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Improved Beta? A Comparison of Index-Weighting Schemes

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Abstract

Abstract

This paper analyses a set of equity indices whose aim is to improve on capitalisation weighting and thus to provide "improved beta". Four main weighting schemes are analysed: efficient indices, fundamental indices, minimum-volatility indices, and equal-weighted indices. Empirical results for US data on these indices show that the average returns of all four alternative index construction methods are superior to those of cap-weighted equity indices and that, by several measures of risk-adjusted performance, they are likewise superior. With the notable exception of fundamental indices, which have substantial exposure to the value factor, none of the aforementioned weighting schemes has a significant style bias. Our analysis suggests that their superiority to capitalisation weighting can be explained by better diversification rather than by greater exposure to rewarded risk factors.

Introduction

Introduction

In recent years, many alternatives to cap-weighted equity indices have been launched. These indices are constructed using other weighting schemes, which are supposed to improve on capitalisation weighting and thus provide investors with "improved beta". The objective of this paper is to analyse the performance of a set of such indices. The results suggest that the improved beta approaches do provide benefits compared to the standard cap-weighted indices. Moreover, the weighting schemes achieve very different objectives, making good on their promise to alleviate specific problems inherent to capitalisation weighting.

Cap-weighted equity indices have come to dominate the market for equity index products. Standard & Poor's introduced its first cap-weighted stock index in 1923. Such indices were meant to provide information on the market's mood and direction and often serve as a bellwether for the economy. The leading economic indicator computed by the Conference Board, for example, has such a stock market index as one of its components. Stock market indices have also become a popular underlying for derivatives contracts. In 1982, the Chicago Mercantile Exchange introduced futures contracts on the S&P 500 index and, one year later, the Chicago Board of Options Exchange listed options on the same index. The predominance of cap-weighting in equity index construction is closely linked to these uses. Arguably, reflecting the performance of stocks in proportion to their market capitalisation allows a good representation of market movements. And, for the kind of short-term trading needed to replicate derivatives contracts, the liquidity inherent to cap-weighting is an advantage.

However, investors do not use equity indices only to obtain information and for short-term trading. Today, cap-weighted indices have become an integral part of the investment process of long-term investors such as pension funds, endowments, and insurance companies. The choice of an index will have a critical impact on both asset allocation and performance measurement. In particular, by creating a set of rules for selection of the asset universe, the weighting scheme of the selected assets, and periodic rebalancing, a particular index construction method will direct the risk exposures and performance of related passive investment vehicles and of active mandates managed with reference to the index.

To be useful in the investment process, an index must be more than a reliable indicator of short-term market movements. Bailey, Richard, and Tierney (1990) and Bailey (1992) point out that a chosen benchmark needs to be unambiguous, investable, measurable, appropriate, reflective of the investor's current investment views, and specified in advance. These criteria may of course be fulfilled by construction methods other than cap-weighting, leaving room for different weighting schemes.

Such alternatives have been developed in response to critiques of capitalisation weighting. About twenty years ago, papers by Ferson, Kandel, and Stambaugh (1987), Haugen and Baker (1991), and Grinold (1992) presented convincing empirical evidence that cap-weighted indices provide an inefficient risk/return trade-off. In addition, Ranaldo and Häberle (2007) point out that many capitalisation-weighted indices may be perceived as active investment strategies. In pursuit of

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a more representative weighting scheme, recently launched indices have proposed to weight stocks by firm characteristics such as earnings or book value (Arnott, Hsu, and Moore 2005; Siegel, Schwartz, and Siracusano 2007). Other indices weight stocks to achieve the highest risk/reward efficiency (Amenc *et al.* 2010) or the lowest possible portfolio volatility (Nielsen and Aylursubramanian 2008). Rather than exploiting public information based on accounting data or risk/return computations, equal-weighted indices simply attribute an identical weight to all constituents (Dash and Loggie 2008).

As a consequence of these developments, investors now have a wide range of weighting schemes at their disposal. A natural question is to ask how these schemes compare. In particular, these indices have very different objectives, ranging from minimising risk to improving the representation of the economy through a stock market index. They also use very different types of information to attribute weights, including risk/return data, accounting data, or even ignoring any information, as in the case of equal weighting. A detailed comparison will help investors decide which of these alternatives are most useful to them. This paper does such a comparison for US equity indices that use the different weighting schemes. We focus on the four following weighting schemes that have been used by the main index providers to propose alternatives to market-cap-weighted indices: efficient indices (FTSE), fundamental indices (FTSE), minimum-volatility indices (MSCI), and equal-weighted indices (S&P). Our performance analysis roughly covers the past decade, for which data for a variety of indices is available. The paper proceeds as follows. Section one lists the indices that will be analysed and describes their construction principles. Section two reports risk and return statistics for these indices and compares them to cap-weighted indices. The third section assesses the factor exposures of the indices. The final section provides the main conclusions.

Introduction

1. Available Weighting Schemes

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Investors may choose to use indices for information acquisition, for performance measurement, or as an investment vehicle. One of the key attractions of equity indexing is the transparency such indices provide. Indices are also sought for their purported ability to represent the equity market. Finally, but perhaps most importantly, equity indices are supposed to provide investors an attractive risk/reward ratio so that they can give useful guidance on investment choices.

There are a variety of systematic weighting approaches—other than weighting the stocks by their market capitalisation—that may fulfil the criteria of representativity and efficiency. It turns out, however, that the approaches usually have a focus that is on one of the two aspects. In addition, they exploit very different sources of information to reach their objectives. Cap-weighted indices and fundamental indices are mainly concerned with representativity by weighting stocks by firm characteristics, either market capitalisation or accounting characteristics. Minimum-volatility indices and efficient indices, on the other hand, exploit information in the returns data of constituent stocks, concerning either volatility and correlation (for minimum-volatility indices) or volatility, correlation, and expected returns (for efficient indexation). Equal-weighted indices are the extreme in the sense that they do not exploit any stock-specific information. Their weights can be computed simply from the number of constituent stocks in the index without any further knowledge of any characteristics of these stocks. We now turn to a detailed description of these weighting schemes and of the data sources we use to represent them.

1.1 Indices Focusing on Representativity

A focus on representativity naturally leads to indices that allocate greater weights to larger companies than to smaller companies. There are, however, two main approaches to measuring the size of a company. The cap-weighting scheme assumes that market capitalisation is the best measure for the size of a company, whereas the characteristic-based weighting scheme proposes to use more fundamental measures of company size.

Cap-weighted indices use a stock's market capitalisation (*i.e.*, the number of outstanding shares times the share price) as the weighting criterion. Each stock's weight in the index will correspond to its share of the overall market capitalisation of all stocks in the index. Such market-cap weighting is supposed to provide an accurate representation of the stock market, as more valuable firms will make up a larger share of the index. This weighting scheme is often justified by the CAPM and its central conclusion that the cap-weighted portfolio of all *available* assets in the economy will be mean-variance efficient. The major difference of cap-weighted equity indices from this theoretical market portfolio is that the available indices omit most of the assets available in the economy, as dividends on stocks account for only a small share of wealth compared to income and benefits derived from labour, non-listed businesses, social security, and private housing.

The cap-weighted indices we include in our empirical analysis are the S&P 500 and the Russell 1000, which are made up of the largest stocks by market capitalisation. We chose these indices as they are the most

1. Available Weighting Schemes

widely used by investors. Rather than being weighted by market capitalisation, stocks are actually weighted by their free-float; *i.e.*, only the market capitalisation available to non-strategic investors is accounted for. This is the standard practice in cap-weighted construction of equity indices.

Fundamental-weighted indices attempt to be more representative than cap-weighted indices by introducing a different measure of firm size. Rather than being proportional to the stock's market capitalisation, the weights will be proportional to an accounting-based measure of size, such as the company's earnings or its book value. Such indices thus provide a better representation of stocks by their size as far as size can be captured by accounting measures.

The idea behind such indices is not to optimise the risk/reward trade-off but to have measures of firm size more reliable than market capitalisation. Such indices may, however, improve returns compared to cap-weighted indices, since—compared to capitalisation weighting—they will favour stocks with low price earnings ratios or high book-to-market ratios.

In our empirical analysis, we use the FTSE RAFI 1000 index. This index weights and selects the one thousand largest stocks by a set of four characteristics measured over the past five years: dividends paid, book value, earnings, and company sales.

1.2 Indices Focusing on Efficiency

Portfolio theory suggests that when indices are used as investment benchmarks the focus should be not on representativity but on achieving the highest possible risk/reward ratio. As mentioned in the introduction, one of the key shortcomings of the cap-weighted indices is inefficiency resulting from poor diversification. Several indices have attempted to improve this dimension, while exploiting different approaches to building more well diversified portfolios.

Equal-weighted indices simply attribute the same weight to each of their constituents. These indices may provide a fair representation of the stock market, as their return for a given day actually shows the average return of all stocks on this day. More importantly, perhaps, equal weighting may lead to favourable risk/reward properties, since it is a straightforward way to construct well-diversified portfolios. This diversification rule, known as naive diversification, has its origins in a recommendation, known as the one-third rule, more than fifteen hundred years old. This rule, cited in the Talmud, recommends dividing one's wealth into equal shares of land, business, and cash. In the case of stock market indices, it is called the 1/N rule. It recommends giving an equal weight to each of the N index constituents. However, equal weighting is an extreme view since it also means that we agree to give up deriving any form of useful information for weighting constituents, and that information on market capitalisation or other measures used to derive index weights is entirely useless.

An equal-weighted version of the S&P 500, which we use in our empirical analysis, is computed by Standard & Poor's. This index is based on the same 500 constituents as the cap-weighted version of the index but it attributes an equal weight to each constituent. Each quarter, the weight of each constituent is set to 0.2%.

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Minimum-volatility weighting is an initial approach to building scientifically rather than naively diversified portfolios. The focus here is on finding the constituent weights that lead to the lowest possible portfolio volatility. To construct such an index, one need only estimate volatilities and correlations of index constituent stocks. No knowledge of expected returns is necessary.

Such a portfolio would be representative of the tangency portfolio if expected returns were identical for all stocks. It may thus represent the opportunity set of mean-variance investors in the absence of any information on differences in expected returns across stocks. In terms of risk/reward efficiency, the index focuses on lowering risk, without addressing its expected return properties.

The empirical analyses below draw on data for the MSCI Minimum Volatility Index of US stocks. This index is based on all constituents in the MSCI US Index. The Barra portfolio optimiser is then used to find the minimum-volatility weights.

Efficient-weighted indices are based on portfolio optimisation. They aim to improve the Sharpe ratio compared to cap-weighted indices by weighting stocks by their impact on portfolio risk and reward. It can be argued that these indices provide higher welfare for investors in the mean-variance space and could thus be seen as better representing the equity risk premium accessible in the stock market.

Efficient indices focus directly on risk/reward properties. Their greater efficiency thus results from the construction method, as long as robust parameter estimates for expected returns, correlations, and volatilities are used. These indices are different from cap-weighted, equal-weighted, or fundamentally weighted indices in that, to create an optimal portfolio, they weight constituents by quantitative information on expected returns, correlations, and volatilities.

In our empirical analysis, we use the FTSE EDHEC-Risk Efficient Index for the US market. The index weights stocks to maximise the index Sharpe ratio. To obtain parameter estimates for the stocks' return comovements, an equity factor model is used to estimate common return drivers. To estimate the stocks' expected returns, downside risk is measured for each stock. The stock's riskiness is then used as an indicator of its expected returns. Portfolio optimisation is conducted on all mid- and large-cap stocks in the FTSE US index, which is made up of approximately 700 stocks.

2. Comparing Risk and Return

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Over the period for which data is available, we first assess the return and risk properties of all the indices. We compute average returns, various risk measures, and risk-adjusted return ratios. Our concern is mainly with the four non-cap-weighted indices and their comparison with two cap-weighted indices, the S&P 500 and the Russell 1000. The paper looks at the period from 8 January 1999 to 1 January 2010. This period is chosen so as to have data available for all four of the non-cap-weighted indices.

Table 1 reports the results. Table 1 shows that all four alternatives to capitalisation weighting achieve higher returns over this period. While the cap-weighted indices return only about one percent per year over this period, the efficient index, the fundamental index, and the equal-weighted index have annual returns in excess of 5%. With a return of 2.5% per year, the minimum-volatility index yields more than the cap-weighted indices, but considerably less than the other non-cap-weighted methods.

In terms of risk, table 1 reports the standard deviation and downside risk (semi-deviation below zero) for all indices. In addition, the table shows both the tracking error volatility and the beta with respect to the cap-weighted S&P 500. Minimum volatility stands out as it has the lowest volatility of all indices. The volatility of the efficient index is slightly lower than that of the cap-weighted indices, whereas that of fundamental and equal-weighted indices is slightly higher. Minimum volatility has a much lower beta with respect to the S&P 500 than any of the other non-cap-weighted indices. This result suggests that minimising volatility leads to a portfolio that loads up on the more defensive low-beta stocks. Equal weighting and fundamental

Table 1: Performance statistics - This table shows summary statistics for different equity indices. The construction principles of the indices are more fully described in section one. The statistics are based on eleven years of weekly data from 8 January 1999 to 1 January 2010. All statistics are annualised and performance ratios that involve the average returns are based on the geometric average, which reliably reflects multiple holding period returns for investors. A Cornish-Fisher expansion was used to compute a Value-at-Risk estimate that takes into account the mean, volatility, skewness, and excess kurtosis of index returns.

	Non-cap-weighted				Cap-weighted	
	Efficient Index	Minimum Volatility	Fundamental Index	S&P 500 Equal-Weighted	S&P 500	Russell 1000
Average return (geometric)	6.4%	2.5%	5.3%	5.7%	0.9%	1.3%
Standard deviation	19.4%	16.6%	20.5%	21.4%	19.8%	20.0%
Semi-deviation (below zero)	13.9%	12.2%	14.5%	15.2%	14.3%	14.4%
Tracking error (w.r.t. S&P 500)	5.8%	6.6%	6.5%	6.5%	0.0%	1.3%
Beta (w.r.t. S&P 500)	0.94	0.80	0.99	1.03	1.00	1.01
Sharpe ratio	0.18	-0.03	0.11	0.13	-0.10	-0.08
Sortino ratio	0.46	0.20	0.36	0.38	0.06	0.09
Information ratio	0.95	0.24	0.67	0.75	NA	0.32
Treynor ratio	0.04	-0.01	0.02	0.03	-0.02	-0.02
95% Value-at-Risk	4.4%	3.9%	4.4%	4.8%	4.5%	4.6%
99% Value-at-Risk	11.0%	10.3%	11.9%	11.3%	10.5%	10.6%
Skewness	-0.62	-0.83	-0.39	-0.46	-0.50	-0.49
Kurtosis	9.44	10.89	10.20	8.43	8.33	8.35

2. Comparing Risk and Return

weighting lead to a beta almost identical to one, whereas efficient indexation, with a beta of 0.94, falls somewhat in between these two groups.

Interestingly, efficient indexation has the lowest tracking error volatility of the non-cap-weighted indices, suggesting that its outperformance of the S&P 500 over this period is more stable than that of the other three alternatives.

Table 1 also shows risk-adjusted performance measures—the Sharpe, Sortino, information, and Treynor ratios—for all indices. The Sharpe ratio reflects the indices' risk/reward efficiency by adjusting excess returns over the risk-free interest rate by the volatility incurred by the index. The Sharpe ratio of all non-cap-weighted indices is positive and clearly more attractive than that of the cap-weighted indices, which have negative Sharpe ratios over this period. The only non-cap-weighted index with a negative Sharpe ratio is the minimum-volatility index. We can see here that reducing volatility does not necessarily result in attractive risk/reward efficiency, as the index has lower volatility than its non-cap-weighted rivals, but also markedly lower returns. Its risk/reward profile, however, is still more attractive than that of the cap-weighted indices.
The efficient index has the highest Sharpe ratio of all indices, reflecting that, compared to the cap-weighted S&P 500, it increases expected returns and lowers volatility.

The results for the Sortino ratio, which uses downside risk instead of volatility to adjust for risk, and for the Treynor ratio, which uses the market beta to adjust for risk, are similar to the results for the Sharpe ratio.

Table 1 shows the indices' information ratios computed with respect to the S&P 500 cap-weighted index. This statistic reflects the average return difference with the S&P 500 cap-weighted index when it is adjusted for the incurred tracking error. We see that all non-cap-weighted indices have rather high information ratios, meaning that they outperform the cap-weighted S&P 500 fairly consistently.

The minimum-volatility index, which effectively generates the lowest volatility of all indices, also has the highest kurtosis, *i.e.*, the highest indicator of fat tails in the returns distribution (see table 1). This suggests that the focus on decreasing average risk (volatility) comes at the cost of an increase in tail risk, a result that has been put forward in the finance literature (Andersen, Simonetti, and Sornette 2000).

Although the non-cap-weighted indices appear attractive overall in terms of risk and reward statistics, it is interesting to ask whether these differences are actually statistically significant. In fact, it would be possible that one would observe positive differences over a particular time period, even if the "true" performance of the underlying strategies were not better than that of the cap-weighting scheme. A statistical significance test allows us to assess whether we would be likely to observe such differences in the data if there were no true difference with respect to the cap-weighted S&P 500. Table 2 shows the results of significance tests for these three summary

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Table 2: Risk/reward difference compared to S&P 500 - This table, based on eleven years of weekly data, from 8 January 1999 to 1 January 1 2010, shows differences in average returns, in volatility, and in Sharpe ratios between each index and the cap-weighted S&P 500 and the associated p-values. All differences are computed from annualised statistics and the average returns are a geometric average. The p-values for differences are computed using a paired t-test for the average returns, a Fisher test for the volatility, and a Jobson-Korkie test for the Sharpe ratio. Differences that are significantly different from zero at the 5% level are indicated in bold.

	Non-cap-weighted			
	Efficient Index	Minimum Volatility	Fundamental Index	S&P 500 Equal-Weighted
Diff. in average	**5.5%**	1.6%	**4.4%**	**4.9%**
p-value	0.3%	61.6%	2.5%	1.0%
Diff. in volatility	-0.4%	**-3.2%**	0.8%	1.6%
p-value	64.3%	0.0%	36.1%	5.8%
Diff. in Sharpe ratio	**0.28**	0.08	**0.22**	**0.23**
p-value	0.2%	53.6%	2.7%	1.0%

performance measures. All differences are computed with respect to the S&P 500 cap-weighted index and results that are significant at the 5% level are indicated in bold.

The results in table 2 show that three of the non-cap-weighted indices have significantly higher average returns than the cap-weighted S&P 500. Only the minimum-volatility index has significantly lower volatility. In terms of risk/reward efficiency, three of the non-cap-weighted indices have significantly higher Sharpe ratios than the cap-weighted S&P 500.

It is useful to give some intuition on the statistical significance levels shown in table 2. For the Sharpe ratio, the efficient index has the most significant increase over the cap-weighted S&P 500, with a probability value of 0.2%. What this means is that, if there were no true difference in the Sharpe ratio with the cap-weighted S&P 500 index, we would expect to observe a difference as pronounced as the one we observed (*i.e.*, 0.28) about one out of every 500 times we look at a dataset of eleven years. The probability values for the fundamental index and the equal-weighted index are on the order of one to three percent; hence it would also be highly unlikely to obtain such results if there were no true difference. To summarise the results that are statistically significant, we can conclude that—compared to the cap-weighted S&P 500—minimum-volatility indices have lower volatility and the other non-cap-weighted indices have higher average returns and higher Sharpe ratios.

3. Factor Exposures

3. Factor Exposures

The analysis of risk and return measures yields insights into how the indices behave, which is obviously important information for investors. However, it is also interesting to analyse where the return properties come from. The non-cap-weighted indices may take on exposures to common risk factors that are well known in the academic finance literature, such as value, momentum, and small-cap exposures.

Since the indices are broadly diversified across constituent stocks, one may in fact expect that the risk and return properties are largely driven by such factor exposures, leaving only a small fraction of returns that are completely specific to the method of index design. From the investor's perspective, such risk exposures matter. They are often implicit results of portfolio construction, but investors want to know how exposed they are to certain factors.

In this section, we use factor models to analyse exposure to the equity factors commonly used in the academic literature. The standard factor models in the empirical finance literature use a market risk factor, which is made up of all stocks that are traded on the US market and additional factors that are long/short portfolios, rebalanced monthly, of stocks that have been selected from this universe for their style characteristics. In our empirical analysis, we use the standard four-factor model (Carhart 1997), in which we regress the returns in excess of the risk-free rate of the indices on the excess returns of the cap-weighted index of all stocks listed on the NYSE, AMEX, and NASDAQ, on the Fama-French (1992) factors for the value and small-cap premium, and on an additional factor representing a momentum strategy. The value factor is a portfolio that is long high book-to-price stocks (value stocks) and short low book-to-price stocks (growth stocks). The small-cap factor is a portfolio that is long low- market-cap stocks (small stocks) and short high-market-cap stocks (large stocks). The momentum factor goes long in stocks with high recent returns

Table 3: Factor exposures - This table, based on eleven years of weekly data, from 8 January 1999 to 1 January 2010, shows results for factor regressions of the excess returns of various equity indices on the market factor, value factor, small-cap factor, and momentum factor. The table shows R-squares, regression coefficients, and the p-values associated with the null hypothesis that the regression coefficients are zero. Coefficients that are significantly different from zero at the 5% level are indicated in bold.

	Non-cap-weighted				Cap-weighted	
	Efficient Index	Minimum Volatility	Fundamental Index	S&P 500 Equal-Weight	S&P 500	Russell 1000
Adj. R-squared	0.95	0.91	0.96	0.96	0.99	0.99
Ann. Alpha	2.45%	-0.41%	1.70%	2.44%	-0.37%	-0.17%
p-value	5%	75%	12%	6%	53%	71%
Market Beta	**0.90**	**0.80**	**0.94**	**0.97**	**0.97**	**0.98**
p-value	0%	0%	0%	0%	0%	0%
Small-Cap Beta	-0.02	**-0.27**	**-0.12**	0.01	**-0.21**	**-0.15**
p-value	47%	0%	0%	73%	0%	0%
Value Beta	**0.32**	**0.23**	**0.41**	**0.30**	0.00	-0.01
p-value	0%	0%	0%	0%	99%	39%
Momentum Beta	**-0.05**	**0.06**	**-0.08**	**-0.13**	-0.02	**-0.02**
p-value	2%	0%	0%	0%	7%	1%

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(winners) and short in stocks with low recent returns (losers). Table 3 shows the results of these four-factor regressions.

When the commonly used equity risk factors are adjusted for, only the efficient index and the equal-weighted index show marginal *statistical* significance for alpha if one considers the 5% level the threshold. Outperformance of the cap-weighted total market index is nevertheless *economically* significant for three of the non-cap-weighted indices (annual outperformance on the order of 2%).

We now turn to a detailed discussion of estimated factor exposures reported in Table 3.

Market exposure

The results for the beta with the broad cap-weighted market proxy used here are qualitatively similar to what was obtained in table 2 when the indices are regressed on the S&P 500 as a single market factor. The results confirm the low beta nature of the minimum-volatility index, whereas the other indices have beta reasonably close to one.

Value/growth exposure

It should first be noted that any reasonable definition of style neutrality would lead to the conclusion that equal weighting should be free of a value or growth bias. In fact, since no information whatsoever on valuation enters the determination of weights in an equal-weighted index, it is difficult to imagine that such an index would imply any choices in terms of value or growth exposure. That the equal-weighted index shows a value bias with respect to the cap-weighted index in table 3 indicates only the relativity of the reference point, and one could actually argue that the cap-weighted index has a growth bias relative to the equal-weighted reference. If we take the equal-weighted index as a reference for value/growth neutrality, the direct implication is that indices whose factor exposure is not markedly different from that of the equal-weighted index do not include any value biases.

The results in table 3 show that only the fundamental index has a value exposure that is substantially greater than that of the equal-weighted index. Other non-cap-weighted indices such as efficient indexation and minimum volatility have value exposures that are comparable to that of equal weighting. These results are consistent with economic intuition: the fundamental index method derives constituent weights from company characteristics such as earnings. Kaplan (2008) has shown that weighting stocks by their earnings actually corresponds to an adjustment of the market-cap weight for the earnings yield of each stock relative to the earnings yield of the cap-weighted index. Thus, stocks with a high earnings yield will be mechanically overweighted, whereas stocks with a low earnings yield will be underweighted for their capitalisation weight. Similar arguments can be made concerning the additional firm characteristics used in the index method, notably dividends, book value, and sales: stocks with a high dividend yield, high book-to-market ratio, and high sales-to-price ratio will be overweighted for their capitalisation weight. As these are typical ratios used in

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value strategies, it is not surprising to find a substantial exposure to the value factor. Other weighting schemes considered in this analysis do not use fundamental information, and therefore do not lead to such a mechanical value bias. Compared to the equal-weighted reference, neither the efficient index nor the minimum-volatility index displays any value bias.

Small-cap exposure

If one were to use an equal-weighted index that included a broad set of stocks covering all ranges of market capitalisation, one would ascertain a small-cap bias, as most of the stocks traded on exchange are small- or even micro-cap stocks. However, the equal-weighted index used here is composed of S&P 500 constituents, *i.e.*, large-cap stocks, the reason for which the small-cap exposure in table 3 is insignificantly different from zero for the equal-weighted index. Moreover, the indices studied here are made up of large-cap stocks, so none of these indices should show any meaningful bias towards small caps.

Interestingly, the minimum-volatility index and the fundamental index show the opposite of a small-cap bias. Table 3 shows a statistically significant negative exposure to the small-cap factor for these two indices, as well as for the two cap-weighted indices. This can be explained by the fact that the cap-weighted market factor in these models is not the narrow S&P 500 but the much broader index reflecting the entire stock universe of all NYSE, AMEX, and NASDAQ stocks. Compared to this market factor, the returns of cap-weighted and fundamental-weighted indices are driven largely by the largest stocks. This can be explained by the fact that their constituents are made up of the largest stocks; in addition, their weighting mechanism depends on company size. The minimum-volatility index also has a significantly negative exposure to small caps, which can perhaps be explained by a concentration in low beta stocks that leads to a bias towards defensive industries such as telecoms and utilities, which are usually dominated by a few large companies. In contrast, the efficient and equal-weighted indices have insignificant exposures to the small-cap factor. They appear to be the least biased towards large-cap stocks by virtue of their weighting mechanism, even though their constituent universe is also made up of the largest and most liquid stocks.

Momentum exposure

Of all the non-cap-weighted indices, momentum exposure is most negative for equal-weighted indices. After all, compared to capitalisation weighting, equal-weighting mechanically rebalances away from stocks that increase in price. This mechanical rebalancing is also inherent to the fundamental index, which has the next most pronounced negative momentum beta. Momentum exposure is less pronounced for the efficient index and the minimum-volatility index. This can perhaps be explained by the fact that the efficient index and minimum-volatility index are rebalanced based on currently available quantitative information on risk and returns of the constituent stocks, so they do not necessarily have a mechanical rebalancing effect built into their weighting mechanism.

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In addition to the factor exposures, table 3 contains interesting results concerning the goodness-of-fit of the factor models. The R-squared for these regressions indicates how well the factor model fits the observed returns of the respective index, with an R-squared of one indicating a perfect fit, meaning that the index would be perfectly replicable with the equity factors. For the cap-weighted indices, the results in table 3 show that the factor model suffices to get an R-squared close to one. This is not the case for the non-cap-weighted indices. They contain some return variation that cannot be explained by the factors. The R-squared reaches levels on the order of 0.95, leaving 5% of the return variation unexplained by exposure to common factors. This unexplained part can be linked to the unique index construction method of each of the non-cap-weighted indices.

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Conclusion

Conclusion

The analysis provided in this paper clearly shows that the non-cap-weighted indices beat the standard cap-weighted indices such as the S&P 500 and the Russell 1000 in terms of risk-adjusted performance over the eleven years for which data is available for all indices.

Moreover, the "improved beta" strategies achieve the main objectives, which vary widely from one non-cap-weighted index to another, that they have set for themselves. The efficient index, whose aim is higher risk/reward efficiency, does indeed obtain the highest Sharpe ratio of all the indices. The minimum-volatility index obtains the lowest volatility. Equal-weighted indices and fundamental indices obtain higher average returns as a result of their mechanical rebalancing feature. The differences among the indices are also reflected in quite different factor exposures. Minimum volatility, as it favours low beta stocks, clearly has the lowest market beta of all non-cap-weighted indices, while fundamental weighting leads to the highest value exposure, and equal weighting to the most pronounced anti-momentum exposure.

In sum, efficient indices, the newest of the strategies analysed in this paper, not only obtain the highest Sharpe ratios in the period analysed in this paper but also appear to have the most diversified factor exposures. Their volatility is lower than that of equal-weighted and fundamental-weighted indices, and since they are not subject to the same tilt towards low beta stocks their average returns are higher than those of minimum-volatility indices. Efficient indices, which are an attempt to provide an investable proxy for the tangency portfolio from modern portfolio theory, are thus a significant new addition to the improved beta toolbox.

That the four weighting schemes have rather different risk and return properties also suggests that different investors may choose different alternatives, depending on which characteristic they value most. Moreover, combining these alternatives may add even more value, as different return properties may allow an investor who wants to move away from capitalisation weighting to diversify his exposure to non-cap-weighted schemes. This issue is left for further research.

Appendix

Appendix

A.1 Summary Statistics and Differences with Capitalisation Weighting in Sub-Periods

This section of the appendix contains an analysis of results for the two sub-periods of the sample. The analysis of sub-periods is provided for the information of the reader. On the whole, the results per sub-period confirm the conclusions drawn for the full period. The above results can thus be considered quite robust.

Table A.1: Performance statistics for sub-periods - This table shows summary statistics for different equity indices. The construction principles of the indices are more fully described in section one. The statistics are based on weekly data. All statistics are annualised and performance ratios that involve the average returns are based on the geometric average, which reliably reflects multiple holding period returns for investors. A Cornish-Fisher expansion was used to compute a Value-at-Risk estimate that takes into account the mean, volatility, skewness, and excess kurtosis of index returns.

First sub-period (from 8 January 1999 to 2 July 2004)

	Non-cap-weighted				Cap-weighted	
	Efficient Index	Minimum Volatility	Fundamental Index	S&P 500 Equal-Weighted	S&P 500	Russell 1000
Average (geometric)	7.8%	1.7%	6.5%	7.3%	-0.1%	0.2%
Std. Dev.	16.5%	15.2%	17.2%	18.7%	19.3%	19.4%
Semi-deviation (below zero)	11.7%	11.1%	12.1%	13.2%	13.8%	13.9%
Tracking error	7.3%	8.0%	7.3%	7.5%	0.0%	1.6%
Beta with S&P 500	0.79	0.73	0.83	0.90	1.00	1.00
Sharpe ratio	0.28	-0.10	0.19	0.22	-0.17	-0.15
Sortino ratio	0.67	0.15	0.54	0.55	-0.01	0.02
Information ratio	1.09	0.23	0.91	0.99	NA	0.24
Treynor ratio	0.06	-0.02	0.04	0.05	-0.03	-0.03
95% Value-at-Risk	3.9%	3.6%	4.0%	4.4%	4.5%	4.5%
199% Value-at-Risk	7.2%	6.7%	7.6%	7.8%	7.9%	8.0%
Skewness	-0.69	-0.50	-0.49	-0.54	-0.34	-0.35
Kurtosis	5.49	5.49	5.74	4.98	4.92	4.98

Second sub-period (from 9 July 2004 to 1 January 2010)

	Non-cap-weighted				Cap-weighted	
	Efficient Index	Minimum Volatility	Fundamental Index	S&P 500 Equal-Weighted	S&P 500	Russell 1000
Average (geometric)	5.0%	3.3%	4.0%	4.2%	1.9%	2.3%
Std. Dev.	21.9%	17.9%	23.4%	23.8%	20.3%	20.6%
Semi-deviation (below 0)	15.7%	13.2%	16.6%	16.9%	14.7%	14.9%
Tracking error	3.7%	4.9%	5.7%	5.2%	0.0%	0.9%
Beta with S&P 500	1.07	0.86	1.13	1.16	1.00	1.01
Sharpe ratio	0.10	0.03	0.06	0.06	-0.04	-0.02
Sortino ratio	0.32	0.25	0.24	0.25	0.13	0.16
Information ratio	0.83	0.28	0.38	0.44	NA	0.48
Treynor ratio	0.02	0.01	0.01	0.01	-0.01	0.00
5% VaR (Cornish Fisher)	4.9%	4.1%	5.0%	5.2%	4.6%	4.6%
1% VaR (Cornish Fisher)	12.7%	12.6%	13.7%	13.0%	12.7%	12.8%
Skewness	-0.55	-1.02	-0.33	-0.40	-0.64	-0.61
Kurtosis	9.81	13.33	10.41	9.14	11.10	10.99

Appendix

Table A.2: Risk/reward difference compared to S&P 500 for sub-periods - This table shows differences in average returns, in volatility, and in Sharpe ratios between each index and the cap-weighted S&P 500 and the associated p-values. All statistics are computed from weekly returns data. All differences are computed from annualised statistics and the average returns are a geometric average. The p-values for differences are computed using a paired t-test for the average returns, a Fisher test for the volatility, and a Jobson-Korkie test for the Sharpe ratio. Differences that are significantly different from zero at the 5% level are indicated in bold.

First sub-period (from 8 January 1999 to 2 July 2004)

	Non-cap-weighted			
	Efficient Index	Minimum Volatility	Fundamental Index	S&P 500 Equal-Weighted
Diff. in average	**8.0%**	1.8%	6.6%	**7.4%**
p-value	2.1%	74.2%	5.1%	2.7%
Diff. in volatility	**-2.8%**	**-4.1%**	-2.1%	-0.6%
p-value	0.8%	0.0%	5.3%	62.4%
Diff. in Sharpe ratio	**0.45**	0.07	**0.37**	**0.39**
p-value	0.9%	75.1%	3.6%	2.5%

Second sub-period (from 9 July 2004 to 1 January 2010)

	Non-cap-weighted			
	Efficient Index	Minimum Volatility	Fundamental Index	S&P 500 Equal-Weighted
Diff. in average	**3.1%**	1.4%	2.1%	2.3%
p-value	3.6%	67.3%	25.3%	18.0%
Diff. in volatility	1.7%	**-2.4%**	**3.2%**	**3.5%**
p-value	18.2%	3.6%	1.4%	0.7%
Diff. in Sharpe ratio	**0.14**	0.07	0.10	0.10
p-value	2.9%	54.7%	23.5%	12.2%

A.2 Additional Description of Data Sources

For the non-cap-weighted indices, the data for MSCI and S&P EW is obtained from Datastream. The information on fundamental indices is obtained from the data described in Amenc, Goltz, and Le Sourd (2009) and updated with returns from Datastream on the FTSE RAFI 1000 index. The data on efficient US index is obtained from the data in Amenc *et al.* (2010) and updated using the FTSE EDHEC-Risk Efficient Index for the US from Datastream.

The risk-free rate is taken from the daily risk-free rate data in the Fama-French factors provided by Kenneth French. It is converted into weekly returns from daily returns. This rate reflects a one-month Treasury bill index. The average risk-free rate is 2.91% per annum. The market factor in the factor regressions is taken from Kenneth French; this is the value-weighted CRSP total market index (NYSE, AMEX, and NASDAQ stocks).

Appendix

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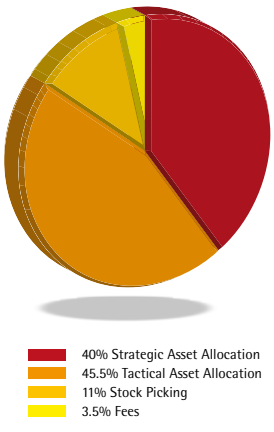
About EDHEC-Risk Institute

About EDHEC-Risk Institute

Founded in 1906, EDHEC is one of the foremost French business schools. Accredited by the three main international academic organisations, EQUIS, AACSB, and Association of MBAs, EDHEC has for a number of years been pursuing a strategy for international excellence that led it to set up EDHEC-Risk in 2001. With 47 professors, research engineers and research associates, EDHEC-Risk has the largest asset management research team in Europe.

The Choice of Asset Allocation and Risk Management

EDHEC-Risk structures all of its research work around asset allocation and risk management. 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 diversification alone as a risk management technique and the usefulness of approaches based on dynamic portfolio allocation. On the other, the appearance of new asset classes (hedge funds, private equity, real assets), with risk profiles that are very different from those of the traditional investment universe, constitutes a new opportunity and challenge for the implementation of allocation in an asset management or asset/liability management context. 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; taking extreme risks into account in portfolio construction; studying the usefulness of derivatives in implementing asset/liability management approaches; or orienting the concept of dynamic "core-satellite" investment management in the framework of absolute return or target-date funds.



Source EDHEC (2002) and Ibbotson, Kaplan (2000)

An Applied Research Approach

In an attempt to ensure that the research it carries out is truly applicable, EDHEC has implemented a dual validation system for the work of EDHEC-Risk. 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 EDHEC-Risk's advisory board. This board is made up of internationally recognised researchers, the centre's business partners and representatives of major international institutional investors. The management of the research programmes respects a rigorous validation process, which guarantees the scientific quality and the operational usefulness of the programmes.

Six research programmes have been undertaken :

- Asset allocation and alternative diversification
- Style and performance analysis
- Indices and benchmarking
- Operational risks and performance
- Asset allocation and derivative instruments
- ALM and asset management

These programmes receive the support of a large number of financial companies. The results of the research programmes are disseminated through the three EDHEC-Risk locations in London, Nice, and Singapore.

In addition, EDHEC-Risk has developed close partnerships with a small number of sponsors within the framework of research chairs. These research chairs involve a three-year commitment by EDHEC-Risk and the sponsor to research themes on which the parties to the chair have agreed.

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- Regulation and Institutional Investment, *in partnership with AXA Investment Managers (AXA IM)*
- Asset/Liability Management and Institutional Investment Management, *in partnership with BNP Paribas Investment Partners*
- Risk and Regulation in the European Fund Management Industry, *in partnership with CACEIS*
- Structured Products and Derivative Instruments, *sponsored by the French Banking Federation (FBF)*
- Private Asset/Liability Management, *in partnership with ORTEC Finance*
- Dynamic Allocation Models and New Forms of Target-Date Funds, *in partnership with UFG*
- Advanced Modelling for Alternative Investments, *in partnership with Newedge Prime Brokerage*
- Asset/Liability Management Techniques for Sovereign Wealth Fund Management, *in partnership with Deutsche Bank*
- Core-Satellite and ETF Investment, *in partnership with Amundi ETF*
- The Case for Inflation-Linked Bonds: Issuers' and Investors' Perspectives, *in partnership with Rothschild & Cie*

The philosophy of the institute is to validate its work by publication in international journals, but also to make it available to the sector through its position papers, published studies and conferences.

Each year, EDHEC-Risk organises a major international conference for institutional investors and investment management professionals with a view to presenting the results of its research: EDHEC-Risk Institutional Days.

EDHEC also provides professionals with access to its website, **www.edhec-risk.com**, which is entirely devoted to international asset management research. The website, which has more than 35,000 regular visitors, is aimed at professionals who wish to benefit from EDHEC's analysis and expertise in the area of applied portfolio management research. Its monthly newsletter is distributed to more than 400,000 readers.

EDHEC-Risk Institute: Key Figures, 2008-2009

Number of permanent staff	47
Number of research associates	17
Number of affiliate professors	5
Overall budget	€8,700,000
External financing	€5,900,000
Number of conference delegates	1,950
Number of participants at EDHEC-Risk Executive Education seminars	371

Research for Business

EDHEC-Risk's activities have also given rise to executive education and research service offshoots.

EDHEC-Risk's executive education programmes help investment professionals to upgrade their skills with advanced risk and asset managementtraining across traditional and alternative classes.

About EDHEC-Risk Institute

The EDHEC-Risk Institute PhD in Finance

The EDHEC-Risk Institute PhD in Finance at EDHEC Business School is designed for professionals who aspire to higher intellectual levels and aim to redefine the investment banking and asset management industries. It is offered in two tracks: a residential track for high-potential graduate students, who hold part-time positions at EDHEC Business School, and an executive track for practitioners who keep their full-time jobs. Drawing its faculty from the world's best universities and enjoying the support of the research centre with the greatest impact on the European financial industry, the EDHEC-Risk Institute PhD in Finance creates an extraordinary platform for professional development and industry innovation.

The EDHEC-Risk Institute MSc in Risk and Investment Management

The EDHEC-Risk Institute Executive MSc in Risk and Investment Management is designed for professionals in the investment management industry who wish to progress, or maintain leadership in their field, and for other finance practitioners who are contemplating lateral moves. It appeals to senior executives, investment and risk managers or advisors, and analysts. This postgraduate programme is designed to be completed in seventeen months of part-time study and is formatted to be compatible with professional schedules.

The programme has two tracks: an executive track for practitioners with significant investment management experience and an apprenticeship track for selected high-potential graduate students who have recently joined the industry. The programme is offered in Asia—from Singapore—and in Europe—from London and Nice.

FTSE EDHEC-Risk Efficient Indices

FTSE Group, the award winning global index provider, and EDHEC-Risk Institute launched the first set of FTSE EDHEC Risk Efficient Indices at the beginning of 2010. Initially offered for the UK, the Eurobloc, the USA, Developed Asia-Pacific, ex. Japan, and Japan, the index series aims to capture equity market returns with an improved risk/reward efficiency compared to cap-weighted indices. The weighting of the portfolio of constituents achieves the highest possible return-to-risk efficiency by maximising the Sharpe ratio (the reward of an investment per unit of risk).

EDHEC-Risk Alternative Indexes

The different hedge fund indexes available on the market are computed from different data, according to diverse fund selection criteria and index construction methods; they unsurprisingly tell very different stories. Challenged by this heterogeneity, investors cannot rely on competing hedge fund indexes to obtain a "true and fair" view of performance and are at a loss when selecting benchmarks. To address this issue, EDHEC-Risk was the first to launch composite hedge fund strategy indexes as early as 2003.

The thirteen EDHEC-Risk Alternative Indexes are published monthly on **www.edhec-risk.com** and are freely available to managers and investors.

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Notes

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