Ranking of equity mutual funds: The bias in using survivorship bias-free datasets

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Ranking of equity mutual funds:
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Abstract

Using survivorship bias-free datasets to rank fund performance introduces a market climate bias that depends on the lengths of the funds' return histories. Based on Carhart's (1997) four-factor model, we analytically show how the market climate affects commonly used performance measures. Our empirical results confirm that this market climate bias creates different rankings depending on the measure used for US equity funds. Moreover, the data availability within the fund sample impacts correlations between rankings based on different measures. Adjusting measures for the different fund return histories corrects for the market climate bias and produces more consistent rankings across different measures.

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1 Introduction

Several papers investigate the impact of survivorship bias on mutual fund performance and reach the general conclusion that the average performance is biased upwards if the fund samples only include surviving funds. Papers by Grinblatt and Titman (1989), Brown and Goetzman (1995), Malkiel (1995), Elton et al. (1996) and Carhart et al. (2002) find that survivorship bias in US equity funds increases average annual returns by approximately 10 to 150 basis points. Internationally, Blake and Timmermann (1998), Otten and Bams (2002) and Deaves (2004) obtain similar results. Recent studies adjust for survivorship bias either by utilizing a survivorship bias-free dataset such as CRSP or by adjusting for non-surviving funds in other databases like Morningstar. Consequently, these datasets include both surviving and non-surviving funds with return histories of different lengths.

The main objective of this paper is to investigate the impact of using survivorship bias-free datasets to rank the performance of funds that have existed during different time periods. Specifically, we study the impact of data availability on rankings based on six commonly used measures: average excess return, Sharpe ratio, Treynor ratio, one-, three- and four-factor alpha. We illustrate the mathematical relationship between these measures and fund-specific characteristics as well as market factors based on Carhart's (1997) four-factor model, which shows how the measures are affected by market climate.

Our secondary objective is to analyze the impact of data availability and market climate on correlations between different measures. Many studies investigate whether the use of various performance measures leads to similar fund rankings, but they frequently do not discuss the impact of different lengths of fund return histories or the impact of the fund sample used. For example, studies such as Wermers (2000) and Stotz (2007) show correlations between performance measures, but the samples include both surviving and non-surviving equity mutual funds, which may influence the ranking due to the prevailing market climate. In contrast, studies like Bal and Leger (1996), Ferruz et al. (2006), Hübner (2007) and Bessler et al. (2007) report correlations between performance measures but employ only funds which have existed over the full evaluation period (so-called full-data funds). While these funds exhibit return histories of the same length, these samples regularly contain only a fraction of all possible funds which could also impact the results. Eling and Schuhmacher (2007) compare the ranking of hedge funds based on Sharpe ratios with rankings according to alternative measures. They show rank correlations for a survivorship bias-free dataset and for subsamples of (end-of-sample) survivors and non-survivors. Recently, Eling (2008) extends the latter study by analyzing funds investing in seven different asset classes.

The present study adds to this literature by not only directly comparing the correlations of fund rankings based on different measures, but by investigating how these correlations are affected by the prevailing market climate during the funds' lifetimes and by different fund samples employed. Furthermore, we investigate how the correlations change once the prevailing market climate is controlled for.

Our empirical findings confirm the relationship between performance measures and market climate. Including non-survivors in a fund sample introduces a „survivorship bias-free bias!" Evaluating non-survivors and surviving funds in a joint sample impacts resulting rankings severely. Moreover, rankings differ according to the measure used and the period during which funds with different return histories existed. Thus the market climate during a fund's lifetime clearly affects its performance and the resulting ranking in the fund universe. Furthermore, rank correlations between different measures vary with the return data availability within the fund sample used.

While the disclosure of the market climate bias on performance measures and fund rankings is important to researchers and practitioners in itself, we also analyze an approach suggested by Pastor and Stambaugh (2002) that adjusts performance measures for the bias due to different return histories. Applying this time period adjustment, the market climate bias in measures disappears in our sample and fund rankings become more consistent across various measures.

The innovative findings reported here are not only useful for researchers investigating fund performance, rankings and persistence, but are also important for individual and institutional investors who rank funds based on their past performance to make investment decisions. Empirical research shows substantial evidence that investors increase the flow into funds based on the funds' past performance.[1] Many studies confirm a convex flows-performance relationship for mutual funds, with the funds that show higher performance – especially in terms of unadjusted raw returns – receiving higher inflows. In contrast, Del Guercio and Tkac (2002) find a more linear flow-performance relationship related to risk-adjusted measures like Jensen's alpha for the pension fund segment. Since mutual fund managers are rewarded primarily based on assets under management (Khorana, 1996), and since assets under management increase based on past performance, the results of our study are also useful for investment company boards tasked with rewarding managers for their funds' performance relative to other funds in the fund universe.

The remainder of this article is organized as follows. The next section presents the performance measures applied and illustrates how they are impacted by market climate. Section 3 presents the data and analyzes rankings of funds based on different measures, showing the impact of data availability and market climate. Subsequently, we determine time period-adjusted measures and resulting fund rankings and compare these results with rankings based on original return histories. Rank correlations between measures for fund samples exhibiting differences in return histories are also analyzed. Section 4 concludes.

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[1] For examples, see Ippolito (1992), Gruber (1996), Chevalier and Ellison (1997), Sirri and Tufano (1998), Edelen (1999), Bergstresser and Poterba (2002) and Kempf and Ruenzi (2008).

2 Performance measures and the impact of market climate

2.1 Performance measures

In order to analyze fund rankings, we utilize the raw unadjusted average excess returns (henceforth called average ER) and five commonly used risk-adjusted performance measures.[2] Our first measure is the average of the fund's excess returns, which is computed as the difference between the total return of a fund i (r_i) and a risk-free short-term interest rate r_f. The second measure used is the Sharpe ratio (henceforth SR). The ex-post Sharpe ratio (SR_i) of a fund i is usually calculated employing the average ($\bar{er}_i = \bar{r}_i - \bar{r}_f$) and the standard deviation (σ_i) of the fund excess returns (Sharpe, 1966 and 1994).

$$SR_i = \frac{\bar{er}_i}{\sigma_i} \tag{1}$$

The third measure is the Treynor ratio (henceforth TR), which utilizes the fund's systematic risk as the risk measure (Treynor, 1965). Typically, systematic risk is measured by beta and is estimated utilizing a linear regression according to (3).

$$TR_i = \frac{\bar{er}_i}{\beta_i^{M\text{-}1F}} \tag{2}$$

Our fourth measure is Jensen's one-factor alpha. In the model, the excess return of fund i for period t (er_{it}) is determined in accordance with a one-factor model utilizing the market excess return $ERM_t = r_{Mt} - r_{ft}$ for the same period (Jensen, 1968).

$$er_{it} = \alpha_i^{1F} + \beta_i^{M\text{-}1F} ERM_t + \varepsilon_{it} \tag{3}$$

Jensen's alpha is the constant term α_i^{1F} in (3). The coefficient beta $\beta_i^{M\text{-}1F}$ denotes the fund's systematic risk. Positive (negative) selection activities of the fund yield a positive (negative) Jensen alpha.

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[2] Goetzmann et al. (2007) show that it is possible to manipulate (game) traditional performance measures to obtain more favorable rankings.

The alpha from Fama and French's (1993) model is the fifth measure used. In this model, alpha (α_i^{3F}) is calculated by determining the fund's excess return in accordance with a three-factor model including the market excess return and additional size and book-to-market factors SMB and HML.

$$er_{it} = \alpha_i^{3F} + \beta_i^{M\text{-}3F} ERM_t + \beta_i^{S\text{-}3F} SMB_t + \beta_i^{H\text{-}3F} HML_t + \eta_{it} \tag{4}$$

The sixth measure is the alpha (α_i^{4F}) according to Carhart's (1997) four-factor model, which includes an additional momentum factor MOM.

$$er_{it} = \alpha_i^{4F} + \beta_i^{M\text{-}4F} ERM_t + \beta_i^{S\text{-}4F} SMB_t + \beta_i^{H\text{-}4F} HML_t + \beta_i^{MO\text{-}4F} MOM_t + \upsilon_{it} \tag{5}$$

2.2 Market climates and their impact on performance measures

The performance measures illustrated in Section 2.1 are commonly computed based on fund excess returns which reflect both the fund-specific characteristics mainly determined by the fund management as well as market factors (as ERM, SMB, HML and MOM) reflecting the prevailing market climate. Assuming Carhart's four-factor model as the return-generating process of funds, the realizations of these factors over time, including their dependencies, determine the market climate. In turn, this market climate impacts the excess returns of funds according to (5) depending on the fund-specific loadings against the four (market) factors ($\beta_i^{M\text{-}4F}$, $\beta_i^{S\text{-}4F}$, $\beta_i^{H\text{-}4F}$ and $\beta_i^{MO\text{-}4F}$).

To display the market climate impact on performance measures, we now apply an approach by Pastor and Stambaugh (2002) and express all six measures used in terms of fund-specific characteristics and market parameters for the evaluation period considered. First, average and standard deviation of fund excess returns for a respective period are:

$$\overline{er}_i = \alpha_i^{4F} + \beta_i^{M\text{-}4F} \overline{ERM} + \beta_i^{S\text{-}4F} \overline{SMB} + \beta_i^{H\text{-}4F} \overline{HML} + \beta_i^{MO\text{-}4F} \overline{MOM} \tag{6}$$

$$\sigma_i = \sqrt{\boldsymbol{\beta}_i^T \mathbf{V} \boldsymbol{\beta}_i + \sigma_{\upsilon_i}^2}, \tag{7}$$

where $\overline{ERM}$, $\overline{SMB}$, $\overline{HML}$ and $\overline{MOM}$ denote the means and $\boldsymbol{V}$ the covariance matrix of the four factors for a respective period. $\boldsymbol{\beta_i}$ is the vector of the fund's factor loadings with $\boldsymbol{\beta_i}$ = $\{\beta_i^{M\text{-}4F}, \beta_i^{S\text{-}4F}, \beta_i^{H\text{-}4F}, \beta_i^{MO\text{-}4F}\}$ and $\sigma_{\upsilon_i}^2$ the fund's specific risk according to the four-factor model. Based on this, the Sharpe ratio in (1) can be rewritten as:

$$SR_i = \frac{\alpha_i^{4F} + \beta_i^{M\text{-}4F}\,\overline{ERM} + \beta_i^{S\text{-}4F}\,\overline{SMB} + \beta_i^{H\text{-}4F}\,\overline{HML} + \beta_i^{MO\text{-}4F}\,\overline{MOM}}{\sqrt{\boldsymbol{\beta}_i^T\,\mathbf{V_f}\,\boldsymbol{\beta}_i + \sigma_{\upsilon_i}^2}} \tag{8}$$

Moreover, based on the fund-specific characteristics, alternatively to (3), the Jensen alpha can be computed as:

$$\alpha_i^{1F} = \alpha_i^{4F} + \beta_i^{S\text{-}4F}\,\alpha_{SMB}^{1F} + \beta_i^{H\text{-}4F}\,\alpha_{HML}^{1F} + \beta_i^{MO\text{-}4F}\,\alpha_{MOM}^{1F} \tag{9}$$

where α_{SMB}^{1F}, α_{HML}^{1F} and α_{MOM}^{1F} are the one-factor alphas according to (3) of the factors SMB, HML and MOM. This equation shows that a fund's Jensen alpha depends on its fund-specific characteristics and the one-factor alphas of the three factors not included in the one-factor model. Moreover, alternatively to (4), the three-factor alpha can be written as:

$$\alpha_i^{3F} = \alpha_i^{4F} + \beta_i^{MO\text{-}4F}\,\alpha_{MOM}^{3F} \tag{10}$$

where α_{MOM}^{3F} is the three-factor alpha according to (4) of the MOM factor which is not included in the three-factor model. Similar to (9), the fund's one-factor beta $\beta_i^{M\text{-}1F}$ in (3) can be separated into its components:

$$\beta_i^{M\text{-}1F} = \beta_i^{M\text{-}4F} + \beta_i^{S\text{-}4F}\,\beta_{SMB}^{1F} + \beta_i^{H\text{-}4F}\,\beta_{HML}^{1F} + \beta_i^{MO\text{-}4F}\,\beta_{MOM}^{1F} \tag{11}$$

where β_{SMB}^{1F}, β_{HML}^{1F} and β_{MOM}^{1F} are the one-factor betas according to (3) of the factors SMB, HML and MOM. Based on this, resorting to (6) and (11), we can alternatively determine the Treynor ratio in (2) as:

$$TR_i = \frac{\alpha_i^{4F} + \beta_i^{M\text{-}4F}\,\overline{ERM} + \beta_i^{S\text{-}4F}\,\overline{SMB} + \beta_i^{H\text{-}4F}\,\overline{HML} + \beta_i^{MO\text{-}4F}\,\overline{MOM}}{\beta_i^{M\text{-}4F} + \beta_i^{S\text{-}4F}\,\beta_{SMB}^{1F} + \beta_i^{H\text{-}4F}\,\beta_{HML}^{1F} + \beta_i^{MO\text{-}4F}\,\beta_{MOM}^{1F}} \tag{12}$$

The equations above effectively express the performance measures used here in terms of the fund-specific characteristics according to Carhart's model combined with the respective realizations of the market parameters. When funds exhibit different return histories, these equations show all measures except for the four-factor alpha to be influenced differently by the respective market climate during the funds' lifetimes. Consequently, the impact of market climate on the performance measures may result in different rankings depending on the measure used and depending on the employed return histories of funds.

3 Empirical analysis

3.1 Data

In the empirical analysis, the Center for Research in Securities Prices (CRSP) mutual fund database for 2006 is utilized. We focus on equity funds classified solely as either Aggressive Growth (AG), Growth & Income (GI) or Long-term Growth (LG), as they are the most widely used categories in fund research.[3] To examine a relatively homogeneous sample, we have chosen all funds which at no time showed an ICDI objective different than the three mentioned above. Since ICDI objectives were available for the first time in 1993, our evaluation period starts in January 1993 and ends in December 2006. This period contains both bull and bear market periods and is appropriate for investigating the impact of market climate on performance measures.

Of the funds classified as either AG, GI or LG, we require the funds included to show at least 36 months of continuous monthly returns to ensure a sufficient number of observations when estimating mean returns, risk and alphas. We use total returns, including reinvestments of all distributions (e.g., dividends), but disregarding load

[3] See, for example, Carhart (1997).

charges. To avoid data-errors and outliers, we eliminate funds with implausible monthly returns greater than 50 percent or less than −50 percent. Lastly, funds with identical returns (different batches of the same fund) were eliminated, resulting in a final total sample of 6,148 funds.

To analyze fund performance, we use the value-weighted CRSP market index that contains all NYSE, AMEX and Nasdaq stocks and the factors SMB, HML and MOM.[4] Summary statistics of the market returns and the SMB, HML and MOM factors are presented in Table 1 and Figure 1. Table 1 shows the average monthly returns, standard deviations,and p-values for the market excess return and the three factors.

– Insert Table 1 about here –

Also presented in Table 1 are the variance covariance matrix and the correlation matrix for these four factors. Notice that the market excess return is negatively correlated with both the book-to-market factor HML and the momentum factor MOM, while it is positively correlated with the size factor SMB. These statistics are in line with previous research findings. However, for each of the four factors the Variance Inflation Factor (VIF) is clearly below the critical value of ten, indicating that the results should not be biased due to multicollinearity.

Regressing the factors SMB, HML and MOM on the market returns according to (3) yields their one-factor alphas and betas which are also presented in Table 1. Moreover, a regression of the MOM factor on the other three factors according to (4) yields α_{MOM}^{3F} = 1.04 percent. Since these values are non-zero, differences between fund alphas and betas using the one-, three- and four-factor approach are explained by equations (9) to (11).

[4] Monthly index, factor and T-bill returns are downloadable from Kenneth French's Website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html) which also contains a detailed description of the calculation of the factors SMB, HML and MOM.

– Insert Figure 1 about here –

Panel A to D in Figure 1 present rolling 36-month averages of the market excess return ERM and of the factors SMB, HML and MOM. Obviously, there are distinct changes in these averages over time. Rolling 36-month correlations between the four factors also show variations over time.[5] However, the maximum of the respective VIFs are well below the critical value of ten for all periods. Moreover, 36-month rolling windows of the market parameters α_{SMB}^{1F}, α_{HML}^{1F}, α_{MOM}^{1F} and α_{MOM}^{3F} in Panel E to H show that these alphas change over time as well. That means, for instance, that according to (9) a fund's positive loading on the SMB factor will bias its Jensen alpha downward in the 1990s but will bias it upward at the beginning of the 21st century.

To investigate whether a bull or bear market climate impacts the performance and ranking of funds with different data histories, three subsamples are created. The first subsample A is formed to contain "non-bear" funds. It contains all funds that either had no returns in August 2001 or later or that were included in the database in March 2001 or later.[6] These months were chosen so that the market index shows positive average excess returns for the last three years or for the first three years of the data histories of these non-bear funds, respectively. This insures that these funds primarily existed during a bull market, since the subsample contains non-survivors that existed until August 2001 and relatively new funds that entered the database in March 2001 or later. 1,413 funds belong to subsample A.

The second subsample B is formed analogously to A so as to contain "bear" funds; all funds with return data starting between October 1998 and February 2001 are identified.

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[5] The corresponding figure is omitted for reasons of brevity and is available upon request.

[6] When utilizing samples based on two months prior to or following these months, only a small number of funds changed the respective subsamples. Thus, apart from small alterations in the numerical results the main economic interpretations remain unchanged.

We again chose these two months so that the market index had negative average excess returns during the first three years of these funds' lifetimes. The average lifespan of these funds is rather short, as they only appear late in the dataset. Thus, these funds have a relatively high proportion of monthly declining periods relative to their total lifetimes. 1,649 funds are in subsample B. The remaining 3,086 funds in our sample that are not in either A or B are classified as a third subsample C.

We expect subsample A to have relatively low alphas, since it contains a large proportion of non-survivors. However, since these funds do not live in long declining periods, we also expect them to have relatively high average ERs which should impact their SRs and TRs. For subsample B, we expect opposite results of relatively low average ERs and relatively low SRs and TRs. Subsample C does not contain many non-survivors and thus should exhibit about average performance. Specifically, funds in subsample C should have average alphas and average SRs and TRs.

3.2 Performance and ranking of funds based on original return data histories

Table 2 reports fund-specific characteristics of the survivorship bias-free total fund sample and for the three subsamples. For each sample, means and standard deviations of the individual funds' alphas and betas, as well as error term standard deviations and R^2 based on the four-factor model according to (5) are presented.

– Insert Table 2 about here –

Our total fund sample exhibits a mean four-factor alpha of –0.16 percent and a market beta of 1.00. The mean R^2 of 0.88 is rather high. The non-bear fund subsample A, as expected, shows a mean four-factor alpha of –0.22 percent per month that is lower than for the total fund sample, due to the fact that this subsample contains a large proportion of non-surviving funds.[7] Interestingly, the R^2-value for subsample A of 0.90 is higher. The bear fund subsample B exhibits only a slightly lower mean four-factor alpha (–0.17 percent) than the total sample. The average R^2 of subsample B is almost identical to that of the total fund sample. Overall, the results confirm previous findings that equity funds on average exhibit slight underperformance relative to the market.

Table 3 presents the means and medians of the six measures described in Section 2.1 as well as the average rank of funds within the total sample for each fund subsample.[8]

– Insert Table 3 about here –

The second column of Table 3 shows that, on average, funds in the total sample have continuous monthly returns for 98.1 months, with a relatively large standard deviation of 38.9 months. The cross-sectional mean of the funds' average ERs is 0.40 percent (with a standard deviation of 0.54 percent). As expected, the non-bear fund subsample A has a shorter average life, with only 58.6 continuously monthly returns and a standard deviation of 13 months. For subsample A, the mean average ER of 0.65 percent (0.46 percent standard deviation) is higher than that for the total sample, which is attributable to the bull market during which funds in subsample A existed. For the bear fund subsample B, the average life is a little longer, with continuous returns averaging 76.0 months. However, the mean average ER of 0.04 percent is lower than the corresponding figures for all other

[7] The non-survivors in subsample A showing no return in 2001:08 or later have a mean four-factor alpha of –0.31 percent while funds born in 2001:03 or later show a respective alpha of –0.19 percent.

[8] Ranking based on alpha is typical in the literature and is also utilized here. However, due to the so-called „leverage effect“, such rankings have to be interpreted with caution. This bias can be avoided using the generalized Treynor Ratio introduced by Hübner (2005).

samples, supporting the bear market climate. Subsample C is similar to our total sample, although the average lifetime of its funds is higher, as is the mean average ER.

The findings in Table 3 show that the mean alphas for subsample A are clearly lower than the alphas of the total sample and of subsamples B and C for the one-, three- and four-factor models, as expected. For example, the average one-factor alpha for subsample A is –0.19 percent, while it is –0.06 percent for the total fund sample. This is because subsample A contains a relatively high proportion of non-survivors. As a result, the average rank based on alpha of funds in subsample A within the total sample is relatively poor. For instance, the average rank according to four-factor alpha is 3,410, and thus substantially worse than the average rank for the total fund sample (which is 3,074.5). Likewise, all other alpha-based rankings are below average for subsample A.

Unlike the alpha measures, average ER, SR and TR for subsample A are clearly higher than for the total fund sample. For example, subsample A has a median average ER of 0.65 percent, compared to a median value of 0.47 percent for the total sample. As a result, the average rank position according to the average ER, and thus based on SR and TR, is not only substantially better than the average rank of all funds in the total sample, but also more than 1,000 rank positions more favorable than it is according to the alpha measures. These high average ERs, SRs and TRs and resulting better ranks are undoubtedly attributable to the bull market in the period during which these funds existed.

For subsample B, the expected findings are also largely confirmed. Alphas are about average, while average ER, SR and TR are clearly lower than for the total sample. This is also due to the bear climate during which these funds predominantly existed. As a result, funds in subsample B are ranked about 1,000 positions lower based on average ER, SR and TR than they would be based on the alphas.

In order to check for the robustness of our results, we also test whether the medians of the cross-sectional distributions of the six measures are equal across the fund subsamples investigated. Since these distributions are non-normal (see, e.g., Kosowski et al., 2006),[9] we apply a variant of the non-parametric median test based upon Pearson's χ^2 test of independence to evaluate the significance of these results. For the SR, the χ^2 test statistic of 647.37 and a corresponding p-value of 0.000 clearly refute the null hypothesis of equal medians of SRs across the subsamples A, B, and C. Similarly, the equality of medians is rejected for all other measures across the subsamples. This further confirms the expected finding (and the results reported in Table 3) that fund rankings are influenced by the market climate during which the funds existed.

Overall, the results presented here confirm our expectation that there is a bias in using a survivorship bias-free dataset. Market climate significantly affects the measures of funds that exist primarily in bull or bear market periods, resulting in different rankings depending on the measure used.

3.3 Performance and ranking of funds based on time period-adjusted measures

In order to eliminate the market climate bias in rankings due to different return histories of funds, an approach by Pastor and Stambaugh (2002) is applied, using the longer-history estimates of the market parameters to obtain better estimates of fund performance.[10] In

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[9] Applying the Jacque-Bera test, the null hypothesis of normally distributed measures is refuted at the 1% level for all measures based on the total fund sample. Note that all cross-sectional distributions show a positive kurtosis.

[10] For a comparable approach to account for different return histories see Stambaugh (1997). Muralidhar (2004) suggests a model for standardizing mutual fund manager evaluation that focuses on manager skill and confidence for managers with different tenures. However, he does

doing so, we standardize the evaluation period for all funds by determining the measures the funds would have shown had they existed during the full evaluation from 1993 to 2006. We here assume Carhart's model to be an appropriate return-generating process for the equity funds in our sample.[11] Thus the four-factor characteristics are utilized for each fund based on its respective return history.[12] We combine these characteristics with the market parameters determined for the full evaluation period utilizing (6), (8), (9), (10) and (12) to compute time period-adjusted average ERs, SRs, TRs and one- and three-factor alphas.

For the previously-defined subsamples, Table 4 is similar in format to Table 3, but the results are adjusted for time periods. Next to the average rank position of the fund subsamples within the total sample, the average change in rank for the subsamples resulting from the use of time period-adjusted measures compared to these measures based on the original fund return histories is displayed.

– Insert Table 4 about here –

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not consider the impact of return data availability on the *magnitude* of performance measures and ignores this potential impact of market climate on rankings.

11 The four risk factors of the Carhart (1997) model capture most of the systematic risk of the equity funds examined in our study. The mean R^2 of the individual funds is 0.88, the R^2 of an equally-weighted portfolio of these funds 0.98. Thus the four-factor model is well suited for explaining systematic variations in equity fund returns. For other fund groups, e.g., hybrid funds, a different set of factors would be more appropriate (Comer et al., 2007).

12 One assumption underlying this procedure are the constant fund-specific characteristics of individual funds during the entire period. However, our main goal is not to generate correct returns but to achieve an appropriate average fund ranking for fund subsamples based on time period-adjusted measures. Therefore, that assumption is not critical for our purposes.

For subsample A, Table 4 reports that the average rankings according to the average ER, the SR and the TR change considerably due to the time period adjustment. For the average ER, the average rank increases by 1,289; for SR and TR, this increase is 1,407 and 1,147, respectively. The average ranks based on the one- and three-factor alphas change less severely. Using time period-adjusted measures clearly corrects the favorable ranking of non-bear funds according to average ER, SR and TR that result from the bull market in which many non-survivors have existed. Based on the risk-adjusted measures, Table 4 shows that the average rank of funds in subsample A is now between 3,375 and 3,450.

For subsample B, the corrections of average ER, SR and TR are in the opposite direction. Using the respective time period-adjusted measures corrects the unfavorable ranking of these bear funds. The average rank based on all measures is now between 3,038 and 3,089. Thus using adjusted measures for funds with non-full data corrects the average ranking for the impact of the bear market during which subsample B funds primarily existed.

In summary, the results presented in Table 4 show that using time period-adjusted measures standardizes the evaluation period and results in a more consistent ranking across the measures employed here to rank funds. Consequently, the market climate bias reported in Table 3 was corrected for.

As a robustness check, the non-parametric χ^2 test again clearly refutes the equality of the medians of the performance measures across the three subsamples. As expected, more funds from subsample A are below the median value for each of the six measures when focusing on the time period-adjusted measures. Conversely, more funds from subsample B are above the median for each of these measures than was the case applying measures based on original return histories. Thus, average ER, SR and TR are no longer biased upward (downward) for subsample A (B).

While the findings in Table 4 illustrate the average changes in the rank positions of the fund samples, they do not speak to the distribution of rank changes of individual funds.

– Insert Figure 2 about here –

Figure 2 presents histograms of the changes in ranks of individual funds to illustrate the impact of the market climate adjustment across the different measures. Panels A, B and C of Figure 2 show that the highest rank changes are for the average ER, the SR and the TR corresponding to the high average rank changes reported for fund subsamples A and B. Additionally, Panels D and E reveal that there are also considerable but less pronounced rank changes of funds based on one- und three factor alphas.[13]

Focusing on absolute rank changes, the time period adjustment leads to changes based on average ER of at least 1,000 rank position for 2,283 individual funds (37.13 percent of all funds), for 2,471 funds based on the SR (40.19 percent), for 2,091 funds based on the TR (34.01 percent), for 616 funds based on the one-factor alpha (10.02 percent) and for 582 funds (9.47 percent) based on the three-factor alpha. These results for the alphas show that the time period adjustment also corrects for a market climate impact on one- and three-factor alphas of individual funds, which was not apparent when focusing on the average rank positions of the fund subsamples.

3.4 Correlations between ranking of funds based on different measures

While the results illustrate that using time period-adjusted measures corrects for the market climate bias that funds with non-full return data histories are subject to, it is also interesting to analyze how using time period-adjusted measures impacts the rank

[13] The Spearman rank correlations between the different measures before and after time period adjustment reflects these rank changes. For average ER, SR and TR these correlations are 0.67, 0.65 and 0.72, respectively. For the one- and three-factor alphas they are 0.92 and 0.94.

correlations across different measures. Table 5 presents Spearman rank correlations for three funds samples.[14] Our total fund sample is presented in Panel A and B. Panel A presents the rank correlations based on time period-adjusted measures. Not surprisingly, the Spearman correlation between SR and TR is rather high with 0.96. Similarly, the correlations between the SR or the TR and the one-factor alpha are also high with 0.97 and 0.98, respectively. However, the highest correlation between the three- and four-factor alphas and either the SR or the TR is 0.68. This again confirms that SR and TR may rank funds differently than these alphas.

Panel B of Table 5 also presents the Spearman correlations between these measures for the total sample but based on the original return histories (i.e., without correcting for differences in return histories). The right side of Panel B shows differences in correlations relative to Panel A where the time period-adjusted measures are used. Notice in Panel B that correlations between SR and TR and all three alphas are clearly lower in all cases compared to Panel A. The largest negative difference of −0.35 occurs between the SR and the one-factor alpha. This confirms our previous finding that using time period-adjusted measures increases the consistency of rankings between different measures.

– Insert Table 5 about here –

Panels C of Table 5 presents the correlations for a subsample of 4,210 (end-of-sample) funds existing at the end of the evaluation period in December 2006, and Panel D for a sample of 600 (full-data) funds with return data over the entire evaluation period.

One might expect to get similarly high correlations based on these fund samples as in Panel A, since the difference in the data availability in these samples is clearly smaller than in the total sample. This argument applies to the end-of-sample funds and especially

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[14] Kendall's tau between measures was also computed. While Kendall's tau tends to be somewhat smaller, the overall interpretation of our results remains the same.

to the full-data funds where all funds by definition exhibit the same length of return history. However, Panels C and D of Table 5 show these correlations to be smaller than expected. One reason is that these subsamples are not representative of all funds in the survivorship bias-free total fund sample. For instance, full-data funds are subject to an attrition effect, since these funds survived the entire 14-year evaluation period (Carpenter and Lynch, 1999), so differences between the best and the worst funds in this sample are understated. For example, the average four-factor alpha of the full-data funds is −0.09 percent, compared to −0.16 percent for the total fund sample. Moreover, the standard deviation of the cross-sectional distribution of the four-factor alpha for these funds is only 0.20 percent, which is clearly lower than for the total fund sample and for the subsamples reported in Table 2. Therefore, since four-factor alphas of the full-data funds are quite similar, different measures will more easily result in different rankings, which explains the lower correlations between the measures in Panels C and D compared to Panel A.[15]

4 Conclusion

The theoretical analysis presented here shows that using survivorship bias-free datasets to rank fund performance during different market phases may introduce a market climate bias that depends on the period during which a non-full-data fund existed. This bias tends to create different rankings depending on the measure used to evaluate fund performance.

Applying a survivorship bias-free equity mutual fund sample from 1993 to 2006, we find that funds existing primarily during a bull market exhibit above-average average ERs, SRs and TRs, but below-average one-, three- and four-factor alphas due to a relative high proportion of poorly performing non-survivors. Conversely, funds existing during a

[15] Eling and Schuhmacher (2007) and Eling (2008) also compare rank correlations based on a survivorship bias-free dataset with correlations based on a sample of end-of-sample survivors. However, they find quite small changes in the rank correlations between the measures applied.

relatively long bear market period exhibit below-average average ERs, SRs and TRs. The market climate also affects one- and three-factor alphas, which again may impact rank positions of individual funds. Consequently, the market phase during which a fund exists impacts its performance depending on the measure used and the respective market climate. Therefore, fund rankings can be clearly inconsistent across different measures. Once time period-adjusted measures are used to correct for the market climate and to evaluate non-full-data funds, i.e. non-surviving funds and relative new funds, rankings become more consistent across various risk-adjusted measures.

The findings reported here are not only important to researcher concerned with fund performance, ranking and persistence, but also to investors or analysts comparing the performance of individual funds. While future research may reveal additional methods and measures to rank funds more consistently, the approach applied here overcomes a market climate bias in fund rankings based on the most commonly used performance measures.

Several possible future research directions emerge from these results. Especially in the context of transferring the use of time period-adjusted measures to funds investing in different asset classes, the choice of a suitable set of market factors is a challenging empirical question. Moreover, while we have assumed that the equity funds analyzed show constant fund-specific characteristics according to Carhart's four-factor model over the entire evaluation period, previous research following the seminal paper by Ferson and Schadt (1996) on conditional fund performance illustrates that the market risk of funds may change over time conditioned on public information. Thus another possible extension to the research reported here is to incorporate conditional models into our approach and investigate how fund rankings and their correlations change once fund-specific characteristics are allowed to vary over time. We leave the answer to this question to future research.

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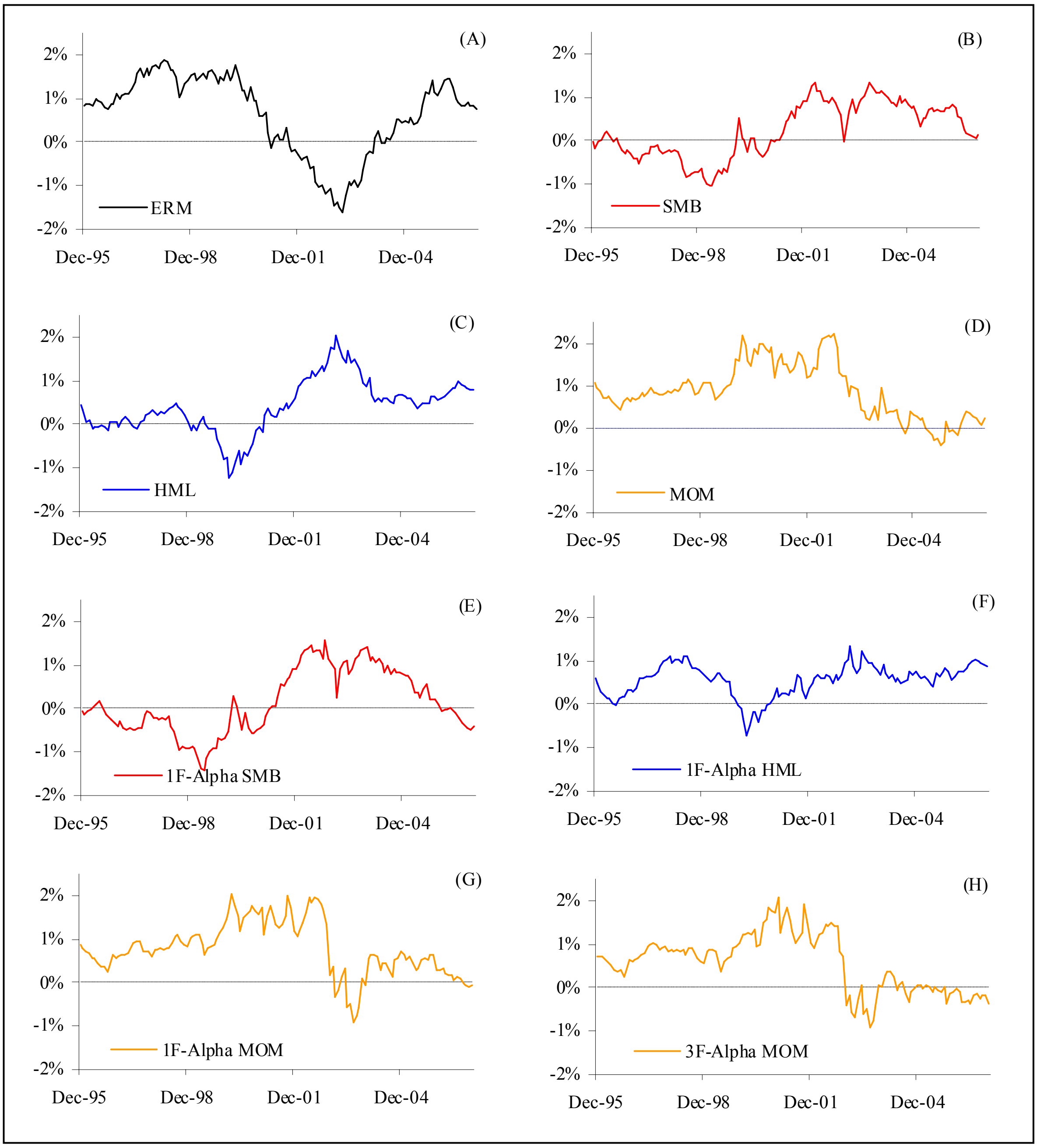
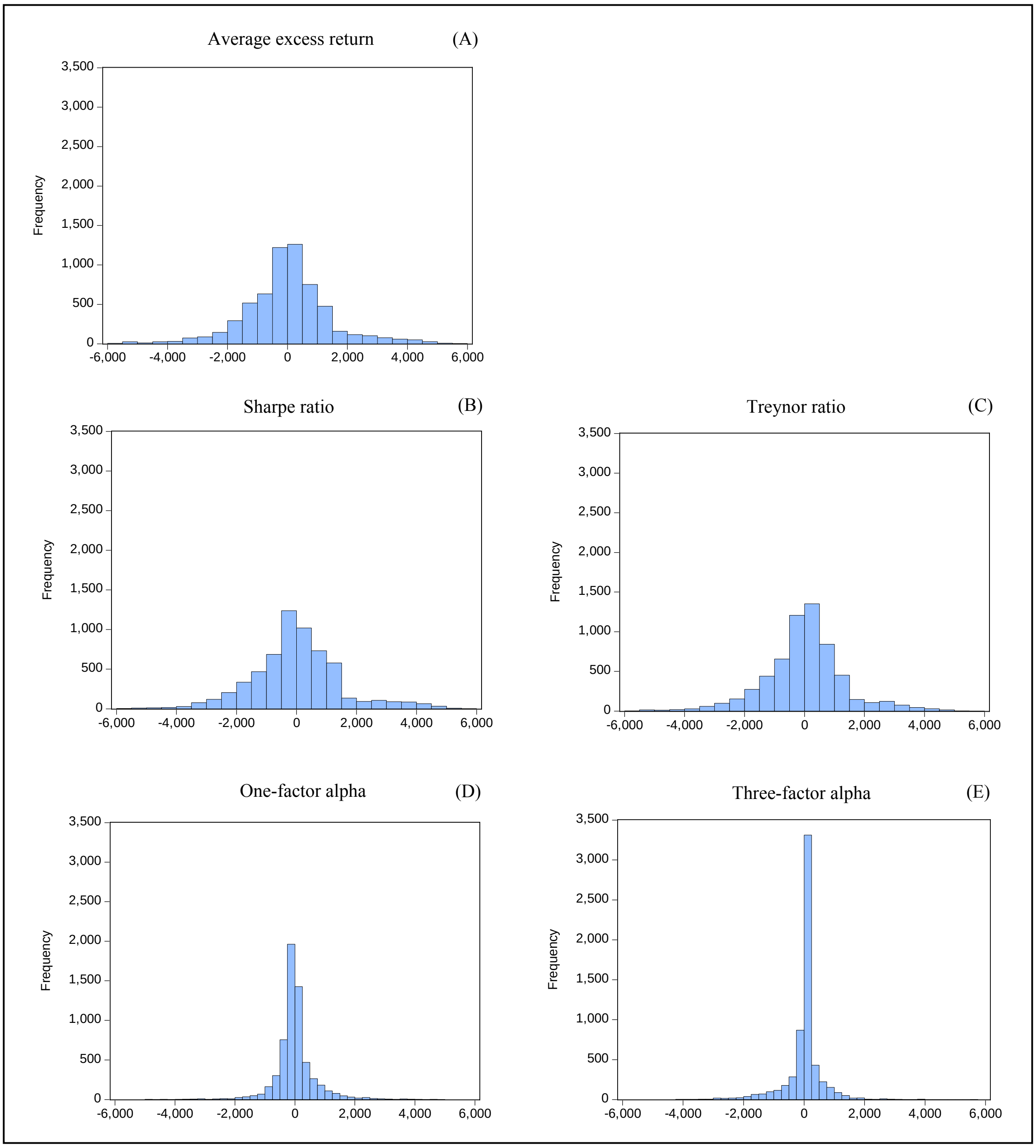
Figure 1: Rolling 36-month averages and alphas of the factors of Carhart's model, January 1993 to December 2006



Notes: Panels A to D show the rolling 36-month averages of the four factors ERM, SMB, HML and MOM for the Carhart (1997) model. Panels E to G present the rolling 36-month one-factor alphas from regressing the factors SMB, HML and MOM on the market excess return ERM according to (3). Moreover, Panel H shows the rolling 36-month three-factor alpha from regressing the MOM factor on the first three factors according to (4). In every panel, the first window ranges from 1993:01 to 1995:12, the last one from 2004:01 to 2006:12, and windows are sequentially advanced by one month (a total of 133 observations). Each observation represents the average or alpha of the respective factor over the previous 36 months. For example, the observation for December 2001 represents the particular value from 1999:01 to 2001:12.

Figure 2: Rank changes of individual funds resulting from applying the time period adjustment for different performance measures



Notes: This figure shows the frequencies of changes in the rankings of individual funds which result from using time period-adjusted performance measures compared to the commonly used measures based on the fund's return history. Panel (A) contains the results for the average excess return, Panel (B) for the Sharpe ratio, Panel (C) for the Treynor ratio, Panel (D) for Jensen's (1968) one-factor alpha, and Panel (E) for Fama and French's (1993) three-factor alpha. The figure shows these rank changes for all 6,148 equity mutual funds in the survivorship bias-free total fund sample used here.

Table 1: Model summary statistics, January 1993 to December 2006

Factor	Mean Monthly Return (p-value)	Std Dev	Variance Covariance Matrix ***V*** (Correlation Matrix)				VIF	α^{1F} (p-value)	β^{1F} (p-value)
			ERM	SMB	HML	MOM			
ERM	0.64% (0.046)	4.12%	0.17% (1)	0.03% (0.21)	-0.08% (-0.52)	-0.04% (-0.19)	1.47		
SMB	0.20% (0.496)	3.83%	0.03% (0.21)	0.15% (1)	-0.07% (-0.49)	0.03% (0.18)	1.37	0.08% (0.761)	0.20 (0.001)
HML	0.50% (0.068)	3.53%	-0.08% (-0.52)	-0.07% (-0.49)	0.12% (1)	-0.01% (-0.04)	1.75	0.79% (0.007)	-0.45 (0.000)
MOM	0.81% (0.038)	5.00%	-0.04% (-0.19)	0.03% (0.18)	-0.01% (-0.04)	0.25% (1)	1.10	0.96% (0.003)	-0.24 (0.158)

Notes: This table presents mean and standard deviations of monthly returns of the four factors from Carhart's (1997) model for the sample period from 1993:01 to 2006:12. Moreover, the table shows the variance covariance and the correlation matrix for these factors. The Variance Inflation Factor (VIF) for a given factor is calculated as $1/(1-R^2)$ where the R^2 results from a regression of this factor on the other respective three factors. A VIF of 1 signalizes linear independency while a VIF of ten indicates that problems in interpreting results caused by multicollinearity are likely. The one-factor alphas α^{1F} and betas β^{1F} of the factors SMB, HML and MOM were calculated using one-factor regressions according to (3).

Table 2: Fund-specific characteristics according to Carhart's (1997) four-factor model

	α^{4F}	$\beta^{M\text{-}4F}$	$\beta^{S\text{-}4F}$	$\beta^{H\text{-}4F}$	$\beta^{MO\text{-}4F}$	σ_{υ}	R^2
Total fund sample							
Mean	-0.16%	1.00	0.19	0.05	0.02	1.70%	0.88
Std Dev	0.30%	0.22	0.35	0.36	0.14	0.88%	0.08
Subsample A							
Mean	-0.22%	0.98	0.23	0.04	0.01	1.30%	0.90
Std Dev	0.29%	0.18	0.39	0.32	0.15	0.72%	0.08
Subsample B							
Mean	-0.17%	1.02	0.17	0.05	0.04	1.71%	0.89
Std Dev	0.33%	0.27	0.33	0.37	0.14	0.85%	0.09
Subsample C							
Mean	-0.13%	1.01	0.17	0.06	0.02	1.88%	0.87
Std Dev	0.29%	0.22	0.34	0.38	0.14	0.91%	0.08

Notes: This table shows descriptive statistics for monthly excess returns of several fund samples. The table shows the fund-specific characteristic of funds based on Carhart's (1997) four-factor model according to (5). The total fund sample contains all 6,148 funds in the survivorship bias-free total fund sample used here. Subsample A contains 1,413 "non-bear" funds showing no returns in 2001:08 or later (473 funds) or starting in 2001:03 or later (940 funds). 1,649 "bear" funds with returns starting from 1998:10 until 2001:02 belong to subsample B, while all remaining 3,086 funds in the total sample (not included in the subsamples A and B) make up subsample C.

Table 3: Monthly excess returns and risk-adjusted performance of funds

		M		Performance					
				Avg. ER	*SR*	*TR*	α^{1F}	α^{3F}	α^{4F}
Total fund sample									
	Mean	98.1	Mean	0.40%	9.09%	0.42%	-0.06%	-0.15%	-0.16%
	Std Dev	38.9	Median	0.47%	9.28%	0.46%	-0.07%	-0.14%	-0.15%
Subsample A									
	Mean	58.6	Mean	0.65%	17.03%	0.65%	-0.19%	-0.23%	-0.22%
	Std Dev	13.0	Median	0.65%	15.80%	0.66%	-0.16%	-0.19%	-0.18%
			Avg. rank	2,247	1,968	2,302	3,554	3,507	3,410
Subsample B									
	Mean	76.0	Mean	0.04%	1.73%	0.07%	0.00%	-0.16%	-0.17%
	Std Dev	16.4	Median	0.05%	1.07%	0.05%	-0.07%	-0.15%	-0.15%
			Avg. rank	4,134	4,157	4,090	2,896	3,123	3,089
Subsample C									
	Mean	128.0	Mean	0.47%	9.40%	0.50%	-0.04%	-0.11%	-0.13%
	Std Dev	30.4	Median	0.50%	9.61%	0.49%	-0.05%	-0.12%	-0.13%
			Avg. rank	2,887	3,003	2,885	2,950	2,851	2,913

Notes: This table gives descriptive statistics for average monthly excess returns and risk-adjusted performance measures for several fund samples. The total fund sample contains all 6,148 funds in the survivorship bias-free total fund sample used here. Subsample A contains 1,413 "non-bear" funds showing no returns in 2001:08 or later (473 funds) or starting in 2001:03 or later (940 funds). 1,649 "bear" funds with returns starting from 1998:10 until 2001:02 belong to subsample B, while all remaining 3,086 funds in our full sample (not included in the subsamples A and B) make up subsample C. *M* represents the number of continuous monthly excess returns of funds in the respective samples. The table also shows the mean and median of performance measures for these fund samples as well as the respective average rank positions of the subsamples in the total fund sample.

Table 4: Average excess returns and risk-adjusted performance of funds corrected for differences in evaluation periods

	Avg. ER	*SR*	*TR*	α^{1F}	α^{3F}	α^{4F}
Total fund sample						
Mean	0.56%	12.01%	0.59%	-0.09%	-0.14%	-0.16%
Median	0.55%	12.09%	0.56%	-0.07%	-0.14%	-0.15%
Subsample A						
Mean	0.48%	10.87%	0.51%	-0.16%	-0.21%	-0.22%
Median	0.49%	10.96%	0.50%	-0.13%	-0.17%	-0.18%
Avg. rank	3,536	3,375	3,450	3,427	3,444	3,410
Avg. rank change	1,289	1,407	1,147	-127	-63	0
Subsample B						
Mean	0.57%	12.28%	0.60%	-0.08%	-0.13%	-0.17%
Median	0.54%	11.83%	0.55%	-0.08%	-0.13%	-0.15%
Avg. rank	3,071	3,055	3,075	3,060	3,038	3,089
Avg. rank change	-1,063	-1,101	-1,015	164	-85	0
Subsample C						
Mean	0.59%	12.38%	0.63%	-0.05%	-0.11%	-0.13%
Median	0.58%	12.59%	0.59%	-0.04%	-0.12%	-0.13%
Avg. rank	2,865	2,947	2,902	2,921	2,925	2,913
Avg. rank change	-23	-56	17	-29	74	0

Notes: This table gives descriptive statistics for time period-adjusted average monthly excess returns and risk-adjusted performance measures for several fund samples. The total fund sample contains all 6,148 funds in the survivorship bias-free total fund sample used here. Subsample A contains 1,413 "non-bear" funds showing no returns in 2001:08 or later (473 funds) or starting in 2001:03 or later (940 funds). 1,649 "bear" funds with returns starting from 1998:10 until 2001:02 belong to subsample B, while all remaining 3,086 funds in our full sample (not included in the subsamples A and B) make up subsample C. The table shows the mean and median of time period-adjusted average monthly excess returns and performance measures for these fund subsamples as well as their respective average rank position in the total fund sample. Furthermore, it reports the average rank changes for these subsamples resulting from correcting these measures for differences in evaluation periods. For funds with non-full data, i.e. less than 168 monthly returns, we assume Carhart's (1997) four-factor model as return generating process and use longer-history estimates of the parameter of the factors to obtain better estimates of fund performance. The characteristics for each fund based on its own return history are combined with the factor parameters for the full evaluation period according to (6), (8), (9), (10) and (12) to calculate time period-adjusted measures for the average excess return, the Sharpe ratio, Treynor ratio, and one- and three-factor alphas.

Table 5: Spearman correlation coefficients between different performance measures for varying data samples

Panel A: Total fund sample based on time period-adjusted measures

Spearman correlations					
	Avg. ER	*SR*	*TR*	α^{1F}	α^{3F}
SR	0.86				
TR	0.86	0.96			
α^{1F}	0.85	0.97	0.98		
α^{3F}	0.64	0.55	0.50	0.50	
α^{4F}	0.64	0.68	0.62	0.63	0.83

Panel B: Total fund sample based on original return histories

Spearman correlations					
	Avg. ER	*SR*	*TR*	α^{1F}	α^{3F}
SR	0.94				
TR	0.94	0.96			
α^{1F}	0.62	0.62	0.68		
α^{3F}	0.39	0.33	0.34	0.49	
α^{4F}	0.40	0.40	0.40	0.55	0.88

Changes in correlations compared to Panel A					
	Avg. ER	*SR*	*TR*	α^{1F}	α^{3F}
SR	0.08				
TR	0.08	0.00			
α^{1F}	-0.23	-0.35	-0.29		
α^{3F}	-0.25	-0.22	-0.17	-0.01	
α^{4F}	-0.24	-0.28	-0.22	-0.07	0.04

Panel C: End-of-sample funds based on original return histories

Spearman correlations					
	Avg. ER	*SR*	*TR*	α^{1F}	α^{3F}
SR	0.90				
TR	0.91	0.95			
α^{1F}	0.69	0.69	0.77		
α^{3F}	0.41	0.32	0.33	0.40	
α^{4F}	0.42	0.41	0.42	0.49	0.88

Changes in correlations compared to Panel A					
	Avg. ER	*SR*	*TR*	α^{1F}	α^{3F}
SR	0.04				
TR	0.05	-0.01			
α^{1F}	-0.16	-0.28	-0.21		
α^{3F}	-0.24	-0.22	-0.17	-0.10	
α^{4F}	-0.22	-0.26	-0.20	-0.14	0.04

Panel D: Full-data funds based on original return histories

Spearman correlations					
	Avg. ER	*SR*	*TR*	α^{1F}	α^{3F}
SR	0.75				
TR	0.78	0.97			
α^{1F}	0.77	0.97	0.99		
α^{3F}	0.43	0.25	0.20	0.18	
α^{4F}	0.51	0.57	0.50	0.50	0.74

Changes in correlations compared to Panel A					
	Avg. ER	*SR*	*TR*	α^{1F}	α^{3F}
SR	-0.11				
TR	-0.08	0.01			
α^{1F}	-0.08	0.00	0.02		
α^{3F}	-0.21	-0.30	-0.31	-0.32	
α^{4F}	-0.12	-0.11	-0.12	-0.13	-0.09

Notes: For different fund samples, this table presents Spearman correlations between six performance measures of funds. The total fund sample analyzed in Panel A contains all 6,148 funds in the survivorship bias-free total fund sample used here. These funds show at least 36 months of continuous monthly return data in the sample period from 1993:01 to 2006:12. However, for funds with non-full data, i.e. less than 168 monthly returns, we assume Carhart's (1997) four-factor model as return generating process and use longer-history estimates of the parameter of the factors to obtain better estimates of fund performance. The characteristics for each fund based on its own return history are combined with the factor parameters for the full evaluation period according to (6), (8), (9), (10) and (12) to calculate time period-adjusted measures for the average excess return, the Sharpe ratio, Treynor ratio, and one- and three-factor alphas. Panel B also presents results for the total fund sample, but the measures are based on original return histories of funds without time period adjustment. Panels C presents Spearman correlations between the (non-time period-adjusted) measures for funds with data available at the end of the evaluation period in 2006:12 (4,210 funds) and Panel D for funds with continuous monthly data over the entire evaluation period from 1993:01 to 2006:12 (600 funds). The left-hand side of each panel presents Spearman correlations for the respective fund sample; all correlations are significant at the 1% level. The right-hand side of Panels B, C and D reports differences in the correlations compared to Panel A.