* is the portion of the average portfolio return that could not be explained by the risk factors included in the APT or CAPM equation. However, *alpha* is not a proper measure of risk-free excess return since the unexplained volatility of returns is not taken into account (Schneeweis, 1999).

We measure excess performance of hedge funds differently by taking into account both the explained and unexplained part of return volatility as far as captured by the variance of the portfolio returns. In this study, *alpha* is defined as the difference between, on the one hand, the average return on a mean-variance efficient portfolio containing exclusively traditional market assets (such as stocks and bonds), and, on the other hand, the average return on a mean-variance efficient portfolio containing traditional market assets and the new asset (such as a hedge fund index), where both portfolios carry the same risk. *Alpha* is conditioned on this risk level. Hence, in contrast with *alpha* in the CAPM or APT model, the benefit of our approach is that it reveals at which risk levels hedge funds under or over-perform traditional investment strategies.

We use the Credit Suisse/Tremont broad hedge fund index as a measure for the performance of the hedge fund industry in the aggregate. By virtue of the central limit theorem, indices of hedge fund returns are usually closer to the normal distribution than individual hedge fund returns. That said, our results in section 2 show that, in comparison to the normal distribution, most of the Credit Suisse/Tremont hedge fund return indices also display excess of kurtosis and asymmetry. In most cases this is due to a few outlying, i.e. extreme, observations. Chan and Lakonishik (1992) propose to use outlier-robust estimation techniques to achieve efficiency gains when estimating *beta*-risk under non-normality. We construct outlier-robust mean-variance efficient portfolios by weighing each observation according to its distance to the Minimum Volume Ellipsoid (MVE) estimate of the centre of the corresponding return series. By giving less weight to a few outliers, most of the hedge fund and traditional indices are transformed into normal return series, which makes it possible to apply the mean-variance optimisation framework.

The main contribution of this paper is that it measures the total-risk-adjusted performance of hedge fund indices in well-diversified portfolios. Most studies so far have presented factor-risk-adjusted performance and the Sharpe ratio of individual indices. The former performance measure ignores unexplained return volatility whereas the latter performance measure ignores potential portfolio diversification benefits.

We find that, between July 1995 and December 2005, the broad Credit Suisse/Tremont hedge index did not deliver significant *alpha*. Some of the Credit Suisse/Tremont sub-indices, which show the average return of a group of hedge funds pursuing a particular investment strategy, delivered significant *alpha* between July 1995 and September 2000, but none of them kept up with their excess performance in the five years that followed. These results are aligned with those of Fung et al. (2006), who find that, over approximately the same sample period, the average fund-of-hedge-funds only showed factor-risk-adjusted excess performance between October 1998 and March 2000.

The structure of this paper is as follows. Section 2 provides a descriptive analysis of the data and discusses possible selection biases, outlier treatment, and the normality of hedge fund indices. Section 3 explains how we measure risk-adjusted performance, i.e. *alpha*. Section 4 contains estimates of *alpha* for the hedge fund industry in the aggregate and for ten broad groups of hedge fund investment styles. Section 5 concludes.

2. Sample selection bias, outliers, and descriptive statistics

2.1 The data

Our dataset consists of 126 monthly observations for 11 Credit Suisse/Tremont hedge fund return indices and 9 traditional market return indices covering the period July 1995 – December 2005. The hedge fund indices include the broad hedge fund index and ten sub-indices representing different hedge fund strategies: convertible arbitrage, dedicated short bias, emerging markets, equity market neutral, event driven, fixed income arbitrage, global macro, long/short equity, managed futures and multi-strategy.[1] The internet-site www.hedgeindex.com gives a brief description of these strategies. The traditional market indices include the S&P 500 index, the S&P 400 midcap index, the S&P 600 smallcap index, the Technology PSE-ArcaEx Tech 100 index, a Bloomberg real estate investment trust index, the S&P/IFC emerging market index, a Bloomberg US Treasury 3-months bill total return index, a Bloomberg US Treasury 10-year bond total return index, and a Bloomberg US industrial 10-year Baa1-rated bond total return index. Hence, the selected traditional indices cover stock markets for small, medium and large firms, stock markets for firms using innovative technologies, real estate stock markets, emerging stock markets, and parts of the

[1] A multi-strategy fund pursues more than one of the mentioned strategies. We note that funds-of-hedge-funds (i.e. hedge funds that invest in other hedge funds) are excluded.

US corporate and sovereign bond markets. Table A1 of the annex shows the Bloomberg ticker codes of the used series.

The Credit Suisse/Tremont index universe contains about 900 hedge funds, which voluntarily report their performance to the Credit Suisse/Tremont database. To be included in the index universe, funds need to have a minimum of US $50 million in (net) assets under management (AUM), a minimum one-year track record, and current audited financial statements. The broad index includes funds worldwide, is asset-weighted, re-selects hedge funds on a quarterly basis, and is computed and re-balanced monthly.

The hedge fund indices show returns net of management fees, incentive fees, and other fund expenses. On average, hedge funds charge about 1% of AUM in annual management fees and skim about 20% of the annual profit once profits surpass some hurdle rate (Ackermann et al. 1999).

2.2 Potential biases in hedge fund indices

Some studies have warned against a number of potential selection biases in hedge fund indices because reporting by hedge funds is done on a voluntary basis (see, among others, Fung and Hsieh, 2000). As a consequence, the indices may lead to a distorted view of the true performance of the hedge fund industry due to, for instance, backfill bias, survivorship bias, and look-ahead bias.

Backfill bias may arise when an incomplete set of returns (e.g. the best months of performance) of a hedge fund made before the first of month of reporting (to the hedge fund database) are included in the database. Early years of hedge fund databases are thought to contain most of the backfilled data. We exclude the first 20 observations, i.e. the first one-and-a-half year of data, available in the Credit Suisse/Tremont index universe, which covers hedge fund returns from January 1994. Therefore, backfill bias is likely to be limited for our dataset.

Excluding failed companies from the performance analysis may lead to survivorship bias. Survivorship bias may also occur when a fund stops reporting to the database while the fund does not cease its operations. Funds that are in the process of liquidation are kept in the Credit Suisse/Tremont index universe as long as financial statements are available in order to reduce survivorship bias. Moreover, past index values are not revised once funds in the index universe are liquidated. Therefore, the Credit Suisse/Tremont index method avoids survivorship bias as much as possible.

Look-ahead bias may occur when information is used that would not be available when predictions are made. According to Baquero, Horst and Verbeek (2004), look-ahead bias arises because the index universe is conditioned on survival of funds over a number of consecutive months. In this case, the look-ahead bias is a particular form of survivorship bias. Baquero, Horst and Verbeek (2004) find that look-ahead bias in annual performance can be as large as 3.8 percentage points for some funds in the Trading Advisors Selection System (TASS) database, which is the main source for the Credit Suisse/Tremont database. However, the average bias in one-quarter returns is only 0.15 percentage point. Since our dataset contains monthly returns of hedge fund indices, look-ahead bias is expected to be minimal.

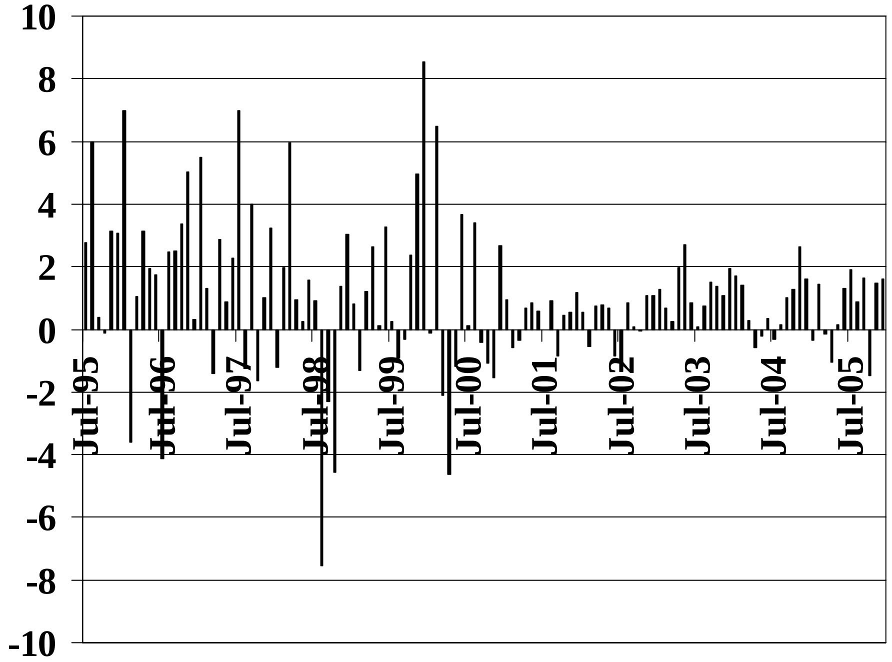
Ackermann et al. (1999) find that positive selection biases, such as the survivorship bias, may be offset by a negative selection bias. Well-established funds, which often outperform the less well-known (often younger) funds, may not need to report to hedge fund databases to attract investors. Indeed, some of the largest hedge funds do not report to any public database.

Our dataset covers at best about 15% of all hedge funds worldwide. Evidently, only to the extent that this is a representative sample of funds, the results of our analysis will hold at the aggregate hedge fund industry level.

2.3 Outliers

A second problem that complicates hedge fund performance analysis is the relatively frequent occurrence of extreme returns. Figure 1 below shows that the monthly return on the broad hedge index was as high (low) as about 8% (-8%) in some months, whereas the average monthly return over the period 1995-2005 was 1% with a standard deviation of 2.3%. These outliers may distort *alpha* and need to be accommodated to ensure that the results are not dominated by a few observations.

Figure 1 Monthly return (in %) on the broad Credit Suisse/Tremont hedge index



To reduce the influence of outliers, we apply the following weight function:

$$w(r_t) = \min\left(1, \frac{\sqrt{\chi^2_{0.975}(1)}}{RD_t}\right) \qquad t = 1,..,T \qquad (1)$$

where RD_t is the robust distance of return r_t of period t to the centre (location) of the return vector. Notice that only observations with a robust distance exceeding the 97.5th percentile of the $\chi^2(1)$ distribution are identified as outliers and receive weights less than unity.

Application of the weight function in (1) is adequate when the majority of the returns represent the normal distribution. The robust distances RD_t are computed by inserting the Minimum Volume Ellipsoid estimates of location (M) and scatter (C) in the Mahalanobis distance formula:

$$RD_t = \frac{r_t - M}{\sqrt{C}} \qquad t = 1,..,T \, . \qquad (2)$$

MVE estimates are obtained with the re-sampling algorithm of Rousseeuw and Leroy (1987) and by applying the correction factor presented in Hinloopen and Wagenvoort (1997).

In comparison to the selected traditional market indices, most of the Credit Suisse/Tremont hedge fund indices contain more and bigger outliers. Table A2 of the annex shows that, in the case of traditional market indices, the number of observations receiving a weight less than unity varies from 0 (US Treasury bill) to 5 (PSE-ArcaEx Tech 100, Real estate, S&P/IFC emerging market and US industrial Baa1 bond) whereas in the case of the hedge fund indices it varies from 1 (Global macro) to 18 (Fixed income arbitrage). Thus, for example, weighing was not required in the case of the US Treasury bill index because no outliers were found. The minimum of the weights (computed for each series separately) varies, in the case of traditional market indices, from 0.44 (S&P/IFC emerging market) to 1 (US Treasury bill) whereas in the case of hedge fund indices it varies from 0.16 (Fixed income arbitrage) to 0.80 (Managed futures). Hence, extreme events affect hedge fund indices more often than traditional market indices, and have a larger impact on the former than the latter.

Figure 1 above reveals, in addition to the presence of outliers, a structural break in monthly returns towards the end of the year 2000. During the period 1995-2000, hedge fund returns were relatively volatile in comparison to the period 2001-2005. One may expect *alpha* to differ between these two periods since hedge funds may have changed investment strategies and their use of leverage. Therefore, besides the full sample analysis, we also present estimates of *alpha* for the sub-periods July 1995-September 2000 and October 2000-December 2005, where each sub-sample contains 63 observations.

2.4 Normality of returns

To test for normality of the original and weighted return series, we apply the Doornik and Hansen (1994) normality test, which is more reliable in small samples than the common Bera-Jarque asymptotic test.

Table A3 of the annex shows that, at the 99% confidence level, normality is rejected for six out of nine traditional market indices and nine out of eleven hedge fund indices when outliers are not accommodated. In contrast, after the influence of outliers is reduced, normality is only rejected for one traditional market index (US Treasury bill) and three hedge fund indices (Convertible arbitrage, Fixed income arbitrage, and Global macro). The large majority of the traditional and hedge fund weighted indices follow the normal distribution. Except for three particular hedge fund strategies, the necessary conditions for mean-variance optimisation are thus fulfilled.

2.5 Robust Sharpe ratios

Furthermore, Sharpe ratios can be used to compare risk-adjusted performance on a stand-alone basis across those indices that are normal. Table 1 shows Sharpe ratios of weighted return indices, where excess performance is measured against the US Treasury bill index.

Over the period July 1995 – December 2005, on a stand-alone basis, most hedge fund indices outperformed most of the traditional market indices. Ignoring the non-normal hedge fund indices (i.e. Convertible arbitrage, Fixed income arbitrage, and Global macro), Table 1 reveals that five hedge indices (i.e., Broad hedge, Equity market neutral, Event driven, Long/short equity and Multi-strategy) have higher Sharpe ratios than all traditional market indices (ignoring the US Treasury bill index). One hedge index (Emerging markets) beats six of the traditional indices whereas, in contrast, two hedge indices (Dedicated short bias and Managed futures) under-perform the traditional market indices.

Most professional investors, however, hold well-diversified portfolios of both stocks and bonds. For these investors, the intriguing question is not so much whether hedge fund indices have higher Sharpe ratios but whether hedge funds may add value to well-diversified portfolios of stocks and bonds? In other words, does the hedge fund industry deliver *alpha*?

Table 1: Robust risk-adjusted performance estimates of stand-alone traditional market and hedge fund indices over the period July 1995-December 2005

Series	Mean (in %)[2]	St. deviation[3]	Sharpe ratio[4]
Traditional Market Indices			
S&P 500	9.8	51.1	0.12
S&P 400 midcap	15.2	56.2	0.20
S&P 600 smallcap	14.4	60.3	0.18
Technology PSE-ArcaEx Tech 100 (NYSE)	18.4	99.4	0.15
Bloomberg real estate investment trust	9.0	43.0	0.12
S&P/IFC emerging market	9.5	67.0	0.09
US Treasury bill, 3-months, total return	3.8*	1.9*	
US Treasury bond, 10-year, total return	7.1	24.8	0.13
US industrial bond Baa1, 10-year, total return	8.5	20.7	0.23
Credit Suisse/Tremont Hedge Fund Indices			
Broad hedge	12.3	25.5	0.33
Convertible arbitrage	10.7*	12.2*	0.57*
Dedicated short bias	-2.6	57.8	-0.11
Emerging markets	12.1	42.5	0.20
Equity market neutral	10.0	8.8	0.71
Event driven	13.0	14.2	0.65
Fixed income arbitrage	7.9*	8.3*	0.49*
Global macro	15.7*	37.8*	0.32*
Long/short equity	12.6	29.5	0.30
Managed futures	7.1	40.9	0.08
Multi-strategy	10.1	11.2	0.57

[1] Non-normal (at the 1% significance level) weighted returns are indicated with an asterisk.
[2] Annualised mean of weighted monthly returns (in %)
[3] Annualised standard deviation of weighted monthly returns (in %)
[4] Sharpe ratio of weighted monthly returns

3. Defining *alpha*

Let R_t be a n-dimensional column-vector that contains the returns of n traditional assets in period t $(t = 1,..,T)$, s be a n-dimensional row-vector of portfolio shares for n traditional assets $(i = 1,..,n)$, S be a n-dimensional row-vector of *optimal* portfolio shares, and Σ be the variance-covariance matrix of return vector R_t. Similarly, let R_t^* be a $n+1$-dimensional column-vector that contains the returns of the n traditional assets $(i = 1,..,n)$ and the new asset ($i = n+1$, which in our case is a hedge fund index), s^* be a $n+1$-dimensional row-vector of portfolio shares, S^* be a $n+1$-dimensional row-vector of *optimal* portfolio shares, and Σ^* be the variance-covariance matrix of return vector R_t^*.

It is common practice to measure the excess performance of a financial asset with returns r_t $(t = 1,..,T)$ by the constant, commonly referred to as *alpha*, of a factor-pricing model. For example, a commonly used one-factor model is:

$$(r_t - rf_t) = \alpha + \beta(rm_t - rf_t) + \varepsilon_t \tag{3}$$

where rf_t is the return on a risk-free asset, rm_t is the return on the market portfolio, and ε_t is the error term.

The traditional *alpha* is not a risk-free measure. To see this, suppose that hedge fund returns have zero risk-factor sensitivities (i.e. $\beta = 0$). In this case, *alpha* would be computed as the difference in average returns between the hedge fund index and the risk-free asset without any correction for the risk of hedge fund index returns. The constant of factor pricing models measures factor-risk-adjusted performance, which ignores unexplained return volatility.

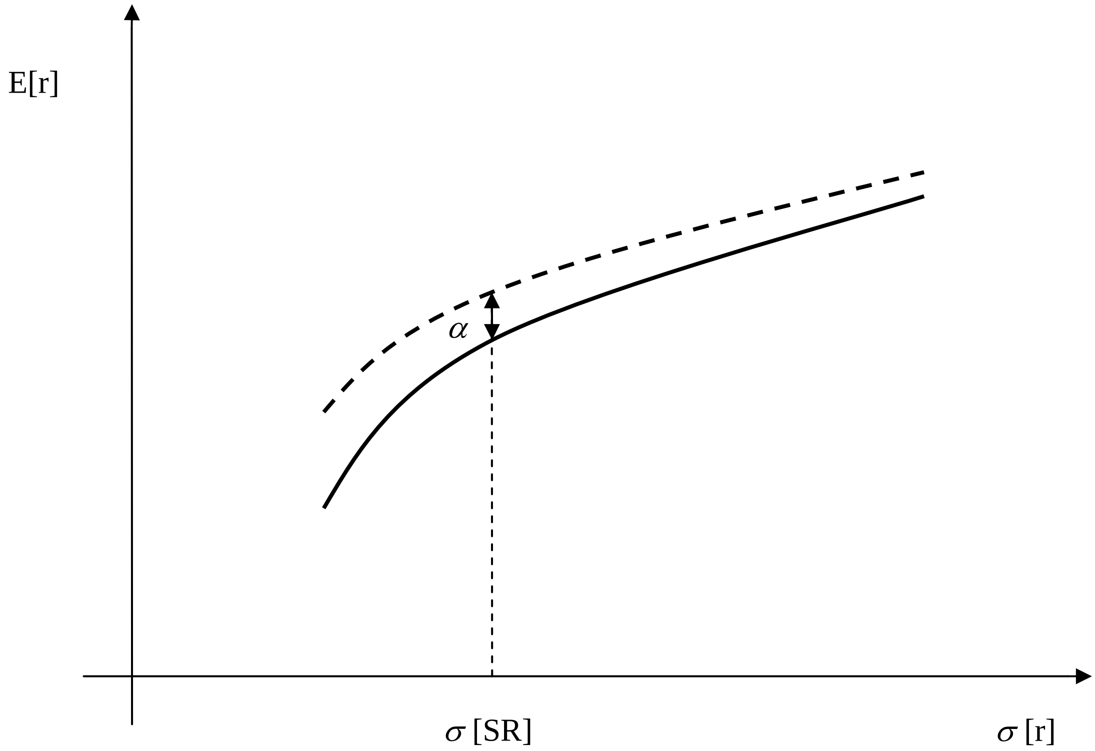
We propose to measure excess performance by the difference between, on the one hand, the average return on a mean-variance efficient portfolio containing exclusively traditional market assets (such as stocks and bonds), and, on the other hand, the average return on a mean-variance efficient portfolio containing traditional market assets and the new asset (such as a hedge fund index), where both portfolios carry the same risk. We include the least risky asset, which in our case is the US Treasury bill index, when optimising the portfolios.

Figure 2 below illustrates our definition of *alpha*. *Alpha* is equal to the vertical distance between the solid hyperbola of frontier portfolios of traditional assets and the dashed hyperbola of frontier portfolios that include the new asset. We note that *alpha* is not necessarily the same for each risk level.

More specifically, let σ be a pre-specified risk level. Then, conditioned on σ, *alpha* is defined as follows:

$$\alpha(\sigma) = \frac{1}{T}\sum_{t=1}^{T} S^* R_t^* - \frac{1}{T}\sum_{t=1}^{T} SR_t \tag{4}$$

Figure 2 *Alpha* measured by the difference in the frontier portfolios



S is the solution to the following optimisation problem

$$\max \sum_{t=1}^{T} sR_t$$

$$\text{s.t. } s\Sigma s' = \sigma^2, \ \sum_{i=1}^{n} s_i = 1, \ s_i \geq 0 \ (i = 1,..,n)$$

where $s^{'}$ indicates the transpose of s,
and S^* is the solution to the following optimisation problem

$$\max \sum_{t=1}^{T} s^* R_t^*$$

$$\text{s.t. } s^* \Sigma^* s^{*}{}' = \sigma^2, \ \sum_{i=1}^{n+1} s_i^* = 1, \ s_i^* \geq 0 \ (i = 1,..,n+1)$$

Alpha in (4) is a total-risk-adjusted excess performance measure.

Notice that we impose the restriction of positive portfolio weights, which would be justified for investors who cannot go short in the selected asset classes. Furthermore, we assume that investors pursue static long-term investment strategies. This implies that portfolio weights can be kept constant across different periods. For many pension fund investors and individuals for instance these two assumptions are appropriate.

In principle, *alpha* can be significantly different from zero for the following reasons. Firstly, hedge funds may operate in markets that are not covered by the n traditional asset classes and, as a consequence, may deliver diversification benefits. Secondly, hedge funds may exploit inefficiencies in asset prices by trading successfully on price corrections of these assets. Thirdly, in comparison to traditional investment companies, hedge funds may work at lower operating cost, and may be less restricted in investment choices (e.g. short selling), because they are less regulated.

The next section shows robust estimates of *alpha* based on (4) for the outlier-weighted hedge fund indices.

4. Measuring *alpha*

Before looking at *alpha*, we briefly discuss the optimal portfolio weights. We begin our analysis by considering an investor who sets portfolio risk at the level of the corresponding stand-alone hedge index. Then, other strategies are considered that are more or less risky.

Table A4 of the annex shows mean-variance efficient portfolios of traditional market indices where each portfolio carries the same risk as the corresponding stand-alone hedge index. For example, the performance of the broad hedge index is measured with respect to a portfolio of traditional assets where 41.7% is invested in the S&P 400 midcap index, 0.7% is invested in the PSE-ArcaEx Tech 100 index and 57.6% in the US industrial Baa1 bond index. The variance of the monthly returns of this portfolio and the variance of the broad hedge index returns are both equal to 4.5. The presented optimal portfolios all contain between two and four asset classes. Thus, it is not necessary to include all nine traditional fund indices in a well-diversified portfolio. Portfolios with a relatively low risk level, such as the portfolio at the risk level of the fixed income arbitrage strategy, put a relatively high weight on the Treasury bill index whereas portfolios with a relatively high risk level, such as the portfolio at the risk level of the dedicated short bias strategy, put a higher weight on the PSE-ArcaEx Tech index. The S&P 400 midcap index and the US industrial Baa1 bond index have important shares in most portfolios, which is not a surprise given their relatively high Sharpe ratios among the traditional fund indices (see Table 1).

Mean-variance efficient portfolios that possibly include the traditional market indices and the hedge index under scrutiny are shown in Table A5 of the Annex. Except for the dedicated short bias strategy and the managed futures strategy, the hedge indices have an important share in the optimal portfolios. In one case, i.e. the event driven strategy, the optimal portfolio only consists of the hedge index. But, how much value do hedge funds add to the portfolios shown in Table A4?

Table 2 reveals that the hedge fund industry in the aggregate (measured by the broad hedge fund index) did not deliver significant *alpha* between 1995 and 2005. Over the full sample period, annualised *alpha* was 1.1% for the broad hedge index (first row, first column) but not significantly different from zero at the 95%-confidence level. For the broad hedge index, *alpha* was neither significant for the sub-periods July 1995 – September 2000 (4.0%, second column) and October 2000 – December 2005 (-1.8%, third column). Thus, although the optimal portfolio with the hedge index (in the first row of Table A5) consists for about three-quarters of hedge funds, the portfolio does not significantly outperform the corresponding traditional portfolio (in the first row of Table A4).

Table 2: Robust *Alpha* measured at the risk level of the corresponding hedge index[1,2]

Hedge fund strategy	Jul 1995 - Dec 2005	Jul 1995 - Sept 2000	Oct 2000 - Dec 2005
Broad hedge index	1.1	4.0	-1.8
	(0.71)	(1.47)	(-1.16)
Convertible arbitrage	**3.3**	**6.7**	-0.1
	(2.87)	**(4.29)**	(-0.08)
Dedicated short bias[3]			
Emerging markets	0.1	-0.5	0.7
	(0.13)	(-0.40)	(1.27)
Equity market neutral	**3.4**	**5.3**	1.5
	(4.40)	**(4.39)**	(1.65)
Event driven	**4.6**	**7.0**	2.3
	(3.29)	**(3.33)**	(1.23)
Fixed income arbitrage	**2.0**	**2.6**	1.5
	(3.30)	**(2.84)**	(1.77)
Global macro	3.1	2.8	3.4
	(1.01)	(0.53)	(1.08)
Long/short equity	0.7	4.3	-2.9
	(0.48)	(1.79)	(-1.72)
Managed futures[3]			
Multi-strategy	**2.97**	**4.78**	1.15
	(3.09)	**(3.30)**	(0.94)

[1] This table shows the difference between the average return of a mean-variance efficient portfolio of traditional market indices (excluding hedge fund indices) and a mean-variance efficient portfolio that may include the corresponding hedge fund index. *Alpha* is annualised.
[2] T-statistics are within parentheses, *alpha*'s that are significantly different from zero at the 95%-confidence level are shown in bold.
[3] Mean-variance efficient portfolios do not include the dedicated short bias index and the managed futures index. Inclusion of these indices would lead to a negative alpha.

Table 3: Robust *Alpha* by risk level for the broad Credit Suisse/Tremont hedge index[1,2]

Variance of monthly portfolio returns	Jul 1995 - Dec 2005	Jul 1995 - Sept 2000	Oct 2000 - Dec 2005
	0.7	1.8	-0.4
1	(1.20)	(1.70)	(-0.72)
	1.0	3.6	-1.5
3	(0.87)	(1.72)	(-1.31)
	1.2	4.2	-1.9
5	(0.69)	(1.44)	(-1.14)
	1.1	3.9	-1.7
7	(0.79)	(1.62)	(-1.34)
	1.0	3.7	-1.8
9	(0.75)	(1.64)	(-1.59)
	0.8	3.5	-1.8
11	(0.68)	(1.59)	(-1.72)

[1] This table shows the difference between the average return of a mean-variance efficient portfolio of traditional market indices (excluding hedge fund indices) and a mean-variance efficient portfolio that may include the broad hedge fund index. *Alpha* is annualised. [2] T-statistics are within parentheses.

Turning to the sub-groups of hedge fund strategies in Table 2, but ignoring the convertible arbitrage, fixed income arbitrage and global macro strategies due to their non-normality, we find that some hedge fund styles (i.e. equity market neutral, event driven and multi-strategy) delivered a significantly positive *alpha*. However, none of the over-performers of the first period provided significant *alpha* in the second period (between October 2000 and December 2005). In contrast, the under-performers of the first period improved their results in the second period as their contribution was not any longer significantly negative. That said, none of the investment strategies provided significant *alpha* in the second period. These results are in accordance with Fung et al. (2006) who find that, between January 1995 and December 2004, the average fund-of-hedge funds only delivered *alpha* in the period from October 1998 to March 2000.

So far we have computed *alpha* conditional on the risk of the corresponding hedge index. In principle, significant *alphas* could possibly occur at other risk levels. Table 3 shows estimates of *alpha* for the broad hedge index at various risk levels in order to check the robustness of our findings.[2] We let the risk (= variance) of the optimal portfolio vary from 1 to 11. Notice that the variance of the monthly broad hedge index (weighted) returns is 4.5. Therefore, we consider both less risky and more risky portfolios than the broad hedge index on a stand-alone basis. *Alpha* is found significant in none of the investigated cases presented in Table 3. *Alpha* is actually lower at the extremes of the risk interval than at mid-levels. We conclude that the hedge fund industry in the aggregate did not deliver *alpha* at a wide range of risk levels.

Finally, we also computed non-robust *alphas* (not shown) by comparing the non-weighted returns of the optimal portfolios. Now, except for the portfolio optimisation stage, outliers are not accommodated. Non-robust *alphas* lead to the same broad conclusions as presented for robust *alphas*.

5. Conclusion

Hedge funds advocate that their alternative investment strategies lead to excess returns, which are little correlated to the traditional markets. If hedge fund returns indeed have low factor sensitivities in classical asset pricing models, while carrying substantially more risk than the risk-free asset, then the conventional *alpha* can be a misleading measure of excess performance because it ignores the unexplained return volatility.

Based on the total-risk-adjusted performance measure developed in this paper, the hedge fund industry in the aggregate did not deliver on their claim to bring additional benefits to investors who hold well-diversified portfolios across traditional asset classes. Some of the hedge fund strategies delivered significant *alpha* between July 1995 and September 2000 but none of them kept up with their excess performance in the five years that followed. The broad Credit Suisse/Tremont hedge fund index did not deliver significant *alpha* between 1995 and 2005.

[2] Table A6 and Table A7 of the Annex show the corresponding optimal portfolio weights.

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Annex

Table A1: Bloomberg ticker codes

Series	Bloomberg Ticker
Traditional Market Indices	
S&P 500	SPX
S&P 400 midcap	MID
S&P 600 smallcap	SML
Technology PSE-ArcaEx Tech 100 (NYSE)	PSE
Bloomberg real estate investment trust	BBREIT
S&P/IFC emerging market	IDRGCOPD
US Treasury bill, 3-months, total return	F0823MR
US Treasury bond, 10-year, total return	F08210YR
US industrial bond Baa1, 10-year, total return	F00810YR
Hedge Fund Indices	
Broad hedge	HEDGNAV
Convertible arbitrage	HEDGCONV
Dedicated short bias	HEDGDEDS
Emerging markets	HEDGEMGM
Equity market neutral	HEDGNEUT
Event driven	HEDGDRIV
Fixed income arbitrage	HEDGFIAR
Global macro	HEDGGLMA
Long/short equity	HEDGLSEQ
Managed futures	HEDGFUTR
Multi-strategy	HEDGMSTR

Table A2: Number of extreme observations[1]

Series	Number of observations receiving a weight < 1	Minimum weight[2]
	Traditional Market Indices	
S&P 500	3	0.63
S&P 400 midcap	3	0.54
S&P 600 smallcap	3	0.59
Technology PSE-ArcaEx Tech 100 (NYSE)	5	0.7
Bloomberg real estate investment trust	5	0.51
S&P/IFC emerging market	5	0.44
US Treasury bill, 3-months, total return	0	1
US Treasury bond, 10-year, total return	3	0.62
US industrial bond Baa1, 10-year, total return	5	0.52
	Hedge Fund Indices	
Broad hedge	6	0.56
Convertible arbitrage	14	0.33
Dedicated short bias	3	0.49
Emerging markets	9	0.3
Equity market neutral	6	0.65
Event driven	6	0.2
Fixed income arbitrage	18	0.16
Global macro	1	0.68
Long/short equity	8	0.42
Managed futures	4	0.8
Multi-strategy	4	0.37

[1] In a series of 126 monthly observations between July 1995 and December 2005.
[2] Outlying observations are weighted based on their distance to the Minimum Volume Ellipsoide (MVE) estimate of location.

Table A3: Doornik & Hansen (1994) normality test results[1]

Series	Original series	Weighted series[2]
Traditional Market Indices		
S&P 500	6.35	3.52
S&P 400 midcap	8.77	0.76
S&P 600 smallcap	9.22	1.59
Technology PSE-ArcaEx Tech 100 (NYSE)	0.69	0.50
Bloomberg real estate investment trust	10.41	0.08
S&P/IFC emerging market	13.21	1.53
US Treasury bill, 3-months, total return	20.46	20.46
US Treasury bond, 10-year, total return	3.27	0.63
US industrial bond Baa1, 10-year, total return	8.77	3.08
Hedge Fund Indices		
Broad hedge	25.01	7.43
Convertible arbitrage	42.79	9.05
Dedicated short bias	13.84	5.78
Emerging markets	45.83	1.92
Equity market neutral	4.21	0.43
Event driven	156.36	4.21
Fixed income arbitrage	208.47	24.14
Global macro	34.09	18.72
Long/short equity	45.93	0.17
Managed futures	0.96	0.01
Multi-strategy	30.38	1.15

[1] The normality test statistic is approximately chi-squared distributed with two degrees of freedom,
$X^2_{0.95}(2) = 5.99, \; X^2_{0.99}(2) = 7.82$.

[2] Outlying observations are weighted based on their distance to the Minimum Volume Ellipsoide (MVE) estimate of location.

Table A4: Mean-variance efficient portfolios of traditional market indices (excluding hedge fund indices), over the period July 1995 – December 2005, measured at the risk level of the corresponding hedge index

Hedge fund strategy	Portfolio weight (in %)								
	S&P 500	S&P 400 midcap	S&P 600 smallcap	PSE-ArcaEx Tech 100	Real estate trust	S&P/IFC emerging market	US Treasury bill, 3 month	US Treasury bond, 10-year	US industrial bond, Baa1, 10-year
Broad hedge	0	41.7	0	0.7	0	0	0	0	57.6
Convertible arbitrage	0	14	0	0	3	0	37	0	46
Dedicated short bias	0	93	0	7	0	0	0	0	0
Emerging markets	0	70	0	4	0	0	0	0	26
Equity market neutral	0	10	0	0	2	0	55	0	33
Event driven	0	16.9	0	0	3.5	0	26.4	0	53.2
Fixed income arbitrage	0	10	0	0	2	0	57	0	31
Global macro	0	63	0	3	0	0	0	0	34
Long/short equity	0	49	0	2	0	0	0	0	49
Managed futures	0	67.6	0	3.9	0	0	0	0	28.5
Multi-strategy	0	13	0	0	3	0	42	0	42

Table A5: Mean-variance efficient portfolios that possibly include the traditional market indices and the hedge fund index, over the period July 1995 – December 2005, measured at the risk level of the corresponding hedge index

Hedge fund strategy	Portfolio weight (in %)									
	S&P 500	S&P 400 midcap	S&P 600 smallcap	PSE-ArcaEx Tech 100	Real estate trust	S&P/IFC emerging market	US Treasury bill, 3-months	US Treasury bond, 10-year	US Industrial bond, Baa1, 10-year	Corre-sponding hedge index
Broad hedge	0	15.6	0	0	0	0	0	0	6.8	77.6
Convertible arbitrage	0	10	0	0	0	0	0	0	6	84
Dedicated short bias	0	93	0	7	0	0	0	0	0	0
Emerging markets	0	61.8	0	2.7	0	0	0	0	13.6	21.9
Equity market neutral	0	2	1	0	0	0	0	0	6	91
Event driven	0	0	0	0	0	0	0	0	0	100
Fixed income arbitrage	0	7	0	0	0	0	0	0	18	75
Global macro	0	1	0	16	0	0	0	0	0	83
Long/short equity	0	17	0	0	0	0	0	0	8	75
Managed futures	0	67.6	0	3.9	0	0	0	0	28.5	0
Multi-strategy	0	8.4	0	0	0	0	0	0	10.3	81.3

Table A6: Mean-variance efficient portfolios of traditional market indices (excluding hedge fund indices), over the period July 1995 – December 2005, by risk level

Variance of monthly portfolio return	Portfolio weight (in %)								
	S&P 500	S&P 400 midcap	S&P 600 smallcap	PSE-ArcaEx Tech 100	Real estate trust	S&P/IFC emerging market	US Treasury bill, 3 month	US Treasury bond, 10-year	US industrial bond, Baa1, 10-year
1	0	14	0	0	3	0	38	0	45
3	0	29.6	0	0	0.7	0	0	0	69.7
5	0	44	0	1	0	0	0	0	55
7	0	53	0	2	0	0	0	0	45
9	0	60	0	3	0	0	0	0	37
11	0	66	0	4	0	0	0	0	30

Table A7: Mean-variance efficient portfolios of traditional market indices and the broad hedge fund index, over the period July 1995 – December 2005, by risk level

Variance of monthly portfolio return	Portfolio weight (in %)									
	S&P 500	S&P 400 midcap	S&P 600 smallcap	PSE-ArcaEx Tech 100	Real estate trust	S&P/IFC emerging market	US Treasury bill, 3-months	US Treasury bond, 10-year	US Industrial bond, Baa1, 10-year	Corre-sponding hedge index
1	0	4.8	0	0	3.1	0	33.6	0	28.9	29.6
3	0	11.7	0	0	0	0	0	0	29	59.3
5	0	17	0	0	0	0	0	0	1	82
7	0	29	0	4	0	0	0	0	0	67
9	0	32.5	0	8.9	0	0	0	0	0	58.6
11	0	35	0	13	0	0	0	0	0	52