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Chasing performance persistence of hedge funds

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ABSTRACT

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The thesis examines the performance persistence of hedge funds using complement methodologies (namely cross-sectional regressions, quantile portfolio analysis and Spearman rank correlation test). In addition, six performance ranking metrics and six different combinations of selection and holding periods are compared. The data is gathered from HFI and Tremont databases covering over 14,000 hedge funds and time horizon is set from January 1996 to December 2007. The results suggest that there definitely exists performance persistence among hedge funds and the strength and existence of persistence vary among fund styles. The persistence depends on the metrics and combination of selection and prediction period applied. According to the results, the combination of 36-month selection and holding period outperforms other five period combinations in capturing performance persistence within the sample. Furthermore, model-free performance metrics capture persistence more sensitively than model-specific metrics. The study is the first one ever to use MVR as a performance ranking metric, and surprisingly MVR is more sensitive to detect persistence than other performance metrics employed.

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Tämän tutkimuksen tarkoituksena on selvittää hedgerahastojen suorituskyvyn pysyvyyttä. Suorituskykyä tarkastellaan monien toisiaan täydentävien menetelmien avulla (poikkileikkausregressiot, kvantiiliportfolio analyysi ja Spearmanin järjestyskorrelaatiotestit). Lisäksi tutkielmassa käytetään kuutta eri suorituskyvyn mittaria ja kuutta eri arviointi- ja ennustejakson yhdistelmää. Tutkimuksen data on peräisin HFI:n ja Tremontin tietokannoista kattaen yli 14 000 hedgerahastoa. Data ajoittuu tammikuusta 1996 joulukuuhun 2007. Tutkimuksen tulosten mukaan suorituskyvyn pysyvyyttä esiintyy selvästi hedgerahastoilla ja pysyvyyden olemassaolo sekä voimakkuus riippuvat rahastotyylistä. Myös suorituskykymittari sekä arviointi- ja ennustamisjaksojen yhdistelmä vaikuttavat suorituskyvyn pysyvyyteen. Tulosten mukaan 36 kk:n arviointi- ja ennustamisjakson yhdistelmä on herkin havaitsemaan suorituskyvyn pysyvyyttä tutkimuksen otoksessa. Lisäksi mallista riippumattomat suorituskykymittarit havaitsevat herkemmin suorituskyvyn pysyvyyttä kuin mallipohjaiset mittarit. Tutkimus on ensimmäinen laatuaan, joka käyttää MVR-lukua suorituskyvyn mittaamiseen. Yllättäen MVR on tutkimuksen mittareista kaikkein herkin suorituskyvyn pysyvyyden havaitsemiseen.

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1 INTRODUCTION

1.1 Background of the study

Equity markets have weakened during the last years and interest rates have declined. As a result, investors have started to look some alternative investment possibilities. Especially they have started to look for investments, which are not dependent on the performance of many traditional markets. As a result of this change in the investors' behaviour, hedge fund industry has grown in an enormous pace, because hedge fund performance is not influenced by the direction of equity, debt, or other markets; the performance is driven by manager-specific idiosyncratic investment strategies that attempt to benefit from various market inefficiencies or anticipate various markets' directional trends. (Herzberg and Mozes 2003, 22)

The change can be distinctly seen by viewing the growth of hedge fund industry; according to Titman and Tiu (2011, 123) the size of hedge fund industry grew enormously from 1994 to 2008 when it doubled almost every two years. In July 2008, when the hedge fund industry was as its biggest, there where over 11 000 active funds managing more than $2,5 trillion.

Because the hedge fund industry has become so large and important alternative for the investors, it would be interesting to know whether performance persistence exists among hedge funds; if an investor could identify the funds that are superior in the future by using past information, he/she could increase the performance of his/her portfolio. From this point of view, the existence of performance persistence is a crucial element of the fund selection process and thus, an important topic of research.

In order to understand better the hedge fund performance and the fees they charge, hedge fund returns can be split into two components; one component which tracks an index or a passive portfolio, and an uncorrelated active component. In theory, investors should be able to get exposure to these two components of risk separately by acquiring the passive components through index funds and the active components through market-neutral hedge funds. Nevertheless, in practice, most hedge funds are not market-neutral and can be viewed as a mix of the two components. (Titman and Tiu 2011, 123)

According to Géhin (2004) many investors allocate to different hedge funds on the basis of their track record, which implies that investors expect some consistency in performance of hedge funds over time. A great number of papers have studied the performance persistence of hedge funds. For example, Brown et al. (1999) found little persistence in relative performance across managers in offshore hedge funds after controlling for style effect. Agarwal and Naik (2000) found evidence of quarterly persistence but on the other hand, no persistence at the annual horizon when they used multi-period framework. The persistence was especially driven by “losers” in their research. Like Agarwal and Naik (2000), Edwards and Caglayan (2001) used 8-factor model and found evidence of performance persistence over 1- and 2-year horizons. However, according to their research, the persistence holds among both “winners” and “losers”. Baquero et al. (2005) found performance persistence in top three deciles at the annual level in both raw returns and on a risk-adjusted basis. Kosowski et al.(2007) found evidence of performance persistence over a 1-year horizon when they used a seven-factor model and applied a bootstrap procedure as well as Bayesian measures. On the other hand Capocci et al.(2005), Chen and Passow (2003) and De Souza and Gokcan (2004) found no evidence of persistence, or persistence depending on the funds selected or periods analysed. Also Herzberg and

Mozes (2003) found no evidence on persistence of hedge fund returns but instead, they found that hedge fund risk is highly persistent.

Aggarwal and Jorion (2010) found that for individual funds, early performance is very persistent; they found persistence up to five years for emerging funds but thereafter, the persistence fades away. Jagannathan et al. (2010) found evidence of performance persistence of hedge funds relative to their style benchmarks over a 3-year horizon. Evidence of performance persistence was especially found among top hedge funds but little evidence was found among bottom funds. Pätäri and Tolvanen (2009) found that the degree and existence of performance persistence fluctuates among different hedge fund styles and depend on performance metric employed. They found that especially model-free performance metrics detect more sensitively performance persistence.

As a conclusion from previous research, results concerning performance persistence of hedge funds are mixed. Up to this day, only few studies have employed such a large data as this thesis. As of December 2007, the database of this thesis covers over 9,900 funds. With such a large data, a huge scale of thorough tests and analyses including cross-sectional tests, rank correlation tests and quantile portfolio analyses can be conducted.

1.2 Objectives and methodology

Hedge funds are found as private entities, usually in the form of limited partnerships and, as such, are mainly unregulated. As a result, tracking the performance persistence of hedge funds is much more difficult than mutual funds. Because hedge fund industry is very secretive and highly non-transparent, numerous biases and problems exist that have to be encountered. Hedge funds do not have such requirements as mutual funds; hedge fund performance is not open for all to see and hedge funds do not have to provide specific periodic and standardized valuation and pricing information to investors like mutual funds have to. (Gitman and Joehnk 2008, 534) Also when hedge funds' dynamic trading strategies and holdings of derivative type securities are given, funds' returns do not follow any standard distributions. In addition, the complexity of hedge fund strategies can cause model misspecifications leading to fallacious persistence findings. (Pätäri and Tolvanen 2009, 224) Based on previous studies, biases such as backfill, survivorship, look-ahead, and incubation biases have to be controlled.

In this study, six performance metrics (raw return, Sharpe ratio (SR), skewness- and kurtosis-adjusted Sharpe ratio (SKASR), mean variance ratio (MVR), style-adjusted Fung-Hsieh 8-factor alpha and adjusted R^2-ratio obtained from the style-adjusted 8-factor regression) are used to determine, whether the performance persistence of hedge funds is dependent on performance metrics applied. Moreover, six different combinations of selection and holding periods are examined to find out whether the performance persistence is dependent on the time horizon employed.

The adjusted Fung-Hsieh model is used, because evidence of relative performance persistence cannot be directly interpreted as outstanding performance to an investor; having outstanding performance in one's group of peers does not guarantee superior alpha in absolute returns, because the entire group may have superior performance. Hence, to study whether manager with outstanding historical relative performance also have superior future performance, portfolios of hedge funds based on historical relative performance measures is constructed and out-of-sample performance examined using the adjusted Fung-Hsieh multifactor model. (Jagannathan et al. 2010, 218)

When selecting the variables to the multifactor model, the methodology that has been used in many studies is followed (see Amenc et al 2003, Kosowski et al. 2007, Pätäri and Tolvanen 2009, Titman and Tiu 2010 and Jagannathan et al. 2010): Rather than trying to screen hundreds of variables through stepwise regression techniques, which typically leads to high in-sample r-squares but low out-of-sample r-squares (known as a robustness problem), variables introduced by Fung and Hsieh (2004) are chosen to this research. These variables are able to measure many dimensions of financial risk (including market risk, default risk, volatility risk and liquidity risk) and have evidence to predict asset returns or their natural influence on asset returns. In addition, a style factor was included to the Fung-Hsieh multifactor model in order to capture appropriate risk related with different strategies.

In order to examine the performance persistence of eleven different hedge fund styles, three different methodologies are used in this study. First, in order to discover whether the performance metrics from the selection period explain those from the holding period, cross-sectional regression analysis is performed by regressing the holding period performance on selection period performance. Second, the Spearman rank correlation test is applied in order to test the consistency of performance rankings to the whole sample and separately to each fund class. Third, quartile portfolios are formed based on selection period performance and then tested by their holding period performance difference in order to find out, whether the difference in performance remains between the past outperformers and past underperformers. Finally, decile portfolios are formed from the whole sample based on selection period performance and then compared by their subsequent holding period performance in order to examine whether the performance difference remains when the portfolios are not categorized according to a certain fund style. In these three analyses, various combinations of selection and holding periods are used. For the quantile portfolio analyses, Sharpe ratio difference test and alpha spread tests are employed in order to find out whether performance persistence exists among top and bottom performers of the past. Following the study of Kosowski et al. (2007), the generalized method of moments (GMM) technique is utilized in the quantile portfolio analyses.

The research problems examined in this thesis can be expressed to as following research questions:

1. Is the performance persistence of hedge funds dependent on the metrics applied?
2. Does performance in the selection period explain the holding period performance?
3. Does the difference between the past outperformers and past underperformers remain?

1.3 Limitations and structure

The timespan of the returns are limited from the beginning of 1996 to the end of 2007. This is because the data obtained from Tremont database starts from the beginning of 1996 and ends in December 2007. The Tremont data is combined with the data obtained from HFI database. Hedge fund styles that did not have 18 or more funds in any subperiods were excluded from the data sample. Also as the study is limited to study long-term performance persistence, funds that had fewer than 24 monthly return observations after controlling various biases were excluded from the data sample.

In hedge fund literature, numerous performance measures are suggested to measure performance persistence of hedge funds. In this research, comprehensive performance measure assortment is utilized; raw return, Sharpe ratio, mean variance ratio, alpha t-value and adjusted R-square value are chosen to gauge performance persistence.

Many combinations of the lengths for selection and holding periods have been employed in performance persistence literature. Due to growing amount of interest in measuring long-term performance persistence (e.g., Jagannathan et al., 2010, Fung et al., 2008 and Kosowski et al., 2007), short-term performance persistence is excluded and yearly time horizons used in this thesis. Hence, selection periods of 24 months and 36 months and holding periods of 12 months, 24 months and 36 months are utilized.

Various models have been suggested to evaluate performance persistence of hedge funds. Usually, the multifactor models, which pursue to capture the common risk factors of diversified portfolios of hedge funds, are utilized for this purpose (Pätäri 2009, 225). Following the majority of hedge fund performance persistence studies, the Fung-Hsieh 7-factor model, which is the most widely-used model, is employed in this thesis. Because long time-series returns bias alphas upwards, style factor is added to the original Fung and Hsieh 7-factor model. This addition must be taken into consideration when interpreting the results.

Section 1 introduces background of the thesis and previous academic literature related to performance persistence of hedge funds. In section 2 the theoretical background and interpretation of methods and metrics is explained. Section 3 introduces the data and section 4 the methodologies employed in the empirical part. The results of the thesis are presented in section 5 and section 6 concludes.

2 THEORETICAL BACKGROUND

2.1 Performance persistence

Before introducing the tools used to measure the performance persistence in this study, it would be appropriate to first explain the meaning of performance persistence. Performance persistence typically means identifying winners and losers within a particular industry. Moreover, it means identifying winners that continue as winners or losers that continue as losers. From a practical point of view the interest is to find out whether some funds perform consistently better than others. The importance of discovering performance persistence lies on the fact that it may enable investors to beat the market average. The winners and losers within an industry are defined by evaluating them based on a given benchmark or an index for the industry. In hedge fund environment, this can be done by using multifactor model with the factors representing the asset classes where hedge funds invest, in other words equities, bonds, currencies, commodities and cash. (Harri and Brorsen 2004, 133)

Many researchers have discussed reasons for performance persistence. One possible reason for short-term persistence could be that monthly returns are smoothed out, either due to holding illiquid assets or managed returns (see Kosowski et al. 2007). Barès et al. (2003) and Jagannathan et al. (2010) believe that short-term persistence is associated with the hot-hands effect documented in mutual fund context (see Hendricks et al. 1993). The hot-hands effect emerge when securities held by funds having better performance during one period generate superior returns the following period. (Eling 2009, 372-373)

Nevertheless, the effects of backfill and survivorship bias as well as return smoothing generate serious doubts on whether the discovered short-term persistence is related at all to outstanding managerial skill. And even if short-term persistence due to manager skill exists, it cannot be profitably capitalized by investors due to significant lockup periods, entry costs, and exist costs. Consequently, it is reasonable to analyse long-term performance persistence in hedge fund returns. (Eling 2009, 396)

2.2 Performance metrics

So far, institutional investors distinctly allocate more funds to past good performers. For example, Fung et al. (2008) found that for hedge funds, alpha funds attract more capital than beta-only funds. Funds that have unique return in excess of benchmarks index are named as “Alpha funds” while “beta-only funds” do not generate excess return over benchmark index. Beta refers to the market-based returns of an asset class and investors can capture beta passively as it requires minimal skill. In this point of view, beta can be viewed as a commodity and should not obtain a pricing premium (Rice et al., 2012). Agarwal et al. (2004) found that hedge funds with persistently great (bad) performance attract bigger (smaller) inflows compared to those with no persistent performance. Therefore, an investor may be able to realise superior performance in the presence of performance persistence.

Numerous measures can be used to quantify performance persistence of hedge funds. One of the widely used measures in mutual fund research is Jensen’s alpha, the intercept of the capital asset pricing model. In the case of hedge funds that widely use leverage in their investment strategies the leverage invariant measures are more proper. These kind of measures include the Sharpe ratio and the appraisal ratio (similar to alpha t-value), defined as the ratio of alpha to the standard deviation. (Harri and Brorsen, 2004, 133) Although alpha indicates abnormal performance, it has a relatively big coverage error in the construction of confidence intervals. Furthermore, an alpha is estimated with less precision to the funds that have a shorter return history. This tends to generate alphas that are outliers. Alpha t-statistic corrects these spurious outliers by normalizing the estimated alpha by the estimated precision of the alpha estimate. In addition, t-statistic is often related to the popular information ratio of Treynor and Black (1973), which practitioners commonly use to rank fund managers.

According to literature overview provided by Eling (2009), hedge fund performance studies differ widely in methodology, investigation period, database, performance measures and conclusions. As a result, at least persistence of risk-adjusted returns and raw returns should be investigated in order to achieve a proper picture of performance. In this study, raw-returns, model-free risk-adjusted returns (Sharpe ratio, mean variance ratio and skewness- and kurtosis-adjusted Sharpe ratio) and marked-based performance metrics (alpha t-statistics of 8-factor alphas and adjusted R-squared) are used for performance evaluation of sample funds.

The results concerning the importance of performance measure applied is somewhat mixed. Eling (2009; 2008) found that the choice of different performance measures is not the reason for the mixed results found in performance persistence literature, when he compared the rankings of the same point of time. In contrast, Pätäri and Tolvanen (2009) found that the degree and existence of performance persistence depend on performance metric applied, when they compared the rankings between two time periods. Hence, it is appropriate to use different performance measures in order to rule out the model-dependency as a potential explanation to performance persistence.

2.2.1 Raw returns

The raw return is the most common performance measure. For example, Manser and Schmid (2009) found some evidence of performance persistence in raw returns of long-short hedge funds at 1-year horizon. Harri and Brorsen (2004) and Boyson and Cooper (2004) have also found short-term persistence while using raw returns as a performance metric. Baquero et al. (2005) found clear persistence in raw returns at the quarterly horizon but no statistically significant persistence at the annual horizon.

In this thesis, logarithmized raw returns are used as one performance metric to measure the performance persistence of hedge funds. Monthly US Treasury yield rate is used as a proxy for risk-free return. Raw return for fund *i* in a specific period can be calculated as follows:

$$Raw\ return = \int_{n=1}^{K} (Ln(1 + R_{i,n} - R_{f,n}))\ /K\ , \qquad (1)$$

where $R_{i,n}$ is the monthly return of a fund *i* at time n, $R_{f,n}$ is the monthly risk free rate of return at time n and K is the number of observations.

2.2.2 The Sharpe ratio

The Sharpe ratio developed by Sharpe (1966) is one of the most commonly used performance measures. One reason for its popularity is in its simplicity; the ratio is calculated by dividing the excess return of the fund by its standard deviation. The Sharpe ratio tells to the investors, how much excess return they get for the extra volatility they bear for holding a riskier security. According to Gitman and Joehnk (2008, 585), Sharpe ratio is especially reasonable when compared either to the market or to other portfolios. In general, the higher the Sharpe ratio is, the better the risk premium per unit of risk obtained from the investment is.

According to Elton et al., (2003) because the risk in the Sharpe ratio is measured using standard deviation, it also includes the unsystematic risk that could be diversified. In other words, unlike the CAPM-based performance metrics, the Sharpe ratio ignores the correlation with investor's other investments. Sharpe ratio represents the investment decision from the investor's point of view. Hence it assumes investors to select funds to represent all of their risky investments. In this kind of situation, investors are only concerned with the total risk meaning that the standard deviation is an applicable measure for the risk.

As a total risk based performance measure, the Sharpe ratio is used in this study as a performance metric to notice performance persistence. Sharpe ratio as a performance metric for a hedge fund has been questioned in many studies. For example Fung and Hsieh (2001), Lo (2002), Brooks and Kat (2002), Gregoriou and Gueyie (2003), Mahdavi (2004), Sharma (2004) and Morton et al. (2006) have strongly criticized the usage of Sharpe ratio as a performance measure for hedge funds as Sharpe ratio is not designed to capture the nonlinear return features that are quite common among hedge funds. According to Lo (2002), the overestimation can be even 65% of the annual Sharpe ratio in the presence of a serial correlation.

Nevertheless, more recent findings of Elling and Schuhmacher (2007) and Pätäri and Tolvanen (2009) show that despite significant deviancies of hedge fund returns from a normal distribution, Sharpe ratio results in rank orders which are almost identical to other performance metrics that are based on downside risk. Furthermore, according to Ferruz et al. (2008; 2006) and Pätäri (2008), who examined the mutual fund markets, performance rank orders are not very sensitive to the selection of risk measure. Following the study of Pätäri and Tolvanen (2009), the Sharpe ratio is used as a performance measure and performance metrics capturing downside risk (for example, Sortino ratio and modified Sharpe ratio) are excluded from this research as they would not barely add any value to the analysis. According to Eling (2008), the Sharpe ratio is the best known and best understood performance measure and might thus be found superior to the other performance measures from both a practitioner’s and a theoretical point of view. He concludes that the Sharpe ratio is therefore adequate for analyzing the returns of hedge funds.

The Sharpe ratio employed in this thesis is calculated as follows:

$$Sharpe\ ratio = \frac{r_i - r_f}{\sigma_i^{(\frac{ER}{|ER|})}}, \tag{2}$$

where $r_i - r_f$ is the fund’s excess return and $\sigma_i^{(\frac{ER}{|ER|})}$ is the standard deviation of the logarithmized monthly excess returns of a fund i (in excess of the risk free rate of return).

Respectively, the standard deviation σ_i of fund *i* needed in the previous formula can be given as follows:

$$\sigma_i = \sqrt{\frac{\sum_{i=1}^{N}(r_{i,n} - \overline{r}_i)}{n}}, \tag{3}$$

where $r_{i,n}$ is the return of fund *i* at time n, $\overline{r}_i$ is the mean return of fund *i* within the calculation period and n is the total number of observations included in the calculation period.

According to Israelsen (2005;2003), there may be situations where the fund has underperformed the risk free rate, on average, and thus has negative excess returns. In these situations, ranking funds on descending order can lead to false results; if the average excess return is negative, the higher the standard deviation is, the better the Sharpe ratio for this kind of fund is. Therefore the adjustment for negative Sharpe ratios was done as follows (Pätäri 2011, 73):

$$SR = \frac{r_i - r_f}{SR_i^{(\frac{ER}{|ER|})}} \quad . \tag{4}$$

2.2.3 Mean variance ratio

Mean variance approach was first applied to hedge fund ranking by Fung and Hsieh (1999), who found that mean variance criterion is applicable to rank hedge funds. According to Bai et al. (2009), sometimes it is not meaningful to measure Sharpe ratios for too long periods as the standard deviations and means could be empirically non-stationary and/or controlling structural breaks. Furthermore, the main problem in developing the Sharpe ratio test for small samples is that it is impossible to get a uniformly most powerful unbiased test to check for the equality of Sharpe ratios in situation of small samples. Bai et al. (2009) suggested the use of MVR to circumvent this problem. The MVR test developed by Bai et al. (2009) circumvents the limitation of mean-risk analysis and stochastic dominance test according to which academics cannot develop their asymptotic distributions for small samples, and even for large sample investors do not know how big the sample size should be to make these distributions valid for testing purposes. In addition, mean variance statistic may not only draw conclusion for investors with normally-distributed assets and quadratic utility functions; it may be used by any risk-averse investor, as Meyer (1987), Broll et al. (2006). Wong (2006; 2007) and Wong and Ma (2008) point out in the case of mean-risk analysis, where the conclusion drawn from the mean risk-analysis comparison could be equivalent to the comparison of expected maximization of utility for any risk-averse investor. MVR is calculated as follows:

$$Mean\ variance\ ratio = \frac{r_i - r_f}{\sigma_i^{2(\frac{ER}{|ER|})}} \quad , \tag{5}$$

where $r_i - r_f$ is the fund's excess return and $\sigma_i^{2(\frac{ER}{|ER|})}$ is the variance of the logarithmized monthly excess returns of a fund i (in excess of the risk free rate of return). The calculation of the mean variance ratio was also refined like that of the Sharpe ratio; if a fund's excess return was negative, the average excess return was multiplied by the variance. As a result, a reliable MVR ranking was achieved.

2.2.4 Skewness and kurtosis adjusted sharpe ratio (SKASR)

According to Favre and Signer (2002), fund returns can show excess kurtosis (often referred to as fat tails) which implies bigger probabilities of big positive and negative returns than indicated by normal probability distribution. On the other hand, investors seek positive skewness because it offers better protection against losses and higher profit opportunities in form of returns.

Zakamouline and Koekebakker (2009) showed that adjusted for skewness and kurtosis Sharpe ratio (ASKSR) can diminish the shortcomings of the Sharpe ratio in resolving some Sharpe ratio paradoxes and revealing the true performance of portfolios with manipulated Sharpe ratios. Pätäri (2011) presented a more straightforward and simpler procedure, named as the skewness and kurtosis adjusted Sharpe ratio (SKASR) as an extension to the traditional Sharpe ratio. Compared to Sharpe ratio and the mean variance ratio employed in this study, the risk metrics of the skewness and kurtosis adjusted Sharpe ratio takes the third (skewness) and the fourth (kurtosis) moment of return distribution into account. Pätäri (2011, 83) found that the direction of total impact of skewness and kurtosis on risk estimates varies within hedge fund styles and hence, in the hedge fund context it is highly suggestible to apply risk metrics that take both skewness and kurtosis into account when calculating the risk. On the other hand, the total impact of third and fourth moments on dispersion was quite marginal for the pooled sample data in his research. Pätäri (2011) also found that as the performance rankings of the SKASR and many computationally complicated measures (including the Okunev ratio, reward-to-expected shortfall ratio, the modified Sharpe ratio and Omega ratio) are highly correlated, SKASR measures can be employed as ranking approximates of these complicated measures. As the SKASR ratio requires only the first four moments of return distributions as inputs (mean return, standard deviation, skewness and kurtosis) it is employed also in this thesis as an alternative performance metric for the standard Sharpe ratio.

Following the framework of Pätäri (2011) and Favre and Galéano (2002) in defining modified Value-at-Risk, the adjusted Z value (Z_{CF}) is calculated at first. The fourth order Cornish-Fisher expansion (Cornish and Fisher, 1937), which is an approximation of the true distribution using the sample moments and standard normal distribution, is applied to estimate Z_{CF} as follows:

$$Z_{CF} = Z_C \frac{1}{6}(Z_C^2 - 1)S + \frac{1}{24}(Z_C^3 - 3Z_C)K - \frac{1}{36}(2Z_C^3 - 5Z_C)S^2 \,, \qquad (6)$$

where Z_C denotes the critical value for probability based on standard normal distribution, S skewness and K kurtosis of the return distribution. Correspondingly, skewness and kurtosis are calculated as follows:

$$S = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{r_{it}-\bar{r}_i}{\sigma}\right)^3 \,, \qquad (7)$$

$$K = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{r_{it}-\bar{r}_i}{\sigma}\right)^4 - 3 \,, \qquad (8)$$

where N is number of outcomes, $\bar{r}_i$ is the average return and σ denotes the standard deviation.

Next, the skewness- and kurtosis-adjusted deviation (SKAD) is calculated by multiplying the standard deviation by the Z_{CF}/Z_C value. Following Favre and Galeano (2002), we use -1.96 as Z_C in the adjustment procedure. Finally, to obtain the skewness and kurtosis adjusted Sharpe ratio, SKAD is substituted for standard deviation and the resulting ratio is modified to capture the potential validity problem caused by negative excess returns. The resulting ratio is presented in equation (9) as follows (Pätäri 2011):

$$SKASR = \frac{\bar{r}_i - \bar{r}_f}{SKAD_i^{(ER/|ER|)}} \,, \qquad (9)$$

where $SKAD_p$ is skewness- and kurtosis-adjusted deviation of the monthly excess returns of a fund *i* and ER is the average excess returns of a fund *i*.

According to Pätäri (2011), the SKASR takes into account all distributional asymmetries revealed by skewness and kurtosis whereas the traditional Sharpe ratio oversimplifies the risk. For example in a situation where the return distribution is right skewed, the traditional Sharpe ratio neglects the skewness and as a result, variance suffers from greater downside risk, which from an investor's point of a view would be negative. This kind of dilemma is not possible when the SKASR is used. If the return distribution is exactly normal, the standard deviation equals SKAD regardless of the probability levels used in determining Z_{CF}/Z_C ratio.

In order to circumvent the problem of average negative excess returns leading to false performance rankings, the same adjustment was made to SKASR as for the Sharpe ratio and mean variance ratio; if the average excess return of a fund was negative, the average excess return was multiplied with the $SKAD_i$. If the $SKAD_i^{(ER/|ER|)}$ term was negative, the excess return was divided by 0.000001. This kind of approach is employed in order to achieve reliable rankings. For example to those funds whose SKAD and excess return is negative, the SKASR is positive. In order to prevent this dilemma, boundary ranges introduced by Pätäri (2011, 73) are employed.

2.2.5 Alpha t-values

Kosowski et al. (2007) found that performance of funds sorted on alpha t-statistics persisted more than performance of funds sorted on alpha over the same period. According to Jagannathan et al. (2010), performing regression in terms of the t-statistic of alpha would result in a more accurate persistence estimate, because more accurate alphas would have higher absolute t-statistic values and less accurately measured alphas would have lower absolute t-statistic values.

The t-statistic of alpha (t_α) is calculated as follows:

$$t_\alpha = \frac{\alpha}{SE_\alpha}, \tag{10}$$

Where α denotes the intercept obtained from the regression and σ_α is the standard error of the intercept.

Following the study of Kosowski et al. (2007) and Jagannathan et al. (2010) alpha t-values as a performance measure are applied to this study. The alpha t-values for the funds were obtained from the adjusted Fung-Hsieh multifactor regression. The higher the t-statistic of alpha, the better the performances of hedge fund.

2.2.6 Adjusted R^2-values

Based on the previous findings of Titman and Tiu (2011) and Ingersoll et al. (2007), one metric to measure the performance of hedge funds is the adjusted R-squared obtained from multifactor regression. Titman and Tiu (2011) used the R-squared values obtained from the Fung and Hsieh 7-factor model and from the stepwise regression model to measure the performance of hedge funds. According to Ingersoll et al. (2007) and Titman and Tiu (2011), funds with low R-squared have higher alphas, information ratios, Sharpe ratios and manipulation-proof measures than high R-squared funds. As a result, the low R-squared funds outperform the high R-squared funds. Furthermore, Titman and Tiu (2010) found that investors recognize that low R-squared funds are likely to generate higher abnormal returns which justifies higher fees and results in higher capital inflows attraction for the low R-squared funds.

One concern related to hedge fund performance suggested by Ingersoll et al. (2007) is that funds may employ non-linear strategies to game their performance measures, which can lead to a negative relationship between

R-squareds and performance. In contrast to other performance measures, ranking based on adjusted R^2 values is executed so that funds having the smallest values are ranked into top portfolios and funds having the highest adjusted R^2 -values are ranked to bottom portfolios.

2.3 Ordinary least squares (OLS) regression

Following the studies of Jagannathan et al. (2010) and Pätäri and Tolvanen (2009) the OLS regression approach is applied to the cross-sectional analysis. The simple linear regression can be presented as follows:

$$y_i = a + \beta x_i + e_i \,, \tag{11}$$

Where y_i is the dependent variable, a is the intercept, β is the slope coefficient, x_i is the independent variable and e_i is the residual. Performance persistence would mean that β is statistically different from zero.

Nevertheless, according to Jagannathan et al. (2010, 230), statistically insignificant slope coefficient would not necessarily mean the lack of persistence, because the slope estimate can be biased towards zero due to measurement errors. In reality, measurement error is always present in estimates. Assume that

$$x_i = x_i^* + u_i \,, \tag{12}$$

$$y_i = y_i^* + v_i \,, \tag{13}$$

where x_i^* and y_i^* are true measures of relative performance, and the noise components u_i and v_i are independent from each other and from the true alphas. Hence the OLS slope coefficient from regression (14) is equal to

$$\beta_{OLS} = \frac{Cov(y_i,x_i)}{Var(x_i)} = \frac{Cov(y_i^*,x_i^*)}{Var(x_i^*)+Var(u_i)}\ , \tag{14}$$

As can be seen from regression 14, the error u_i in measuring x_i creates the downward bias in the naive estimate β_{OLS} compared to the true persistence estimate β^*, because

$$|\beta_{OLS}| = \left|\frac{Cov(y_i^*,x_i^*)}{Var(x_i^*)+Var(u_i)}\right| < \frac{Cov(y_i,x_i)}{Var(x_i)} = |\beta^*|\ , \tag{15}$$

Notice that the error in measuring y_i does not result in a biased estimate of persistence and it can be assumed without loss of generality that $y_i = y_i^*$. (Jagannathan et al. 2010, 230)

Residual term e_i represents unexplained variation after fitting a regression model. It is the difference between observed value y_i and the value $\hat{y}$ suggested by the model. (Easton and McColl 1997) In other words, e_i is the vertical distance from the regression line to each observation and can be expressed as follows:

$$\hat{e}_i = y_i - \hat{y} = y_i - a - bx_i\ . \tag{16}$$

The residual term is small and completely random in a desirable model. If the residuals are correlated, the OLS estimators are not BLUE (Best Linear Unbiased Estimates) anymore due to the fallacious mean errors. This can be corrected by using heteroskedasticity and autocorrelation consistent (HAC) errors, for example.

In the least squares approach, the distance between observations and the regression line is minimized. Hence, a line where the sum of squares of these differences is smallest should be pursued. This can be presented as follows:

$$S(\alpha,\beta) = \sum_{i=1}^{N}(y_i - \alpha - \beta x_i)^2 \ , \tag{17}$$

From the equation (17), we can derive estimates to parameters α and β:

$$b = \frac{N\sum x_i y_i - \sum x_i \sum y_i}{N\sum x_i^2 - (\sum x_i)^2} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sum(x_i - \bar{x})^2} \ , \tag{18}$$

$$a = \bar{y} - b\bar{x} \ . \tag{19}$$

The ordinary least squares approach is applicable, if the assumptions of the linear regressions are not harmed. Otherwise OLS estimates may not be BLUE (Best Linear Unbiased Estimates) anymore and some other approach should be applied.

Performance measures like Jensen’s alpha or Sharpe ratio are not adequate to measure abnormal performance with the ordinary least squares. This is because the measurement errors are likely to arise in context of hedge fund returns causing errors in variables. To illustrate the problem, two effects can be emphasized according to Cragg (1994, 1997). The first effect, “attenuation effect”, is the measurement error that biases the slope coefficient towards zero. The second effect, called “contamination effect”, means that measurement error “produces a bias of the opposite sign on the intercept coefficient when the average of the explanatory variable is positive” (Cragg 1994, 780). According to Cragg (1994, 1997), the bias of a given parameter depends on its own error (the attenuation effect) but also on the errors in all other variables (the contamination effect). (Coën and Hübner 2009, 113)

Instead of OLS, higher moment estimation (HME) techniques should be used as increasing body of the hedge fund literature uses option-based factors to explain hedge fund returns and hedge fund returns are usually nonlinear. The HME is not only suitable as a methodological treatment of errors in variables but it also enhances the explanatory power of most OLS cases. Furthermore, the performance of hedge fund strategies is widely modified when measurement errors are properly taken into account. When HME is applied, it alters the risk premiums attributable to the equity market risk, while errors in variables have no clear effect on the other risk sources. (Coën and Hübner, 2009, 113, 124) As a result, GMM based model using HME technique is applied in this thesis in order to reduce the bias caused by measurement error.

2.4 The General Method of Moments (GMM)

The General Method of Moments (GMM) model first introduced by Hansen (1982) has been very popular since then and has had a huge impact on econometrics. The basic idea is to choose model parameters so as to match the moments of the model to those of the data as accurately as possible. A weighting matrix decides the relative importance of matching every moment.

The key advantage to GMM over other estimation procedures is that the required statistical assumptions required for hypothesis testing are rather weak; the GMM offers a compromise between the efficiency and robustness to deviations from normality. It is a trade-off between statistical efficiency and economic interpretability of the results. Also except for some special cases, the results of GMM are asymptotic resulting in accurate estimates with large samples. (Cliff, 2003, 2)

According to Cochrane (2005, 271) the benefit of the GMM approach is that it allows a simple technique for evaluating nonlinear or complex models, for including conditioning information while not requiring the econometrician to see everything that the agent sees, and for letting the researcher to circumvent inevitable model misspecifications or simplifications and data problems.

Consider the following simple model

$$y_t = x_t\theta + e_t \text{ , t=1,...,T ,} \tag{20}$$

where y_t and e_t scalar, x_t is 1 x K and θ is K x 1 vector of parameters. In vector form, the equation (20) can be written as

$$Y = X\theta + E. \tag{21}$$

If x_t and e_t would be correlated, the OLS-estimators are not best linear unbiased estimators (BLUE) anymore, and a consistent estimator would be obtained by using instrumental variables (Z). The idea is to find 1 x L vector z_t that is as highly correlated with x_t as possible and simultaneously independent of residual e_t. z_t should have an effect on Y only via x_t. As a result, if x_t is uncorrelated with e_t, x_t itself should be used as an instrumental variable. In this way, all the simple estimators, like OLS, are special cases of Instrumental variables (IV)- and GMM-estimation. On the other hand, since instrumental estimators are less efficient than OLS estimators due to higher variance, they should only be used when necessary.

According to Hansen (1982), in order to achieve the most efficient parameter estimates, a quadratic form in the orthogonality conditions with a weighting matrix equal to the variance-covariance matrix of the orthogonality conditions should be minimized. According to Greene (2002, 23, 165), if the variables in a multiple regression are orthogonal (i.e. not correlated), then the multiple regression slopes are the same as the slopes in the individual sample regressions. In the context of linear model, the orthogonality conditions set means of functions of the data and parameters to zero. As a result, to obtain more efficient estimator than the OLS estimator, different weight to different equations have to be given.

Some asset returns may have much more variance than other assets. Therefore, it would be appropriate to pay less attention to pricing errors from assets with high variance. The optimal weighting matrix is achieved by achieving the lowest variance of the estimator. The most efficient estimator is achieved by weighing each equation by the inverse of its variances which proposes to choose the weighting matrix $(\sigma^2)^{-1}$. (Cochrane 2005, 182; Sørensen (2007, 3)

In practice, an optimal weighting matrix requires an estimate of the parameter vector but when the vector is unknown the parameter vector cannot be estimated with the criterion function with W=$(\sigma^2)^{-1}$. In this situation, one possibility to achieve a consistent but inefficient parameter is to set the initial weighting matrix to the identity matrix. The formula of nonlinear GMM estimation applied in this thesis is as follows:

$$Y = h(X, \theta) + U. \tag{22}$$

In nonlinear equation (22), the X-variable should be changed to $\frac{\vartheta h}{\vartheta \theta}$. Hence, the asymptotic variance of the estimated parameter would be:

$$var(\hat{\theta}) = (\frac{\vartheta h'}{\vartheta \theta}(\sigma^2)^{-1}\frac{\vartheta h}{\vartheta \theta})^{-1}, \quad (23)$$

where $(\sigma^2)^{-1}$ is the inverse of an estimator's variance.

In GMM framework, the model would be formulated as:

$$U = f(\tilde{X}, \theta), \quad (24)$$

where $\tilde{X}$= Y,X and $f(\tilde{X}, \theta) = Y - X\theta$. The tilde is dropped from equation (24) and the model is summarized by L orthogonality conditions:

$$EU(X, \theta) = 0 \ , \quad (25)$$

where U denotes a theoretical model. In GMM equation the orthogonality conditions are fixed. In rational expectations models, the theory usually suggests which variables will be valid instruments, although this is not always the case. (Sørensen, 2007)

If the number of orthogonality conditions is the same as the number of parameters the weighting matrix does not matter. This method is also applicable for other moments than for first moments. More generally, a model often implies that the moments are some nonlinear functions of the parameters, which can be found by matching the empirical moments with the models implied by the model. If exactly as many moment equations exist as there are parameters to be estimated, the case is exactly identified and there will be single solution to the moment equations, and at that solution, the equations are fully satisfied. But situations also exist where there are more moment equations than parameters. In this case the system is over determined. The GMM model allows more moments than parameters and that is allowed for instruments. (Sørensen, 2007; Greene 2002, 536)

As the covariance matrix of the disturbance terms is not usually diagonal (does not have same number of rows and columns) and there often exists heteroscedasticity (see Marshall and Tang, 2011) and autocorrelation in hedge fund returns (see Getmansky et al., 2004), the GMM model should be adjusted. In this research the covariance matrix is estimated by using Newey-West adjusted estimates.

2.5 Heteroskedasticity and autocorrelation consistent GMM model

The most commonly used continuous function (also denominated as “a kernel”) suggested by Bartlett and popularized by Newey and West (1987) is applied to this study. The estimator allows the possibility of serial correlation that causes the non-diagonal elements of the covariance matrix. The formula for the Newey-West robust covariance matrix estimator can be expressed as (Greene 2002, 200):

$$\hat{Q}_* = S_0 + \frac{1}{n}\sum_{l=1}^{L}\sum_{t=l+1}^{n} w_l\, e_t e_{t-l}(x_t x'_{t-l} + x_{t-l}x'_t);\ w_l = 1 - \frac{l}{(L+1)}, \quad (26)$$

where S_0 is the matrix of mean squares and cross products of the residuals, w_l denotes a set of weights called a lag window, L is the maximum lag length, $e_t e_{t-l}$ are the least squares residuals, $x_{t-l}x_t^{'}$ is the k x k deviation sums of squares and cross products matrix for x_{t-l} and the transpose of x_t. According to Greene (2002, 267) “the maximum lag must be determined in advance to be large enough that autocorrelations at lags longer than L are small enough to ignore”. On the other hand, if the bandwidth parameter (also referred to as smoothing parameter) is unusually large due to high lag length, the matrix estimate and standard error estimate may be inaccurate. In this study, the maximum lag length is set to 3 in portfolio analyses, while in the analysis, where the alphas and r-squared are calculated to individual funds, the maximum lag length is 1. These lengths were determined empirically by comparing different lags in the SAS program and the largest lag lengths that gave accurate results were chosen.

2.6 Style-adjusted Fung-Hsieh 8-factor model

If a hedge fund would have positive performance persistence, it would indicate that the hedge fund manager has superior skills relative to his or her peers. However this kind of information is not beneficial for the investors, if it is not measured against set of market factors. (Jagannathan et al. 2010, 229)

According to Fung and Hsieh (2004), a properly build risk-factor model can reveal vital information about the risk profile of a hedge fund portfolio. It provides important hints where the average fund of hedge funds was placing its bets, how these bets varied over time, and whether the average fund added value beyond systematic bets on the asset-based style factors. This is something that a simple index and its return statistics cannot indicate.

To capture such performance and account for potential smoothing of reported returns, the Fung-Hsieh 7-factor model is applied. It is the most widely used model to evaluate the performance of hedge funds. The model uses diversified portfolios of hedge funds and captures the common systematic risk factors associated with the portfolios. The Fung-Hsieh 7-factor model can be presented as follows (Fung and Hsieh 2004):

$$R_{i,t} = \alpha_i + \beta_1 Wilsh_t + \beta_2 Changeinm_t + \beta_3 Changeins_t + \beta_4 PTFSBD_t + \beta_5 PTFSFX_t + \beta_6 PTFSCOM_t + \beta_7 World_t + \varepsilon_{i,t} \;, \qquad (27)$$

where $R_{i,t}$ denotes the monthly excess return(in excess of the risk-free rate) series of portfolio i at time t, α_i is the intercept which denotes the abnormal performance of portfolio i over the regression time period after controlling the common risk factors, $Wilsh_t$ is the difference between Wilshire Small cap 1750 return and Wilshire Large Cap 750 return indicating size spread, $Changeinm_t$ denotes the change in the constant maturity yield of the US Federal reserve 10-year Treasury, $Changeins_t$ is the excess return on the Moody's Baa minus the 10-year constant maturity yield indicating credit spread, bond PTFS(PTFSBD), currency PTFS(PTFSFX), and commodities PTFS(PTFSCOM), where PTFS denotes primitive trend following strategy, $World_t$ denotes the All-Country WORLD –index minus risk-free rate and $\varepsilon_{i,t}$ is the error term. According to Fung and Hsieh (2004, 78) the set of Asset Based Style factors that offers the most direct link to conventional asset class indexes should be used. In this study, the AC WORLD –index is used rather than Standard&Poor's 500, because the data comprises of funds all over the world. The $Wilsh_t$ and $World_t$ factors measure the stock market risk and the spread, $Changeinm_t$ and $Changeins_t$ are fixed-income factors, while $PTFSBD_t$, $PTFSFX_t$ and $PTFSCOM_t$ are trend-following factors.

Following the research of Jagannathan et al. (2010, 248-249), an absolute performance of a portfolio during the holding period ($R_{i,t}$) was obtained in the following way. Funds were sorted based on their past relative performance in the selection period, and then divided into portfolios. Next, one dollar is invested in every portfolio in the beginning of the holding period, and a portfolio's dollar is equally split among all the funds in the given portfolio. If a fund disappears during the holding period, its money is reinvested among the surviving funds in the portfolio. As a result, an absolute return series for the portfolio was achieved.

The portfolio approach reduces performance measurement errors, and increases the accuracy of the Fung and Hsieh (2004) model. Furthermore, it allows taking into account the performance of funds that disappeared from the sample during the holding period, as they remain in their portfolios up to the time of their disappearance from the database. Every portfolio's out-of-sample performance during the holding period and in-sample past performance during the selection period is calculated using the performance metrics. (Jagannathan et al. 2010, 249)

According to Fung and Hsieh (2004, 72), the seven factors can explain a significant part (up to 80 per cent) of monthly return variations in hedge fund portfolios. On the other hand the explanatory power regarding to the individual hedge funds is much lower. Also as Kosowski et al. (2007, 238, 246) point out, there may exist an omitted factor that is not included in the Fung and Hsieh (2004) multifactor model. If the model neglects the omitted factor, the alpha t-statistics may be upward biased and this may lead to wrong conclusion, that fund managers would have security selection ability. Moreover, as the average hedge fund has a quite short time series, it reduces the precision on which performance measures like alpha can be estimated.

According to Racicot and Théoret (2009), estimation of financial models in the context of hedge fund returns often leads to abnormally high alphas.

On contrast, previous studies of mutual funds have reported the alpha to be zero or even negative in case of mutual funds. This illogicality is also called the alpha puzzle, which means that if no bias is found in the estimation of the alpha of hedge funds, then the financial markets are not efficient. Racicot and Théoret (2009, 38) show that adding an alternative factor, which takes into account the conditional volatility of returns, is one efficient way to incorporate the interaction between the alpha and the innovation of a model of returns and to achieve an estimate of alpha, which is more related to the term of market efficiency. In their research, Racicot and Théoret (2009) followed the research of Kuenzi and Xu (2007) and added the return of a short put on the Standard and Poor's 500, where the underlying volatility was the VIX. The VIX is a popular indicator of financial market instability, thus very suitable to explain hedge fund returns. Furthermore, many hedge funds have payoffs that are similar to those of a short put. As a result, when adding the factor to the model, lower average alphas were reported.

At first, regressions were analysed using the Fung-Hsieh 7-factor model. The results showed that alpha estimates and t-statistics were upward biased as almost every estimate was positive. Following the research of Pätäri and Tolvanen (2009) and Harri and Brorsen (2004), one additional factor was added in the model in order to improve the applicability of the model for hedge fund portfolio selection. The style factor for each fund category was included in order to discern the funds' true abnormal performance, in other words, the performance beyond following a particular fund style. When the style factor was added to the model, the prediction power of the model improved and alpha estimates became more significant and were not upward biased anymore.

Racicot and Théoret (2009, 60) suggest that no universal method exists to achieve a lower alpha. In their research, higher moments of returns that are dimensions of risk, have different effects on different strategies. They suggest that the method used varies with the strategy and therefore every hedge fund strategy must be analysed separately. Following this conclusion, the style factor was added to the Fung-Hsieh 7-factor model in order to capture appropriate risk related with different strategies.

When a fund joins to the database, it is given an option to select a strategy from the list. These strategies are then used in calculation of monthly self-reported style indices. The style indices are calculated as returns on equally weighted portfolios of all funds using the same strategy. (Jagannathan et al. 2010, 235)

The style-adjusted Fung-Hsieh 8-factor regression model used in this study can be presented as follows:

$$R_{i,t} = \alpha_i + \sum_{k=1}^{K} \beta_{i,k} F_{k,t} + \varepsilon_{i,t} \, , \qquad (28)$$

where $R_{i,t}$ is the monthly excess return (in excess of the risk-free rate) series of the portfolio *i* at time *t*, α_i is the intercept denoting the abnormal performance of fund or portfolio i over the regression time period, $\beta_{i,k}$ is the factor loading of hedge fund or portfolio *i* on factor *k* during the regression period, $F_{k,t}$ is the return of factor *k* at time t and $\varepsilon_{i,t}$ is the error term.

2.7 Newey-West adjusted Opdyke test

Many previous papers have discussed implications on statistical comparison of Sharpe ratios (see Lo (2002), Opdyke (2007)). However, the problem is that the simple and easily-implemented solution for the case of general stationary data to exempt both normality and independent and identically distributed (I.I.D.) assumptions at the same time does not exist. Thus, instead of trying to improve statistical estimates to be valid under general I.I.D. conditions (ie. when normality and I.I.D. assumptions hold at the same time), the Sharpe ratios can be adjusted to take account such characteristics of return distributions that are caused by violations of such conditions (see for example Titman and Tiu 2011, Getmansky et al. 2004, Di Cesare et al. 2011, Zakamouline and Koekebakker 2009, Pätäri 2011). However, neither of these methods can cope with simultaneous violation of normality and I.I.D. assumptions. The test procedure that captures both the impact of the violation of normality assumption and that of I.I.D. assumption on statistical inference is introduced next.

Apart from majority of the hedge fund research, this thesis takes also the third and the fourth moment of return distribution to account and employs the Newey-west autocorrelation adjusted variances in calculating the performance differences. In order to capture the impact of the violation of normality assumption and I.I.D. assumption on statistical inference, Newey-West corrected variances are employed in this thesis. The refinement is carried out by adjusting the variance and the related terms with autocorrelation correction accordingly to the Newey-West (1987) to get valid test statistics also under general I.I.D. conditions (Lo 2009, 82):

$$\hat{\hat{\sigma}}_{NW}^2 \equiv \frac{1}{T}\sum_1^T (R_t - \hat{\mu})^2 + \frac{2}{T}\sum_{j=1}^m \left(1 - \frac{j}{m+1}\right) \sum_{t=j+1}^T (R_t - \hat{\mu})(R_{t-j} - \hat{\mu}), \qquad (29)$$

where $\hat{\mu}$ is the sample mean of $\{R_t\}$. For the Newey-West adjustment, total of 23 lags are utilized.

The Newey-West adjusted variances are employed to the test of Opdyke (2007). The Opdyke test considers the case of general I.I.D. data (i.e., not necessarily normal) and corrects the formulae for the limiting variances of Lo (2002, Section "IID Returns") and of Memmel (2003), respectively, which assume normality. He also considers the case of general stationary data (i.e., time series) and suggests the skewness- and kurtosis-adjusted formula for the calculation of asymptotic variance of the test statistic as follows:

$$Var_{diff} = 2 - SR_a \frac{\mu_{3a}}{\sigma_a^3} - SR_b \frac{\mu_{3b}}{\sigma_b^3} + SR_a \frac{\mu_{1b,2a}}{\sigma_b \sigma_a^2} + SR_b \frac{\mu_{1a,2b}}{\sigma_a \sigma_b^2} + \frac{{SR_a}^2}{4}\left[\frac{\mu_{4a}}{\sigma_a^4} - 1\right] + \frac{{SR_b}^2}{4}\left[\frac{\mu_{4b}}{\sigma_b^4} - 1\right] - 2\rho_{a,b} - SR_a SR_b \frac{1}{2}\left[\frac{\mu_{2a,2b} - \sigma_a^2 \sigma_b^2}{\sigma_a^2 \sigma_b^2}\right] = 2 - SR_a \frac{\mu_{3a}}{\sigma_a^3} - SR_b \frac{\mu_{3b}}{\sigma_b^3} + SR_a \frac{\mu_{1b,2a}}{\sigma_b \sigma_a^2} + SR_b \frac{\mu_{1a,2b}}{\sigma_a \sigma_b^2} + \frac{{SR_a}^2}{4}\left[\frac{\mu_{4a}}{\sigma_a^4} - 1\right] + \frac{{SR_b}^2}{4}\left[\frac{\mu_{4b}}{\sigma_b^4} - 1\right] - 2 * \left[\rho_{a,b} + \frac{SR_a SR_b}{4}\left[\frac{\mu_{2a,2b}}{\sigma_a^2 \sigma_b^2} - 1\right]\right], \qquad (30)$$

where the variances are corrected with the Newey-West adjustment.

The final test statistic of performance difference between two portfolios (*i*, *n*) can be given as follows (Memmel, 2003):

$$Z = \frac{Sh_i - Sh_j}{\sqrt{V}}, \qquad (31)$$

where Sh_i and Sh_j are the Sharpe ratios of portfolios *i* and *j* and $\sqrt{V}$ is the asymptotic variance obtained from equation (30).

A statistically significant Z-statistic would implicate that the portfolio with the higher Sharpe ratio outperforms the other portfolio and as a result, significant Z-statistic would mean the rejection of the equal risk-adjusted performance on the holding period between the two portfolios.

2.8 The alpha spread test

Following the study of Pätäri et al. (2010) the statistical significance of differences between portfolio alphas is also tested by using the appropriate alpha spread as follows:

$$t = \frac{\alpha_i - \alpha_j}{\sqrt{SE_{\alpha i}^2 + SE_{\alpha j}^2}}, \quad (32)$$

where α_* is 8-factor model alpha of portfolio * and $SE_{\alpha *}$ is standard error of portfolio *.

The degrees of freedom for the test statistic are given as:

$$v = \frac{\left(SE_{\alpha i}^2 + SE_{\alpha j}^2\right)^2}{\frac{SE_{\alpha i}^4}{v_i} + \frac{SE_{\alpha j}^4}{v_j}}, \quad (33)$$

Where v_i and v_j are the degrees of freedom determined on the basis of number of time series returns in samples *i* and *j (v = n - 1).*

Throughout the thesis the Newey-West (1987) standard errors are used in statistical tests to avoid problems related to autocorrelation and heteroscedasticity.

The alpha spread test indicates performance persistence, if the top-performing funds of the selection period also remain top performers during the holding period. This kind of performance consistency leads to positive and statistically siginificant alpha spread. Moreover, both the alpha spread test and the Sharpe ratio performance difference test may give some explanations for possible persistence.

3 DATA DESCRIPTION

Three major hedge fund database providers exist that are typically used in hedge fund academic studies (see Liang and Park, 2007, 337): Center for International Securities and Derivatives Markets (CISDM, formerly Managed Account Reports, contains 4,200 active and 2,000 inactive funds at present), Hedge Fund Research (HFR, 6,000 active and 3,500 inactive funds), and Tremont Advisory Shareholders Services (3,900 active and 2,400 inactive funds). These three databases have also been used in combination. The data of this study was provided by two grand databases; the HFI and Tremont database. HFI database contains over 10,500 hedge funds and Tremont database over 3,900 funds.

According to Eling (2009, 368-369), no clear answer is found in the hedge fund literature to the question of which investigation period to select in measuring performance persistence. There are studies with very short investigation periods of only three years (see Agarwal and Naik 2000) but also studies with very large time periods up to 21 years (see Harri and Brorsen 2004). The consideration of returns prior to 1994 may not be too meaningful due to the survivorship bias prior to that year (Liang, 2000). In addition, it is vital not to use extremely long time periods, as hedge fund managers typically do not work for more than ten years with the same hedge fund (see Boyson and Cooper, 2004). As performance persistence is mostly related with the unique skills of a hedge fund manager, extremely long investigation periods (over 10 years) should not be applied.

Because the time series returns obtained from Tremont database starts at the beginning of 1996, the first two years (years 1994 and 1995) from the return series of HFI database were excluded to obtain better comparability. As a conclusion, the combined data comprises hedge funds world widely covering the years from 1996 to 2007 and consists of monthly returns on a sample of hedge funds. After controlling the backfilling bias, the investigation period is set to nine years (years 1998-2007. According to Ackermann et al. (1999, 839), monthly returns have strong advantages over other returns. Monthly returns greatly enhance the accuracy of standard deviation measure of risk as the estimates are based on much higher number of observations compared to yearly returns, for example. Apart from quarterly, biannual and annual returns, monthly returns do not smooth large variations in returns caused by external market forces and dynamic hedge fund strategies. Given the importance of risk-adjusted returns and direct analysis of hedge fund risks, this accuracy is critical. In addition, as nowadays major part of the hedge fund studies uses monthly returns in their analyses, monthly returns are also used in this research.

At first, when the HFI and Tremont databases were merged, duplicate share classes of the same fund family and funds that had the same name up to one fund having the designation “offshore” and the other having the designation “onshore”, or funds that were otherwise duplicates, were removed so that the fund with a shorter time series history was eliminated. However, in most cases, monthly returns reported to databases were identical. In these cases, one or the other was eliminated.

When excluding duplicate classes and funds providing returns in currencies other than US dollars is adequate to eliminate most situations of the same hedge fund appearing multiple times in the database, it does not entirely resolve the problem. For example, two funds can be run by same manager, appear in the same database, and have the same name up to one fund being an “LP” and other being “investment” or “limited company”. These situations are common in fund companies organized with a master-feeder fund structure where capital is channelled to one investing master fund funded by multiple feeder. (Agarwal et al. 2004, 4) Following the research of Pätäri (2011, 82), a filter rule concerning duplicates suggested by Aggarwal and Jorion (2010) was also applied into this study. According to the rule, any duplicate whose returns are 0.99 correlated or more with the remaining fund, were eliminated from the final sample.

To eliminate the backfill bias, 24 first observations from the monthly return series were removed. Because the shortest selection period was 24 months, funds that had less than 24 monthly observations after controlling the backfill bias were excluded from the sample. The shortest selection period is set to 24 months because this is the minimum length for computing meaningful performance measures (see Ackermann *et al*., 1999; Gregoriou, 2002; Capocci and Hübner, 2004; Liang and Park, 2007). To avoid survivorship bias in quantile analyses, the full time series of holding period returns were not required. In addition, note that in cross-sectional regression analysis the minimum length of returns is set to three years after the elimination of backfill bias since at least two year selection period and one year holding period must be employed. As the returns of the funds used in this study were all originally quoted as in US dollars, there was no need to convert the returns to US dollars.

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The funds are divided into different style classes according to the classification of databases. To get consistent results, funds that belong into small fund classes were excluded. The fund class was defined as too small if it did not include 18 or more funds in any of selection periods. After the qualification 11 classes were included. These classes were distressed securities (DS), equity market neutral (EMN), fund of funds (FoF), Macro (M), Event Driven (ED), managed futures (MF), emerging markets (EM), multi strategy (MS), long/short (L/S), fixed income (FI) and convertible equity arbitrage (CEA). Finally after controlling various biases, removing duplicates and excluding small fund classes from the data, the data sample of this study consists of 3,144 funds.

The MSCI All-Country World Index, the Wilshire Small Cap Index, the Wilshire Large Cap Index, US treasury securities at 10-year constant maturity and Moody's Baa Bond Index are from DataStream. The 3-month US Treasury Bill is from the Federal Reserve database and indices for PTFSs are from the internet pages of the Fuqua School of Business.[1] 11 different style indices of hedge funds are obtained from the TASS database.

3.1.1 Potential biases and elimination

As found in many hedge fund studies, hedge fund data is far away from unbiased, which can generate potential biases. One of the most severe biases in hedge fund performance measurement is backfilling bias. Backfilling bias is the result of adding a hedge fund whose previous good returns are backfilled between the inception date and the date it enters the database, when bad track records are not backfilled. The backfilling is particularly problematic when individual managers can establish multiple funds. For example, managers can only report the returns of the successful funds from the funds he or she started. (Titman and Tiu 2010, 130) The common practice in hedge fund academic research (see Kosowski et al., 2007; Malkiel and Saha, 2005) for handling the backfilling bias is to drop the first 12 or 24 months of returns. However, according to Titman and Tiu (2010) there still preserves backfill bias for the 50% of the funds with backfill longer than 1 year. Therefore, backfill bias was controlled in this study by excluding the first 24 months from the return series and so the data used in this study starts in the beginning of 1998.

Survivorship bias is also a problem in hedge fund data. Reporting to hedge fund databases is voluntary, and funds may stop reporting for a plenty of reasons. Survivorship bias occurs if the database contains only

[1] Available at: http://faculty.fuqua.duke.edu/~dah7/DataLibrary/TF-Fac.xls

information on surviving funds and excludes defunct funds, which stop reporting for example because of bankruptcy or liquidation. As a result, the data is downward biased as the “graveyard” funds that create upward bias are removed from the data. (Géhin, 2004; Titman and Tiu 2010, 129) According to various studies (see Fung and Hsieh, 2000; Brown et al., 1999) the performance difference between the surviving funds and a portfolio of all funds is estimated to be about 3% annually. Survivorship bias was a major problem before 1994, because data editors discarded funds that stopped reporting. But since 1994, “graveyard” funds which ceased reporting have been included to the databases. This inclusion has minimized the survivorship bias. (Titman and Tiu 2010, 130) As the databases of this study contains graveyard sample and the data starts from 1996, the survivorship bias was minimized. However, in cross-sectional analysis full time-series of holding period returns from sample funds are required, which raises some survivorship bias.

Look-ahead bias emerges because the employed methodology explicitly or implicitly conditions upon survival over a number of consecutive periods. Look-ahead bias occurs, when funds disappear in a non-random way during the ranking or selection period. This bias is not corrected even if a survivorship free data is used. If look-ahead bias is ignored, average returns may be overestimated. Especially for hedge funds, whose attrition rates are high, correcting for look-ahead bias is quite important. (Baquero et al., 2005,494-495, 515; ter Horst et al., 2001, 347) Look-ahead bias occurs due to fund liquidation or self-selection. According to Pätäri (2008), self-selection bias stems from the voluntary nature of data provision. It exists in mainly because underperforming funds do not necessarily send their records to data vendors.

A self-selection bias may also occur in the context of fund mergers when a fund management company launches two funds at year-end, and decides to merge the underperformed fund with the outperformed fund at the end of the next year. When there is usually some delay before a fund's records are sent to the administrator of hedge fund database the firm may be tempted to provide the full record of the outperformed fund while omitting the data of the underperformed fund. It is therefore likely that firms can sometimes use this opportunity as timing option which creates a distinct potential for upward performance bias and attracts new inflows from individual investors, as the outstanding past performance has been shown to be the predominant criterion in fund selection (see Jagannathan et al., 2010, for evidence in the hedge fund context). This bias is also called as incubation bias.

On the other hand, according to Titman and Tiu (2011, 130) and Géhin (2004), upward bias is limited because funds with a great performance close quickly. They may have reached their goal (for example assets under management or target size) and do not have any reason to "advertise" anymore. These two phenomena overrule each other in a comprehensive database. According to Pätäri (2011, 82), incubation bias is usually controlled by excluding the first 12 monthly returns of every fund. The incubation bias is eliminated or at least alleviated in this study simultaneously as the backfill bias is controlled by excluding the first 24 months of the funds' return series. According to Aggarwal and Jorion (2010) some trade-offs related to using simple age filters in controlling incubation bias exists, but as the bias is not crucial to the robustness of the results, this simple age filter method is established in this thesis.

3.1.2 Hedge Fund strategies

The classification of hedge fund strategies is based on the Tremont and HFI databases. When a hedge fund joins the HFI or Tremont databases, it has to choose a class from the given options that matches best to its strategy. Based on these choices the hedge funds are separated to 11 different classes in this study.

Neither a legal definition of hedge fund strategies, nor an official classification does exist. As a result, class definitions are obtained from other studies or directly from TASS documentation.

3.1.2.1 Distressed Securities

Distressed securities class consists of funds that invest in both equity and debt of companies that are near bankruptcy or in bankruptcy. These investments include buying the securities of companies that are near, in or emerging from bankruptcy, shorting securities of a company that is near bankruptcy and purchasing another class of the securities of the same company, and owning the securities of bankrupt firms and participating in the bankruptcy proceedings. Most funds following distressed securities strategy are mainly long due to illiquidity of distressed assets and difficulty of short sales. On the other hand, some relative value trades are possible, for example selling short one class of a distressed securities and buying another. (Schneeweis et al., 2003, 13)

Because of many risks involved in distressed securities (like the time lag between the investment is made and the value realized and the legal and monitoring costs involved in these securities), many funds ease these risks through diversification. The strategy is based on the assumption that, on average, a widely diversified distressed assets portfolio will prove to be underpriced. Distressed securities are underpriced because investors prefer to avoid them; investor has a potential career risk associated with holding securities that lose all their value and a headline risk related to actively pressing claims against a bankrupt firm. The returns of the strategy are positively affected by a decrease in one's discount rate, decrease in economic stress of the firm acquired, market factors increasing the probability of bankruptcy success and reducing required risk premium. (Schneeweis et al., 2003, 13)

3.1.2.2 Equity Market Neutral

The strategy depends heavily on the skill of the manager in identifying the value of a security, because the managers base their investment decision on their view of whether the security is under- or overvalued relative to current market prices. The key for this strategy is to exploit equity market inefficiencies. The manager also aims the portfolio to be cash or beta neutral, or both. Usually the portfolio will have a small or zero net market exposure. Equity market neutral portfolios are designed to have low exposure to various market factors and this signifies to equal weights in long and short positions. Leverage is often utilized to improve returns. As the funds following the equity market neutral strategy have low exposure to market factors, increasing interest rates or unstable market conditions may negatively affect to the ability to acquire shorts or to leverage the positions. (Schneeweis et al., 2003, 14)

3.1.2.3 Fund of Funds

Fund of funds invest in numerous hedge funds and usually have lower minimum investment requirements. Fund of funds allocate their assets among various management styles, such as equity market neutral, convertible arbitrage, event driven, long/short, dedicated short bias or macro. In addition, most fund of funds diversify within style by picking several fund of that type. As a result, fund of funds are typically made up of 20 to 40 individual hedge funds. (Kosowski et al., 2007, 235; Ennis and Sebastian 2003, 104)

3.1.2.4 Macro

The strategy includes leveraged bets in liquid market on interest rates, foreign exchange, anticipated stock market price movements and physical commodities. These factors pursue a base strategy e.g. long/short to which highly leverage bets in other markets are added a couple of times every year. The macro strategy funds seek opportunity after another and trend after trend. The funds aim to anticipate price changes early and not to utilize market inefficiencies. (Favre and Galéano 2001,452)

3.1.2.5 Event Driven

The strategy is also known as the "corporate life cycle" investing. The strategy aims to identify investment opportunities that benefit from specific market conditions or events. The event driven funds focus on taking positions in companies, which are anticipated to involve in bankruptcies, mergers or other special situations. Thus, the event driven class consists of funds following multiple event strategies. The returns of funds following event driven strategy may be based on fundamental research as well as directional market returns (for example reduction in credit risk and positive changes in equity markets). The asset prices of the firms involved in remarkable transactional events are usually influenced more by the dynamics of the particular event than by common appreciation or depreciation of the equity and debt markets. (Schneeweis et al. 2003, 13; Favre and Galéano 2001,451; Tass documentation 2011).

3.1.2.6 Managed Futures

Managed Futures funds (often referred to as CTAs or Commodity Trading Advisors) invest in listed bond, equity, commodity futures and currency markets, globally. Managers tend to employ systematic trading programs that largely rely upon historical price data and market trends. A significant amount of leverage is employed, since the strategy involves the use of futures contracts. CTAs do not have a particular bias towards being net long or net short in any particular market. (Tass documentation 2011)

3.1.2.7 Emerging Markets

Fund following emerging market strategy invest in securities of firms or the sovereign debt of developing or emerging countries. Because most emerging markets allow only limited short selling and do not offer a considerable futures contract to control risk, and emerging markets are more volatile than developed ones, the emerging market style is one of the most volatile hedge fund styles. As a result, hedge funds in emerging markets have a strong long bias. (Favre and Galéano 2001,451)

3.1.2.8 Multi Strategy

Multi-Strategy funds are characterized by their ability to allocate capital based on perceived opportunities among several hedge fund strategies. Through capital diversification, managers seek to consistently deliver positive returns regardless of the directional movement in equity, interest rate or currency markets. The added diversification benefits reduce the risk profile, help to smoothen returns, reduce volatility, and decrease asset-class and single-strategy risks. Strategies adopted in a Multi-Strategy fund may include, but are not limited to, styles like convertible bond arbitrage, equity long/short, statistical arbitrage and merger arbitrage. (Tass documentation 2011)

3.1.2.9 Long/Short

Long/Short Equity funds invest on both long and short sides of equity markets, generally focusing on diversifying or hedging across specific sectors, regions or market capitalizations. Managers have the flexibility to shift from value to growth; small to medium or large capitalization stocks; and net long to net short. Furthermore, managers can also trade equity futures and options as well as equity-related securities and debt, or build portfolios that are more concentrated than traditional long-only equity funds. (Tass documentation 2011)

3.1.2.10 Fixed Income

Fixed income strategy groups all strategies together, which can be performed with fixed income instruments like diversified-, convertible-, arbitrage-, high yield- and mortgage bonds. The strategy is implemented via long and short bond positions, via derivatives or cash markets in corporate, government, and/or asset-backed securities. Risk depends on credit exposure, duration, and the degree of leverage used. (Agarwal and Naik 2000, 340; Favre and Galéano 2001,451-452)

3.1.2.11 Convertible and Equity Arbitrage

The strategy attempts to benefit from anomalies in prices of corporate convertible securities, such as warrants, convertible bonds, and convertible preferred stock. The managers usually take long positions in these securities and hedge the associated risks, such as changes in expected volatility of the stock, changes in the price of the underlying stock and changes in level of interest rates. The aim for the managers is usually to achieve a delta-neutral total position, but some deliberately over-hedge because of concern about default. The strategy makes money, when expected volatility increases, pay-time decay or stock price increases sharply. As long as convertible securities remain underpriced, a strategy that buys the debt and hedges the risks associated with it should earn risk-adjusted returns that are related to exposure to the stock option. To the degree that the fixed income and equity exposures are not fully hedged, the strategy should earn positive returns because of positive exposures to bond and equity markets and improvements in credit quality. (Schneeweis et al. 2003, 12)

4 METHODOLOGY

Six different performance metrics, six different combinations of selection and holding periods and three persistence tests are used in this study to find out, whether there is any superb performance metric that outperforms others in detecting performance persistence. Performance metrics examined are raw return, Sharpe ratio, Mean variance ratio, skewness- and kurtosis-adjusted Sharpe ratio, alpha t-values and adjusted R^2-values both obtained from the style-adjusted Fung-Hsieh 8-factor model. Several models have been employed in order to evaluate the performance of hedge funds. Following the majority of hedge fund studies (for example Titman and Tiu, 2011; Jagannathan et al., 2010; Pätäri and Tolvanen, 2009; Kosowski et al., 2007), the Fung and Hsieh (2004) multifactor model is utilized to this study.

Following the previous studies of Pätäri and Tolvanen (2009) and Kosowski et al. (2007), Newey West (1987) standard errors are used in statistical tests to avoid econometric problems stemming from autocorrelation and heteroskedasticity. In addition, Jarque and Bera (1980) normality test is conducted for each return distribution to check for normality.

In order to shed some light to the selection of performance measure for the selection period and combination of selection and holding period utilized in hedge fund research, comprehensive assortment of performance metrics and period combinations are explored in this study in order to discover the best method for performance selection and to benefit from performance persistence.

4.1 Cross-sectional regression analysis

One method to examine performance persistence is to use the method of cross-sectional regressions. The method has been employed in several previous studies (e.g., see Bollen and Busse, 2005; Pätäri and Tolvanen, 2009; Jagannathan et al., 2010).

In order to test the prediction power of performance persistence in hedge fund returns for different performance metrics, cross-sectional regressions were used. In cross-sectional regression, performance metrics of the holding period are regressed with the corresponding metrics from the selection period. Note that in contrast to the quantile portfolio comparison, funds are required to have complete return series during both selection and holding period in cross-sectional analyses. This may raise some survivorship bias, which cannot be avoided in the cross-sectional samples. Equation (34) presents the cross-sectional regression:

$$P_{i,t} = \alpha + \beta P_{i,t-1} + \varepsilon_{i,t} \text{ , i=1,2,...,N ,} \quad (34)$$

where $P_{i,t}$is the performance metric of fund i at time t, α is the intercept, β is the slope coefficient, and $P_{i,t-1}$is the performance metric of fund i at time t-1. $\varepsilon_{i,t}$ is the error term. In cross-sectional regression (34), the existence of persistence implies that the slope coefficient β differs statistically from zero. In addition, positive estimates for the slope coefficients with significant t-statistics indicate that past performance predicts the future performance on the subsequent period. On the other hand, negative statistically significant slope coefficients would indicate performance reversal. Furthermore, the higher the r-squared obtained from the cross-sectional regression, the stronger the explanatory power of the past performance. (Jagannathan et al. 2010, 230)

In this study, total of 6 different performance metrics and six different combinations of selection and holding periods were used to evaluate the performance persistence. In cross-sectional analysis, total of 36 regressions were run and based on the results, four combinations of selection and holding periods and three performance metrics with the best prediction power were chosen to the decile and quartile portfolio analysis.

4.2 Spearman rank correlation test

Following the research of Allen and Tan (1999),Harri and Brorsen (2004) and Eling and Schuhmacher (2007), the Spearman rank correlation test is employed in this study in order to examine the persistence in fund performance. Because the Spearman rank correlation test is a nonparametric test of association, it does not depend upon the underlying empirical distribution of the performance measure and, furthermore, is not influenced by extreme observations. In addition, the test grants additional insight into both the direction and the strength of the relationship between subsequent and prior period performance. (Sauer 1997, 555)

Under Spearman's rank correlation test, performance rankings are compared for different time periods. If persistence is found, the correlation between the rankings of two consecutive periods should be relatively high, while a correlation coefficient of 0 indicates the lack of persistence. (Eling 2009, 371) The rank correlation estimate can be calculated using the following equation (35):

$$\rho_s = 1 - \frac{6\sum D^2}{n(n^2-1)}, \qquad (35)$$

where ρ_s denotes the rank correlation coefficient, D is the difference between selection and holding period ranks of a fund and n is the number of funds. Because the correlation coefficient follows asymptotically a t-Student distribution, the statistical significance can be tested using the t-test (Casarin et al. (2008, 10)). The t-test can be expressed as follows:

$$t = \rho_s \left(\frac{(n-2)}{(1-\rho)^2}\right)^2, \qquad (36)$$

where ρ_s is the Spearman correlation coefficient and n is the number of funds.

The Spearman's rank order correlation gets values between -1 and 1, where -1 indicates that the first ranking is the opposite of the second, and value 1 indicates that the rankings are identical. 0 means that the rankings are completely independent. The null hypothesis assumes that no persistence is found in performance and therefore past return information is useless in predicting the future performance. As a result, if the fund rankings show persistence, the coefficient should be statistically significant and positive. In case of a statistically negative Spearman rank correlation coefficient, rational investors would sell hedge funds, which have performed well in the past and replace them with funds that have performed poorly in the prior period. This situation can also be called as performance reversal. Finally, if the coefficient would be insignificant or zero, it would indicate that past performance rankings are not useful in predicting future performance. (Sauer 1997, 556)

The Spearman rank correlation procedure in this study goes as follows: After measuring the performance of funds in selection periods and holding periods, the funds are ranked based on the performance measure. After the ranking the ranks from selection and holding periods are compared in order to find out, whether performance persistence exists. For the Spearman correlation test, the performance is measured with the same three performance metrics and combinations of selection and holding periods as used in quantile analyses. The Spearman rank correlation test is also conducted to each fund style separately.

For each combination of selection and holding periods, Spearman's ρ_s are calculated for rankings based on each performance measure. This study follows the methodology applied by Pätäri (2011): Since the values of Spearman's ρ are not directly comparable for different sample sizes, the size-adjusted rank correlation coefficients for each subsample on the basis of the significance level of the original rank correlation coefficients are calculated. The size-adjusted rank correlations are calculated for a sample of 100 funds, implying that the rank correlation is significant at the 1% (5%) level in cases for which the size-adjusted Spearman's ρ exceeds 0.2565 (0.1966).

4.3 Quartile portfolio analysis

Following previous studies of Fung et al. (2002), Pätäri and Tolvanen (2009) and Titman and Tiu (2011), the quartile portfolio analysis is also implemented in this study in order to examine the performance persistence of different fund styles. The quartile portfolios are formed based on selection period performance and the portfolios' performances are then compared with the subsequent holding period. The first quartile portfolio contains the best performing 25 per cent of the funds and the bottom quartile contains the quarter of worst performers within the same style during the selection period. With quartile portfolio analysis, the performance persistence of a certain fund style can be analyzed. The quartile division is used in analyzing style-specific performance persistence as the sample sizes of some hedge fund strategies were relatively small.

Following the methodology of this study, each fund is ranked by their alpha t-value, MVR and Sharpe ratio over the previous 24 or 36 months. Then the quartile portfolios are formed for each style based on the fund rankings on different performance measures. These portfolios are then held for 24 or 36 months, and the quartiles are rebalanced for every January. Depending on the combination of selection and holding periods employed we get monthly stacked excess return time series from 1/2000 to 12/2007, or from 1/2001 to 12/2007 including 144 (selection period 36 months and holding period 24 months), 180 (selection period 36 months and holding period 36 months) or 216 (selection period 24 months and holding period 36 months) observations. A fund that disappears during the course of the holding period is dropped out of the further periods only after the holding period. As full time-series of holding period returns from sample funds are not required in the quartile and decile portfolio analyses, survivorship bias is eliminated from these analyses.

Pätäri and Tolvanen (2009) found differences in performance persistence between different fund classes. They report that strongest evidence of persistence was found among event-driven funds, concentrated on top and bottom quartiles. Also equity market neutral funds showed strong persistence on middle quartiles. The results of Pätäri and Tolvanen (2009) are in line with those of Gregoriou et al. (2007), who found stronger persistence within non-directional styles (like convertible arbitrage, equity market neutral and event driven) than within directional styles (like macro). Gregoriou et al. (2007) also found that in-sample portfolios of hedge funds and equally-weighted out-of-sample portfolios of hedge funds clearly outperform fund of funds irrespective the performance measure applied. This result implies that the extra layer of fees paid to fund of fund managers are hugely undeserved.

4.4 Decile portfolio analysis

Following the studies of Capocci and Hübner (2004), Baquero et al. (2005), Capocci et al. (2005) and Kosowski et al. (2007), the decile portfolio analysis is also employed in this study to complement the perception of performance persistence. The methodology of Carhart (1997) in constructing decile portfolios is used in this study. All funds are ranked based on their past 24- or 36-month performance measured by the Sharpe ratio, the mean variance ratio or the alpha t-value. Every January, all funds are put into 10 equally weighted portfolios, ordered from the highest to the lowest past performance. If the number of funds differs from even number, for example if the remainder would be three, the following distribution basis to deciles is used; the lowest two deciles with worst performance get one additional fund in their deciles, and also the top decile portfolio having the best past performance gets one additional fund. Hence if the remainder of funds is four, then the best two and worst two deciles would get additional fund to their deciles. This kind of distribution basis is also applied to the construction of quartile portfolios. The decile portfolios are held 24 or 36 months and rebalancing is carried out in every January leading to the same situation as in quartile portfolio analysis, where some subperiods are running at the same time (for example holding periods of 2000-2002 and 2001-2003). This yields to monthly stacked excess return time series of logarithmized relative investment values on each decile portfolio from 1/2000 to 12/2007, or from 1/2001 to 12/2007 including 144 (selection period 36 months and holding period 24 months), 180 (selection period 36 months and holding period 36 months) or 216 (selection period 24 months and holding period 36 months) observations.

A fund that disappears during the holding period is handled in the same way as in quartile portfolio analysis.

The results from previous studies using decile portfolio analysis are mixed. Capocci and Hübner (2004) found limited evidence of persistence in middle decile funds, but no persistence in performance among top and bottom deciles. Capocci et al. (2005) found also persistence among medium performers. In contrast, Baquero et al. (2005) found persistence in hedge fund performance in both the top and bottom parts of the distribution. Also Kosowski et al. (2007) found persistence in top and bottom deciles.

Apart from the other tests applied in this study, the quartile portfolio and decile portfolio analyses show whether there is difference in holding period return if an investor continues investing in the past top performers in comparison to investing in past bottom performers and whether the performance difference between the past top and bottom performers remain.

5 EMPIRICAL RESULTS

5.1 Descriptive statistics

The sample data of this study is described in Table 1, which includes the mean value, the median, the standard deviation, the minimum, and the maximum value of the first four moments of the return distributions for pooled sample and each hedge fund style. On average, the mean returns are positive within all hedge fund styles and pooled sample. This denotes that hedge funds have, on average, outperformed the risk-free rate. When comparing the mean returns of the styles, the best performers are the EM and DS styles while the worst average returns are obtained within the CEA and EMN styles. The fund styles with the highest deviations of returns are EM, L/S and Macro styles.

Table 1 also contains Jarque-Bera rejection rate for pooled sample and for each style. The normality is rejected for 41,92% (48,92%) of hedge fund return distributions at the 1% (5%) significance level. Nevertheless, great differences are found between the hedge fund styles. The lowest rejection rate is reported for the equity market neutral style (34,55% (38,22%) at the 1% (5%) significance level) whereas the highest rate is enrolled for the Fixed Income style (65,38% (68,27%) at the 1% (5%) significance level).

Table 1. Descriptive statistics 1998-2007. The table reports the descriptive statistics of the hedge fund sample merged from the Tremont and HFI databases. The sample includes funds that have 24 or more observations in the time period of January 1998 to December 2007. The statistics are based on the monthly returns of the hedge funds. The Jarque-Bera rejection rate gives the portion of funds for which the assumption of normally distributed returns is rejected at the 1% (5%) significance level.

Fund style	Mean	Median	St. Dev.	Min.	Max.
Pooled sample (3144 funds having 24 month or longer return distributions)					
Jarque-Bera rejection rate: 41,92%(48,92%) at 1% (5%) significance level					
mean (%)	0.80 %	0.72 %	0.61 %	-2.82 %	8.83 %
st dev (%)	2.99 %	2.21 %	2.39 %	0.04 %	22.41 %
skewness	-0.04	-0.07	1.07	-9.22	8.43
excess kurtosis	2.73	1.19	5.54	-1.47	92.51
Distressed securities (46 funds having 24 month or longer return distributions)					
Jarque-Bera rejection rate: 56.52%(63.04%) at 1% (5%) significance level					
mean (%)	1.05 %	1.02 %	0.40 %	0.26 %	2.09 %
st dev (%)	2.36 %	2.02 %	1.50 %	0.60 %	8.06 %
skewness	0.16	0.07	0.91	-1.62	2.61
excess kurtosis	3.02	1.87	3.35	-0.72	13.73
Equity market neutral (191 funds having 24 month or longer return distributions)					
Jarque-Bera rejection rate: 34.55%(38.22%) at 1% (5%) significance level					
mean (%)	0.53 %	0.49 %	0.48 %	-1.42 %	3.12 %
st dev (%)	1.90 %	1.59 %	1.29 %	0.19 %	10.27 %
skewness	0.01	-0.06	0.82	-2.84	3.51
excess kurtosis	1.76	0.86	2.63	-1.47	15.00
Fund of Funds (868 funds having 24 month or longer return distributions)					
Jarque-Bera rejection rate: 38.36%(45.74%) at 1% (5%) significance level					
mean (%)	0.68 %	0.66 %	0.30 %	-0.36 %	2.79 %
st dev (%)	1.70 %	1.40 %	1.05 %	0.34 %	10.14 %
skewness	-0.29	-0.35	0.94	-6.37	8.43
excess kurtosis	2.36	0.96	4.72	-1.39	75.12
Macro (143 funds having 24 month or longer return distributions)					
Jarque-Bera rejection rate: 44.76%(55.24%) at 1% (5%) significance level					
mean (%)	0.83 %	0.81 %	0.64 %	-1.40 %	2.62 %
st dev (%)	3.85 %	3.28 %	2.27 %	0.30 %	10.47 %
skewness	0.18	0.08	1.31	-3.13	8.26
excess kurtosis	3.83	1.36	8.05	-0.65	84.04
Event Driven (225 funds having 24 month or longer return distributions)					
Jarque-Bera rejection rate: 51.11%(60.44%) at 1% (5%) significance level					
mean (%)	0.86 %	0.78 %	0.84 %	-2.70 %	8.83 %
st dev (%)	2.31 %	1.71 %	2.20 %	0.18 %	17.03 %
skewness	-0.19	-0.26	1.10	-3.71	4.89
excess kurtosis	3.12	1.71	4.02	-0.95	26.41

Table 1 *continued*

Fund Style	Mean	Median	St.Dev.	Min.	Max.
Managed Futures (401 funds having 24 month or longer return distributions)					
Jarque-Bera rejection rate: 35.16%(43.89%) at 1% (5%) significance level					
mean (%)	0.77 %	0.69 %	0.66 %	-1.31 %	5.32 %
st dev (%)	5.17 %	4.52 %	2.98 %	0.42 %	22.41 %
skewness	0.31	0.24	0.85	-4.18	5.05
excess kurtosis	2.12	0.80	4.22	-0.92	38.26
Emerging markets (50 funds having 24 month or longer return distributions)					
Jarque-Bera rejection rate: 58.00%(66.00%) at 1% (5%) significance level					
mean (%)	1.72 %	1.51 %	1.04 %	-0.47 %	4.04 %
st dev (%)	4.86 %	3.71 %	3.45 %	0.79 %	13.53 %
skewness	-0.10	-0.02	1.26	-5.02	2.15
excess kurtosis	3.94	2.10	6.66	-0.60	41.11
Multi strategy (96 funds having 24 month or longer return distributions)					
Jarque-Bera rejection rate: 50.00%(55.21%) at 1% (5%) significance level					
mean (%)	0.87 %	0.83 %	0.39 %	0.09 %	2.24 %
st dev (%)	2.17 %	1.60 %	1.64 %	0.64 %	9.99 %
skewness	-0.05	0.02	1.32	-5.50	3.77
excess kurtosis	3.90	1.67	6.82	-0.78	37.83
Long/short (895 funds having 24 month or longer return distributions)					
Jarque-Bera rejection rate: 40.11%(46.15%) at 1% (5%) significance level					
mean (%)	0.95 %	0.89 %	0.68 %	-2.82 %	3.83 %
st dev (%)	3.87 %	3.25 %	2.36 %	0.41 %	17.12 %
skewness	0.12	0.04	0.89	-4.86	4.68
excess kurtosis	2.30	1.20	3.81	-1.03	30.76
Fixed income (104 funds having 24 month or longer return distributions)					
Jarque-Bera rejection rate: 65.38%(68.27%) at 1% (5%) significance level					
mean (%)	0.60 %	0.59 %	0.34 %	-0.31 %	1.63 %
st dev (%)	1.68 %	1.36 %	1.12 %	0.05 %	5.21 %
skewness	-0.76	-0.42	2.33	-9.22	7.49
excess kurtosis	8.98	3.67	16.15	-1.20	92.51
Convertible and equity arbitrage (125 funds having 24 month or longer return distributions)					
Jarque-Bera rejection rate: 55.20%(62.40%) at 1% (5%) significance level					
mean (%)	0.53 %	0.54 %	0.51 %	-2.53 %	2.18 %
st dev (%)	1.86 %	1.52 %	1.43 %	0.04 %	9.44 %
skewness	-0.06	-0.32	1.25	-2.93	6.99
excess kurtosis	3.30	2.02	5.62	-1.26	52.60

Table 1 shows that the hedge fund sample applied in this study appears to be different to those employed in recent studies (Elling 2008; Pätäri and Tolvanen 2009; Pätäri (2011)) in that the return distributions of the pooled sample of hedge funds are, on average, slightly negatively skewed. On the other hand, differences are found in skewness between hedge fund strategies, as the return distributions of DS,EMN, Macro, MF and L/S are, positively skewed, while for FoF, ED, EM, MS, FI and CEA styles the average skewness of return distributions is negative. Furthermore, the return distributions of the pooled sample and different hedge fund styles are all, on average, slightly leptokurtic. In this way, the sample is parallel to those employed in recent studies (Elling 2008; Pätäri and Tolvanen 2009; Pätäri 2011).

5.2 Cross-sectional regression results

Based on numerous cross-sectional regressions with combinations of different selection and holding periods and various performance metrics applied, the following combinations of sub periods and metrics were chosen to the final study: The mean variance ratio, the Sharpe ratio and the alpha t-statistic with combinations of 24-month selection period and holding period, 24-month selection period and 36-month holding period, 36-month selection period and 24-month holding period and 36-month selection and holding periods. This selection was done based on the prediction power of the metrics in the sub periods achieved from the cross-sectional regressions. The prediction power was the strongest for these combinations of metrics and sub periods listed above. As a result, raw return, SKAD 95 and adjusted r-square as well as combinations of selection period 24 months and holding period 12 months and selection period 36 months and holding period 12 months were dropped out from further analyses.

Table 2 shows the results from cross-sectional regressions. Overall, the coefficients of these tests are relatively high indicating strong explanatory power of these tests in general. Strong evidence of performance persistence for all performance measures is found as the results are highly significant for all combinations of selection and holding periods. However, except the combinations of 24-month selection period and 24-month or 36-month holding period where alpha t-statistic (t(α)) is used as a performance measure, the results of distressed securities (DS) class are not significant regardless of the performance metric or combination of periods applied. Also the performance of emerging markets (EM) funds is not persistent, on the basis of Sharpe ratios comparisons. On the other hand, when Mean variance ratio and t-statistic alphas are used as input variables, the results for the emerging markets class are significant for every combinations of selection and holding periods. Since the cross-sectional regression results of emerging markets are in dissonance, they should be interpreted with extreme caution. Furthermore, it is notable that the numbers of observations are relatively small for the distressed securities and the emerging market classes.

On the basis of cross-sectional regression, the strength of persistence varies between different fund classes. Fund styles with the strongest persistence are the convertible and equity arbitrage (CEA) and equity market neutral style (EMN). This is consistent with the results of Pätäri and Tolvanen (2009), who also found the strongest persistence among these styles in cross-sectional regressions. It is also notable that the MVR is very sensitive to detect performance persistence especially among event driven (the prediction power varies from 50% to 67%) and long short (L/S) styles (the prediction power varies from 25% to 33%). For fund of funds (FoF), emerging markets and distressed securities classes, the slopes and prediction powers are relatively low regardless of the performance measure employed indicating weak performance persistence. Notice that slope coefficient is positive to almost every fund style and pooled sample despite of the combination of selection and holding periods or performance metrics applied, indicating that positive past performance has a positive relationship to the future performance. On the other hand, within distressed securities class, the relationship between future and past performance was reversal in many combinations of selection and holding periods and performance metrics applied, indicating performance reversal. Note that these slopes were not significant, so further conclusions of performance reversal results should not be drawn.

Table 2. Cross-sectional regression results. At the beginning of each year, realized performance measures over the subsequent holding period are regressed on the performance measures over the preceding selection period. Different combinations of holding and selection periods were employed. The performance was estimated using the Sharpe ratios, mean variance ratios and Alpha t-values. The analysis is conducted both on full sample of funds and different fund styles separately. Number of observations, regression slope coefficient and its P-value (***, ** and * denote significance at the 1%, 5% and 10% level, respectively), and R-squared values of the regressions are reported.

Fund style	N	Slope	P-value	R^2	N	Slope	P-value	R^2	N	Slope	P-value	R^2
	Selection period 24 months and Holding period 24 months											
	Sharpe ratio vs. Sharpe ratio				**Mean Variance ratio vs. Mean**				**Alpha t-value vs. Alpha t-value**			
DS	113	0.09	0.23	0.01	113	0.08	0.15	0.02	113	-0.14	0.04**	0.04
EMN	357	0.59	<0.01***	0.49	357	0.63	<0.01***	0.41	357	0.40	<0.01***	0.16
FoF	2360	0.15	<0.01***	0.04	2360	0.26	<0.01***	0.15	2360	0.34	<0.01***	0.12
M	379	0.51	<0.01***	0.24	379	0.21	<0.01***	0.04	379	0.31	<0.01***	0.10
ED	641	0.28	<0.01***	0.08	641	0.85	<0.01***	0.50	641	0.23	<0.01***	0.06
MF	1405	0.23	<0.01***	0.06	1405	0.47	<0.01***	0.24	1405	0.14	<0.01***	0.11
EM	159	0.10	0.061*	0.02	159	0.43	<0.01***	0.28	159	0.29	<0.01***	0.09
MS	307	0.32	<0.01***	0.13	307	0.44	<0.01***	0.22	307	0.26	<0.01***	0.07
L/S	2357	0.12	<0.01***	0.02	2357	0.45	<0.01***	0.25	2357	0.20	<0.01***	0.04
FI	267	0.64	<0.01***	0.38	267	0.45	<0.01***	0.18	267	<0.01	<0.01***	0.19
CEA	343	0.57	<0.01***	0.30	343	0.14	<0.02***	0.02	343	0.55	<0.01***	0.30
All	8688	0.46	<0.01***	0.23	8688	0.21	<0.01***	0.04	8688	0.32	<0.01***	0.14
Selection period 24 months and Holding period 36 months												
Fund	**Sharpe ratio vs. Sharpe ratio**				**Mean Variance ratio vs. Mean**				**Alpha t-value vs. Alpha t-value**			
DS	77	-0.05	0.51	0.01	77	<0.01	0.95	<0.01	77	-0.19	0.01**	0.08
EMN	238	0.50	<0.01***	0.48	238	0.53	<0.01***	0.34	238	0.40	<0.01***	0.13
FoF	1702	0.12	<0.01***	0.04	1702	0.20	<0.01***	0.16	1702	0.27	<0.01***	0.11
M	277	0.58	<0.01***	0.29	277	0.95	<0.01***	0.39	277	0.28	<0.01***	0.10
ED	476	0.23	<0.01***	0.07	476	0.75	<0.01***	0.51	476	0.26	<0.01***	0.08
MF	1070	0.16	<0.01***	0.03	1070	0.37	<0.01***	0.20	1070	0.05	<0.01***	0.03
EM	115	0.09	0.07*	0.03	115	0.34	<0.01***	0.28	115	0.28	<0.01***	0.09
MS	233	0.27	<0.01***	0.14	233	0.37	<0.01***	0.23	233	0.22	<0.01***	0.07
L/S	1710	0.08	<0.01***	0.01	1710	0.40	<0.01***	0.27	1710	0.18	<0.01***	0.04
FI	187	0.49	<0.01***	0.33	187	0.24	<0.01***	0.09	187	0.39	<0.01***	0.20
CEA	252	0.91	<0.01***	0.55	252	2.73	<0.01***	0.70	252	0.64	<0.01***	0.42
All	6337	0.40	<0.01***	0.23	6337	0.40	<0.01***	0.17	6337	0.24	<0.01***	0.11
Selection period 36 months and Holding period 24 months												
Fund	**Sharpe ratio vs. Sharpe ratio**				**Mean Variance ratio vs. Mean**				**Alpha t-value vs. Alpha t-value**			
DS	77	-0.13	0.16	0.03	77	-0.04	0.64	<0.01	77	-0.07	0.48	0.01
EMN	238	0.76	<0.01***	0.55	238	0.73	<0.01***	0.28	238	0.39	<0.01***	0.12
FoF	1702	0.17	<0.01***	0.04	1702	0.32	<0.01***	0.15	1702	0.33	<0.01***	0.13
M	277	0.75	<0.01***	0.30	277	1.32	<0.01***	0.17	277	0.44	<0.01***	0.13
ED	476	0.39	<0.01***	0.10	476	1.34	<0.01***	0.63	476	0.26	<0.01***	0.08
MF	1070	0.20	<0.01***	0.03	1070	0.51	<0.01***	0.22	1070	0.06	<0.01***	0.02
EM	115	0.02	0.76	<0.01	115	0.39	<0.01***	0.19	115	0.30	<0.01***	0.12
MS	233	0.35	<0.01***	0.12	233	0.50	<0.01***	0.19	233	0.20	<0.01***	0.04
L/S	1710	0.10	<0.01***	0.01	1710	0.56	<0.01***	0.27	1710	0.17	<0.01***	0.03
FI	187	0.65	<0.01***	0.34	187	0.38	<0.01***	0.09	187	0.58	<0.01***	0.26
CEA	252	1.10	<0.01***	0.63	252	2.44	<0.01***	0.83	252	0.67	<0.01***	0.42
All	6337	0.55	<0.01***	0.26	6337	0.60	<0.01***	0.18	6337	0.32	<0.01***	0.13

Table 2 *continued*

Fund style	N	Slope	P-value	R^2	N	Slope	P-value	R^2	N	Slope	P-value	R^2
	Selection period 36 months and Holding period 36 months											
	Sharpe ratio vs. Sharpe ratio				**Mean Variance ratio vs. Mean**				**Alpha t-value vs. Alpha t-value**			
DS	53	-0.19	0.095*	0.05	53	-0.06	0.55	0.01	53	-0.19	0.11	0.05
EMN	166	0.70	<0.01***	0.59	166	0.60	<0.01***	0.18	166	0.47	<0.01***	0.12
FoF	1199	0.14	<0.01***	0.04	1199	0.23	<0.01***	0.14	1199	0.18	<0.01***	0.06
M	195	0.71	<0.01***	0.33	195	1.41	<0.01***	0.41	195	0.32	<0.01***	0.10
ED	346	0.41	<0.01***	0.14	346	1.28	<0.01***	0.67	346	0.30	<0.01***	0.08
MF	767	0.14	<0.01***	0.02	767	0.35	<0.01***	0.16	767	0.04	<0.01***	0.02
EM	76	-0.02	0.77	<0.01	76	0.24	<0.01***	0.11	76	0.25	<0.01***	0.10
MS	171	0.29	<0.01***	0.12	171	0.40	<0.01***	0.18	171	0.22	<0.01***	0.06
L/S	1203	0.10	<0.01***	0.01	1203	0.57	<0.01***	0.33	1203	0.19	<0.01***	0.04
FI	134	0.52	<0.01***	0.37	134	0.27	<0.01***	0.09	134	0.55	<0.01***	0.35
CEA	175	0.90	<0.01***	0.56	175	2.27	<0.01***	0.82	175	0.70	<0.01***	0.45
All	4486	0.49	<0.01***	0.27	4486	0.41	<0.01***	0.14	4486	0.26	<0.01***	0.11

According to the cross-sectional tests, generally the best combination of sub-periods to detect performance persistence is the combination of 36-month selection period and 24-month holding period. This is because the slope coefficients and prediction powers are highest with this combination. On the other hand, the most powerful single results are obtained with the combination of 36-month selection period and 36-month holding period when the Sharpe ratio is used as a performance metric. The combination of 24-month selection and holding period is the least sensitive to detect performance persistence, and thus is dropped out from the further analyses due to space limitations

The results of cross-sectional tests in Table 2 show that the mean variance ratio is the most sensitive to detect performance persistence for different fund style classes. The explanatory power of the selection period counterpart varies from 2 per cent to 83 per cent. On the other hand, when the cross-sectional regression is runned to the whole sample, the most sensitive measure to detect the performance persistence is the Sharpe ratio. For the whole sample measured with Sharpe ratio, the explanatory power of the selection period counterpart varies from 23 per cent to 27 per cent. Furthermore, based on the results of cross-sectional tests, it seems that the model-specific performance measure (alpha t-value) is not so sensitive to detect performance persistence than model-free performance metrics. In this sense, the results are consistent with Pätäri and Tolvanen (2009).

5.3 Spearman rank correlation test

Spearman rank correlation test is conducted in order to check for the robustness of the results obtained from cross-sectional regressions. The results of Spearman rank correlation tests are introduced in Table 3. The pooled sample shows significant results for almost every combinations of selection and holding period regardless of the performance measure applied. This is parallel with the results of Harri and Brorsen (2004), and support the hypothesis of performance persistence when all styles are analyzed as group, regardless of the measure utilized to rank funds. The only cases, in which the results are not significant for pooled sample, are the first sub-periods consisting of the combinations of 24-month selection period and 36-month holding period and 36-month selection period and 24-month holding period when performance is evaluated on the basis of Sharpe ratio. The significant correlations are all positive, except for the M and ED style for which one significant coefficient is negative, and for the CEA style, for which multiple significant coefficients are negative when Sharpe ratio is used as ranking basis, indicating performance reversal. When the ranking is based on MVR or Sharpe ratio, most of the coefficients are below the five-percent critical value where the null hypothesis of no performance persistence is rejected. This result provides support for the presumption that performance persistence exists in the hedge fund universe and is parallel with the results of Harri and Brorsen (2004).

Table 3. Sample size-adjusted rank correlation between various performance metrics. The table reports the average sample size-adjusted rank correlation between each pair of performance metrics being compared. The employed measure of rank correlation is Spearman's ρ. To validate the computation of their averages, the rank correlation coefficients are at first, on the basis of their significance levels, converted to correspond to the equal sample size (100) for each sub-period. The reported values are averages of these sample size-adjusted Spearman's ρs calculated over sub-periods and their p-values. For $r > 0.1966$ (0.2565), the reported coefficients are significant at the 5%

(1%) level. Panel A shows the results based on the use of alpha t-value as a ranking criterion. Correspondingly, Panel B shows the results based on the use of SR as a ranking criterion, and Panel C the results where the ranking is based on the use of MVR. Bolded values are significant at the 1% level whereas italicized values are significant at the 5% level.

Spearman correlation test:	All styles	DS	EMN	FoF	M	ED	MF	EM	MS	L/S	FI	CEA
Panel A **(t(α))**												
H00_02&S98_99	**0.41**		0.15	**0.27**	0.13	-0.07	*0.24*		-0.02	**0.29**	0.09	0.04
H01_03&S99_00	**0.57**		0.18	**0.48**	0.07	-0.11	*0.21*		**0.28**	**0.52**	0.19	*0.22*
H02_04&S00_01	**0.57**		0.11	**0.44**	0.03	-0.09	0.12		**0.37**	*0.20*	**0.47**	*0.23*
H03_05&S01_02	**0.71**		0.02	*0.22*	0.17	**0.66**	0.08	*0.21*	0.08	*0.25*	0.18	-0.09
H04_06&S02_03	**0.71**		<0.01	**0.33**	0.03	**0.46**	0.05	*0.24*	0.05	**0.32**	*0.20*	0.13
H05_07&S03_04	**0.87**	0.04	0.05	**0.69**	-0.08	**0.32**	**0.33**	*0.26*	**0.32**	0.03	0.04	**0.45**
Average S24_H36	**0.64**		**0.08**	**0.41**	**0.06**	**0.20**	**0.17**		**0.18**	**0.27**	**0.19**	**0.16**
H01_02&S98_00	**0.29**		0.14	0.14	0.04	0.06	**0.35**		-0.01	**0.35**	*0.21*	-0.03
H02_03&S99_01	**0.46**		0.12	**0.39**	-0.01	-0.01	0.03		*0.22*	**0.31**	**0.34**	**0.37**
H03_04&S00_02	**0.54**		0.06	**0.28**	0.01	0.01	-0.05		-0.04	**0.31**	**0.30**	0.04
H04_05&S01_03	**0.36**		0.03	0.16	0.17	*0.21*	-0.05	0.17	0.03	0.02	0.08	0.04
H05_06&S02_04	**0.76**		0.08	**0.39**	<0.01	<0.01	0.01	**0.31**	*0.22*	0.19	**0.27**	0.15
H06_07&S03_05	**0.98**	0.19	0.09	**0.74**	<0.01	<0.01	**0.55**	*0.22*	**0.29**	0.13	0.06	**0.49**
Average S36_H24	**0.56**		**0.09**	**0.35**	**0.04**	**0.05**	**0.14**		**0.12**	**0.22**	**0.21**	**0.18**
H01_03&S98_00	**0.54**		0.13	*0.23*	0.10	*-0.22*	**0.37**		0.04	**0.38**	0.16	0.03
H02_04&S99_01	**0.70**		-0.09	**0.46**	-0.02	-0.09	0.05		**0.35**	**0.32**	**0.38**	**0.37**
H03_05&S00_02	**0.80**		0.05	0.09	-0.07	**0.41**	0.09		0.06	0.11	*0.23*	-0.05
H04_06&S01_03	**0.88**		0.04	*0.23*	0.02	**0.46**	-0.04	*0.23*	0.10	**0.35**	**0.28**	0.13
H05_07&S02_04	**0.99**		0.02	**0.42**	-0.07	**0.29**	**0.35**	0.19	0.13	0.16	0.16	0.17
Average S36_H36	**0.78**		**0.03**	**0.28**	**-0.01**	**0.17**	**0.16**		**0.13**	**0.26**	**0.24**	**0.13**

Spearman correlation test:	All styles	DS	EMN	FoF	M	ED	MF	EM	MS	L/S	FI	CEA
Panel B ***(Sharpe)***												
H00_02&S98_99	-0.13		*0.24*	0.17	-0.04	0.06	-0.08		<0.01	**-0.44**	0.03	0.09
H01_03&S99_00	**0.77**		**0.36**	**0.65**	0.18	*-0.20*	0.16		**0.37**	0.02	*0.24*	*0.23*
H02_04&S00_01	**0.94**		**0.50**	**0.76**	**0.26**	0.11	0.17		**0.35**	**0.48**	**0.32**	**0.26**
H03_05&S01_02	**0.36**		**0.36**	*0.23*	-0.07	**0.51**	0.05	0.18	0.10	0.18	0.17	**-0.38**
H04_06&S02_03	**0.92**		**0.41**	**0.50**	0.17	**0.60**	0.15	**0.29**	**0.36**	**0.48**	**0.34**	-0.08
H05_07&S03_04	**0.96**	0.09	**0.47**	**0.69**	**0.31**	**0.41**	*0.20*	0.14	*0.21*	0.11	0.19	*0.25*
Average S24_H36	**0.64**		**0.39**	**0.50**	**0.13**	**0.25**	**0.11**		**0.23**	**0.14**	**0.22**	**0.06**
H01_02&S98_00	0.13		**0.31**	**0.32**	0.13	0.20	0.08		0.08	**-0.27**	0.12	0.10
H02_03&S99_01	**0.91**		**0.35**	**0.66**	0.13	0.18	*0.23*		**0.32**	**0.31**	0.16	**0.35**
H03_04&S00_02	**0.45**		**0.33**	**0.40**	-0.11	-0.15	0.16		0.11	0.08	0.14	-0.05
H04_05&S01_03	**0.75**		**0.41**	**0.27**	0.15	0.18	0.16	0.12	*0.23*	**0.31**	**0.30**	*-0.23*
H05_06&S02_04	**0.96**		**0.50**	**0.62**	**0.28**	**0.36**	0.17	0.09	**0.36**	**0.50**	**0.41**	0.01
H06_07&S03_05	**0.92**	0.11	**0.47**	**0.67**	**0.26**	**0.32**	**0.33**	*0.20*	0.18	0.06	<0.01	*0.25*
Average S36_H24	**0.69**		**0.39**	**0.49**	**0.14**	**0.18**	**0.19**		**0.21**	**0.17**	**0.19**	**0.07**
H01_03&S98_00	**0.28**		**0.31**	**0.39**	0.18	*-0.21*	0.15		0.09	**-0.36**	0.09	0.11
H02_04&S99_01	**0.95**		**0.38**	**0.69**	0.19	0.05	0.21		**0.34**	*0.24*	*0.23*	*0.20*
H03_05&S00_02	**0.30**		**0.33**	**0.27**	-0.17	**0.29**	0.09		0.05	0.07	*0.21*	*-0.23*
H04_06&S01_03	**0.85**		**0.44**	**0.31**	0.14	**0.62**	0.14	*0.25*	**0.33**	**0.38**	**0.38**	-0.17
H05_07&S02_04	**0.37**		**0.47**	**0.47**	*0.21*	**0.42**	0.12	0.08	*0.22*	*0.23*	**0.35**	-0.03
Average S36_H36	**0.55**		**0.38**	**0.43**	**0.11**	**0.23**	**0.14**		**0.20**	**0.11**	**0.25**	**-0.03**

Table 3 *continued*

Spearman correlation test:	All styles	DS	EMN	FoF	M	ED	MF	EM	MS	L/S	FI	CEA
*Panel C **(MVR)***												
H00_02&S98_99	**0.51**		**0.26**	**0.49**	0.09	*0.21*	<0.01		0.19	-0.11	<0.01	*0.25*
H01_03&S99_00	**0.97**		**0.36**	**0.83**	*0.24*	0.08	*0.25*		**0.49**	**0.41**	*0.24*	**0.45**
H02_04&S00_01	**0.99**		**0.50**	**0.88**	**0.33**	**0.38**	**0.34**		**0.52**	**0.66**	**0.37**	**0.45**
H03_05&S01_02	**0.88**		**0.35**	**0.66**	-0.01	**0.63**	*0.23*	**0.29**	**0.35**	**0.56**	**0.26**	-0.18
H04_06&S02_03	**1.00**		**0.44**	**0.79**	*0.20*	**0.59**	**0.33**	**0.52**	**0.45**	**0.65**	**0.31**	0.01
H05_07&S03_04	**1.00**	0.15	**0.42**	**0.89**	**0.32**	**0.45**	**0.32**	**0.33**	**0.54**	**0.43**	0.12	**0.32**
Average S24_H36	**0.89**		**0.39**	**0.76**	**0.20**	**0.39**	**0.25**		**0.42**	**0.43**	**0.22**	**0.22**
H01_02&S98_00	**0.59**		**0.31**	**0.54**	0.17	*0.25*	0.18		*0.23*	0.03	0.17	*0.21*
H02_03&S99_01	**0.99**		**0.34**	**0.79**	0.17	*0.24*	**0.32**		**0.43**	**0.57**	*0.21*	**0.52**
H03_04&S00_02	**0.91**		**0.37**	**0.75**	0.03	0.04	**0.34**		**0.35**	**0.45**	**0.30**	**0.28**
H04_05&S01_03	**0.97**		**0.39**	**0.73**	0.15	0.19	**0.28**	**0.45**	**0.43**	**0.57**	**0.33**	-0.14
H05_06&S02_04	**1.00**		**0.51**	**0.86**	**0.30**	**0.39**	**0.33**	**0.28**	**0.50**	**0.67**	**0.36**	0.14
H06_07&S03_05	**1.00**	0.14	**0.46**	**0.86**	**0.29**	**0.36**	**0.34**	**0.32**	**0.53**	**0.35**	0.14	**0.29**
Average S36_H24	**0.91**		**0.40**	**0.76**	**0.19**	**0.25**	**0.30**		**0.41**	**0.44**	**0.25**	**0.22**
H01_03&S98_00	**0.79**		**0.33**	**0.65**	*0.22*	-0.04	*0.24*		**0.29**	-0.03	0.12	**0.26**
H02_04&S99_01	**1.00**		**0.39**	**0.82**	*0.21*	**0.38**	**0.31**		**0.42**	**0.55**	**0.31**	**0.44**
H03_05&S00_02	**0.87**		**0.37**	**0.70**	-0.08	**0.53**	**0.28**		**0.31**	**0.50**	*0.25*	-0.05
H04_06&S01_03	**0.98**		**0.41**	**0.67**	0.17	**0.60**	**0.30**	**0.50**	**0.39**	**0.60**	**0.31**	-0.07
H05_07&S02_04	**0.99**		**0.45**	**0.78**	**0.29**	**0.40**	*0.22*	*0.26*	**0.39**	**0.48**	*0.24*	0.14
Average S36_H36	**0.93**		**0.39**	**0.73**	**0.16**	**0.37**	**0.27**		**0.36**	**0.42**	**0.25**	**0.15**

When comparing combinations of selection and holding periods, selection period of 36 months and holding period of 36 months gives, on average, the highest coefficients for the full sample although significant results are found in every combination of selection and holding periods. On the other hand, differences are also found, when comparing the performance metrics used; according to Spearman rank correlations, the alpha t-value is clearly the least sensitive to indicate performance persistence while the mean variance ratio is the best metric in the same sense as the coefficients are higher and more significant. Based on mean variance ratio, the rank order correlation is significant among EMN, FoF and MS styles in all period combinations and in addition, MF style except for one period.

According to table 3, the persistence in rank orders is highest among FoF style. The rank correlation is also significant within EMN style in all period combinations, when the rankings are based either on Sharpe ratio or on mean variance ratio. Our results are consistent with Harri and Brorsen (2004), where FoF and market neutral style were also among the styles showing the strongest performance persistence. Quite significant results are obtained also for ED and L/S strategies. Instead, the rank order persistence is not detected within DS style. Overall results indicate that, on average, stronger persistence is found within non-directional styles than within directional styles.

5.4 Quartile portfolio results

On the basis of cross-sectional regression results in Table 2, combinations of 24-month selection period and 36-month holding period, 36-month selection period and 24-month holding period, and 36-month selection period and holding period of equal length, were chosen to the further analyses (that is quartile and decile portfolio analyses) as the prediction powers and slopes of the regressions were highest for these period combinations. In the quartile portfolio approach, the portfolios are formed for each style based on the selection period rankings on different performance measures. These portfolios are then held for 24 or 36 months, and the quartiles are rebalanced for every January. The monthly stacked excess return time series of each quartile portfolio is then explained by the eight factors in GMM model in order to find out the performance persistence of each quartile measured against a set of market factors. In quartile portfolio analysis, the performance is also evaluated on the basis of the Sharpe ratio. Mean returns and standard deviations for each portfolio are also reported. Furthermore, performance differences between top- and bottom quartiles are reported in tables 13-14.

The results of table 4-12 show that, on average, the past best performers outperform past underperformers in the subsequent period. This is indicated by the fact that top portfolios have higher alphas and better Sharpe ratios than bottom portfolios, despite of the metrics or combinations of selection and holding periods applied. Also, the Sharpe ratio performance difference tests in table 13 support this finding although the persistence varies between fund styles. These results are in line with those of Baquero et al. (2005) who found persistence in both the top and bottom parts of the ranking. The performance differences between top and bottom portfolios for different fund classes are shown in tables 13-14. Table 13 shows the performance differences measured by the Sharpe ratio while table 14 shows the performance differences measured by the 8-factor alpha.

All strategies show significant positive factor loadings on the Style factor according to the results of tables 4-12. Especially the FoF style has very strong style factor loadings regardless of the metrics or the combinations of periods applied. The M and L/S strategies exhibit high positive factor loadings on the difference between Wilshire Small cap and Large cap return. Compared to other strategies, M strategy has high positive factor loadings on the change in 10-year maturity yield factor. It is also notable that the excess return on the credit spread and change in 10-year maturity yield factors have generally negative factor loadings in all styles and the bottom portfolios of CEA style have exceptionally high negative factor loadings on the credit spread factor. Compared to other factors, primitive trend following strategy factors have relatively low loadings. In addition, M and L/S strategies have relatively high factor loadings on the World factor.

The quartile portfolio results are reported in the following way: At first different combinations of selection and holding periods are compared in order to find out the best period combination to detect performance persistence. Next, different ranking metrics are compared to find out the most sensitive metric to detect persistence. Then, different quartiles are compared in order to discover whether the performance persistence exists especially among specific quartile. Finally, different hedge fund strategies are analyzed in order to find out whether the degree of performance persistence varies among different fund classes.

Table 4. Quartile portfolio results from subsequent 36 months, when ranking is based on preceding 24 months alpha t-value.

Portfolio	Mean return (pct/year)	Std. dev. (pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	R2	p-value(JB)
EMN																
Top	4.70	2.86	-0.94	-1.18	0.24	0.20	0.10	0.07	-0.01	<0.01	<0.01	<0.01	0.05	0.27	0.23	<0.01
2nd	8.17	3.44	0.96	0.80	0.43	0.43	0.03	-0.03	-0.11	<0.01	0.01	<0.01	0.07	0.42	0.21	<0.01
3rd	6.25	2.79	0.58	0.59	0.56	0.35	0.01	-0.03	-0.04	<0.01	<0.01	0.01	0.02	0.33	0.07	<0.01
4th	5.45	3.33	-0.62	-0.58	0.56	0.23	0.02	-0.04	-0.05	<0.01	<0.01	<0.01	<0.01	0.38	0.04	<0.01
FoF																
Top	8.32	3.68	-1.34	-1.66	0.10	0.42	-0.02	-0.05	-0.04	<0.01	<0.01	<0.01	0.02	0.76	0.82	<0.01
2nd	8.07	4.42	-2.96	-4.99	<0.01	0.33	0.01	-0.02	-0.02	<0.01	<0.01	<0.01	0.03	0.91	0.90	<0.01
3rd	6.84	4.06	-3.19	-4.53	<0.01	0.28	<0.01	-0.05	-0.02	<0.01	<0.01	0.01	0.03	0.82	0.85	0.18
4th	6.94	4.04	-2.88	-3.62	<0.01	0.29	-0.01	-0.08	-0.04	<0.01	<0.01	<0.01	0.04	0.77	0.79	0.12
M																
Top	11.25	5.74	1.02	0.46	0.64	0.40	0.16	0.11	-0.10	-0.01	0.01	0.02	0.20	0.38	0.51	<0.01
2nd	11.49	7.99	-3.25	-1.66	0.10	0.30	0.10	0.10	-0.25	-0.01	0.03	0.03	0.16	0.68	0.44	<0.01
3rd	10.33	8.34	-7.43	-2.77	<0.01	0.25	0.10	-0.15	-0.31	-0.01	0.02	0.02	0.22	0.87	0.54	<0.01
4th	9.59	7.24	-3.25	-1.70	0.09	0.26	0.09	-0.04	-0.27	-0.01	0.03	0.02	0.19	0.53	0.47	0.01
ED																
Top	10.81	3.78	0.82	1.04	0.30	0.58	0.04	-0.02	-0.02	<0.01	<0.01	<0.01	0.06	0.56	0.69	<0.01
2nd	9.24	4.19	-1.84	-2.22	0.03	0.42	-0.01	-0.10	-0.05	<0.01	<0.01	<0.01	0.08	0.69	0.75	<0.01
3rd	10.70	5.37	-2.56	-3.32	<0.01	0.40	0.04	<0.01	-0.05	<0.01	<0.01	0.01	0.11	0.86	0.79	<0.01
4th	10.92	5.30	-1.70	-1.63	0.10	0.41	0.03	-0.28	-0.06	0.01	<0.01	-0.01	0.08	0.79	0.75	<0.01
MF																
Top	9.91	9.46	1.83	1.51	0.13	0.21	0.05	-0.04	-0.04	0.01	0.02	0.01	-0.02	0.57	0.71	0.90
2nd	8.89	9.98	0.38	0.44	0.66	0.17	0.01	-0.05	-0.08	0.01	0.03	0.03	-0.03	0.64	0.85	0.97
3rd	7.79	12.75	-2.50	-2.14	0.03	0.11	0.04	-0.05	-0.06	0.01	0.03	0.02	-0.05	0.86	0.88	0.73
4th	6.72	12.32	-2.62	-2.21	0.03	0.09	0.04	0.22	0.02	0.01	0.01	0.03	0.05	0.87	0.90	0.85
MS																
Top	10.06	2.40	3.09	4.85	<0.01	0.86	<0.01	-0.01	0.01	<0.01	<0.01	<0.01	0.01	0.38	0.56	<0.01
2nd	9.64	4.26	1.31	1.11	0.27	0.45	-0.03	-0.12	-0.09	0.01	0.01	0.01	0.01	0.52	0.34	0.11
3rd	10.34	5.21	1.28	0.94	0.35	0.40	0.11	-0.24	-0.17	<0.01	0.02	0.03	-0.06	0.43	0.40	<0.01
4th	12.34	6.06	0.93	0.67	0.51	0.42	0.06	-0.29	-0.20	<0.01	0.02	<0.01	0.14	0.58	0.60	0.43
L/S																
Top	12.16	6.70	5.11	3.94	<0.01	0.38	0.15	-0.25	-0.08	0.01	<0.01	<0.01	0.32	0.17	0.81	<0.01
2nd	11.75	7.08	3.01	2.26	0.02	0.34	0.18	-0.12	-0.07	<0.01	0.01	0.01	0.22	0.38	0.77	0.23
3rd	10.66	8.12	1.58	1.28	0.20	0.26	0.20	-0.07	-0.10	<0.01	0.01	0.01	0.31	0.40	0.83	0.36
4th	7.98	8.78	-1.15	-1.17	0.24	0.16	0.26	-0.02	-0.01	0.02	<0.01	<0.01	0.27	0.58	0.87	<0.01
FI																
Top	8.04	2.45	2.01	2.85	<0.01	0.60	0.04	0.03	-0.08	-0.01	<0.01	<0.01	-0.02	0.39	0.24	<0.01
2nd	9.39	2.74	3.42	3.26	<0.01	0.65	0.01	-0.11	-0.12	<0.01	<0.01	<0.01	0.02	0.35	0.16	<0.01
3rd	8.04	3.21	1.92	2.03	0.04	0.45	<0.01	-0.15	-0.26	0.01	<0.01	<0.01	0.04	0.35	0.26	<0.01
4th	7.77	2.95	1.41	1.42	0.16	0.46	-0.01	-0.32	-0.24	<0.01	<0.01	<0.01	0.03	0.31	0.30	<0.01
CEA																
Top	7.80	3.00	0.57	1.00	0.32	0.48	0.02	<0.01	-0.03	<0.01	<0.01	0.01	0.03	0.55	0.70	0.27
2nd	7.15	3.91	-1.21	-1.28	0.20	0.31	0.03	-0.15	-0.09	<0.01	<0.01	<0.01	0.06	0.62	0.64	<0.01
3rd	6.93	5.79	-3.23	-2.54	0.01	0.20	0.10	-0.28	-0.07	<0.01	-0.01	<0.01	0.16	0.73	0.67	<0.01
4th	11.83	6.31	0.56	0.41	0.69	0.39	0.04	-0.40	-0.19	-0.01	<0.01	<0.01	0.14	0.76	0.53	<0.01

Table 5. Quartile portfolio results from subsequent 24 months, when ranking is based on preceding 36 months alpha t-value.

Portfolio	Mean return (pct/year)	Std. dev. (pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	R2	p-value(JB)
EMN																
Top	4.65	2.14	-0.64	-0.73	0.47	0.27	0.09	0.02	-0.02	<0.01	<0.01	<0.01	-0.02	0.28	0.15	0.14
2nd	6.02	3.31	0.73	0.74	0.46	0.28	0.02	0.03	-0.02	0.01	<0.01	<0.01	0.15	0.23	0.37	0.28
3rd	6.52	3.10	1.63	1.19	0.24	0.33	0.05	-0.12	-0.08	<0.01	0.01	<0.01	0.04	0.15	0.08	<0.01
4th	5.71	3.64	-1.27	-0.86	0.39	0.23	0.10	-0.03	-0.06	<0.01	<0.01	0.01	-0.06	0.45	0.07	<0.01
FoF																
Top	8.54	3.48	-3.16	-4.56	<0.01	0.46	0.01	-0.01	-0.02	<0.01	<0.01	<0.01	-0.02	0.93	0.88	0.17
2nd	7.95	4.20	-4.33	-6.91	<0.01	0.35	0.04	0.05	-0.01	<0.01	<0.01	<0.01	0.04	0.98	0.90	0.36
3rd	7.47	3.99	-4.64	-5.96	<0.01	0.33	0.03	<0.01	-0.01	<0.01	<0.01	0.01	0.01	0.97	0.87	0.27
4th	7.60	4.07	-4.78	-6.32	<0.01	0.33	0.06	-0.01	-0.02	<0.01	<0.01	<0.01	<0.01	0.98	0.86	0.20
M																
Top	11.76	4.27	-0.49	-0.39	0.70	0.57	0.11	-0.08	-0.04	-0.01	<0.01	0.01	0.14	0.54	0.59	0.43
2nd	11.60	8.09	-7.09	-2.70	<0.01	0.30	0.06	-0.04	-0.23	-0.02	0.03	0.04	0.14	0.93	0.45	0.07
3rd	11.31	6.56	-2.64	-1.28	0.20	0.35	0.13	0.19	-0.28	-0.01	0.01	0.02	0.30	0.56	0.60	0.46
4th	9.32	7.85	-9.48	-3.89	<0.01	0.23	0.18	0.05	-0.23	-0.02	0.04	0.02	0.18	0.92	0.55	0.78
ED																
Top	11.93	3.41	2.00	2.97	<0.01	0.73	0.02	-0.09	-0.08	-0.01	<0.01	0.01	0.06	0.48	0.67	0.07
2nd	8.65	4.36	-2.94	-3.10	<0.01	0.37	0.02	-0.11	-0.06	<0.01	<0.01	<0.01	0.09	0.68	0.77	<0.01
3rd	9.25	5.29	-3.91	-4.00	<0.01	0.34	0.05	-0.06	-0.03	<0.01	<0.01	<0.01	0.15	0.79	0.88	<0.01
4th	12.15	5.51	-1.10	-0.73	0.47	0.46	0.11	-0.24	-0.08	<0.01	<0.01	-0.01	0.09	0.73	0.72	<0.01
MF																
Top	10.36	8.78	2.70	1.89	0.06	0.24	-0.01	-0.14	-0.02	0.01	0.02	0.01	-0.01	0.53	0.71	0.56
2nd	8.46	10.13	-0.17	-0.13	0.89	0.16	0.01	-0.02	-0.08	0.01	0.03	0.02	0.03	0.64	0.82	0.58
3rd	7.12	12.19	-2.24	-1.53	0.13	0.10	0.02	0.01	-0.06	0.02	0.02	0.04	-0.04	0.83	0.89	0.78
4th	5.23	13.20	-5.36	-4.27	<0.01	0.05	0.07	0.11	0.07	0.01	0.01	0.02	0.01	0.98	0.91	0.72
MS																
Top	9.39	2.45	2.29	3.04	<0.01	0.76	-0.01	-0.06	0.01	<0.01	<0.01	<0.01	0.01	0.37	0.57	0.21
2nd	8.95	3.89	0.25	0.23	0.81	0.45	0.04	-0.08	-0.02	0.01	<0.01	<0.01	0.05	0.51	0.58	0.99
3rd	10.93	5.13	1.16	0.59	0.56	0.44	0.14	-0.16	-0.18	-0.01	0.02	0.02	-0.01	0.42	0.40	0.06
4th	12.30	5.98	0.38	0.24	0.81	0.43	0.12	-0.33	-0.22	0.01	0.02	0.01	0.04	0.61	0.52	0.87
L/S																
Top	10.95	6.29	1.77	2.06	0.04	0.35	0.20	-0.31	-0.11	<0.01	<0.01	<0.01	0.27	0.28	0.88	<0.01
2nd	13.77	7.12	1.31	0.93	0.35	0.41	0.22	-0.14	-0.06	-0.01	<0.01	0.01	0.12	0.70	0.79	0.02
3rd	10.34	7.60	-0.28	-0.32	0.75	0.27	0.20	-0.06	-0.05	0.01	<0.01	<0.01	0.29	0.57	0.91	0.25
4th	8.34	8.45	-2.10	-1.44	0.15	0.18	0.30	-0.08	0.04	0.02	<0.01	<0.01	0.28	0.59	0.86	0.28
FI																
Top	8.00	2.64	2.93	3.23	<0.01	0.55	0.05	0.18	-0.04	<0.01	<0.01	<0.01	-0.05	0.42	0.28	<0.01
2nd	7.60	2.63	1.07	0.76	0.45	0.50	<0.01	-0.22	-0.16	<0.01	<0.01	-0.01	0.06	0.38	0.34	<0.01
3rd	7.25	3.04	1.80	1.59	0.12	0.41	-0.07	-0.30	-0.23	-0.01	<0.01	<0.01	0.05	0.14	0.19	<0.01
4th	8.28	2.90	1.35	1.20	0.23	0.51	0.01	-0.23	-0.25	0.01	<0.01	<0.01	0.03	0.49	0.42	<0.01
CEA																
Top	7.27	2.82	0.54	0.94	0.35	0.45	<0.01	<0.01	-0.03	<0.01	<0.01	<0.01	0.02	0.59	0.78	0.08
2nd	8.05	3.43	-0.08	-0.08	0.94	0.43	0.01	-0.12	-0.11	<0.01	<0.01	<0.01	0.04	0.64	0.72	<0.01
3rd	4.18	6.82	-5.27	-2.91	<0.01	0.06	0.06	-0.33	-0.03	<0.01	-0.01	-0.01	0.23	0.70	0.61	<0.01
4th	11.58	6.42	-0.12	-0.06	0.95	0.37	0.10	-0.47	-0.22	-0.01	<0.01	<0.01	0.12	0.79	0.56	<0.01

Table 6. Quartile portfolio results from subsequent 36 months, when ranking is based on preceding 36 months alpha t-value.

Portfolio	Mean return (pct/year)	Std. dev. (pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	R2	p-value(JB)
EMN																
Top	3.97	2.48	-1.12	-1.47	0.14	0.17	0.09	-0.04	-0.02	<0.01	<0.01	<0.01	-0.03	0.28	0.09	<0.01
2nd	5.49	3.52	0.11	0.12	0.90	0.23	0.05	0.04	-0.05	0.01	<0.01	<0.01	0.16	0.18	0.35	<0.01
3rd	7.43	2.80	2.37	1.97	0.05	0.47	0.04	-0.14	-0.07	<0.01	0.01	<0.01	0.04	0.19	0.10	<0.01
4th	5.39	3.47	-0.44	-0.45	0.66	0.23	0.10	0.01	-0.07	-0.01	<0.01	<0.01	-0.06	0.32	0.07	<0.01
FoF																
Top	8.65	3.46	-3.23	-5.02	<0.01	0.49	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-0.03	0.96	0.89	0.03
2nd	8.20	4.11	-4.08	-7.49	<0.01	0.38	0.04	0.07	0.01	<0.01	<0.01	0.01	0.04	0.98	0.90	0.19
3rd	7.65	4.09	-4.88	-7.18	<0.01	0.35	0.03	0.01	-0.03	<0.01	<0.01	0.01	0.01	0.99	0.86	0.08
4th	8.46	4.28	-4.64	-7.21	<0.01	0.38	0.05	<0.01	-0.03	<0.01	<0.01	<0.01	0.01	1.03	0.86	0.09
M																
Top	12.68	4.54	-0.58	-0.49	0.62	0.60	0.15	0.12	<0.01	-0.01	<0.01	0.01	0.16	0.62	0.65	0.12
2nd	12.11	8.66	-8.15	-3.45	<0.01	0.30	0.06	-0.17	-0.33	-0.03	0.03	0.03	0.17	0.98	0.46	0.03
3rd	11.74	7.35	-4.39	-2.28	0.02	0.34	0.12	0.12	-0.25	-0.01	0.01	0.02	0.31	0.68	0.55	0.65
4th	10.55	7.73	-6.82	-3.19	<0.01	0.28	0.16	0.21	-0.12	-0.01	0.03	0.02	0.18	0.87	0.53	0.07
ED																
Top	12.70	3.60	1.65	2.73	<0.01	0.76	0.01	-0.07	-0.08	-0.01	<0.01	0.01	0.07	0.55	0.70	0.25
2nd	9.96	4.18	-2.29	-2.64	<0.01	0.48	0.02	-0.07	-0.08	<0.01	<0.01	<0.01	0.10	0.69	0.79	<0.01
3rd	10.20	5.11	-3.43	-3.65	<0.01	0.41	0.05	-0.04	-0.02	<0.01	<0.01	<0.01	0.15	0.78	0.86	<0.01
4th	12.91	5.43	-1.20	-0.89	0.37	0.51	0.10	-0.33	-0.12	0.01	<0.01	-0.01	0.09	0.74	0.73	<0.01
MF																
Top	9.10	8.93	1.16	0.88	0.38	0.20	-0.01	-0.17	-0.11	0.01	0.03	0.02	<0.01	0.52	0.69	0.95
2nd	8.66	10.34	-0.29	-0.25	0.80	0.16	0.01	-0.08	-0.06	0.01	0.02	0.01	0.03	0.69	0.82	0.21
3rd	7.22	11.91	-1.85	-1.29	0.20	0.11	0.02	-0.01	-0.09	0.01	0.01	0.04	-0.05	0.83	0.87	0.72
4th	4.80	13.46	-4.82	-3.57	<0.01	0.05	0.07	0.17	0.13	0.02	0.01	0.02	0.01	1.00	0.90	0.70
MS																
Top	9.25	2.50	1.84	2.42	0.02	0.75	-0.01	-0.05	0.01	<0.01	<0.01	<0.01	0.01	0.40	0.57	0.26
2nd	8.91	3.81	-0.06	-0.05	0.96	0.47	0.03	-0.03	0.02	0.01	<0.01	<0.01	0.04	0.55	0.60	0.72
3rd	10.05	5.29	0.52	0.29	0.78	0.39	0.13	-0.27	-0.24	-0.01	0.02	0.02	<0.01	0.35	0.34	<0.01
4th	12.91	6.27	-0.86	-0.59	0.55	0.44	0.14	-0.24	-0.21	<0.01	0.02	0.01	0.04	0.72	0.58	0.95
L/S																
Top	12.19	6.20	1.88	2.41	0.02	0.42	0.20	-0.20	-0.09	<0.01	<0.01	<0.01	0.27	0.33	0.89	<0.01
2nd	14.16	7.22	0.68	0.54	0.59	0.43	0.24	-0.06	-0.04	-0.01	<0.01	0.01	0.11	0.74	0.81	0.01
3rd	12.08	7.87	0.16	0.17	0.87	0.33	0.20	-0.07	-0.04	0.02	<0.01	<0.01	0.30	0.59	0.89	0.26
4th	9.73	8.56	-2.02	-1.52	0.13	0.23	0.33	-0.05	0.03	0.02	<0.01	<0.01	0.29	0.60	0.87	0.18
FI																
Top	8.92	2.77	3.93	4.47	<0.01	0.64	-0.01	0.07	-0.13	<0.01	<0.01	<0.01	-0.04	0.34	0.25	<0.01
2nd	8.08	2.83	2.26	2.70	<0.01	0.54	<0.01	-0.22	-0.18	-0.01	<0.01	-0.01	0.06	0.20	0.23	<0.01
3rd	7.32	2.77	1.91	1.84	0.07	0.47	-0.06	-0.29	-0.21	-0.01	<0.01	<0.01	0.04	0.16	0.19	<0.01
4th	8.18	2.85	1.17	1.49	0.14	0.52	<0.01	-0.23	-0.24	<0.01	<0.01	<0.01	0.03	0.51	0.43	<0.01
CEA																
Top	6.54	2.84	0.32	0.65	0.52	0.40	-0.01	0.02	-0.02	<0.01	<0.01	<0.01	0.02	0.61	0.80	0.03
2nd	6.84	3.41	-0.79	-0.98	0.33	0.35	0.02	-0.09	-0.09	<0.01	<0.01	<0.01	0.03	0.65	0.75	<0.01
3rd	5.66	7.12	-4.92	-2.86	<0.01	0.12	0.06	-0.43	-0.09	<0.01	-0.01	-0.01	0.24	0.77	0.63	<0.01
4th	11.58	6.36	-0.06	-0.03	0.98	0.38	0.12	-0.33	-0.19	-0.01	<0.01	<0.01	0.12	0.82	0.57	<0.01

Table 7. Quartile portfolio results from subsequent 36 months, when ranking is based on preceding 24 months Sharpe ratio.

Portfolio	Mean return (pct/year)	Std. dev. (pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	R2	p-value(JB)
EMN																
Top	8.43	1.76	1.61	2.57	0.01	0.93	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-0.01	0.48	0.29	<0.01
2nd	7.00	3.53	-1.22	-0.89	0.37	0.34	0.06	-0.13	-0.06	0.01	<0.01	<0.01	0.08	0.60	0.35	<0.01
3rd	3.94	3.50	-0.86	-0.73	0.47	0.10	0.08	0.07	-0.06	<0.01	0.01	<0.01	0.05	0.16	0.16	<0.01
4th	5.05	3.83	0.10	0.09	0.93	0.17	0.03	0.02	-0.10	-0.01	<0.01	0.01	0.02	0.16	0.02	<0.01
FoF																
Top	8.28	3.39	-1.43	-2.08	0.04	0.45	-0.02	-0.04	-0.02	<0.01	<0.01	<0.01	-0.01	0.78	0.86	<0.01
2nd	7.18	4.33	-3.95	-7.96	<0.01	0.28	-0.01	<0.01	-0.02	<0.01	<0.01	0.01	0.01	0.97	0.90	<0.01
3rd	6.88	4.16	-3.32	-4.72	<0.01	0.27	0.01	-0.03	-0.02	<0.01	<0.01	0.01	0.03	0.83	0.86	0.18
4th	8.06	4.69	-1.48	-1.27	0.21	0.31	0.01	-0.13	-0.06	<0.01	<0.01	0.01	0.10	0.67	0.71	0.03
M																
Top	10.42	6.88	-4.18	-2.22	0.03	0.30	0.15	0.10	-0.23	-0.01	<0.01	0.02	0.22	0.68	0.57	<0.01
2nd	11.47	8.17	-5.22	-2.72	<0.01	0.29	0.12	0.09	-0.23	-0.01	0.03	0.03	0.22	0.82	0.58	<0.01
3rd	11.64	6.86	-0.53	-0.23	0.82	0.35	0.03	-0.04	-0.24	-0.01	0.03	0.02	0.11	0.53	0.37	<0.01
4th	8.89	7.62	-2.26	-1.02	0.31	0.22	0.13	-0.18	-0.26	-0.01	0.03	0.02	0.22	0.37	0.39	<0.01
ED																
Top	10.57	3.43	0.52	0.91	0.36	0.62	0.01	-0.05	-0.03	<0.01	<0.01	<0.01	0.04	0.58	0.72	<0.01
2nd	8.96	4.06	-2.04	-3.83	<0.01	0.42	<0.01	-0.04	-0.02	<0.01	<0.01	<0.01	0.08	0.71	0.84	<0.01
3rd	10.61	4.83	-1.96	-2.43	0.02	0.44	0.04	-0.08	-0.08	<0.01	<0.01	<0.01	0.08	0.79	0.75	<0.01
4th	11.37	6.14	-1.97	-1.70	0.09	0.38	0.05	-0.24	-0.06	0.01	<0.01	-0.01	0.13	0.83	0.74	<0.01
MF																
Top	8.42	8.44	0.55	0.75	0.46	0.18	-0.01	-0.15	-0.15	0.01	0.02	0.02	0.03	0.52	0.83	0.48
2nd	8.07	11.89	-1.74	-1.87	0.06	0.12	0.03	-0.06	-0.06	0.01	0.02	0.03	-0.01	0.84	0.91	0.60
3rd	7.18	11.13	-1.76	-1.68	0.10	0.11	0.06	0.12	0.11	0.01	0.02	0.01	0.01	0.78	0.87	0.33
4th	9.61	12.89	0.24	0.16	0.87	0.15	0.05	0.16	-0.05	0.01	0.03	0.03	-0.08	0.79	0.77	0.02
MS																
Top	9.56	2.64	2.85	3.10	<0.01	0.73	0.02	-0.12	0.01	<0.01	<0.01	<0.01	0.02	-0.03	0.03	0.02
2nd	10.18	3.52	2.81	2.90	<0.01	0.59	-0.02	<0.01	-0.01	<0.01	0.01	<0.01	-0.01	0.08	<0.01	<0.01
3rd	9.49	4.83	1.90	1.61	0.11	0.38	0.03	-0.15	-0.09	0.01	<0.01	-0.01	0.03	0.03	0.05	<0.01
4th	13.05	6.98	2.78	1.49	0.14	0.39	0.13	-0.33	-0.30	0.01	0.03	0.02	0.07	0.41	0.44	0.74
L/S																
Top	8.73	6.92	-0.84	-1.19	0.24	0.24	0.10	-0.10	0.01	<0.01	-0.01	0.01	0.08	0.74	0.86	<0.01
2nd	10.52	7.94	0.97	1.12	0.26	0.26	0.20	-0.03	<0.01	0.01	<0.01	<0.01	0.23	0.60	0.92	<0.01
3rd	9.38	8.04	1.57	1.52	0.13	0.22	0.21	-0.10	-0.10	0.01	<0.01	<0.01	0.40	0.25	0.88	0.07
4th	13.40	8.75	6.69	2.93	<0.01	0.33	0.27	-0.24	-0.16	<0.01	0.02	0.01	0.43	-0.09	0.58	0.31
FI																
Top	8.43	2.23	2.86	4.32	<0.01	0.71	0.03	-0.02	-0.08	-0.01	<0.01	<0.01	-0.02	0.31	0.19	<0.01
2nd	8.69	3.13	1.16	1.37	0.17	0.52	0.03	-0.04	-0.14	<0.01	<0.01	<0.01	0.02	0.59	0.31	<0.01
3rd	7.82	3.36	1.80	1.95	0.05	0.40	-0.03	-0.35	-0.33	<0.01	<0.01	-0.01	0.06	0.21	0.29	<0.01
4th	7.99	2.64	2.91	3.33	<0.01	0.54	0.01	-0.14	-0.15	0.01	<0.01	<0.01	0.01	0.26	0.19	<0.01
CEA																
Top	7.42	2.76	0.52	0.97	0.33	0.48	0.01	-0.02	-0.03	<0.01	<0.01	<0.01	<0.01	0.53	0.72	<0.01
2nd	6.45	4.21	-2.66	-2.53	0.01	0.25	0.06	-0.12	-0.06	<0.01	<0.01	<0.01	0.03	0.72	0.66	<0.01
3rd	6.41	5.89	-3.48	-2.40	0.02	0.17	0.07	-0.28	-0.08	<0.01	<0.01	<0.01	0.15	0.73	0.57	<0.01
4th	13.38	7.16	2.07	1.30	0.20	0.40	0.05	-0.44	-0.20	<0.01	<0.01	-0.01	0.23	0.69	0.54	<0.01

Table 8. Quartile portfolio results from subsequent 24 months, when ranking is based on preceding 36 months Sharpe ratio.

Portfolio	Mean return (pct/year)	Std. dev. (pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	R2	p-value(JB)
EMN																
Top	7.69	1.49	1.42	2.38	0.02	0.95	0.01	0.06	0.01	<0.01	<0.01	<0.01	-0.01	0.44	0.29	<0.01
2nd	6.60	2.91	-0.74	-0.51	0.61	0.37	0.12	-0.25	-0.06	0.01	<0.01	<0.01	0.02	0.45	0.37	<0.01
3rd	4.26	3.30	-1.76	-1.50	0.14	0.14	0.07	0.01	-0.05	0.01	0.01	<0.01	0.09	0.35	0.22	0.31
4th	4.15	4.16	0.87	0.54	0.59	0.10	0.06	0.05	-0.10	-0.01	<0.01	0.01	0.02	-0.09	<0.01	0.92
FoF																
Top	8.07	2.97	-2.60	-4.75	<0.01	0.50	<0.01	-0.02	<0.01	<0.01	<0.01	<0.01	-0.04	0.84	0.90	0.65
2nd	7.38	3.96	-5.05	-8.27	<0.01	0.33	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	1.04	0.90	0.44
3rd	8.16	4.29	-4.81	-6.10	<0.01	0.35	0.04	0.07	-0.02	<0.01	<0.01	0.01	0.01	1.06	0.88	0.22
4th	7.95	4.63	-4.43	-4.78	<0.01	0.31	0.08	-0.04	-0.03	<0.01	<0.01	<0.01	0.05	0.92	0.83	0.10
M																
Top	11.55	5.04	-4.32	-2.86	<0.01	0.48	0.08	-0.08	-0.20	-0.01	<0.01	0.02	0.14	0.79	0.63	0.37
2nd	11.25	7.52	-8.48	-4.84	<0.01	0.31	0.13	0.17	-0.18	-0.02	0.03	0.03	0.15	1.02	0.63	0.61
3rd	10.58	6.15	-2.58	-1.10	0.27	0.35	0.06	0.18	-0.20	-0.01	0.02	0.02	0.18	0.58	0.42	0.71
4th	9.90	7.35	-4.31	-1.71	0.09	0.27	0.17	-0.26	-0.24	-0.01	0.03	0.01	0.27	0.51	0.54	<0.01
ED																
Top	10.21	2.96	0.73	1.30	0.20	0.69	<0.01	-0.09	-0.04	<0.01	<0.01	<0.01	0.04	0.51	0.78	<0.01
2nd	9.87	4.70	-3.31	-4.39	<0.01	0.42	<0.01	0.02	-0.04	<0.01	<0.01	0.01	0.09	0.83	0.80	<0.01
3rd	9.61	5.09	-3.05	-3.61	<0.01	0.37	0.07	-0.20	-0.09	0.01	<0.01	<0.01	0.12	0.72	0.83	<0.01
4th	12.36	5.62	-0.35	-0.27	0.78	0.46	0.13	-0.23	-0.08	<0.01	<0.01	-0.01	0.13	0.63	0.74	<0.01
MF																
Top	8.48	8.71	0.77	0.82	0.41	0.18	-0.04	-0.17	-0.17	0.01	0.02	0.03	<0.01	0.54	0.84	0.82
2nd	8.58	11.46	-1.79	-1.32	0.19	0.14	-0.01	-0.02	-0.07	0.01	0.02	0.03	0.07	0.80	0.88	0.56
3rd	7.03	12.44	-2.82	-1.91	0.06	0.10	0.12	0.04	0.08	0.01	0.01	0.02	-0.07	0.89	0.89	0.54
4th	6.98	11.14	-1.39	-0.89	0.38	0.11	0.02	0.09	0.05	0.01	0.02	0.02	-0.03	0.74	0.81	0.41
MS																
Top	9.21	2.65	1.60	1.85	0.07	0.68	-0.02	-0.13	-0.01	<0.01	<0.01	<0.01	<0.01	0.41	0.55	0.02
2nd	9.40	2.97	0.87	0.89	0.38	0.63	<0.01	-0.08	-0.03	<0.01	<0.01	<0.01	-0.01	0.50	0.59	0.66
3rd	10.98	4.98	0.78	0.45	0.66	0.45	0.12	-0.03	-0.09	<0.01	0.01	0.02	-0.03	0.58	0.41	0.64
4th	12.08	6.68	0.86	0.55	0.59	0.38	0.20	-0.36	-0.29	0.01	0.03	0.01	0.13	0.42	0.59	0.91
L/S																
Top	9.00	5.19	-1.40	-2.37	0.02	0.33	0.10	-0.10	-0.01	<0.01	<0.01	0.01	0.04	0.72	0.90	0.18
2nd	10.34	7.93	-0.48	-0.57	0.57	0.26	0.23	-0.22	-0.07	0.01	<0.01	<0.01	0.33	0.48	0.92	0.02
3rd	10.96	7.65	0.24	0.19	0.85	0.29	0.19	-0.10	-0.07	0.01	<0.01	0.01	0.30	0.52	0.87	0.50
4th	12.65	8.69	2.23	1.16	0.25	0.31	0.38	-0.15	-0.05	0.01	<0.01	<0.01	0.31	0.37	0.75	0.62
FI																
Top	7.94	3.03	1.88	1.07	0.28	0.47	0.06	0.14	-0.03	-0.01	-0.01	<0.01	-0.06	0.52	0.24	<0.01
2nd	6.67	2.75	0.30	0.42	0.67	0.40	0.01	-0.09	-0.11	-0.01	<0.01	<0.01	0.09	0.37	0.34	<0.01
3rd	9.55	3.73	2.04	1.95	0.05	0.49	-0.06	-0.33	-0.40	<0.01	<0.01	-0.01	0.02	0.44	0.36	<0.01
4th	7.02	2.67	2.94	2.16	0.03	0.43	-0.02	-0.27	-0.13	0.01	<0.01	<0.01	0.04	0.11	0.11	0.07
CEA																
Top	6.74	2.75	0.15	0.28	0.78	0.41	0.02	0.01	-0.01	<0.01	<0.01	<0.01	<0.01	0.59	0.80	0.05
2nd	6.50	4.00	-2.18	-2.06	0.04	0.27	<0.01	-0.02	-0.05	<0.01	<0.01	<0.01	<0.01	0.85	0.77	<0.01
3rd	7.26	5.49	-3.43	-2.02	0.05	0.23	0.01	-0.45	-0.19	-0.01	<0.01	<0.01	0.09	0.84	0.67	<0.01
4th	10.49	7.12	0.41	0.24	0.81	0.29	0.13	-0.50	-0.17	<0.01	<0.01	-0.01	0.31	0.46	0.67	<0.01

Table 9. Quartile portfolio results from subsequent 36 months, when ranking is based on preceding 36 months Sharpe ratio.

Portfolio	Mean return (pct/year)	Std. dev. (pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	R2	p-value(JB)
EMN																
Top	7.32	1.37	1.78	3.90	<0.01	1.00	0.01	0.07	0.02	<0.01	<0.01	<0.01	-0.01	0.40	0.31	<0.01
2nd	6.86	2.68	1.87	2.09	0.04	0.44	0.11	-0.18	-0.07	0.01	<0.01	-0.01	<0.01	0.21	0.25	<0.01
3rd	3.37	3.26	-3.58	-3.08	<0.01	0.07	0.08	-0.13	-0.06	0.01	<0.01	<0.01	0.08	0.43	0.28	0.58
4th	4.65	4.42	0.53	0.37	0.71	0.13	0.09	0.12	-0.12	-0.02	<0.01	0.01	0.03	-0.06	0.06	0.80
FoF																
Top	7.92	2.92	-2.64	-4.95	<0.01	0.51	0.01	-0.02	<0.01	<0.01	<0.01	<0.01	-0.04	0.83	0.89	0.22
2nd	7.73	3.91	-4.74	-9.07	<0.01	0.37	0.01	0.05	0.01	<0.01	<0.01	<0.01	<0.01	1.05	0.91	0.25
3rd	8.59	4.35	-4.87	-7.41	<0.01	0.38	0.04	0.08	-0.02	<0.01	<0.01	0.01	0.01	1.09	0.89	0.17
4th	8.74	4.84	-4.61	-5.57	<0.01	0.35	0.08	-0.02	-0.04	<0.01	<0.01	<0.01	0.06	1.00	0.82	0.02
M																
Top	11.53	4.82	-3.12	-2.45	0.02	0.50	0.10	-0.03	-0.18	-0.01	<0.01	0.02	0.13	0.70	0.60	0.23
2nd	11.50	8.02	-9.84	-5.86	<0.01	0.30	0.11	0.04	-0.24	-0.02	0.03	0.03	0.17	1.11	0.66	0.10
3rd	12.00	7.04	-2.90	-1.28	0.20	0.36	0.06	0.28	-0.15	-0.02	0.02	0.02	0.20	0.69	0.40	0.93
4th	11.65	7.91	-4.61	-2.12	0.04	0.31	0.20	-0.03	-0.13	-0.01	0.02	0.02	0.30	0.67	0.58	0.18
ED																
Top	10.69	2.90	0.88	1.69	0.09	0.76	<0.01	-0.06	-0.03	<0.01	<0.01	<0.01	0.05	0.52	0.78	<0.01
2nd	10.97	4.54	-2.58	-4.14	<0.01	0.51	<0.01	0.02	-0.06	<0.01	<0.01	0.01	0.10	0.81	0.79	<0.01
3rd	10.79	4.92	-2.06	-2.69	<0.01	0.45	0.09	-0.21	-0.12	<0.01	<0.01	-0.01	0.14	0.64	0.82	<0.01
4th	13.46	5.71	-1.18	-0.97	0.33	0.51	0.10	-0.26	-0.10	0.01	<0.01	<0.01	0.12	0.77	0.76	<0.01
MF																
Top	7.90	9.03	0.08	0.08	0.93	0.16	-0.05	-0.19	-0.15	0.01	0.02	0.03	0.02	0.58	0.83	0.53
2nd	7.13	11.22	-2.47	-2.22	0.03	0.11	-0.02	-0.05	-0.10	0.01	0.02	0.02	0.06	0.78	0.89	0.45
3rd	5.94	12.76	-3.36	-2.03	0.04	0.07	0.10	-0.01	0.06	0.02	0.02	0.01	-0.06	0.89	0.85	0.58
4th	8.96	11.26	0.42	0.25	0.80	0.16	0.07	0.20	0.07	0.01	0.01	0.02	-0.02	0.76	0.78	0.60
MS																
Top	9.00	2.65	1.17	1.42	0.16	0.68	-0.02	-0.08	<0.01	<0.01	<0.01	<0.01	-0.01	0.44	0.55	0.07
2nd	9.03	2.70	0.97	1.18	0.24	0.67	-0.02	-0.12	-0.01	<0.01	<0.01	<0.01	-0.01	0.46	0.59	0.51
3rd	10.59	4.92	0.36	0.21	0.83	0.45	0.10	-0.09	-0.11	<0.01	0.01	0.01	-0.03	0.58	0.39	0.63
4th	12.53	7.17	-1.12	-0.72	0.47	0.37	0.23	-0.28	-0.29	<0.01	0.03	0.02	0.14	0.54	0.63	0.76
L/S																
Top	10.06	5.12	-0.71	-1.44	0.15	0.40	0.10	-0.05	<0.01	<0.01	<0.01	0.01	0.05	0.71	0.90	0.58
2nd	11.17	7.86	-0.79	-1.05	0.29	0.30	0.27	-0.17	-0.06	0.01	<0.01	<0.01	0.32	0.48	0.93	0.03
3rd	11.89	7.61	-0.10	-0.08	0.94	0.33	0.20	-0.11	-0.07	0.01	<0.01	<0.01	0.29	0.55	0.88	0.19
4th	14.22	9.12	1.81	1.04	0.30	0.34	0.40	-0.05	-0.03	0.02	0.01	<0.01	0.31	0.48	0.78	0.78
FI																
Top	9.06	2.90	3.61	4.35	<0.01	0.63	<0.01	0.05	-0.10	-0.01	<0.01	<0.01	-0.04	0.40	0.20	<0.01
2nd	7.24	2.61	1.10	1.58	0.12	0.50	<0.01	-0.14	-0.09	-0.01	<0.01	<0.01	0.08	0.32	0.32	<0.01
3rd	8.62	3.39	1.62	1.78	0.08	0.48	-0.04	-0.33	-0.40	-0.01	<0.01	-0.01	0.01	0.34	0.42	<0.01
4th	7.36	2.65	2.72	2.38	0.02	0.48	<0.01	-0.24	-0.14	0.01	<0.01	<0.01	0.05	0.17	0.16	0.96
CEA																
Top	5.80	2.59	-0.17	-0.36	0.72	0.35	<0.01	-0.04	-0.03	<0.01	<0.01	<0.01	-0.01	0.57	0.84	0.01
2nd	4.93	4.28	-3.16	-2.50	0.01	0.16	<0.01	-0.10	-0.04	<0.01	<0.01	<0.01	-0.01	0.85	0.69	<0.01
3rd	7.43	5.53	-3.28	-2.36	0.02	0.24	0.05	-0.25	-0.14	-0.01	<0.01	<0.01	0.09	0.94	0.73	<0.01
4th	13.09	7.05	1.78	1.13	0.26	0.40	0.12	-0.42	-0.19	<0.01	<0.01	-0.01	0.32	0.53	0.69	<0.01

Table 10. Quartile portfolio results from subsequent 36 months, when the ranking is based on preceding 24 months mean variance ratio.

Portfolio	Mean return (pct/year)	Std. dev. (pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	R2	p-value(JB)
EMN																
Top	7.16	1.55	0.93	2.09	0.04	0.81	<0.01	0.07	0.03	<0.01	<0.01	<0.01	<0.01	0.46	0.36	<0.01
2nd	8.65	3.42	0.37	0.30	0.77	0.48	0.08	-0.18	-0.08	0.01	<0.01	-0.01	0.03	0.56	0.27	<0.01
3rd	3.61	3.78	-1.67	-1.31	0.19	0.07	0.06	0.06	-0.06	0.01	0.01	<0.01	0.10	0.23	0.23	<0.01
4th	5.02	3.85	0.10	0.09	0.93	0.17	0.03	0.02	-0.10	-0.01	<0.01	0.01	0.02	0.16	0.02	<0.01
FoF																
Top	7.87	2.70	0.05	0.05	0.96	0.53	-0.03	-0.08	-0.02	<0.01	<0.01	<0.01	<0.01	0.56	0.73	0.23
2nd	7.61	4.00	-3.18	-6.14	<0.01	0.34	<0.01	<0.01	-0.03	<0.01	<0.01	<0.01	<0.01	0.90	0.91	<0.01
3rd	6.90	4.84	-4.88	-8.37	<0.01	0.24	0.01	-0.01	-0.02	<0.01	<0.01	0.01	0.02	1.03	0.88	<0.01
4th	8.05	5.20	-2.23	-1.91	0.06	0.28	<0.01	-0.12	-0.05	<0.01	<0.01	0.01	0.11	0.77	0.74	0.04
M																
Top	10.32	4.64	-0.92	-0.72	0.47	0.44	0.09	-0.03	-0.13	-0.01	<0.01	0.01	0.16	0.48	0.61	<0.01
2nd	10.47	7.88	-4.31	-1.53	0.13	0.27	0.10	-0.05	-0.42	-0.01	0.03	0.03	0.17	0.63	0.49	<0.01
3rd	11.60	9.03	-6.00	-2.29	0.02	0.26	0.13	0.23	-0.17	-0.01	0.04	0.02	0.20	0.94	0.50	<0.01
4th	10.51	7.78	-1.24	-0.54	0.59	0.27	0.13	-0.09	-0.21	-0.01	0.03	0.02	0.23	0.42	0.40	<0.01
ED																
Top	8.94	2.50	0.51	0.98	0.33	0.68	<0.01	-0.06	-0.02	<0.01	<0.01	<0.01	0.02	0.48	0.76	<0.01
2nd	10.42	4.32	-1.43	-2.36	0.02	0.48	<0.01	-0.13	-0.06	<0.01	<0.01	<0.01	0.06	0.74	0.77	<0.01
3rd	9.53	4.81	-2.90	-4.45	<0.01	0.39	0.04	-0.01	-0.04	<0.01	<0.01	<0.01	0.09	0.80	0.81	<0.01
4th	13.01	6.74	-1.24	-0.97	0.33	0.41	0.05	-0.23	-0.06	0.01	<0.01	<0.01	0.16	0.89	0.74	<0.01
MF																
Top	7.38	6.81	0.64	1.08	0.28	0.19	-0.01	-0.17	-0.13	0.01	0.02	0.01	-0.03	0.40	0.79	<0.01
2nd	8.91	11.72	-0.66	-0.72	0.47	0.14	0.01	-0.08	-0.09	0.02	0.02	0.03	0.02	0.80	0.90	0.64
3rd	6.29	12.78	-3.91	-3.01	<0.01	0.08	0.08	0.10	0.08	0.01	0.02	0.02	0.04	0.90	0.87	0.49
4th	10.86	13.30	1.34	0.77	0.44	0.17	0.06	0.24	0.01	0.01	0.02	0.03	-0.08	0.82	0.76	0.07
MS																
Top	9.72	2.27	2.88	4.34	<0.01	0.47	-0.02	-0.05	<0.01	<0.01	<0.01	<0.01	-0.01	0.37	0.49	0.13
2nd	9.54	2.76	1.17	1.81	0.07	0.36	-0.03	-0.07	<0.01	<0.01	<0.01	<0.01	-0.03	0.52	0.61	0.40
3rd	9.48	4.77	0.39	0.39	0.70	0.21	0.05	-0.13	-0.07	0.01	<0.01	0.01	0.10	0.52	0.60	0.33
4th	13.61	7.39	1.90	1.10	0.27	0.31	0.13	-0.38	-0.35	0.01	0.04	0.03	0.05	0.53	0.50	0.60
L/S																
Top	8.93	4.67	1.35	2.04	0.04	0.36	0.07	-0.11	-0.02	<0.01	<0.01	<0.01	0.06	0.48	0.85	<0.01
2nd	9.77	8.93	-0.59	-0.71	0.48	0.21	0.21	-0.06	<0.01	0.01	<0.01	<0.01	0.25	0.68	0.89	<0.01
3rd	9.48	8.73	0.93	0.86	0.39	0.21	0.25	-0.11	-0.07	0.01	<0.01	<0.01	0.39	0.34	0.89	0.18
4th	14.00	9.39	6.72	2.83	<0.01	0.32	0.26	-0.21	-0.16	0.01	0.02	0.01	0.45	-0.01	0.60	0.42
FI																
Top	7.60	2.18	2.26	3.36	<0.01	0.62	0.03	-0.02	-0.07	-0.01	<0.01	<0.01	-0.03	0.31	0.20	<0.01
2nd	8.06	2.92	0.89	0.92	0.36	0.50	0.05	-0.02	-0.07	-0.01	-0.01	<0.01	0.03	0.56	0.32	<0.01
3rd	8.69	3.44	2.18	2.10	0.04	0.46	-0.02	-0.20	-0.27	0.01	<0.01	<0.01	0.03	0.40	0.27	<0.01
4th	8.37	3.00	3.11	3.25	<0.01	0.51	-0.01	-0.32	-0.28	0.01	<0.01	<0.01	0.04	0.12	0.26	<0.01
CEA																
Top	6.86	2.48	0.31	0.70	0.49	0.48	0.02	-0.02	-0.03	<0.01	<0.01	<0.01	-0.01	0.48	0.77	0.03
2nd	6.49	3.35	-1.14	-1.62	0.11	0.31	0.04	-0.05	-0.07	<0.01	<0.01	0.01	0.02	0.57	0.63	<0.01
3rd	6.96	5.82	-3.08	-2.11	0.04	0.20	0.07	-0.30	-0.08	<0.01	<0.01	<0.01	0.14	0.73	0.58	<0.01
4th	13.02	8.15	-0.28	-0.16	0.87	0.34	0.07	-0.52	-0.19	-0.01	<0.01	<0.01	0.26	0.92	0.63	<0.01

Table 11. Quartile portfolio results from subsequent 24 months, when ranking is based on preceding 36 months mean variance ratio.

Portfolio	Mean return (pct/year)	Std. dev. (pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	R2	p-value(JB)
EMN																
Top	6.67	1.53	0.33	0.58	0.56	0.73	0.01	0.11	0.03	<0.01	<0.01	<0.01	<0.01	0.50	0.40	<0.01
2nd	7.57	2.97	0.92	0.70	0.48	0.45	0.11	-0.29	-0.07	0.01	<0.01	-0.01	-0.01	0.36	0.26	<0.01
3rd	5.29	2.90	-1.16	-1.07	0.29	0.26	0.11	0.08	-0.07	0.01	0.01	<0.01	0.06	0.36	0.30	0.10
4th	3.63	4.16	0.56	0.36	0.72	0.06	0.04	0.03	-0.09	-0.01	<0.01	<0.01	0.06	-0.11	<0.01	0.88
FoF																
Top	7.53	2.60	-2.09	-4.16	<0.01	0.52	<0.01	-0.04	<0.01	<0.01	<0.01	<0.01	-0.04	0.73	0.88	0.36
2nd	7.58	3.53	-4.14	-7.72	<0.01	0.38	0.02	<0.01	-0.02	<0.01	<0.01	<0.01	-0.01	0.93	0.92	0.54
3rd	7.70	4.40	-5.46	-7.18	<0.01	0.31	0.03	0.05	-0.02	<0.01	<0.01	0.01	0.01	1.08	0.88	0.26
4th	8.84	5.32	-5.27	-4.98	<0.01	0.32	0.07	0.02	-0.01	<0.01	<0.01	0.01	0.06	1.13	0.85	0.12
M																
Top	10.73	4.78	-4.20	-2.53	0.01	0.46	0.10	0.07	-0.06	-0.02	<0.01	0.01	0.10	0.75	0.53	<0.01
2nd	10.02	6.92	-7.38	-3.48	<0.01	0.29	0.10	-0.24	-0.37	-0.01	0.03	0.02	0.11	0.83	0.55	0.10
3rd	12.26	7.41	-3.59	-1.62	0.11	0.35	0.06	0.41	-0.15	-0.02	0.03	0.03	0.24	0.77	0.51	0.31
4th	10.25	7.69	-4.87	-1.93	0.06	0.27	0.19	-0.20	-0.22	-0.01	0.03	0.02	0.30	0.58	0.59	0.05
ED																
Top	9.40	2.70	0.23	0.26	0.80	0.68	<0.01	-0.12	-0.03	<0.01	<0.01	<0.01	0.02	0.50	0.80	<0.01
2nd	8.42	3.64	-2.06	-2.50	0.01	0.43	0.01	-0.10	-0.05	<0.01	<0.01	<0.01	0.07	0.59	0.81	<0.01
3rd	10.75	5.58	-2.83	-3.10	<0.01	0.39	0.07	-0.09	-0.09	<0.01	<0.01	<0.01	0.16	0.78	0.81	<0.01
4th	13.76	6.46	-1.15	-0.71	0.48	0.46	0.12	-0.19	-0.08	<0.01	<0.01	<0.01	0.14	0.82	0.74	<0.01
MF																
Top	7.40	6.72	0.95	1.35	0.18	0.19	-0.03	-0.18	-0.12	0.01	0.02	0.02	-0.05	0.40	0.80	0.18
2nd	8.98	11.78	-1.26	-0.85	0.40	0.15	-0.05	-0.09	-0.11	0.01	0.02	0.03	0.07	0.81	0.86	0.49
3rd	7.63	13.80	-3.31	-1.87	0.06	0.10	0.13	0.06	0.08	0.02	0.02	0.02	-0.01	0.97	0.87	0.77
4th	6.93	11.72	-1.62	-0.97	0.33	0.10	0.04	0.16	0.05	0.02	0.02	0.02	-0.03	0.77	0.81	0.41
MS																
Top	9.04	2.34	2.17	2.96	<0.01	0.76	-0.01	-0.09	<0.01	<0.01	<0.01	<0.01	0.01	0.34	0.56	0.72
2nd	9.13	2.53	1.12	1.50	0.14	0.71	-0.01	-0.06	0.02	<0.01	<0.01	<0.01	-0.04	0.48	0.65	0.22
3rd	11.32	4.79	1.48	0.77	0.45	0.49	0.09	-0.12	-0.08	0.01	0.01	0.02	-0.02	0.56	0.41	0.51
4th	12.36	7.21	-0.59	-0.36	0.72	0.36	0.21	-0.33	-0.33	0.01	0.03	0.01	0.14	0.55	0.63	0.87
L/S																
Top	8.16	3.68	0.13	0.26	0.80	0.41	0.07	-0.14	-0.04	<0.01	<0.01	<0.01	0.05	0.45	0.89	0.05
2nd	10.92	7.58	-0.72	-0.84	0.40	0.29	0.23	-0.22	-0.07	<0.01	<0.01	<0.01	0.25	0.58	0.91	0.08
3rd	10.15	9.23	-0.88	-0.77	0.44	0.22	0.22	-0.17	-0.07	0.01	<0.01	<0.01	0.45	0.45	0.91	0.06
4th	13.71	8.99	1.98	1.03	0.31	0.33	0.38	-0.06	-0.01	0.02	<0.01	<0.01	0.24	0.60	0.77	0.98
FI																
Top	7.45	3.01	1.61	0.97	0.33	0.44	0.06	0.14	-0.03	<0.01	-0.01	<0.01	-0.06	0.51	0.23	<0.01
2nd	7.30	2.34	1.15	2.07	0.04	0.53	-0.01	-0.16	-0.11	<0.01	<0.01	<0.01	0.06	0.37	0.36	<0.01
3rd	8.69	3.40	0.73	0.64	0.52	0.48	-0.01	-0.11	-0.29	<0.01	<0.01	<0.01	0.03	0.59	0.38	<0.01
4th	7.73	2.88	3.69	3.01	<0.01	0.46	-0.06	-0.45	-0.25	0.01	<0.01	<0.01	0.05	-0.04	0.20	0.04
CEA																
Top	6.59	2.39	0.45	1.00	0.32	0.46	0.01	<0.01	-0.02	<0.01	<0.01	<0.01	<0.01	0.51	0.79	0.10
2nd	7.22	3.52	-0.62	-0.72	0.47	0.36	-0.01	-0.03	-0.09	<0.01	<0.01	<0.01	0.02	0.72	0.73	0.21
3rd	5.70	4.32	-2.93	-2.17	0.03	0.19	0.04	-0.18	-0.06	<0.01	<0.01	<0.01	0.07	0.71	0.68	<0.01
4th	11.57	8.43	-1.64	-0.89	0.38	0.28	0.14	-0.69	-0.22	-0.01	<0.01	-0.01	0.32	0.75	0.73	<0.01

Table 12. Quartile portfolio results from subsequent 36 months, when ranking is based on preceding 36 months mean variance ratio.

Portfolio	Mean return (pct/year)	Std. dev. (pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	R2	p-value(JB)
EMN																
Top	6.54	1.45	1.07	2.46	0.01	0.77	0.02	0.12	0.04	<0.01	<0.01	<0.01	<0.01	0.44	0.37	<0.01
2nd	7.28	3.00	2.10	2.18	0.03	0.44	0.09	-0.29	-0.09	0.01	<0.01	-0.01	-0.03	0.22	0.18	<0.01
3rd	4.38	2.92	-2.63	-2.74	<0.01	0.18	0.13	-0.03	-0.07	<0.01	0.01	<0.01	0.05	0.41	0.32	0.32
4th	4.32	4.42	0.42	0.29	0.77	0.11	0.07	0.10	-0.12	-0.01	<0.01	0.01	0.08	-0.09	0.07	0.86
FoF																
Top	7.55	2.62	-2.21	-4.70	<0.01	0.53	<0.01	-0.04	<0.01	<0.01	<0.01	<0.01	-0.04	0.75	0.88	0.16
2nd	7.77	3.59	-4.32	-8.34	<0.01	0.40	0.02	0.02	<0.01	<0.01	<0.01	<0.01	-0.02	0.98	0.93	0.35
3rd	8.32	4.49	-5.24	-8.71	<0.01	0.36	0.04	0.09	-0.02	<0.01	<0.01	0.01	0.02	1.11	0.89	0.23
4th	9.44	5.32	-5.11	-5.54	<0.01	0.35	0.07	0.03	-0.02	<0.01	<0.01	0.01	0.06	1.13	0.84	0.02
M																
Top	11.29	4.90	-3.79	-2.36	0.02	0.49	0.10	0.10	-0.06	-0.02	<0.01	0.01	0.10	0.77	0.52	<0.01
2nd	10.37	7.05	-6.46	-3.66	<0.01	0.30	0.10	-0.25	-0.41	-0.01	0.03	0.02	0.12	0.76	0.59	<0.01
3rd	13.30	8.21	-4.69	-2.16	0.03	0.35	0.07	0.40	-0.11	-0.03	0.02	0.03	0.26	0.89	0.47	0.30
4th	11.80	8.23	-5.46	-2.38	0.02	0.30	0.21	0.02	-0.13	-0.01	0.02	0.02	0.33	0.74	0.62	0.26
ED																
Top	10.12	2.65	0.66	0.83	0.41	0.77	<0.01	-0.10	-0.05	<0.01	<0.01	<0.01	0.03	0.51	0.79	<0.01
2nd	8.86	3.38	-1.75	-2.55	0.01	0.51	0.01	-0.07	-0.03	<0.01	<0.01	<0.01	0.07	0.59	0.83	<0.01
3rd	12.68	5.75	-2.60	-3.18	<0.01	0.47	0.06	-0.07	-0.09	<0.01	<0.01	<0.01	0.16	0.84	0.82	<0.01
4th	14.64	6.14	-0.92	-0.70	0.49	0.52	0.11	-0.24	-0.13	<0.01	<0.01	<0.01	0.14	0.81	0.74	<0.01
MF																
Top	6.90	6.92	0.32	0.42	0.68	0.17	-0.04	-0.20	-0.13	0.01	0.02	0.01	-0.03	0.43	0.79	0.29
2nd	7.61	11.56	-2.28	-2.10	0.04	0.12	-0.06	-0.17	-0.15	0.02	0.01	0.02	0.06	0.82	0.88	0.41
3rd	6.69	13.87	-3.56	-2.02	0.05	0.08	0.11	0.07	0.05	0.02	0.02	0.03	-0.01	0.95	0.85	0.73
4th	8.70	11.89	0.31	0.17	0.86	0.14	0.09	0.28	0.10	0.01	0.01	0.02	-0.02	0.81	0.78	0.66
MS																
Top	8.79	2.42	1.63	2.14	0.03	0.73	-0.02	-0.07	0.01	<0.01	<0.01	<0.01	<0.01	0.39	0.54	0.31
2nd	8.96	2.48	1.03	1.52	0.13	0.72	<0.01	-0.10	-0.02	<0.01	<0.01	<0.01	-0.03	0.45	0.61	0.44
3rd	10.86	4.70	0.97	0.54	0.59	0.48	0.07	-0.15	-0.07	0.01	0.01	0.01	-0.03	0.58	0.39	0.42
4th	12.70	7.54	-2.22	-1.38	0.17	0.36	0.23	-0.28	-0.33	<0.01	0.03	0.02	0.15	0.63	0.67	0.61
L/S																
Top	8.89	3.69	0.57	1.25	0.21	0.47	0.08	-0.09	-0.04	<0.01	<0.01	<0.01	0.06	0.45	0.90	0.25
2nd	12.02	7.65	-1.04	-1.35	0.18	0.33	0.24	-0.14	-0.03	<0.01	<0.01	0.01	0.23	0.67	0.91	0.08
3rd	11.83	9.23	-1.00	-0.96	0.34	0.27	0.25	-0.16	-0.08	0.01	<0.01	<0.01	0.44	0.48	0.91	0.06
4th	14.63	9.12	1.77	1.02	0.31	0.35	0.41	<0.01	-0.01	0.02	0.01	<0.01	0.27	0.58	0.78	0.69
FI																
Top	8.67	2.96	3.48	4.07	<0.01	0.58	-0.01	0.06	-0.11	-0.01	<0.01	<0.01	-0.04	0.38	0.19	<0.01
2nd	7.43	2.29	1.11	2.01	0.05	0.58	0.01	-0.18	-0.09	-0.01	<0.01	<0.01	0.05	0.37	0.40	<0.01
3rd	8.36	3.13	1.50	1.39	0.16	0.51	-0.02	-0.15	-0.31	-0.01	<0.01	<0.01	0.02	0.42	0.39	<0.01
4th	8.00	2.78	3.10	3.21	<0.01	0.52	-0.03	-0.41	-0.24	<0.01	<0.01	<0.01	0.06	0.06	0.24	0.77
CEA																
Top	5.90	2.34	0.24	0.63	0.53	0.41	<0.01	-0.01	-0.03	<0.01	<0.01	<0.01	-0.01	0.50	0.82	0.07
2nd	5.82	3.67	-1.68	-2.02	0.05	0.25	-0.02	-0.07	-0.10	<0.01	<0.01	<0.01	0.01	0.74	0.74	<0.01
3rd	6.15	4.12	-2.00	-1.83	0.07	0.24	0.06	-0.11	-0.04	<0.01	<0.01	<0.01	0.08	0.68	0.71	<0.01
4th	13.24	8.34	-1.24	-0.77	0.44	0.34	0.16	-0.59	-0.22	-0.01	<0.01	-0.01	0.32	0.85	0.76	<0.01

Table 13. Statistical significance of the Sharpe ratio difference between portfolios. The reported values are t-statistic based and the corresponding p-values. For each time series, the variance and the related terms with autocorrelation was adjusted by using the Newey-West autocorrelation corrected estimates (23 lags). Based on these adjustments, the t-statistics and p-values were calculated using the method by Opdyke (2007, 335).

Fund style	Sharpe (d*,m(sign) (P1 vs. P4))			MVR (d*,m(sign) (P1 vs. P4))			Alpha (d*,m(sign) (P1 vs. P4))		
	S24_H36	S36_H24	S36_H36	S24_H36	S36_H24	S36_H36	S24_H36	S36_H24	S36_H36
EMN	6.60	7.51	6.57	7.86	5.58	5.92	-0.60	0.55	-2.50
	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.55	0.58	0.01
FoF	4.97	6.92	4.45	9.53	7.24	2.87	3.49	0.72	1.20
	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.47	0.23
M	3.17	4.67	5.19	4.44	4.09	3.98	4.65	4.90	4.59
	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
ED	1.02	0.14	1.57	0.76	0.05	3.31	1.43	0.17	2.70
	0.31	0.89	0.12	0.45	0.96	<0.01	0.15	0.86	0.01
MF	0.09	4.03	0.62	1.11	5.12	0.49	8.05	4.92	5.75
	0.93	<0.01	0.54	0.27	<0.01	0.62	<0.01	<0.01	<0.01
MS	2.68	2.98	3.97	5.13	3.79	3.96	5.81	3.16	4.06
	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
L/S	-2.88	0.05	0.57	1.88	0.52	1.46	4.85	2.63	5.22
	<0.01	0.96	0.57	0.06	0.60	0.14	<0.01	0.01	<0.01
FI	3.28	0.21	2.94	2.44	-0.14	1.93	1.93	0.17	1.74
	<0.01	0.84	<0.01	0.01	0.89	0.05	0.05	0.86	0.08
CEA	1.55	0.26	-1.97	0.90	0.71	0.74	0.25	0.45	0.06
	0.12	0.79	0.05	0.37	0.48	0.46	0.80	0.65	0.95

Table 14. Statistical significance of the alpha spread tests. The table reports t-statistic and the corresponding p-values obtained from alpha spread tests. For each class, the alpha spread tests are calculated to different performance ranking metrics and combinations of selection and holding periods. The holding period alphas for the test were estimated using the adjusted Fung-Hsieh 8-factor model.

Fund style	Sharpe (α-spread test) (P1 vs. P4))			MVR (α-spread test) (P1 vs. P4))			Alpha (α-spread test) (P1 vs. P4))		
	S24_H36	S36_H24	S36_H36	S24_H36	S36_H24	S36_H36	S24_H36	S36_H24	S36_H36
EMN	1.19	0.32	0.83	0.68	-0.14	0.43	-0.23	0.37	-0.54
	0.24	0.75	0.41	0.49	0.89	0.67	0.82	0.71	0.59
FoF	0.04	1.69	2.00	1.52	2.72	2.80	1.35	1.58	1.56
	0.97	0.09	0.05	0.13	0.01	0.01	0.18	0.12	0.12
M	-0.66	<0.01	0.59	0.12	0.22	0.60	1.46	3.28	2.56
	0.51	1.00	0.56	0.91	0.82	0.55	0.15	<0.01	0.01
ED	1.93	0.77	1.56	1.27	0.75	1.03	1.93	1.88	1.93
	0.05	0.44	0.12	0.21	0.46	0.30	0.05	0.06	0.05
MF	0.18	1.19	-0.18	-0.38	1.42	0.01	2.62	4.24	3.17
	0.86	0.24	0.86	0.71	0.16	0.99	0.01	<0.01	<0.01
MS	0.03	0.42	1.30	0.53	1.54	2.16	1.41	1.10	1.64
	0.97	0.68	0.19	0.59	0.13	0.03	0.16	0.27	0.10
L/S	-3.15	-1.81	-1.39	-2.18	-0.93	-0.67	3.85	2.29	2.53
	<0.01	0.07	0.17	0.03	0.36	0.50	<0.01	0.02	0.01
FI	-0.04	-0.48	0.63	-0.73	-1.01	0.29	0.49	1.09	2.34
	0.97	0.63	0.53	0.47	0.31	0.77	0.62	0.28	0.02
CEA	-0.92	-0.15	-1.19	0.33	1.10	0.90	0.01	0.32	0.18
	0.36	0.88	0.24	0.74	0.27	0.37	0.99	0.75	0.85

When comparing different combinations of selection and holding periods, the results show that the significances of alphas and the level of adjusted R-squares of combination of 36-month selection period and 36-month holding period outperforms the two other period combinations. According to the tables 13-14, some differences are also found among performance difference tests: Clearly the weakest performance persistence for top and bottom portfolios is reported for the combination of 36-month selection period and 24-month holding period, while the strongest persistence is reported for the combination of 36-month selection period and the holding period of equal length. For this combination, the mean variance ratio as a ranking metric is slightly the most sensitive to capture performance persistence; MVR obtains the highest coefficients of determination in cross-sectional analyses and the performance measured with Sharpe ratio or alpha values from the top portfolio to bottom portfolio remains, on average, the same compared to other ranking metrics according to tables 6, 9 and 12.

Comparison of different ranking metrics show that, in general, the significance of alpha does not depend on the three metrics applied as the numbers of significant alphas and the level of prediction powers are almost the same with different ranking measures despite of the period combination applied according to tables 4-12. The performance difference tests in tables 13-14 indicate that no performance ranking metric outperforms other metric in detecting performance persistence. The alpha spread tests show that the most significant alpha spreads are achieved when the performance ranking is based on alpha t-value indicating some bias caused by model dependency of the measure.

The quartile portfolio results indicate that statistically significant performance is found especially in top three portfolios, but the evidence is weaker among bottom portfolios. The bottom portfolios provide consistent statistically significant performance more seldom than other portfolios; the top- and the second-best past performers portfolios get both 41, the past third-best performing portfolio gets 46 and the bottom past performers portfolio achieve only 27 statistically significant alphas overall. Note that the numbers of statistically significant alphas are quite even in the first three portfolios. This is parallel to the results of Jagannathan et al. (2010) and supports the interpretation that investors can outperform during the holding period by avoiding funds belonging to bottom past performer portfolio, but on the other hand, it does not matter whether to invest in the funds belonging to best- second- or third-best past performing portfolio. Especially for M and MS styles, the evidence of performance persistence is superior among top portfolios compared to the comparable bottom portfolios. The Newey-West adjusted Opdyke tests in table 13 support this high performance difference conclusion, although insignificant results are found in the alpha spread tests.

As can be seen from Tables 4-12, regardless of time horizon or performance measure applied, other classes outperformed the FoF style according to abnormal returns (alphas), on average. This supports the results of Gregoriou et al. (2007) implying undue fees paid to fund of fund managers. On the other hand, as the alpha is model-specific measure, it cannot be directly used to compare alphas of different fund classes. When comparing the Sharpe ratios between different fund classes, the FoF style does not have the lowest Sharpe ratios, on average. The lowest Sharpe ratios are found among the MF style. This result weakens the reliability of the results based on alpha values. Parallel to the results of Gregoriou et al. (2007) and Pätäri and Tolvanen (2009), the quartile portfolio results also suggests that stronger persistence is found within non-directional styles than within directional styles.

According to table 13, the strongest evidence of performance persistence is found within macro and multi strategy styles, for which every variant show highly significant results. For these strategies, the past best-performing funds clearly outperform the past worst performing funds. Quite significant results are also obtained within Equity market neutral and Fund of Funds styles, for which seven out of nine tests indicate statistically significant persistence. On the other hand, the weakest evidence of persistence is documented for Convertible & equity arbitrage style, for which only one out of nine results is statistically significant, and for event-driven style, for which two out of nine results are significant.

According to the alpha spread tests, the most significant performance differences are achieved among L/S (6 significant results out of 9, of which 3 out of 6 indicate performance reversal), FoF (4 significant results out of 9) and ED styles (4 significant results out of 9). For CEA and EMN styles alpha spread tests do not indicate any significant performance differences. The L/S style shows some performance reversal, as six out of nine alpha spreads in table 14 were negative and one Sharpe ratio difference test in table 13 is significant and negative. As a result from performance difference tests, the Sharpe ratio difference tests give more evidence of significant persistence than alpha spread tests overall.

In contrast to the cross-sectional regression results, the CEA style shows the weakest evidence of performance persistence as only one significant performance difference was found in the tests presented in tables 13-14. According to the same tests, the evidence of persistence is also weak for the ED style. The combined results indicate that performance persistence among the CEA and ED styles is located among middle performers. In addition, the results of the cross-sectional analyses indicate strong persistence for the CEA and ED styles and some support for persistence is also found from Spearman rank correlation tests.

MF style has clearly higher standard deviation compared to other styles. In addition, standard deviations tend to increase, on average, when shifting from top portfolios towards bottom portfolios. The two worst past performing portfolios (P3 and P4) have the highest standard deviations, on average. The top portfolios have clearly the lowest standard deviations in all styles except in the FI style indicating that funds with a low risk end up in top portfolios.

Based on the Sharpe ratio differences between top- and bottom-quartile portfolios, EMN style shows weak performance persistence when the selection period ranking is based on alpha t-value, but shows significant persistence when the ranking is executed with Sharpe ratios and MVR ratios especially for the combination of 36-month selection period and holding period of equal length. This indicates that performance differences are found more often with model-free performance ranking metrics at least for the EMN style.

Styles indicating strongest evidence of performance persistence are M, MS and FoF on the basis of quartile portfolio analysis. These styles obtain significant Sharpe ratio differences in almost every combination of performance ranking metrics and period combinations as can be seen in table 13. Furthermore, the past better performers tend to obtain better Sharpe ratios also in the holding period than worse performers, on average, among these classes. As a conclusion from the quartile portfolio tests, the performance persistence varies among fund classes.

5.5 Decile portfolio results

In the decile portfolio approach, the portfolios are formed based on the fund rankings on different performance measures in the selection period. These portfolios are then held for 24 or 36 months, and the deciles are rebalanced for every January. The monthly stacked excess return time series of each decile portfolio are then explained by the eight factors of GMM model in order to find out the relative holding period performance for each decile portfolio. Also results for the top- and bottom-percentile and top- and bottom-5% percentiles are reported. The holding period performance is also evaluated on the basis of the Sharpe ratio. In addition, mean returns and standard deviations for each portfolio are reported. Furthermore, performance differences between top- and other deciles and top- and bottom percentiles and 5% percentiles are reported in tables 24-25.

The decile portfolio results are reported in the following way: At first, some interesting features considering deciles and percentiles of this study are presented. Secondly, different combinations of selection and holding periods are compared in order to find out the best period combination to detect performance persistence. Next, different ranking metrics are compared to find out the most sensitive metric to detect persistence. Finally, different deciles are analyzed in order to discover whether the performance persistence especially exists among specific decile.

The results from decile portfolio analyses in tables 15-23 show that the top percentile portfolio has lower standard deviation than other percentiles or deciles. Note also that standard deviation increases monotonically, when proceeding downwards in decile portfolio ranking. This may result from the fact that funds having lowest risk are picked into the top quantiles.

According to the decile portfolio results in tables 15-23, alphas are significant especially among top percentiles and middle deciles. Alpha values are generally negative, except for the top percentiles and deciles. This is probably caused by the style factor that discerns the performance beyond following a particular fund style. Note that when ranking is based on MVR or Sharpe ratio and selection period is 24 months and holding period is 36 months, the negative significant alphas only appear in middle deciles.

The differences between top- and bottom deciles and top and bottom percentiles show that top percentile and decile have, on average, lower mean return and lower standard deviation than their bottom counterparts. Furthermore, the alpha spread tests are generally positive although insignificant. The Sharpe ratio difference tests in table 24 are positive and significant indicating that past outperformers also beat past underperformers in the holding period.

According to the decile portfolio results, all deciles show significant positive factor loadings on the Style factor, which is the fund of fund style in this case. The top percentiles have instead relatively low loadings on style factor especially when the ranking is based on MVR. This may stem from the fact that major part of the funds included in the top percentiles represents FI, EMN or FoF styles. Furthermore, the first percentile has overall relatively low factor loadings indicating that funds that are selected into first percentile, have little exposure to selected explanatory factors. The 10 per cent and 1 per cent spreads are, on average, negative indicating stronger style factor loadings to bottom performers than top performers.

The prediction power of the model is highest for the top deciles. Also the Sharpe ratios are highest in these deciles. On the other hand, the relationship of performance measures (alpha value and Sharpe ratio) and adjusted r-square is opposite in the top percentile indicating that funds that take more active risk tend to perform better. This finding is parallel with Titman and Tiu (2010) although such results in this study were only obtained for top percentiles whereas Titman and Tiu (2010) reported similar findings for top quartiles.

The comparison of different period combinations from tables 15-23 reveal that the combination of 24-month selection period and 36-month holding period is clearly the least sensitive combination to detect performance persistence, while the combination of 36-month selection period and holding period of equal length is a little bit more sensitive to detect persistence than the other combinations. The number of significant performance differences is higher for the combination of 36-month selection and holding period than for other period combinations according to the performance difference tests in tables 24-25. The results are consistent with the results of quartile portfolio analysis. In contrast to the conclusions of Eling (2009, 372) our results suggest that the use of longer selection period enhances the probability of getting evidence for performance persistence.

Table 15. Decile portfolio results from subsequent 36 months, when ranking is based on preceding 24 months Alpha t-value.

Portfolio	Mean return(pct/year)	Std. dev.(pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	Adj.R2	p-value(JB)
Ranking funds on two year Alpha(three-year holding period)																
1%ile	9.54	2.94	1.88	2.31**	0.02	0.62	<0.01	-0.13	-0.03	-0.01	<0.01	<0.01	0.01	0.46	0.53	<0.01
5%ile	9.70	2.98	2.16	2.58**	0.01	0.63	0.02	-0.14	-0.08	<0.01	<0.01	<0.01	0.04	0.40	0.64	<0.01
D 1	10.30	3.41	2.61	2.91***	<0.01	0.60	0.04	-0.13	-0.07	<0.01	<0.01	<0.01	0.08	0.41	0.73	0.30
D 2	10.54	4.76	1.32	1.14	0.26	0.44	0.07	-0.13	-0.05	0.01	<0.01	<0.01	0.13	0.58	0.82	0.37
D 3	10.43	4.78	0.27	0.20	0.84	0.44	0.01	-0.11	-0.10	0.01	0.01	0.01	0.06	0.73	0.70	0.71
D 4	10.10	5.23	-0.31	-0.27	0.78	0.38	0.05	-0.09	-0.13	0.01	0.01	0.01	0.09	0.72	0.74	0.50
D 5	9.57	5.53	-1.14	-0.82	0.41	0.34	<0.01	-0.07	-0.16	0.01	0.02	0.02	0.03	0.85	0.66	0.34
D 6	9.59	5.35	-1.42	-1.07	0.29	0.35	0.02	-0.10	-0.14	<0.01	0.02	0.01	0.02	0.81	0.66	0.16
D 7	9.59	6.12	-1.82	-1.22	0.22	0.31	0.03	-0.08	-0.18	0.01	0.03	0.02	0.01	0.87	0.62	0.67
D 8	9.27	5.85	-1.90	-1.28	0.20	0.30	0.05	-0.10	-0.16	0.02	0.02	0.01	<0.01	0.88	0.63	0.30
D 9	8.92	5.53	-2.02	-1.53	0.13	0.31	0.04	-0.04	-0.14	0.01	0.02	0.01	0.05	0.84	0.71	0.65
D 10	9.13	5.06	-0.46	-0.31	0.76	0.34	0.04	-0.17	-0.14	0.01	0.01	0.01	0.08	0.65	0.65	0.18
Bottom 5%ile	9.25	5.13	0.26	0.15	0.88	0.34	0.03	-0.20	-0.13	0.01	0.02	<0.01	0.09	0.58	0.58	0.77
Bottom 1%ile	7.96	5.99	-0.73	-0.32	0.75	0.24	<0.01	-0.13	-0.17	0.01	0.02	0.02	0.02	0.61	0.39	0.56
Spread 10%	1.17	-1.65	3.07	3.22		0.26	<0.01	0.04	0.07	-0.01	-0.01	<0.01	<0.01	-0.24	0.07	
Spread1%	1.57	-3.05	2.61	2.63		0.38	<0.01	<0.01	0.13	-0.02	-0.03	-0.02	-0.02	-0.15	0.14	

Table 16. Decile portfolio results from subsequent 24 months, when ranking is based on preceding 36 months Alpha t-value.

Portfolio	Mean return(pct/year)	Std. dev.(pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	Adj.R2	p-value(JB)
Ranking funds on three year Alpha(two-year holding period)																
1%ile	9.52	1.88	2.60	3.73***	<0.01	1.01	<0.01	-0.08	-0.03	<0.01	<0.01	<0.01	-0.01	0.38	0.53	<0.01
5%ile	9.56	2.12	2.01	3.95***	<0.01	0.87	0.02	-0.10	-0.07	<0.01	<0.01	<0.01	0.01	0.42	0.70	0.83
D 1	9.64	2.81	0.65	0.87	0.39	0.67	0.05	-0.09	-0.02	<0.01	<0.01	<0.01	<0.01	0.56	0.74	<0.01
D 2	10.55	4.43	-0.07	-0.11	0.91	0.48	0.11	-0.09	-0.06	<0.01	<0.01	0.01	0.12	0.64	0.88	0.76
D 3	10.53	5.02	-2.33	-2.57**	0.01	0.42	0.07	-0.01	-0.07	<0.01	0.01	0.01	0.09	0.92	0.83	0.67
D 4	10.56	5.41	-3.86	-3.44***	<0.01	0.39	0.06	-0.02	-0.15	<0.01	0.01	0.02	<0.01	1.14	0.76	0.90
D 5	10.38	5.14	-2.95	-2.85***	<0.01	0.40	0.07	-0.07	-0.12	0.01	0.01	0.01	<0.01	1.06	0.75	0.82
D 6	9.38	5.62	-4.86	-4.25***	<0.01	0.32	0.06	0.08	-0.10	0.01	0.01	0.02	0.02	1.15	0.78	0.39
D 7	9.07	5.52	-4.91	-3.35***	<0.01	0.31	0.06	0.03	-0.10	0.01	0.01	0.01	-0.05	1.21	0.69	0.08
D 8	9.47	5.78	-6.04	-4.65***	<0.01	0.32	0.09	0.01	-0.06	0.01	0.01	0.01	-0.06	1.35	0.76	0.17
D 9	8.75	6.01	-4.99	-2.59**	0.01	0.27	0.12	-0.02	-0.12	0.02	0.02	<0.01	-0.03	1.14	0.64	0.26
D 10	8.43	4.98	-4.56	-4.04***	<0.01	0.32	0.12	-0.03	-0.06	0.01	0.01	<0.01	0.01	1.01	0.79	0.11
Bottom 5%ile	8.25	5.04	-3.98	-3.86***	<0.01	0.30	0.12	-0.08	-0.06	0.01	0.01	<0.01	0.05	0.90	0.76	0.62
Bottom 1%ile	6.98	5.90	-6.11	-3.04***	<0.01	0.20	0.06	0.11	-0.04	0.01	0.02	0.01	-0.11	1.20	0.50	0.86
Spread 10%	1.20	-2.17	5.21	-3,17		0.35	-0.07	-0.06	0.04	-0.01	-0.01	<0.01	<0.01	-0.44	-0.05	
Spread1%	2.54	-4.03	8.70	0.69		0.81	-0.06	-0.19	0.01	-0.02	-0.02	-0.01	0.10	-0.82	0.03	

Table 17. Decile portfolio results from subsequent 36 months, when ranking is based on preceding 36 months Alpha t-value.

Portfolio	Mean return(pct/year)	Std. dev.(pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	Adj.R2	p-value(JB)
Ranking funds on three year Alpha(three-year holding period)																
1%ile	9.11	1.98	2.07	2.30**	0.02	0.92	<0.01	-0.07	-0.01	-0.01	<0.01	<0.01	-0.02	0.41	0.48	<0.01
5%ile	9.34	2.28	1.03	2.04**	0.04	0.81	0.02	-0.08	-0.05	<0.01	<0.01	<0.01	<0.01	0.51	0.75	0.59
D 1	9.93	2.86	0.31	0.59	0.56	0.70	0.05	-0.07	-0.05	<0.01	<0.01	<0.01	0.02	0.60	0.82	0.52
D 2	10.98	4.64	-0.97	-1.51	0.13	0.49	0.12	-0.02	-0.05	<0.01	<0.01	<0.01	0.11	0.76	0.88	0.40
D 3	10.95	5.19	-2.89	-3.13***	<0.01	0.44	0.09	0.02	-0.05	<0.01	0.01	0.01	0.08	1.00	0.81	0.23
D 4	10.94	5.55	-3.86	-3.84***	<0.01	0.41	0.08	0.03	-0.11	<0.01	0.01	0.02	<0.01	1.16	0.78	0.66
D 5	10.75	5.59	-3.71	-3.46***	<0.01	0.40	0.08	-0.02	-0.10	0.01	0.01	<0.01	-0.01	1.19	0.74	0.99
D 6	9.86	5.84	-5.36	-4.65***	<0.01	0.34	0.04	0.09	-0.07	0.01	0.01	0.01	0.02	1.28	0.78	0.19
D 7	9.55	5.84	-4.88	-3.63***	<0.01	0.33	0.07	0.04	-0.13	0.01	0.01	0.02	-0.04	1.21	0.67	0.08
D 8	9.92	5.93	-5.69	-4.78***	<0.01	0.34	0.11	-0.01	-0.09	0.01	0.01	0.01	-0.04	1.29	0.74	0.08
D 9	9.03	6.36	-5.72	-3.20***	<0.01	0.28	0.12	0.04	-0.07	0.02	0.01	0.01	-0.05	1.29	0.64	0.10
D 10	9.23	5.22	-4.80	-4.82***	<0.01	0.35	0.12	<0.01	-0.05	0.01	0.01	0.01	<0.01	1.12	0.81	0.05
Bottom 5%ile	9.34	5.29	-4.24	-4.63***	<0.01	0.35	0.12	-0.03	-0.05	0.01	<0.01	<0.01	0.05	1.03	0.79	0.32
Bottom 1%ile	7.05	6.49	-7.46	-3.74***	<0.01	0.19	0.03	0.12	-0.03	0.01	0.01	0.02	-0.12	1.37	0.48	0.88
Spread 10%	0.71	-2.36	5.11	-4,23		0.36	-0.07	-0.07	<0.01	-0.01	-0.01	-0.01	0.01	-0.51	0.01	
Spread1%	2.06	-4.51	9.53	-1,44		0.72	-0.04	-0.19	0.02	-0.01	-0.01	-0.02	0.10	-0.97	-0.01	

Table 18. Decile portfolio results from subsequent 36 months, when ranking is based on preceding 24 months Sharpe ratio.

Portfolio	Mean return(pct/year)	Std. dev.(pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	Adj.R2	p-value(JB)
Ranking funds on two year Sharpe(three-year holding period)																
1%ile	9.13	2.11	3.56	3.78***	<0.01	0.85	-0.03	-0.08	-0.03	<0.01	<0.01	<0.01	<0.01	0.27	0.25	<0.01
5%ile	8.95	2.16	1.96	3.40***	<0.01	0.81	-0.01	-0.06	<0.01	<0.01	<0.01	<0.01	-0.02	0.47	0.68	<0.01
D 1	8.71	2.67	0.47	1.05	0.29	0.62	<0.01	-0.04	<0.01	<0.01	<0.01	<0.01	-0.03	0.62	0.82	<0.01
D 2	8.47	4.46	-2.47	-4.77***	<0.01	0.35	0.02	-0.04	-0.05	<0.01	<0.01	<0.01	0.04	0.87	0.84	<0.01
D 3	8.94	4.61	-1.90	-2.22**	0.03	0.37	0.03	-0.06	-0.06	<0.01	<0.01	0.01	0.07	0.83	0.87	0.08
D 4	9.67	5.72	-2.45	-1.97*	0.05	0.33	0.01	-0.13	-0.13	0.01	0.01	0.01	0.06	0.99	0.77	0.59
D 5	9.97	5.96	-1.67	-1.45	0.15	0.33	0.05	-0.21	-0.16	0.01	0.02	0.01	0.09	0.85	0.74	0.93
D 6	9.14	6.16	-1.67	-1.03	0.30	0.28	0.03	-0.14	-0.19	0.01	0.02	0.01	0.11	0.78	0.65	0.49
D 7	9.71	5.82	0.13	0.08	0.93	0.33	0.03	-0.11	-0.16	0.01	0.02	0.01	0.10	0.64	0.58	0.88
D 8	9.32	5.32	0.40	0.22	0.82	0.34	0.02	-0.08	-0.13	0.01	0.02	0.01	0.02	0.62	0.47	0.47
D 9	9.63	6.47	-0.02	-0.01	0.99	0.29	0.02	-0.08	-0.12	0.01	0.03	0.02	-0.02	0.73	0.41	0.40
D 10	13.01	7.90	4.47	1.73*	0.09	0.35	0.15	-0.13	-0.24	0.01	0.03	0.02	0.16	0.31	0.37	0.75
Bottom 5%ile	14.18	9.21	7.12	2.28**	0.02	0.33	0.19	-0.19	-0.21	0.01	0.04	0.02	0.28	0.04	0.33	0.81
Bottom 1%ile	18.54	16.81	13.12	2.68***	0.01	0.25	0.28	-0.57	-0.50	0.02	0.04	<0.01	0.59	-0.59	0.21	<0.01
Spread 10%	-4.30	-5.23	-4.00	-0.68		0.27	-0.15	0.10	0.23	-0.01	-0.03	-0.02	-0.19	0.30	0.44	
Spread1%	-9.40	-14.70	-9.56	1.10		0.60	-0.32	0.50	0.47	-0.02	-0.04	<0.01	-0.59	0.86	0.04	

Table 19. Decile portfolio results from subsequent 24 months, when ranking is based on preceding 36 months Sharpe ratio.

Portfolio	Mean return(pct/year)	Std. dev.(pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	Adj.R2	p-value(JB)
Ranking funds on three year Sharpe(two-year holding period)																
1%ile	9.19	1.70	2.87	3.70***	<0.01	1.10	-0.01	0.02	0.02	-0.01	<0.01	<0.01	-0.03	0.36	0.43	<0.01
5%ile	8.93	1.79	1.63	3.26***	<0.01	0.99	-0.01	-0.05	-0.01	<0.01	<0.01	<0.01	-0.04	0.47	0.68	0.38
D 1	8.82	2.08	0.56	1.31	0.19	0.82	<0.01	-0.05	-0.01	<0.01	<0.01	<0.01	-0.04	0.58	0.82	0.36
D 2	8.22	3.57	-3.40	-6.18***	<0.01	0.43	0.01	-0.07	-0.02	<0.01	<0.01	<0.01	<0.01	0.91	0.90	0.27
D 3	8.86	4.38	-4.42	-7.95***	<0.01	0.39	0.05	-0.03	-0.07	<0.01	<0.01	0.01	0.02	1.04	0.90	0.30
D 4	10.05	5.44	-4.21	-4.02***	<0.01	0.37	0.04	-0.09	-0.12	0.01	<0.01	0.01	0.06	1.12	0.81	0.22
D 5	9.31	6.03	-5.89	-4.84***	<0.01	0.30	0.06	-0.04	-0.12	0.01	0.01	0.01	0.05	1.22	0.79	0.77
D 6	9.77	5.98	-4.99	-3.87***	<0.01	0.32	0.07	-0.06	-0.17	<0.01	0.02	0.01	0.05	1.11	0.76	0.98
D 7	10.35	5.97	-4.13	-2.97***	<0.01	0.35	0.10	0.11	-0.12	<0.01	0.02	0.02	-0.03	1.16	0.67	0.49
D 8	9.39	6.00	-4.18	-2.73***	<0.01	0.30	0.10	0.11	-0.07	0.02	0.02	0.01	-0.05	1.17	0.64	<0.01
D 9	9.39	5.72	-3.38	-1.90*	0.06	0.32	0.11	0.06	-0.03	0.02	0.02	0.02	-0.06	1.10	0.63	0.23
D 10	11.70	7.63	-0.29	-0.11	0.91	0.32	0.25	-0.13	-0.11	0.02	0.02	<0.01	0.10	0.74	0.49	0.66
Bottom 5%ile	12.27	9.20	-3.98	0.05	0.96	0.28	0.32	-0.10	-0.05	0.03	0.02	-0.01	0.19	0.71	0.48	0.65
Bottom 1%ile	14.21	16.33	2.13	0.32	0.75	0.19	0.62	-0.08	-0.05	0.06	<0.01	-0.02	0.40	0.55	0.34	<0.01
Spread 10%	-2.88	-5.55	0.85	1.20		0.51	-0.25	0.08	0.10	-0.02	-0.02	-0.01	-0.13	-0.17	0.33	
Spread1%	-5.02	-14.63	0.74	3.65		0.91	-0.63	0.11	0.07	-0.06	-0.01	0.03	-0.43	-0.19	0.10	

Table 20. Decile portfolio results from subsequent 36 months, when ranking is based on preceding 36 months Sharpe ratio.

Portfolio	Mean return(pct/year)	Std. dev.(pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	Adj.R2	p-value(JB)
Ranking funds on three year Sharpe(three-year holding period)																
1%ile	8.27	1.65	2.51	2.91***	<0.01	1.00	-0.01	0.01	0.03	-0.01	<0.01	<0.01	-0.03	0.33	0.32	<0.01
5%ile	8.51	1.79	1.14	2.31**	0.02	0.95	-0.01	-0.05	<0.01	<0.01	<0.01	<0.01	-0.04	0.50	0.71	<0.01
D 1	8.56	2.06	0.23	0.53	0.60	0.81	<0.01	-0.07	-0.02	<0.01	<0.01	<0.01	-0.04	0.59	0.84	0.18
D 2	8.55	3.36	-2.42	-5.21***	<0.01	0.49	0.01	-0.09	-0.03	<0.01	<0.01	<0.01	0.01	0.81	0.88	0.69
D 3	9.51	4.40	-4.04	-8.17***	<0.01	0.43	0.05	-0.01	-0.05	<0.01	<0.01	0.01	0.02	1.06	0.89	0.43
D 4	10.63	5.48	-3.82	-4.15***	<0.01	0.40	0.07	0.01	-0.10	0.01	<0.01	0.01	0.07	1.11	0.81	0.13
D 5	9.75	6.14	-5.70	-5.60***	<0.01	0.32	0.08	0.07	-0.08	0.01	0.01	0.01	0.06	1.25	0.80	0.58
D 6	9.89	6.18	-5.05	-4.28***	<0.01	0.32	0.09	-0.03	-0.14	0.01	0.02	0.01	0.06	1.11	0.76	0.91
D 7	10.19	6.34	-5.45	-3.77***	<0.01	0.33	0.10	0.11	-0.10	0.01	0.02	0.01	-0.04	1.32	0.66	0.31
D 8	9.99	6.58	-5.75	-3.38***	<0.01	0.31	0.08	0.07	-0.07	0.02	0.01	0.01	-0.08	1.43	0.63	0.30
D 9	9.56	5.89	-4.33	-2.75***	<0.01	0.33	0.10	0.03	-0.07	0.01	0.02	0.02	-0.05	1.16	0.64	0.13
D 10	13.72	8.09	-1.63	-0.68	0.50	0.37	0.30	0.05	-0.09	0.01	0.02	0.01	0.09	1.02	0.59	0.84
Bottom 5%ile	14.90	9.66	-0.90	-0.28	0.78	0.34	0.40	0.16	-0.04	0.01	0.01	<0.01	0.19	0.96	0.55	0.63
Bottom 1%ile	16.90	15.92	4.07	0.74	0.46	0.24	0.74	-0.02	-0.34	0.02	<0.01	-0.01	0.49	0.07	0.35	0.04
Spread 10%	-5.17	-6.02	1.86	-0.15		0.44	-0.30	-0.12	0.08	-0.01	-0.02	-0.01	-0.13	-0.43	0.26	
Spread1%	-8.63	-14.26	-1.56	2.17		0.76	-0.75	0.04	0.37	-0.03	-0.01	0.01	-0.52	0.26	-0.03	

Table 21. Decile portfolio results from subsequent 36 months, when ranking is based on preceding 24 months Mean variance ratio.

Portfolio	Mean return(pct/year)	Std. dev.(pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	Adj.R2	p-value(JB)
Ranking funds on two year MVR(three-year holding period)																
1%ile	6.72	0.92	2.90	6.61***	<0.01	1.32	<0.01	-0.05	-0.02	<0.01	<0.01	<0.01	<0.01	0.08	0.19	<0.01
5%ile	7.80	1.64	2.33	2.95***	<0.01	0.89	-0.03	-0.10	-0.02	<0.01	<0.01	<0.01	-0.01	0.28	0.51	<0.01
D 1	8.05	1.91	1.91	2.22**	0.03	0.79	-0.02	-0.08	-0.01	<0.01	<0.01	<0.01	-0.01	0.37	0.62	0.33
D 2	8.29	2.84	0.08	0.09	0.93	0.54	-0.01	-0.08	-0.03	<0.01	<0.01	<0.01	0.01	0.59	0.82	0.06
D 3	8.34	3.66	-1.54	-2.71***	<0.01	0.42	0.02	-0.07	-0.06	<0.01	<0.01	<0.01	0.01	0.75	0.88	<0.01
D 4	8.67	4.82	-2.64	-5.12***	<0.01	0.34	0.04	-0.11	-0.11	0.01	<0.01	0.01	0.06	0.88	0.87	<0.01
D 5	9.29	6.07	-2.84	-2.30**	0.02	0.29	0.03	-0.14	-0.14	0.01	0.01	0.01	0.09	0.95	0.75	0.16
D 6	9.99	7.35	-3.85	-2.73***	<0.01	0.27	0.05	-0.20	-0.23	0.01	0.02	0.01	0.07	1.07	0.67	0.62
D 7	10.38	6.86	-0.80	-0.54	0.59	0.30	0.06	-0.14	-0.19	0.02	0.02	0.01	0.13	0.82	0.64	0.97
D 8	10.35	6.36	0.63	0.30	0.77	0.33	0.02	-0.03	-0.12	0.01	0.03	0.02	0.09	0.70	0.51	0.29
D 9	10.21	7.06	-0.02	-0.01	0.99	0.29	0.02	<0.01	-0.11	0.01	0.03	0.02	<0.01	0.80	0.44	0.47
D 10	13.28	8.19	4.15	1.52	0.13	0.34	0.15	-0.12	-0.21	0.01	0.03	0.02	0.14	0.41	0.36	0.87
Bottom 5%ile	14.45	9.39	6.62	2.17**	0.03	0.33	0.19	-0.18	-0.22	0.01	0.04	0.02	0.28	0.15	0.37	0.83
Bottom 1%ile	18.51	16.91	12.36	2.42**	0.02	0.24	0.30	-0.57	-0.51	0.02	0.04	0.01	0.60	-0.50	0.23	0.24
Spread 10%	-5.23	-6.27	-2.24	0.70		0.45	-0.17	0.04	0.20	-0.01	-0.03	-0.02	-0.14	-0.05	0.26	
Spread1%	-11.79	-15.98	-9.46	4.19		1.07	-0.31	0.52	0.50	-0.02	-0.04	-0.01	-0.61	0.58	-0.05	

Table 22. Decile portfolio results from subsequent 24 months, when ranking is based on preceding 36 months Mean variance ratio.

Portfolio	Mean return(pct/year)	Std. dev.(pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	Adj.R2	p-value(JB)
Ranking funds on three year MVR(two-year holding period)																
1%ile	7.20	0.27	2.69	5.59***	<0.01	1.40	<0.01	-0.05	-0.01	<0.01	<0.01	<0.01	-0.01	0.17	0.44	<0.01
5%ile	7.79	1.59	1.12	2.39**	0.02	0.90	-0.01	-0.05	-0.01	<0.01	<0.01	<0.01	-0.03	0.41	0.68	0.13
D 1	7.75	1.89	0.14	0.34	0.74	0.75	<0.01	-0.06	<0.01	<0.01	<0.01	<0.01	-0.03	0.51	0.82	0.21
D 2	8.12	2.68	-1.69	-3.85***	<0.01	0.56	0.01	-0.09	-0.02	<0.01	<0.01	<0.01	-0.03	0.73	0.90	0.35
D 3	8.07	3.30	-2.84	-5.45***	<0.01	0.45	0.03	-0.07	-0.04	<0.01	<0.01	<0.01	<0.01	0.81	0.90	0.20
D 4	8.58	3.94	-3.66	-4.31***	<0.01	0.41	0.04	-0.02	-0.06	<0.01	<0.01	0.01	-0.02	0.96	0.83	0.31
D 5	9.17	5.35	-4.63	-4.98***	<0.01	0.33	0.05	-0.19	-0.16	<0.01	<0.01	0.01	0.06	1.01	0.79	0.51
D 6	10.64	7.19	-6.31	-4.36***	<0.01	0.30	0.09	-0.11	-0.22	0.01	0.01	0.01	0.08	1.35	0.75	0.86
D 7	10.62	6.87	-5.32	-3.36***	<0.01	0.31	0.07	<0.01	-0.18	0.01	0.02	0.02	0.09	1.23	0.74	0.73
D 8	11.46	7.49	-4.68	-2.26**	0.03	0.32	0.12	0.21	-0.12	0.01	0.02	0.02	-0.07	1.41	0.61	0.61
D 9	9.85	6.46	-4.57	-2.48**	0.01	0.30	0.12	0.28	0.05	0.02	0.02	0.02	-0.07	1.33	0.66	0.94
D 10	11.75	8.03	-1.12	-0.40	0.69	0.30	0.26	-0.12	-0.08	0.03	0.02	<0.01	0.08	0.89	0.51	0.95
Bottom 5%ile	12.80	9.84	0.83	0.23	0.82	0.27	0.36	-0.12	-0.06	0.03	0.02	<0.01	0.22	0.66	0.48	0.84
Bottom 1%ile	13.40	17.12	0.92	0.13	0.90	0.17	0.60	-0.18	-0.12	0.07	<0.01	-0.03	0.42	0.62	0.33	0.10
Spread 10%	-4.00	-6.15	1.26	-0.06		0.45	-0.26	0.06	0.08	-0.03	-0.02	-0.01	-0.11	-0.37	0.31	
Spread1%	-6.20	-16.85	1.77	5.46		1.24	-0.60	0.13	0.11	-0.07	<0.01	0.03	-0.42	-0.45	0.12	

Table 23. Decile portfolio results from subsequent 36 months, when ranking is based on preceding 36 months Mean variance ratio.

Portfolio	Mean return(pct/year)	Std. dev.(pct/year)	Alpha(pct/year)	Alpha(t)	p-value	Shar-pe	Wilsh	Changeins.	Change-inm.	Ptfs-bd	Ptfs-fx	Ptfs-com	World	Style	Adj.R2	p-value(JB)
Ranking funds on three year MVR(three-year holding period)																
1%ile	6.81	0.94	2.52	5.33***	<0.01	1.29	<0.01	-0.06	-0.02	<0.01	<0.01	<0.01	-0.01	0.14	0.34	<0.01
5%ile	7.73	1.68	0.66	1.37	0.17	0.88	-0.02	-0.04	<0.01	<0.01	<0.01	<0.01	-0.04	0.49	0.75	<0.01
D 1	7.78	1.89	0.04	0.11	0.91	0.78	-0.01	-0.06	<0.01	<0.01	<0.01	<0.01	-0.03	0.54	0.84	0.08
D 2	8.13	2.69	-1.78	-4.39***	<0.01	0.57	0.01	-0.09	-0.03	<0.01	<0.01	<0.01	-0.03	0.74	0.90	0.34
D 3	8.39	3.31	-2.69	-6.37***	<0.01	0.49	0.03	-0.08	-0.05	<0.01	<0.01	<0.01	<0.01	0.82	0.90	0.38
D 4	8.95	4.02	-3.38	-4.60***	<0.01	0.44	0.05	0.01	-0.06	<0.01	<0.01	0.01	-0.01	0.96	0.82	0.80
D 5	9.76	5.50	-4.64	-5.42***	<0.01	0.36	0.08	-0.04	-0.10	<0.01	0.01	0.01	0.06	1.07	0.81	0.42
D 6	11.63	7.37	-6.17	-4.81***	<0.01	0.33	0.11	-0.03	-0.17	0.01	0.01	0.01	0.08	1.41	0.78	0.86
D 7	11.17	7.31	-6.19	-4.03***	<0.01	0.32	0.08	0.09	-0.11	0.01	0.02	0.01	0.07	1.42	0.75	0.34
D 8	11.26	7.94	-6.04	-2.93***	<0.01	0.30	0.12	0.14	-0.14	0.01	0.02	0.02	-0.08	1.53	0.58	0.41
D 9	9.73	6.30	-5.27	-2.97***	<0.01	0.31	0.11	0.19	0.03	0.01	0.01	0.02	-0.09	1.40	0.64	0.26
D 10	13.73	8.42	-1.98	-0.80	0.42	0.35	0.31	0.05	-0.09	0.01	0.02	0.01	0.10	1.06	0.59	0.76
Bottom 5%ile	15.38	10.24	-0.65	-0.20	0.84	0.33	0.43	0.14	-0.05	0.02	0.02	<0.01	0.22	0.96	0.56	0.62
Bottom 1%ile	17.51	16.20	3.31	0.59	0.55	0.24	0.75	-0.04	-0.39	0.02	<0.01	-0.01	0.50	0.19	0.37	0.06
Spread 10%	-5.95	-6.53	2.02	-0.69		0.42	-0.32	-0.10	0.09	-0.01	-0.02	-0.01	-0.13	-0.52	0.25	
Spread1%	-10,70	-15,26	-0,79	4,74		1,05	-0,74	-0,02	0,37	-0,02	0,00	0,01	-0,50	-0,05	-0,03	

Table 24. Statistical significance of the Sharpe ratio difference between portfolios. The reported values are t-statistic based and the corresponding p-values. For each time series, the variance and the related terms with autocorrelation was adjusted by using the Newey-West autocorrelation corrected estimates (23 lags). Based on these adjustments, the t-statistics and p-values were calculated using the method by Opdyke (2007, 335).

	Sharpe (d*,m(sign))			MVR (d*,m(sign))			Alpha (d*,m(sign))		
	S24_H36	S36_H24	S36_H36	S24_H36	S36_H24	S36_H36	S24_H36	S36_H24	S36_H36
5% Spread	5.09	5.90	3.05	4.63	5.52	2.07	2.31	4.19	6.94
	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	0.02	<0.01	<0.01
1%Spread	2.27	4.84	3.39	5.27	6.96	5.03	0.05	4.13	4.05
	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.96	<0.01	<0.01
D1-D2	42.31	7.69	4.86	9.39	23.69	2.80	0.96	2.89	11.83
	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.34	<0.01	<0.01
D1-D3	12.25	7.63	5.26	6.92	7.09	3.11	0.36	3.68	8.35
	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.72	<0.01	<0.01
D1-D4	10.78	7.08	5.27	7.04	6.11	3.04	3.45	0.73	2.42
	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.46	0.02
D1-D5	8.43	7.18	5.27	7.30	6.34	3.37	1.50	1.70	7.11
	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.13	0.09	<0.01
D1-D6	6.50	6.40	5.02	6.74	5.73	3.22	1.17	2.47	5.34
	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.24	0.01	<0.01
D1-D7	5.19	5.39	4.95	6.19	5.26	3.46	0.27	1.51	5.88
	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.79	0.13	<0.01
D1-D8	1.91	5.56	5.29	6.30	3.85	3.13	0.90	1.52	9.80
	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	0.37	0.13	<0.01
D1-D9	3.40	5.89	4.76	7.75	4.74	3.50	1.02	1.95	10.88
	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.31	0.05	<0.01
D1-D10	4.01	5.90	4.61	5.57	5.34	3.35	2.52	2.42	9.03
	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.02	<0.01

Table 25. Statistical significance of the alpha spread tests. The table reports t-statistic and the corresponding p-values obtained from alpha spread tests. The alpha spread tests are calculated to different performance ranking metrics and combinations of selection and holding periods. The holding period alphas for the test were estimated using the adjusted Fung-Hsieh 8-factor model.

	Sharpe (α-spread test)			MVR (α-spread test)			Alpha (α-spread test)		
	S24_H36	S36_H24	S36_H36	S24_H36	S36_H24	S36_H36	S24_H36	S36_H24	S36_H36
1% Spread	-1.92	0.11	-0.28	-1.85	0.25	-0.14	1.08	4.09	4.35
	0.06	0.91	0.78	0.07	0.80	0.89	0.28	<0.01	<0.01
5%Spread	-1.63	0.07	0.63	-1.36	0.08	0.40	1.00	5.21	5.04
	0.11	0.94	0.53	0.17	0.94	0.69	0.32	<0.01	<0.01
D1-D2	4.29	5.67	4.18	1.50	3.02	3.27	0.88	0.73	1.55
	<0.01	<0.01	<0.01	0.13	<0.01	<0.01	0.38	0.47	0.12
D1-D3	2.45	7.09	6.50	3.35	4.46	4.80	1.45	2.54	3.02
	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.15	0.01	<0.01
D1-D4	2.21	4.22	3.98	4.54	4.01	4.13	2.00	3.35	3.68
	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01
D1-D5	1.73	5.00	5.36	3.16	4.68	5.00	2.27	2.82	3.37
	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.01	<0.01
D1-D6	1.27	4.09	4.20	3.49	4.28	4.64	2.52	4.04	4.48
	0.20	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
D1-D7	0.20	3.22	3.76	1.58	3.33	3.94	2.54	3.38	3.60
	0.84	<0.01	<0.01	0.12	<0.01	<0.01	0.01	<0.01	<0.01
D1-D8	0.04	2.98	3.41	0.56	2.28	2.90	2.60	4.47	4.62
	0.97	<0.01	<0.01	0.57	0.02	<0.01	0.01	<0.01	<0.01
D1-D9	0.20	2.15	2.79	0.76	2.49	2.93	2.90	2.73	3.24
	0.84	0.03	0.01	0.45	0.01	<0.01	<0.01	0.01	<0.01
D1-D10	-1.52	0.32	0.76	-0.78	0.45	0.81	1.78	3.85	4.54
	0.13	0.75	0.45	0.43	0.66	0.42	0.08	<0.01	<0.01

MVR-based ranking is the most sensitive to detect performance persistence according to the decile portfolio results: Compared to the Sharpe ratio or alpha t-value rankings, in MVR based ranking the performance rankings of the portfolios remain, on average, more similar in subsequent and preceding periods. When comparing performance differences in tables 24-25, it can be seen that MVR- and Sharpe ratio-based rankings are more sensitive to detect performance differences than alpha t-value-based ranking. Altogether, these model-free performance ranking metrics slightly outperform the model-specific performance ranking metric in detecting persistence although significant results are obtained on the basis of every performance metric. The Sharpe ratio detects performance persistence better than alpha t-value according to the performance difference tests.

The decile results show that the top and the bottom deciles have, on average, insignificant alphas and the alpha spread tests in table 25 are insignificant between these two portfolios. On the other hand, the Sharpe ratio difference tests are very significant between these two portfolios indicating significant performance difference. Furthermore, according to tables 15-23, the bottom decile continuously outperforms eighth and ninth decile indicating performance reversal within the worst selection period performers. However further conclusions cannot be drawn as the alphas of the tenth decile are generally insignificant.

According to the Sharpe ratio difference tests reported in table 24, significant evidence of performance persistence is found within every combination of selection and holding periods and performance measures except for the combination of 24-month selection period and 36-month holding period when the alpha t-value is used as the basis of rankings. The results hold for both decile, 5 percentile and percentile extreme portfolios.

According to the performance difference tests in tables 24-25, the top decile outperforms, on average, other deciles. When the ranking is based on Sharpe ratio or MVR, the top decile outperforms deciles 2-9 on the basis of alpha spread tests, as the results are significant and positive in every comparisons for the period combinations of 36-month selection period and 24-month holding period, and for that of 36-month selection- and holding period. Note that performance difference between the top and the bottom decile portfolios is not significant on the basis of the model-free performance metrics according to the alpha spread test. Based on the same test, the performance differences between top percentiles and bottom percentiles are significant only for the period combination of 24-month selection period and 36-month holding period when the ranking is based on model-free performance metric, and for the period combinations of 36-month selection period and 24-month holding period and 36-month selection and holding period, when the ranking is based on alpha t-value.

The results from performance difference tests indicate that investing only in the best performing decile of funds of the past outperform the strategy of investing in other deciles of funds. Only exceptions for not to support this strategy in this analysis is when the ranking is based on alpha t-value and the combination of 24-month selection period and 36-month holding period or 36-month selection period and 24-month holding period is employed. For these period combinations, only a few significant performance differences were obtained as shown in table 24. According to Sharpe ratio difference tests, the best-performed percentile and the best 5% percentile also outperform the percentile bottom counterparts. The results indicate that performance persistence exists especially among top deciles and percentiles.

6 SUMMARY AND CONCLUSIONS

This thesis examines the long-term performance persistence of hedge funds using four different complement methodologies, six different combinations of selection and holding periods, and six different performance measures. The methods are cross-sectional analysis, Spearman rank correlation test and quartile- and decile portfolio analyses using style-adjusted Fung-Hsieh 8-factor model. To determine statistical significance of performance differences between portfolios, alpha spread test and Newey-West adjusted Opdyke tests were employed in the quantile portfolio analyses. Due to the space limitations, the three metrics (alpha t-value, mean variance ratio and Sharpe ratio) and the three period combinations (24-month selection period and 36-month holding period, 36-month selection period and 24-month holding period and 36-month selection period and 36-month holding period) with best prediction powers from cross-sectional regressions were picked for further analyses. Original data of this study contains over 14,400 hedge funds, wherefrom the sample data was drawn. The sample data consists of 3,144 hedge funds world-widely and the sample period covers the years 1998-2007.

The results suggest that the performance persistence depends on the ranking metric employed where the model-free performance measures tend to outperform the model-specific measures. This is consistent with the results of Pätäri and Tolvanen (2009) and Harri and Brorsen (2004). Especially the MVR was the most sensitive to detect performance persistence. Parallel with the results of Pätäri and Tolvanen (2009) and Agarwal and Naik (2000) the results show that the degree and existence of persistence varies among fund classes. In this thesis, classes with the strongest performance persistence are multi strategy, macro and fund of funds.

All results from methodologies indicate that the selection period performance explains corresponding holding period performance although differences exist between period combinations. According to the results, longer selection period combinations are more sensitive to detect performance persistence. Three out of four tests suggest that the best period combination to detect performance persistence used in this study is the 36-month selection period and holding period of equal length. The result is in contrast with the results of Eling (2009) who found stronger persistence with shorter selection periods.

The quartile and decile portfolio analyses indicate that the performance difference remains between the past outperformers and underperformers. The performance difference tests showed significant performance differences between top and bottom portfolios. In addition, top portfolios had, on average, consistently higher alphas and Sharpe ratios than bottom portfolios. These findings are parallel to the results of Pätäri and Tolvanen (2009) and Baquero et al. (2005).

Many practical implications are found from the results of this thesis. Firstly, as we found evidence for long-term persistence, the results are relevant to investors as they are not driven by incubation and backfill bias. Investors could benefit from long-term persistence instead of short-term persistence as the long-term persistence excludes significant lockup periods, and reduces the entry and exit costs compared to investors trying to benefit from short-term persistence. Secondly, as performance difference remains between the past outperformers and underperformers, on average, and differences are found among hedge fund classes, investors could benefit by selecting hedge funds from a certain style to invest. In this research, top multi strategy and event driven portfolios have clearly higher alphas and Sharpe ratios than other fund styles

Several suggestions emerge for further research. Although we found long-term performance persistence using style-adjusted Fung-Hsieh 8-factor model, other models should also be employed to search persistence using as a large data as in this study. Furthermore, as the time horizon of this study is limited to the end of 2007, it would be interesting to explore whether the worldwide financial crisis has had an effect on the performance persistence of hedge funds. Hereby the sample period should be extended. In addition, as long-term performance is found recently also in many other studies (for example Kosowski et al., 2007; Jagannathan et al., 2010), future research could focus even more on this area and its practical implications, as the long-term persistence is much more valuable for investors than short-term persistence. Finally, the MVR was surprisingly the most sensitive performance measure to detect performance persistence. As this metric has not been employed in any other studies on performance persistence of hedge funds, the applicability of this measure should also be investigated in future research.

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