The Relation between Past Flows and Future Performance: Simple Investment Strategies in the Mutual Fund Sector

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Abstract: In the mutual fund literature, it is an established fact that investors chase past performance. However, the opposite impact of flows on performance is widely discussed. Mainly, liquidity costs are held responsible for short-term erosion of performance while high inflows enhance performance over longer horizons. I investigate this relation for various groups of equity, bond, and money market funds showing significant out-performance of high inflow funds over several months, especially for specific bond fund groups. Also, I test whether this information can be exploited using simple investment strategies but the abnormal returns are too low to offset associated costs.

Keywords: mutual fund performance, fund flows, trading strategies

1. Introduction and Literature Review

In the field of mutual fund research one important strand deals with money flows and the interrelation between fund flows and performance. Within this area exists a broad agreement to the fact that investors “chase performance” (e.g., Ivković and Weisbenner, 2006 and 2009; Fulkerson et al., 2013; public media) meaning that fund investors award superior past performance with new money inflows while inferior performance is punished by money outflows (e.g., Ippolito, 1992). Early studies
document a convex, non-linear shape of this relation showing that good performance leads to high new money flows while bad performance causes only low outflows (e.g., Chevalier and Ellison, 1997; Sirri and Tufano, 1998; Del Guercio and Tkac, 2002; Shrider, 2009). This asymmetry is often attributed to the existence of uninformed (unsophisticated) investors taking irrational investment decisions (e.g., Gruber, 1996), or to the expectation of rational investors that fund firms replace poorly performing fund managers or at least change the investment strategy such that poor performance is unlikely to persist (e.g., Lynch and Musto, 2003). Huang et al. (2007) argue that also participation costs (information or search costs + transaction costs) partly rationalize keeping to a poorly performing fund.

Newer studies on the performance-flow relation find evidence for a more linear relation by using gross money flows instead of net money flows. Among others, Ivković and Weisbenner (2006) find that “old money” punishes poor performance equally as it awards good performance, but “new money” flows into both poorly performing and well performing funds, thereby disguising the punishment and amplifying the award on an aggregate net flow level. Similar results are documented in studies by Cashman et al. (2012; 2014), Ivković and Weisbenner (2009), and Shrider (2009).

On the reverse relation between flow and performance, however, there is less agreement in the literature. Ferson and Schadt (1996) find that fund flows affect fund betas and thereby the funds expected returns. As for the direction, Berk and Green (2004) rationalize from a theoretical point of view that the (rational) allocation of new money to past high performing funds causes diminishing returns to scale and thereby decreasing subsequent performance. On the other hand, poor performing funds face money outflows and either enhance performance or disappear, such that in equilibrium all surviving funds earn equal returns.

Most popular in explaining diseconomies of scale caused by fund flows are liquidity service costs and liquidity trading (e.g., Coval and Stafford, 2007; Edelen et al., 2009; Benson et al., 2010). Besides offering a widely diversified portfolio at reasonably cost, mutual funds provide a high level of liquidity to shareholders who can buy and sell at net asset value any time (e.g., Gruber, 1996; Edelen, 1999). This liquidity service is costly to fund investors, as a fund facing high money inflows might cause a price impact and therefore has to buy new assets above fundamental value (e.g., Gruber, 1996; Edelen, 1999). This is pronounced for large funds or funds investing in illiquid markets (e.g., Chen et al., 2004; Pollet and Wilson, 2008). On the other end, a fund facing high money outflows is also likely to cause a price impact and has to sell assets below fundamental value. Interestingly, Coval and Stafford (2007) find price impact by liquidity trading (“asset fire sales and purchases”) even in the most liquid of asset markets. In addition, Warther (1995), Edelen and Warner (2001), and Bhargava and Konku (2004) document significant price pressure and price changes in the equity market caused by high aggregate flows to the mutual fund market.

Edelen (1999) even finds that it is predominantly due to liquidity service costs that mutual funds on average under-perform their benchmarks. Adjusting for liquidity motivated trading he finds significant levels of skill among mutual fund managers. Further confirmation of these results is reported in related studies by, e.g., Alexander et al. (2007) who analyze returns to trading on information vs. returns to trading on flows. They find significant out-performance for the former and significant under-performance for the latter, respectively. Pollet and Wilson (2008) analyze the different strategies to react to growth, specifically scaling vs. diversification. They find that funds
reacting to growth by simply scaling their existing holdings significantly under-perform funds that diversify, especially in more illiquid markets such as small cap equity.

In most recent studies, e.g., Rakowski and Wang (2009), Rakowski (2010), and Benson et al. (2010) find that the dynamics in fund flows, high flow volatility and unexpected flows significantly erode fund returns as these variables cause the fund to perform more liquidity motivated trades or to hold larger positions of cash as an alternative. However, both Rakowski and Wang (2009) and Benson et al. (2010) find that price pressure through liquidity trading primarily effects fund returns in the short run. For the long-term, both afore named studies document a positive effect of fund flows on mutual fund returns.

Independent of its nature, there must be some information content in past mutual fund flows regarding future returns. However, to my best knowledge, there is no study analyzing the relation between flows and performance for a wide variety of different equity, bond, and money market fund groups. Also, I am aware of no study systematically testing simple investment strategies to exploit the information content in past fund flows in order to earn abnormal returns.

In my empirical study I therefore first examine whether there is a significant relation between fund size and performance, specifically economies or diseconomies of scale. Then, I briefly analyze performance persistence or “hot hands” in mutual funds (e.g., Hendricks et al., 1993) because if investors chase past performance, this can only be beneficial if this performance significantly persists. After that, I assess whether there is a systematic relation between past flows and future performance for different objectives of equity, bond, and money market funds before testing simple investment strategies based upon this information against uninformed strategies.

I find larger funds to significantly out-perform smaller funds, especially among bond and money market funds. Also, I find significant short-term performance persistence as well as significant performance persistence over longer horizons for money market funds. As for the flows-performance relation, I find significant out-performance of high-flow funds over low-flow funds over one month, as well as significant out-performance of high-flow funds over longer horizons for bond funds. However, using simple investment strategies based upon this information is not beneficial as the abnormal returns earned by the strategies are over-compensated for by the high associated costs.

The remainder of the paper is organized as follows. Section 2 describes the methods used in the empirical study. Section 3 describes the data and documents summary statistics and performance. Section 4 presents the results from the empirical study as well as interpreting remarks. Section 5 concludes.

2. Methodology

2.1. Portfolio Construction

For summary statistics on performance and fund characteristics of different fund groups I construct fund portfolios, or “funds of funds” (e.g., Cornell and Green, 1991), rather than using individual funds. This is advantageous as it allows using data on all funds, independent from the time series length. Also, it allows using beginning-of-month TNA directly as weighting-factors (e.g., Rohleder et al., 2012). The time-series also have the same length and cover the same time-period such that market climate bias is of no importance (e.g., Scholz and Schnusenberg, 2009).
To assess the impact of fund flows on the performance of different fund groups I use monthly rebalanced decile-portfolios (e.g., Chen et al., 2004). These are constructed by monthly ranking all funds currently existing by their lagged fund flows and value-weighting the returns of all funds allocated to a certain portfolio by their beginning-of-month TNA. I follow a similar approach when constructing decile-portfolios based upon lagged TNA ranks and on lagged return ranks, respectively.

Note that monthly rebalancing upon lagged fund characteristics might cause look-ahead bias (e.g., ter Horst et al., 2001, 2007) because funds have to have existed in the past months to be ranked and to be considered for evaluation. Depending on the length of the time lag between ranking period and evaluation period this means that especially new funds are excluded automatically in their first months/years of existence. However, as new funds are in general very small (e.g., Rohleder et al., 2011, 2012) and might show incubation bias (e.g., Evans, 2010) or ambiguous flows through fast relative growth (e.g., Rakowski, 2010) I consider this as an advantage rather than a problem.

2.2. Performance Measures

In my empirical analysis I use two different types of performance measures. First, I use the mean excess return \(\text{MER}\) which is represented by

\[
\text{MER}_p = \frac{1}{T} \sum_{t=1}^{T} (R_{pt} - R_{ft})
\]

where \(R_{pt}\) is the return on fund \(p\) in month \(t\), and \(R_{ft}\) is the risk-free rate of return in month \(t\), given by the 1-month US treasury bill rate. This one-dimensional measure does not account for the risk associated with the realized return.

Therefore, I also use multi-factor-models following, e.g., Carhart (1997) and Blake et al. (1993) to assess the risk-adjusted performance of the respective fund portfolios. These models are represented by

\[
(R_{pt} - R_{ft}) = \alpha_p + \sum_{j=1}^{J} \beta_{pj} (F_{jt} - R_{ft}) + \varepsilon_{pt}
\]

where \(F_{jt}\) is the return on factor \(j\) in month \(t\), \(\beta_{pj}\) is the sensitivity of the return on portfolio \(p\) to the return on factor \(j\), and \(\varepsilon_{pt}\) is a normally distributed residual term with zero mean, idiosyncratic to portfolio \(p\) in month \(t\). The average risk-adjusted excess return is measured by the intercept \(\alpha_p\) (alpha).

For the different fund groups in my analysis I use different sets of factors as explanatory variables. To equity funds I apply the Carhart (1997) four-factor-model containing the excess return on a broad US equity market index (Jensen, 1968) as well as the risk factor SMB to capture the small-stock effect, HML to capture the value-vs. growth-stock effect (Fama and French, 1993), and MOM to capture the momentum effect in stock returns (Carhart, 1997).

To bond funds I apply the MIM-Risk model from Rohleder et al. (2011b) containing the returns on five indices representing government bonds (BarCap US Aggregate Government), corporate bonds (BarCap US Corporate Investment Grade), mortgage backed bonds (BarCap US Mortgage Backed), municipal bonds (BarCap US Municipal), and high yield bonds (BarCap US High Yield Composite).

For money market funds I use four factors representing the return to a broad US bond market index (BarCap US Aggregate Bond) as well as the 1-month, 3-month, and 6-month US Treasury bill rates. Table 1 shows the relevant correlations between these factors/indices.
Table 1. Correlations between factors and indices for multi-factor models

This table shows correlations between factors and indices for multi-factor models measuring the risk-adjusted performance of equity, bond, and money market funds. Correlation coefficients are denoted in %.

| Equity funds | Bond funds | Money market funds |
|--------------|------------|-------------------|
| SMB | 22.74 | Corp | 70.68 | Bond | 1m T-Bill | 3m T-Bill |
| HML | -25.93 | -30.59 | Muni | 59.99 | 69.64 | 3m T-Bill | 18.68 | 5.70 |
| MOM | -30.64 | -1.39 | -3.67 | HY | -3.28 | 55.23 | 35.28 | 6m T-Bill | 40.24 | -3.82 | 78.29 |
| MBS | 86.04 | 72.04 | 63.08 | 13.72 |

3. Data

3.1. Data Selection and Pre-Processing

I use data from three different data sources in my empirical analysis. Information on mutual fund characteristics such as monthly returns, yearly expense ratios, loads charges, first-offer-dates (age), and monthly total net assets (TNA) are from the CRSP Survivor-Bias-Free Mutual Fund Database. Barclays Capital (BarCap) bond and treasury performance indices for the evaluation of bond and money market fund performance are from DataStream, and the factors for the Carhart four-factor-model are from the Kenneth R. French data library.¹

The CRSP database provides information on 43,668 US based mutual funds (December 2009) of which I extract my final sample via a number of screens. First, I use Lipper objective codes and Strategic Insight objective codes to select those funds exclusively categorized as equity, bond, and money market funds between 01/1993 and 12/2009.² From these, I delete funds without TNA or return data available. Also, I fill missing values in the TNA time series of the remaining funds with the three-step procedure from Rohleder et al. (2011). I aggregate multiple-share class funds following, e.g., Bessler et al. (2010), by value-weighting returns, loads, and expense ratios, accumulating TNA, and using the oldest share class to determine the funds age. Lastly, I delete those funds with a gap larger or equal to 36 months between first-offer-date and first return observation (Rohleder et al., 2012). In total, my dataset contains 8,100 mutual funds, of which 4,861 are equity funds, 2,141 are bond funds, and 1,098 are money market funds.

For these funds I calculate monthly absolute (relative) fund flows following Brown and Goetzmann (1995) as the difference between end-of-month and beginning-of-month TNA, adjusted by the monthly return over the same month (divided by the beginning-of-month TNA). To avoid biased results through extreme values, e.g. very small but fast growing new funds, I cap relative flows to a maximum of 100 %. Fund flows are given by:

¹ http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.
² Bond funds are further subdivided into “corporate”, “government”, “mortgage backed”, non-single-state “municipal”, and “general” bond funds. Equity funds are split up into “aggressive growth”, “growth”, “growth/income”, “mid cap” and “small cap” funds where I classify, e.g., “small cap growth funds” as small cap rather than as growth because I consider it the more selective classification with respect to liquidity costs (e.g., Chen et al., 2004; Pollet and Wilson, 2008).
\[ \text{Flow}_{it}^{\text{abs}} = TNA_{it} - (1 + R_{it})TNA_{i,t-1} \]  
(3)

\[ \text{Flow}_{it}^{\text{rel}} = \begin{cases} \frac{\text{Flow}_{it}^{\text{abs}}}{TNA_{i,t-1}} & \text{if } \frac{\text{Flow}_{it}^{\text{abs}}}{TNA_{i,t-1}} \geq 100 \% \\ 100 \% & \text{otherwise} \end{cases} \]  
(4)

3.2. Summary Statistics

Table 2 shows summary statistics (Panel A) and performance measures (Panel B) for the funds grouped by their investment objectives in the period from 01/1993 through 12/2009. In terms of numbers, equity funds are the largest fund group with more than twice as many funds as the bond group and more than four times as many funds as the money market group. In terms of fund size, money market funds are the largest and bond funds are the smallest such that equity and money market funds show more or less equal total volume in 12/2009 while the total volume of all bond funds is smaller. Among bond and equity funds, growth funds are the largest followed by growth/income funds and mortgage backed bond funds.

In terms of age, money market funds are the oldest followed by bond funds and equity funds. In terms of the expense ratio equity funds are on average more expensive than bond funds. The “cheapest” funds are money market funds. The most expensive fund asset classes are aggressive growth funds with an expense ratio of 1.65 % p.a. and general bond funds with 1.33 % p.a. The lowest expense ratio among bond funds show mortgage backed and municipal bond funds. Among equity funds, growth/income funds are the cheapest. Value-weighted expense ratios are consistently smaller than equal-weighted expense ratios. This suggests that larger funds are cheaper due to economies of scale. The relation is even more pronounced for equity funds.

Money market funds show the highest absolute flows but – due to their size – relatively low relative flows. Equity funds show higher absolute and relative flows than bond funds. Mortgage backed bond funds show even negative absolute flows during the sample period and very low but positive relative flows. General bond funds have the highest flows among bond funds. Among equity funds absolute and relative flows are more or less evenly distributed.

Panel B shows performance measures for equal-weighted and value-weighted fund portfolios. In terms of the risk-unadjusted MER equity funds show higher performance than bond funds while money market funds show even significant and negative MER. The value-weighted portfolios outperform their equal-weighted counterparts meaning that larger funds earn higher returns than smaller funds. As an exception, smaller small cap funds seem to out-perform larger small-cap funds on average because here the equal-weighted portfolio has the higher MER.

In terms of the risk-adjusted multi-factor-alphas the relation is the other way round. Here, the measures for all fund groups are negative, in most cases significantly, except for money market funds where I find positive, if insignificant, performance. However, the \( R^2 \) statistics (in curly brackets) for bond funds and equity funds are above 90 % for almost all fund groups while they are 33 % and 24 % for equal-weighted and value-weighted money market funds, respectively, such that one cannot directly compare these alphas. Also, equal-weighted bond funds show higher alphas than equal-weighted equity funds, while value-weighted aggressive growth and small cap funds show the highest
Table 2. Summary Statistics and Performance

This Table shows summary statistics (Panel I.) and Performance measures (Panel II.) for fund groups representing different asset classes. Size is denoted in mio US$ and represents the time series mean of the monthly TNA of the fund group. Total volume in 12/2009 is denoted in mio US$ and represents the accumulated TNA of all funds of a fund group at the end of the data sample. Expense ratios are denoted in % p.a. and represent the equal-weighted (value-weighted) time series mean of the fund group. Age is denoted in months since the first return observation and represents the time series mean of the fund group. Absolute (relative) flows are denoted in mio US$ p.m. (% p.m.) and represent the time series mean of the fund group. MER is denoted in % p.m. and represents the intercept of a multi-factor regression. *, **, *** indicates statistical significance on the 1%, 5%, and 10% level based upon HAC-consistent covariances (Newey and West, 1987). Adjusted R² statistics are shown in curly brackets and denoted in %.

| A. Summary Statistics | Bond funds | Equity funds | Money market funds |
|-----------------------|------------|--------------|--------------------|
|                       | All        | Corporate    | Government         | Mortgage backed | Municipal | General | All           | Aggressive growth | Growth | Growth / Income | Mid cap | Small cap | Money market funds |
| Number of funds        | 2,141      | 1,040        | 396               | 127             | 490       | 88      | 4,861         | 308             | 1,987   | 1,156         | 515     | 895       | 1,098            |
| Size [Mio US$]         | 636        | 663          | 341               | 1,059           | 641       | 800     | 817           | 692             | 863     | 1,476         | 274     | 398       | 2,293            |
| Total volume in 12/2009| 1,414,431  | 892,073      | 87,208            | 93,180          | 291,239   | 50,730  | 2,632,994     | 96,694          | 1,022,425 | 983,737       | 203,148 | 326,991   | 2,985,147        |
| Expense ratio equal [% p.a.] | 0.8437 | 0.8379        | 0.8865            | 0.8158          | 0.7870    | 1.3320 | 1.2550         | 1.6567          | 1.2655   | 1.0443         | 1.3206  | 1.3313    | 0.5599           |
| Expense ratio value [% p.a.] | 0.7411 | 0.7660        | 0.7952            | 0.5948          | 0.6605    | 1.3150 | 0.8510         | 1.1693          | 0.6382   | 0.6832         | 1.0037  | 0.4638    |                  |
| Age [Months]           | 124        | 116          | 120               | 139             | 146       | 86      | 98            | 96              | 104     | 54            | 80      | 143       |                  |
| Absolute flow [MUS$ p.m.] | 2.67  | 4.32          | 0.43              | -1.90           | 1.79      | 5.75    | 3.63          | 2.91            | 4.00     | 4.44          | 3.10    | 2.08      | 13.66           |
| Relative flow [% p.m.]  | 1.06       | 1.36         | 0.77              | 0.31            | 0.83      | 2.24    | 2.33          | 2.72            | 2.17     | 2.20          | 3.41    | 2.28      | 1.29            |

B. Performance [% p.m.]

| MER (equal-weighted) | 0.1308* | 0.1567** | 0.1153* | 0.1596*** | 0.0922* | 0.1694* | 0.4072 | 0.3647 | 0.3334 | 0.3530 | 0.5165 | 0.5602 | -0.0272*** |
|----------------------|---------|-----------|---------|-----------|---------|---------|--------|--------|--------|--------|--------|--------|----------|
| MER (value-weighted) | 0.1544** | 0.1938*** | 0.1351** | 0.1830*** | 0.1039* | 0.2249** | 0.3834 | 0.4341 | 0.3610 | 0.3829 | 0.5240 | 0.5206 | -0.0071*** |
| Alpha (equal-weighted) | -0.0644*** | -0.0515*** | -0.0741*** | -0.0377*** | -0.0713*** | -0.0866* | -0.0978* | -0.1041* | -0.1064*** | -0.0722* | -0.1171* | -0.0581 | 0.0031 |
| Alpha (value-weighted) | -0.0620*** | -0.0424*** | -0.0620*** | -0.0396*** | -0.0638*** | -0.0514 | -0.0804*** | -0.0353 | -0.0759 | -0.1160 | -0.1618** | -0.0360 | 0.0074 |

| Alpha (equal-weighted) | 97.28% | 96.00% | 98.29% | 93.05% | 96.92% | 84.18% | 97.92% | 94.78% | 98.75% | 97.71% | 93.41% | 94.99% | 32.95% |
| Alpha (value-weighted) | 96.16% | 91.38% | 98.56% | 96.82% | 96.33% | 89.25% | 98.07% | 93.96% | 98.25% | 97.74% | 92.93% | 94.49% | 24.24% |
performance among bond and equity funds. Apart from that, the other value-weighted equity fund
groups under-perform all bond funds groups. Again, value-weighted portfolios out-perform equal-
weighted portfolios in most cases except growth/income and mid cap funds.

Among bond funds, I expect mortgage backed bond funds to play a special role as these show
negative flows and they are comparatively large. Also, general and corporate bond funds show very
high flows compared to other bond funds. Most equity fund groups show similar relative flows except
for mid cap funds which might play a special role. Despite money market funds showing very high
absolute inflows, I do not expect to find significant results because return and return variability are
very low.

4. Empirical Analysis

4.1. The Size-Performance Relation

Fund flows are strongly related to fund size. Therefore, I report in Table 3 the performance as
well as absolute and relative flows for value-weighted deciles ranked by TNA lagged one month and
grouped into bond funds, equity funds, and money market funds (e.g., Chen et al., 2004). Also, the
table shows performance differences between the smallest (decile 1) and the largest funds (decile 10),
between the smallest 30% and the largest 30%, where, e.g., the smallest 30% is an equal-weighted
portfolio of deciles 1, 2, and 3, and between the middle 40% and the outer 60%.

Table 3. Performance of deciles ranked by fund size

|                                | Bond funds   | Equity funds | Money market funds |
|--------------------------------|--------------|--------------|--------------------|
| *Monthly mean excess return (MER)* |              |              |                    |
| Decile 1 (small)                | 0.0884       | 0.3522       | -0.0687***         |
| Decile 10 (large)               | 0.1607**     | 0.3809       | -0.0008            |
| Largest-smallest                | 0.0723***    | 0.0287       | 0.0679***          |
| Larger 30% - smaller 30%        | 0.0333*      | -0.0168      | 0.0464***          |
| Middle 40% - outer 60%          | 0.0016       | 0.0285       | 0.0026***          |
| *Monthly multi-factor alpha*    |              |              |                    |
| Decile 1 (small)                | -0.1000***   | -0.1099*     | -0.0212**          |
| Decile 10 (large)               | -0.0660***   | -0.0696**    | 0.0083             |
| Largest-smallest                | 0.0341       | 0.0403       | 0.0295***          |
| Larger 30% - smaller 30%        | 0.0116       | -0.0302      | 0.0185***          |
| Middle 40% - outer 60%          | 0.0140       | -0.0128      | -0.0008            |
| *Relative [absolute] fund flows*|              |              |                    |
| Decile 1 (small)                | 3.08         | 6.05         | 3.02               |
|                                | [0.51]       | [0.32]       | [1.83]             |
| Decile 10 (large)               | 0.21         | 0.36         | 0.48               |
|                                | [115.62]     | [58.56]      | [101.54]           |

3 As TNA shows high autocorrelation, I do not report statistics for size-deciles ranked upon TNA with higher time lags than
one month.
In terms of fund flows, the table shows very clear relations throughout all fund groups. For relative flows, small funds experience the highest inflows whereas the largest funds experience the lowest inflows. For absolute flows it is the other way round as here the smallest funds have the lowest inflows and the largest funds have the highest inflows. Not reported in the table due to space limitations, these relations are monotonic throughout all deciles. The highest relative inflows I report for the smallest equity funds, and the highest absolute inflows I report for the largest bond funds, closely followed by the largest money market funds.

Concerning size-decile performance, the table shows different relations depending on the fund group. In the case of bond funds smaller funds under-perform larger funds, measured by MER significantly. The same holds for money market funds where I find significant performance differences for both performance measures. The alpha of decile 10 is even positive, if insignificant. These results clearly show a positive correlation between fund size and performance. For equity funds the table reports mixed results, as here the largest 10% out-perform the smallest 10% but for the 30%-portfolios it is the other way round.

These results clearly show that fund flows are generally and consistently related to fund size, positively with absolute flows and negatively with relative flows. Also performance is positively related to size for bond funds and money market funds. For equity funds the relationship is not as strong but existent in the extreme portfolios. Therefore, I expect fund returns to be related to fund flows, especially for specific bond fund objectives.

4.2. Performance Persistence

Another issue in the relation between fund flows and future returns is performance persistence. It is clearly established that flows chase performance such that in periods following superior returns fund flows should be high and in periods following inferior returns fund flows should be low, if not negative (e.g., Ippolito, 1992; Ivković and Weisbenner, 2009). This is only beneficial if performance persists (e.g., Hendriks et al., 1993; Brown and Goetzmann, 1995; Carhart, 1997). Table 4 gives a first indication of the validity of this relation by showing correlation coefficients between fund portfolio returns and future flows. For bond funds and equity funds the table clearly confirms the relation as future absolute and relative flows are positively correlated with returns while correlation coefficients decrease with increasing time lag. For money market funds the table shows unexpected relations. While absolute flows leading 1, 2 (, and 3) months are positively correlated as expected, relative flows and absolute flows leading by more than 3 months are majorly negatively correlated meaning that superior returns are followed by relative outflows rather than by increased inflows. However, as money market funds have very low returns on average with very low return variability, these correlations might not be too meaningful.

Following the liquidity cost argument from the literature (e.g., Edelen, 1999; Rakowski, 2010), high fund flows should erode fund returns because funds are likely to face problems allocating their new money advantageously. This means that, if flows follow superior performance which Table 4 confirms for bond funds and equity funds, there should be no performance persistence. However, for money market funds, where correlations in Table IV are low or negative, I expect to find at least some evidence for performance persistence. To test for performance persistence Table 5 shows performance
Table 4. Correlation coefficients between returns and future flows
This table shows correlation coefficients between equal-weighted and value-weighted fund portfolio returns and future absolute and relative fund flows to the same portfolios in the period from 01/1993 through 12/2009 for bond funds, equity funds, and money market funds. \((t+1m)\) represents future fund flows leading by 1 month, \((t+2m)\) by 2 months, etc. Correlation coefficients are denoted in %.

|                  | Bond fund returns | Equity fund returns | Money market fund returns |
|------------------|-------------------|---------------------|---------------------------|
|                  | Equal-weighted    | Value-weighted      | Equal-weighted            | Value-weighted            |
| Future absolute flows |                   |                     |                           |                           |
| \((t+1m)\)       | 40.91             | 42.54               | 37.62                     | 37.79                     |
| \((t+2m)\)       | 22.49             | 23.34               | 27.34                     | 26.05                     |
| \((t+3m)\)       | 14.95             | 15.21               | 13.41                     | 14.92                     |
| \((t+4m)\)       | 10.16             | 11.06               | 28.55                     | 29.55                     |
| \((t+5m)\)       | 9.37              | 9.00                | 21.84                     | 21.54                     |
| \((t+6m)\)       | 5.33              | 4.48                | 8.92                      | 10.28                     |
| Future relative flows |                   |                     |                           |                           |
| \((t+1m)\)       | 31.38             | 30.11               | 24.05                     | 22.57                     |
| \((t+2m)\)       | 28.88             | 27.86               | 18.52                     | 17.42                     |
| \((t+3m)\)       | 22.44             | 20.94               | 7.90                      | 9.41                      |
| \((t+4m)\)       | 17.86             | 16.59               | 11.71                     | 12.28                     |
| \((t+5m)\)       | 16.44             | 13.96               | 18.37                     | 18.06                     |
| \((t+6m)\)       | 19.95             | 18.32               | 7.58                      | 7.96                      |

measures and flows for decile-portfolios ranked by past returns as well as performance differences between the deciles, or zero-investment portfolios based upon the deciles, respectively.\(^4\) Panel A shows results for deciles ranked by returns lagged one month \((t+1m)\). In the lower part the table documents negative flows following low performance and positive flows following high performance, as has been expected.

Concerning performance, Panel A shows a clear performance persistence structure with decile 1 showing the lowest performance and decile 10 the highest. Also, I show positive and significant performance of decile 10 even on a risk-adjusted basis as well as significant and positive returns to both zero-investment “highest-lowest” and “higher 30% - lower 30%” portfolios for all three fund groups. This is in line with short-term persistence findings by, among others, Bollen and Busse (2004).

Panel B of Table 5 shows results for deciles ranked by returns lagged two months \((t+2m)\). Consistent with Table 4, decile 1 experiences outflows while decile 10 experiences inflows for all the fund groups. As for performance, I find significant and positive returns to the zero-investment portfolios as well as positive and significant performance in decile 10 only for money market funds. Consistent with Berk and Green (2004) this is not the case for bond funds and equity funds.

Panels C and D show results for deciles ranked by returns lagged three and four months, respectively. In the lower part flows show the same structure as in the Panels before. Concerning performance I find clear evidence for significantly persistent money market fund performance with significantly positive alphas for decile 10. Surprisingly, I also find significant and positive performance persistence for bond funds. For equity funds, both Panels show no evidence for performance persistence.

\(^4\) Note that this way of testing performance persistence potentially suffers from survivorship bias or look-ahead bias because inferior performing funds might disappear between the ranking period and the evaluation period causing positive selection (e.g., ter Horst et al., 2001). However, this is a problem majorly for longer time lags, such that finding significant performance persistence over longer horizons should be treated with caution.
Table 5. Performance of deciles ranked by lagged return

This Table shows performance and fund flows of decile-portfolios ranked by lagged monthly (Panels I-VI). MER and alpha are denoted in % p.m. *, **, *** indicates statistical significance on the 1%, 5%, and 10% level based upon HAC-consistent covariances (Newey and West, 1987). Relative flows are denoted in % p.m. Absolute flows are reported in squared brackets and denoted in mio US$ p.m. The table shows performance differences between the highest and the lowest performance deciles, between the higher 30% and the lower 30% where, e.g., “lower 30%” is an equal-weighted portfolio of deciles 1, 2, and 3, and between the middle 40% and the outer 60%. Due to space limitations the table only shows performance measures and flows for the highest and the lowest return deciles. Measures for all other deciles are available on request.

| Bond funds | Equity Funds | Money market funds | Bond funds | Equity Funds | Money market funds |
|------------|--------------|-------------------|------------|--------------|-------------------|
| **Decile 1 (lowest)** | -0.1652 | -0.0720 | -0.1038*** | 0.1185 | 0.1929 | -0.1077*** |
| **Decile 10 (highest)** | 0.3692*** | 0.8043*** | 0.0235*** | 0.1697 | 0.5728 | 0.0257*** |
| **Highest-lowest** | 0.5343*** | 0.8763*** | 0.1273*** | 0.0511 | 0.3799 | 0.1334*** |
| **Higher 30% - lower 30%** | 0.3183*** | 0.5103*** | 0.0963*** | 0.0498 | 0.1889 | 0.0984*** |
| **Middle 40% - outer 60%** | 0.0393 | -0.0259 | 0.0202*** | 0.0179 | -0.0213 | 0.0202*** |

**Monthly mean excess return (MER)**

| Bond funds | Equity Funds | Money market funds | Bond funds | Equity Funds | Money market funds |
|------------|--------------|-------------------|------------|--------------|-------------------|
| **Decile 1 (lowest)** | -0.4576*** | -0.5638*** | -0.0087 | -0.1140 | -0.1520 | -0.0054 |
| **Decile 10 (highest)** | 0.1655* | 0.2580* | 0.0337*** | -0.0979 | -0.0488 | 0.0298*** |
| **Highest-lowest** | 0.6231*** | 0.8218*** | 0.0425*** | 0.0161 | 0.1032 | 0.0352*** |
| **Higher 30% - lower 30%** | 0.3655*** | 0.4625*** | 0.0330*** | 0.0337 | 0.0120 | 0.0297*** |
| **Middle 40% - outer 60%** | 0.0668** | 0.0189 | -0.0129*** | 0.0145 | 0.0117 | -0.0129*** |

**Monthly multi-factor alpha**

| Bond funds | Equity Funds | Money market funds | Bond funds | Equity Funds | Money market funds |
|------------|--------------|-------------------|------------|--------------|-------------------|
| **Decile 1 (lowest)** | -0.39 | -0.31 | 0.07 | -0.36 | -0.21 | 0.06 |
| **Decile 10 (highest)** | [5.14] | [-14.71] | [-1.26] | [-7.92] | [-17.07] | [-29.37] |
| **Middle 40% - outer 60%** | 31.70 | 55.34 | 156.64 | 39.35 | 51.22 | 65.18 |

**Relative [absolute] fund flows**

| Bond funds | Equity Funds | Money market funds | Bond funds | Equity Funds | Money market funds |
|------------|--------------|-------------------|------------|--------------|-------------------|
| **Decile 1 (lowest)** | 0.0587 | 0.2058 | -0.1089*** | 0.0348 | 0.2206 | -0.1072*** |
| **Decile 10 (highest)** | 0.3402*** | 0.5336 | 0.0272*** | 0.2281** | 0.4669 | 0.0248*** |
| **Highest-lowest** | 0.2814* | 0.3278 | 0.1361*** | -0.1933 | -0.2463 | -0.1320*** |
| **Higher 30% - lower 30%** | 0.2153** | 0.1780 | 0.1005*** | -0.1213 | -0.1742 | -0.0971*** |
| **Middle 40% - outer 60%** | -0.0272 | -0.0087 | 0.0186*** | 0.0344 | 0.0368 | 0.0201*** |

**Monthly mean excess return (MER)**

| Bond funds | Equity Funds | Money market funds | Bond funds | Equity Funds | Money market funds |
|------------|--------------|-------------------|------------|--------------|-------------------|
| **Decile 1 (lowest)** | -0.1803* | -0.1057 | -0.0045 | -0.2444*** | -0.1145 | -0.0045 |
| **Decile 10 (highest)** | 0.1186 | -0.1948 | 0.0272*** | 0.0409 | -0.2026 | 0.0274*** |
| **Highest-lowest** | 0.2989* | -0.0891 | 0.0317*** | 0.2853 | -0.0881 | 0.0319*** |
| **Higher 30% - lower 30%** | 0.2260* | -0.1086 | 0.0261*** | 0.1842 | -0.0295 | 0.0277*** |
| **Middle 40% - outer 60%** | -0.0045 | 0.0342 | -0.0130*** | 0.0433* | 0.0834* | -0.0141*** |

**Relative [absolute] fund flows**

| Bond funds | Equity Funds | Money market funds | Bond funds | Equity Funds | Money market funds |
|------------|--------------|-------------------|------------|--------------|-------------------|
| **Decile 1 (low)** | -0.35 | -0.14 | 0.25 | -0.41 | -0.10 | 0.16 |
| **Decile 10 (high)** | 0.36 | 1.16 | 0.99 | 0.45 | 1.26 | 0.94 |

Panels C and D show results for deciles ranked by returns lagged three and four months, respectively. In the lower part flows show the same structure as in the Panels before. Concerning performance I find clear evidence for significantly persistent money market fund performance with
significantly positive alphas for decile 10. Surprisingly, I also find significant and positive performance persistence for bond funds. For equity funds, both Panels show no evidence for performance persistence.

Panels E and F show results for deciles ranked by returns lagged five and six months, respectively. Especially in Panel F the table shows positive flows also for decile 1 of bond funds and money market funds. Concerning performance persistence, I find evidence for significant and positive returns to the zero-investment portfolios and positive performance for decile 10 for money market funds. Notably, the performance of the zero-investment portfolios is more or less constant over all six Panels. For equity funds Panel E shows significant performance reversal on a risk adjusted basis but no significant results for bond funds. Panel F shows no noteworthy results for equity or bond funds at all. Due to space limitations Panels E and F are not displayed in the paper but available on request.

From this I expect to find significant relations between past flows and future returns for bond funds but not for equity funds in the next section. Even though money market funds show significant performance persistence, the correlations with past flows are very low or even negative (Table 4) such that I do not expect significant results for money market funds.

4.3. The Flow-Performance Relation

In previous sections I show that there are positive correlations between fund returns and future fund flows confirming that investors partly base investment decisions upon past returns. Also, I show performance persistence in bond fund and money market fund performance. As a consequence, I expect fund flows to have at least some information content regarding future returns. To test for the validity of this expectation, Table 6 shows the performance of decile-portfolios ranked by past relative flows as well as performance differences between the highest and the lowest deciles, between the higher 30% and the lower 30%, and between the middle 40% and the outer 60%.\(^5\)

Panel A of Table 6 shows results of flow-deciles ranked by relative flows lagged one month. As a first finding, all fund groups show positive highest-lowest and higher 30%-lower 30% differences, respectively, showing that funds with high past flows out-perform funds with low past flows. This is particularly pronounced for bond funds where most results are statistically significant except for government bond funds. As for equity funds only small cap funds show statistically significant differences while all other groups are insignificant. Money markt funds show significant but very small out-performance of high past flow deciles for MER but not for alpha. Interestingly, for mid cap funds the Panel A shows significant out-performance of the outer deciles over the middle deciles, which is in sharp contrast with the hypothesis that extreme inflows or outflows force managers to inefficiently invest or disinvest, respectively, while moderate flows allow optimal investment decisions. Evidence in favor of this hypothesis is shown for municipal bond funds.

Panel B shows results for flow-deciles ranked by relative flow lagged two months. Here, the evidence in general weakens, as can be expected, but still I find significant out-performance of high past flow deciles over low past flow deciles for mortgage backed and general bond funds. Also, I find

\(^5\) Due to space limitations the table only shows performance measures for the extreme deciles. Measures for all other deciles are available on request.
significant out-performance of middle deciles over outer deciles for municipal bond funds and for growth funds. But in general, there is no relevant information content regarding equity fund returns or money market fund returns.

Panels C and D shows results for flow-deciles ranked by relative flow lagged three and four months, respectively. Again, I find significant out-performance of high past flow mortgage backed and general bond funds. In addition, I find evidence for out-performance of high past flow corporate bond funds. For growth funds, I find out-performance of the middle deciles over the outer deciles in both Panels, as for municipal bond funds I find a significant relation only in Panel C. Panels E and F show results for flow-deciles ranked by relative flows lagged five and six months, respectively, but results show no systematic relations with only weak evidence for out-performance of high past flow mortgage backed bond funds. Therefore, the panels are not displayed in the paper, but available on request.

In a similar fashion Table 6(a) reports performance and performance differences of deciles ranked by past absolute fund flows. For flows lagged one month, Panel A shows significant out-performance of high past flow deciles for mortgage backed, municipal and general bond funds, as well as for growth funds and money market funds. Panel B, which reports results for deciles ranked by absolute flows lagged two months, shows significant out-performance of high past flow deciles for mortgage backed and general bond funds, but no significant results for equity or money market funds. The remaining Panels for deciles ranked by absolute flows lagged more than two months show majorly unsystematic results with the exception of significant out-performance of high past flow corporate bond funds in Panel D. As the absolute flow results are similar in direction but weaker in significance than the relative flow results, I do not report Table 6(a) in the paper, but it is available on request.

From these results I conclude, that there is significant information about future returns in the flows to at least some fund groups. Especially high inflow mortgage backed bond funds and general bond funds show significant out-performance. Also corporate bond fund flows provide some information. As for equity funds the information content is weak.

4.4. Investment Strategies

In this section, I test whether the information content in fund flows regarding future returns can be exploited using simple investment algorithms. To do so, I compare the returns to four different strategies, two of which are uninformed and two are informed. One strategy monthly rebalances the full sample of a respective fund group, one buys and holds the funds existing in a specific fund group at the beginning of the sample period (“initial funds”, e.g., Rohleder et al., 2011), and two invest on past flow ranking information. All of these strategies account for front end and rear end loads charged for rebalancing transactions.

Of the flow-decile based algorithms, strategy three initially invests in flow-decile 10 (highest past flows) and replaces monthly the funds migrated to deciles lower than 8 such that after a warm-up period there are stable weights of deciles 8, 9, and 10 in the portfolio as well as a constant monthly turnover ratio. Strategy four replaces funds migrated to deciles lower than 8 only every second month in order to reduce load payments. Thereby, again after a warm-up period, there are alternating but bi-monthly constant weights between all deciles in one month, or between deciles 8, 9, and 10 in the other month, respectively, as well as a bi-monthly constant turnover ratio.
### Table 6. Deciles ranked by relative flows

This Table shows performance measures and performance differences for decile portfolios ranked by lagged relative flows. MER and alpha are denoted in % p.m. *, **, *** indicates statistical significance on the 1%, 5%, and 10% level based upon HAC-consistent covariances (Newey and West, 1987). The table shows performance differences between the funds with the highest flows and funds with the lowest flows, between the higher 30% and the lower 30% where, e.g., “lower 30%” is an equal-weighted portfolio of deciles 1, 2, and 3, and between the middle 40% and the outer 60%. Due to space limitations the table only shows performance measures for the extreme deciles. Measures for all other deciles are available on request.

| Bond funds | All | Corporate | Gov’t | Mortgage backed | Municipal | General | Equity funds | All | Aggressive growth | Growth | Growth / Income | Mid cap | Small cap | Money market funds |
|------------|-----|-----------|-------|----------------|----------|---------|--------------|-----|------------------|--------|-----------------|---------|-----------|-------------------|
|            |     |           |       |                |          |         |              |     |                  |        |                 |         |           |                   |
| A. Ranking by monthly relative flows lagged 1 month (t-1m) |     |           |       |                |          |         |              |     |                  |        |                 |         |           |                   |
| Monthly mean excess return (MER) |     |           |       |                |          |         |              |     |                  |        |                 |         |           |                   |
| Decile 1 (lowest) | 0.0176 | 0.0363 | 0.1005 | 0.0019 | -0.0380 | 0.0367 | 0.2546 | 0.3275 | 0.1996 | 0.2429 | 0.5724 | 0.3242 | 0.0047 |
| Decile 10 (highest) | 0.2191*** | 0.2518*** | 0.1399* | 0.2300*** | 0.1161* | 0.2894*** | 0.4333 | 0.5157 | 0.3441 | 0.3715 | 0.8162** | 0.7938*** | 0.0043* |
| Highest-lowest | 0.2015*** | 0.2155*** | 0.0394 | 0.2281*** | 0.1541** | 0.2528** | 0.1787 | 0.1882 | 0.1444 | 0.1286 | 0.2438 | 0.4695*** | 0.0039** |
| Higher 30% - lower 30% | 0.1502*** | 0.1395*** | 0.0297 | 0.1346*** | 0.0932** | 0.1794*** | 0.2122 | 0.1484 | 0.1656 | 0.1432* | 0.2209 | 0.3542*** | 0.0046*** |
| Middle 40% - outer 60% | 0.0273 | 0.0504 | -0.0051 | 0.0394*** | 0.0535*** | 0.0322 | 0.0086 | 0.0421 | 0.0509 | 0.0239 | -0.1284*** | -0.0100 | -0.0080*** |
| Monthly multi-factor alpha |     |           |       |                |          |         |              |     |                  |        |                 |         |           |                   |
| Decile 1 (lowest) | -0.1810*** | -0.1433** | -0.0504 | -0.1343* | -0.2106*** | -0.2432*** | -0.1433* | -0.1439 | -0.1156 | -0.1400* | 0.0050 | -0.3391*** | 0.0066 |
| Decile 10 (highest) | 0.0377 | 0.0691 | -0.0460 | 0.0205 | -0.0154 | 0.0428 | -0.1190 | -0.1089 | -0.0739 | -0.1012** | 0.1211 | 0.0469 | 0.1000* |
| Highest-lowest | 0.2186*** | 0.2124*** | 0.0044 | 0.1548*** | 0.1952** | 0.2860* | 0.0244 | 0.0350 | 0.0416 | 0.0388 | 0.1161 | 0.3860*** | 0.0034 |
| Higher 30% - lower 30% | 0.1689*** | 0.1525*** | 0.0168 | 0.0877*** | 0.1179** | 0.1978*** | 0.0713 | 0.0706 | 0.0746 | 0.0792 | 0.0891 | 0.2213** | 0.0032 |
| Middle 40% - outer 60% | 0.0162 | 0.0029 | -0.0189 | 0.0124 | 0.0480*** | 0.0213 | 0.0208 | 0.0514 | 0.0341 | 0.0130 | -0.1362*** | -0.0118 | -0.0035* |
| B. Ranking by monthly relative flows lagged 2 month (t-2m) |     |           |       |                |          |         |              |     |                  |        |                 |         |           |                   |
| Monthly mean excess return (MER) |     |           |       |                |          |         |              |     |                  |        |                 |         |           |                   |
| Decile 1 (lowest) | 0.1050 | 0.1596 | 0.1149 | 0.0034 | -0.0186 | -0.0248 | 0.4881 | 0.4913 | 0.4501 | 0.4829 | 0.6854* | 0.5566 | -0.0012 |
| Decile 10 (highest) | 0.2079*** | 0.2212** | 0.1595* | 0.2649*** | 0.1061 | 0.3154*** | 0.5368 | 0.3619 | 0.5754 | 0.5010* | 0.7564* | 0.8022* | 0.0022 |
| Highest-lowest | 0.1029 | 0.0616 | 0.0446 | 0.2614*** | 0.1247* | 0.3402*** | 0.0487 | -0.1294 | 0.1253 | 0.0181 | 0.0710 | 0.2456* | 0.0034* |
| Higher 30% - lower 30% | 0.0547 | 0.0283 | 0.0175 | 0.1370*** | 0.0557 | 0.2089*** | 0.0322 | -0.0530 | 0.0239 | 0.0905 | 0.1548 | 0.1880 | 0.0041*** |
| Middle 40% - outer 60% | -0.0046 | 0.0047 | 0.0034 | 0.0139 | 0.0426*** | 0.0460 | 0.0280 | 0.0233 | 0.0536 | -0.0054 | -0.0521 | -0.0182 | -0.0149*** |
| Monthly multi-factor alpha |     |           |       |                |          |         |              |     |                  |        |                 |         |           |                   |
| Decile 1 (lowest) | -0.0949* | -0.0694 | -0.0544 | -0.1601*** | -0.1723*** | -0.3170*** | -0.1360 | -0.0023 | -0.1357 | 0.0951 | -0.0308 | -0.2368*** | 0.0045 |
| Decile 10 (highest) | -0.0019 | 0.0170 | -0.0207 | 0.0532 | -0.0421 | 0.0433 | -0.0729 | -0.2952 | 0.0514 | -0.0725* | 0.0437 | -0.0223 | 0.0079 |
| Highest-lowest | 0.0930 | 0.0865 | 0.0337 | 0.2133*** | 0.1303* | 0.3603*** | 0.0632 | -0.2929 | 0.1871 | 0.0226 | 0.0745 | 0.2145 | 0.0035 |
| Higher 30% - lower 30% | 0.0625 | 0.0437 | 0.0182 | 0.1068*** | 0.0774 | 0.1966*** | 0.0037 | -0.0965 | 0.0405 | 0.0769 | 0.1179 | 0.1604 | 0.0020 |
| Middle 40% - outer 60% | -0.0202 | -0.0214 | -0.0042 | -0.0024 | 0.0223* | 0.0188 | 0.0524 | -0.0489 | 0.0581 | 0.0109 | -0.0575 | 0.0115 | -0.0104*** |
### Table 6. Deciles ranked by relative flows (continued)

|                      | Bond funds | Equity funds | Money market funds |
|----------------------|------------|--------------|-------------------|
|                      | All        | Corporate    | Gov’t             | Mortgage backed | Municipal | General | All | Aggressive growth | Growth | Growth / Income | Mid cap | Small cap | funds |
| C. Ranking by monthly relative flows lagged 3 month (t-3m) |            |              |                  |                 |          |         |     |                  |        |               |         |           |       |
| Monthly mean excess return (MER)                  |            |              |                  |                 |          |         |     |                  |        |               |         |           |       |
| Decile 1 (lowest)                                        | 0.0809     | 0.1214       | 0.1266*          | 0.0444          | -0.0251  | 0.0953  | 0.3424 | 0.7466**         | 0.1701 | 0.3669         | 0.3693  | 0.5681      | -0.0005 |
| Decile 10 (highest)                                      | 0.1830***  | 0.2052***    | 0.0799           | 0.2255***       | 0.0878   | 0.1914* | 0.4981 | 0.3003           | 0.3578 | 0.3556         | 0.7429* | 0.7493*     | 0.0029  |
| Highest-lowest                                             | 0.1020*    | 0.0838       | -0.0467          | 0.1812**        | 0.1129** | 0.1146  | 0.1557 | -0.4463          | 0.1877 | -0.0114        | 0.0374* | 0.1813      | 0.0034** |
| Higher 30% - lower 30%                                     | 0.0906*    | 0.0710       | 0.0182           | 0.0854***       | 0.0553   | 0.0975  | 0.0979 | -0.1415          | 0.0945 | 0.0501         | 0.2376* | 0.1322      | 0.0052***|
| Middle 40% - outer 60%                                     | -0.0084    | -0.00186     | 0.0199           | 0.0124          | 0.0422** | 0.0512  | 0.0005 | -0.0178          | 0.0650**| 0.0153        | -0.0199 | -0.0104     | -0.0149**|
| Monthly multi-factor alpha                                 |            |              |                  |                 |          |         |     |                  |        |               |         |           |       |
| Decile 1 (lowest)                                          | -0.1117*** | -0.0649      | -0.0533          | -0.0997         | -0.1714***| -0.1904***| 0.1098 | 0.2485           | -0.1977*| -0.0215        | -0.1948 | -0.1697     | 0.0104  |
| Decile 10 (highest)                                        | -0.0031    | -0.0046      | -0.0974*         | 0.0226          | -0.0645** | -0.0256  | -0.0774 | -0.3887*         | -0.0972 | -0.0935**      | 0.0651  | -0.0469     | 0.0085  |
| Highest-lowest                                             | 0.1085**   | 0.0603       | -0.0441          | 0.1223*         | 0.1069*   | 0.1679* | 0.0324 | -0.6372**        | 0.1006 | -0.0720        | 0.2598  | 0.1228      | -0.0019 |
| Higher 30% - lower 30%                                     | 0.0915**   | 0.0707*      | 0.0119           | 0.0495          | 0.0600    | 0.1040**| -0.0167 | -0.2142          | 0.0353  | -0.0004        | 0.1162  | 0.0189      | -0.0012 |
| Middle 40% - outer 60%                                     | -0.0240    | -0.0567      | 0.0108           | -0.0088         | 0.0288**  | 0.0257  | 0.0532 | 0.0419           | 0.0688**| 0.0189        | -0.0324 | 0.0044      | -0.0088***|
| D. Ranking by monthly relative flows lagged 4 month (t-4m) |            |              |                  |                 |          |         |     |                  |        |               |         |           |       |
| Monthly mean excess return (MER)                  |            |              |                  |                 |          |         |     |                  |        |               |         |           |       |
| Decile 1 (lowest)                                        | 0.1084     | 0.0943       | 0.1192           | 0.1138**        | 0.0312   | 0.1172  | 0.3102 | 0.4478           | 0.1954  | 0.3572         | 0.6688* | 0.5298      | -0.0005 |
| Decile 10 (highest)                                      | 0.2050***  | 0.2438***    | 0.1258           | 0.2321***       | 0.0759   | 0.1886* | 0.3936 | 0.3428           | 0.3113  | 0.3441         | 0.5930  | 0.7633*      | 0.0034  |
| Highest-lowest                                             | 0.0966*    | 0.1495**     | 0.0067           | 0.1184**        | 0.0447   | 0.0952  | 0.0834 | -0.1050          | 0.1160  | -0.0131        | -0.0758 | 0.2335*      | 0.0039**|
| Higher 30% - lower 30%                                     | 0.0864**   | 0.1179**     | -0.0264          | 0.0782**        | 0.0181   | 0.0737  | 0.0763 | 0.0583           | 0.0499  | 0.0758         | 0.0344  | 0.0614      | 0.0046***|
| Middle 40% - outer 60%                                     | -0.0083    | 0.0222       | 0.0287           | 0.0218          | 0.0283*  | 0.0602  | 0.0129 | 0.0795           | 0.0581* | 0.0232        | -0.0570 | -0.0014     | -0.0154***|
| Monthly multi-factor alpha                                 |            |              |                  |                 |          |         |     |                  |        |               |         |           |       |
| Decile 1 (lowest)                                          | -0.0933**  | -0.1135**    | -0.0441          | -0.0189         | -0.1294** | -0.1161 | -0.1693 | 0.0224           | -0.2199*| -0.0808        | 0.0949  | -0.1320     | 0.0093  |
| Decile 10 (highest)                                        | 0.0098     | 0.0420       | -0.0822          | 0.0351          | -0.0670** | -0.0191 | -0.1741**| -0.2809          | -0.1289 | -0.0937**       | -0.1146 | -0.0455     | 0.0067  |
| Highest-lowest                                             | 0.1031*    | 0.1555***    | -0.0381          | 0.0541          | 0.0624    | 0.1040  | -0.0048 | -0.3033          | 0.0909  | -0.0129        | -0.2095 | 0.0864      | -0.0027 |
| Higher 30% - lower 30%                                     | 0.0973***  | 0.1337***    | -0.0315          | 0.0445          | 0.0244    | 0.0806  | 0.0287 | -0.0461          | 0.0457  | 0.0657         | -0.0746 | -0.0607     | -0.0011 |
| Middle 40% - outer 60%                                     | -0.0165    | 0.0129       | 0.0192           | -0.0112         | 0.0132    | 0.0449  | 0.0508 | 0.0805           | 0.0572* | 0.0361        | -0.0614 | 0.0036      | -0.0083**|
4.4. Investment Strategies

In this section, I test whether the information content in fund flows regarding future returns can be exploited using simple investment algorithms. To do so, I compare the returns to four different strategies, two of which are uninformed and two are informed. One strategy monthly rebalances the full sample of a respective fund group, one buys and holds the funds existing in a specific fund group at the beginning of the sample period (“initial funds”, e.g., Rohleder et al., 2011), and two invest on past flow ranking information. All of these strategies account for front end and rear end loads charged for rebalancing transactions.

Of the flow-decile based algorithms, strategy three initially invests in flow-decile 10 (highest past flows) and replaces monthly the funds migrated to deciles lower than 8 such that after a warm-up period there are stable weights of deciles 8, 9, and 10 in the portfolio as well as a constant monthly turnover ratio. Strategy four replaces funds migrated to deciles lower than 8 only every second month in order to reduce load payments. Thereby, again after a warm-up period, there are alternating but bi-monthly constant weights between all deciles in one month, or between deciles 8, 9, and 10 in the other month, respectively, as well as a bi-monthly constant turnover ratio.

For both strategies I calculate the portfolio weights and the turnover ratios from the empirical monthly and bi-monthly migration matrices. As an example, Table 7 shows the migration rates between relative-flow deciles for all small cap equity funds. Variances and standard deviations are calculated using the empirical covariances between the flow-decile returns and the portfolios weights of the strategies. An illustration of the strategies and the covariance matrix of small cap funds are given in the Appendix.

Table 8 shows average loads per transaction and returns to the four investment strategies in the period from 01/1993 through 12/2009. Regarding the loads, bond funds charge lower loads on average than equity funds. Money market funds charge almost no loads. Front end loads are distinctly higher than rear end loads. The average front end load for bond and equity funds range from 0.8634 % of the amount invested for government bond funds to 1.3868 % for aggressive growth funds.

Regarding the investment strategies the table shows a very clear picture. In relation to the uninformed strategies, both flow-decile based strategies show superior – or abnormal – returns before loads are accounted for. At the same time, the standard deviations do not change significantly such that these strategies earn higher returns facing the same risk as the uninformed strategies. But after loads are accounted for the table shows under-performance of the investment algorithms such that the abnormal returns are over-compensated by the associated loads charges.

It is therefore not possible to exploit the information content in lagged flows via these simple investment strategies. Of the two uninformed strategies none is superior to the other. Strategy 1 yields the highest return for MBS, general bond, mid cap, and small cap funds. Strategy 2 shows the highest return for corporate, government, and municipal bond funds as well as for aggressive growth, growth, and growth/income funds.

Noteworthy is the fact that the highest abnormal returns through investing on past flow information are shown for small cap and mid cap funds. First, because the flow-decile results in Table 6 are less significant for these fund groups than for bond funds. Second, because from a theoretical
Table 7. Empirical migration matrices between flow deciles, small cap equity funds
This table shows empirical migration rates between monthly rebalanced relative flow deciles of small cap equity funds in the period from 01/1993 through 12/2009. Panel I shows migration rates within 1 month, Panel II shows migration rates within 2 months. Migration rates are denoted in %.

| Decile (t+1) | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1 (lowest)  | 29.32 | 15.69 | 8.75 | 7.05 | 5.93 | 5.53 | 4.97 | 5.62 | 5.86 | 11.28 |
| 2           | 17.29 | 25.54 | 17.29 | 10.28 | 7.60 | 5.53 | 5.09 | 4.28 | 4.22 | 2.88 |
| 3           | 10.24 | 17.80 | 23.36 | 16.47 | 10.06 | 7.36 | 5.44 | 4.10 | 2.80 | 2.37 |
| 4           | 6.91  | 11.17 | 17.07 | 21.05 | 15.87 | 10.45 | 6.67 | 5.21 | 2.94 | 2.65 |
| 5           | 6.03  | 7.60  | 11.04 | 16.89 | 19.69 | 15.86 | 10.11 | 6.23 | 3.65 | 2.92 |
| 6           | 5.31  | 6.22  | 7.46  | 10.52 | 16.83 | 20.01 | 15.44 | 9.46 | 5.41 | 3.34 |
| 7           | 5.47  | 4.99  | 5.47  | 7.80  | 10.46 | 16.08 | 20.94 | 16.01 | 8.54 | 4.23 |
| 8           | 5.72  | 4.52  | 4.13  | 4.78  | 6.81  | 9.83  | 17.22 | 23.68 | 16.63 | 6.68 |
| 9           | 6.27  | 3.91  | 3.51  | 3.13  | 4.15  | 5.78  | 9.05  | 17.79 | 30.53 | 15.88 |
| 10 (highest)| 8.13  | 3.01  | 2.20  | 2.16  | 2.62  | 3.47  | 4.87  | 7.36  | 19.03 | 47.15 |

| Decile (t+1) | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1 (lowest)  | 26.59 | 16.19 | 9.65 | 7.35 | 6.56 | 5.49 | 5.51 | 5.79 | 6.31 | 10.54 |
| 2           | 17.42 | 23.67 | 17.15 | 11.25 | 7.41 | 6.43 | 5.44 | 4.36 | 3.71 | 3.15 |
| 3           | 10.69 | 17.36 | 21.56 | 16.06 | 10.53 | 7.73 | 5.75 | 4.51 | 3.07 | 2.74 |
| 4           | 8.13  | 11.05 | 16.50 | 19.82 | 14.83 | 10.33 | 7.32 | 5.11 | 3.66 | 3.24 |
| 5           | 6.81  | 8.06  | 11.56 | 15.97 | 18.59 | 14.85 | 9.76 | 6.78 | 4.37 | 3.25 |
| 6           | 6.31  | 6.57  | 8.07  | 10.47 | 15.48 | 18.55 | 14.88 | 9.80 | 5.94 | 3.94 |
| 7           | 6.03  | 4.84  | 5.39  | 7.85  | 11.07 | 15.39 | 18.84 | 15.46 | 9.86 | 5.27 |
| 8           | 5.54  | 5.06  | 4.06  | 5.11  | 7.40  | 10.41 | 16.87 | 21.78 | 16.26 | 7.51 |
| 9           | 5.67  | 4.55  | 3.62  | 3.56  | 4.94  | 6.63  | 9.85  | 17.58 | 27.32 | 16.28 |
| 10 (highest)| 7.49  | 3.09  | 2.72  | 2.69  | 3.21  | 4.15  | 5.63  | 8.49  | 19.08 | 43.45 |

point of view funds investing in small cap or mid cap funds upon flow should not be beneficial because these are considered as less liquid than other equity.

5. Conclusion
In the mutual fund literature, the relationship between flows and performance is a widely discussed topic. There is consensus on the fact that investors chase past performance, but the opposite direction is not as clear. Therefore, I investigate for a variety of bond, equity, and money market funds, the relationship between past flows and future performance, as well as connected economic relations like performance persistence and the size-performance relationship. I find clear evidence for economies of scale in the mutual fund industry, especially for bond and money market funds, but also on a weaker basis for equity funds. Also, I find short-term persistence for all fund groups as well as performance persistence over several months for money market funds. Together, these aforesaid results lead to the finding that there is significant out-performance of high past inflow funds over low past inflow funds, especially for mortgage backed and general bond funds over several months. For equity funds, however I do not find significant results over more than one month. Based on this information, I use simple investment algorithms and find abnormal returns to these strategies for all fund groups, where the highest abnormal returns are possible for mid cap and small cap equity funds, as well as for general and corporate bond funds. At the same time, the standard deviations remain more or less unchanged. However, when accounting for the loads charges associated with these algorithms, the abnormal returns are over-compensated for such that simple informed investment strategies under-perform uninformed strategies.
Table 8. Returns to different investment strategies and loads

This table shows average loads, mean excess returns (MER) to four investment strategies, and turnover ratios of these investment strategies for different fund groups in the period from 01/1993 through 12/2009. Average loads are denoted in % of invested money amount per transaction. Round trip represents the load associated with substituting a fund from the portfolio by another fund. All return measures are denoted in % p.m. Turnover ratios are denoted in % per month (*) or in % per two months (**), respectively. “MER-Loads” is calculated as MER-(monthly turnover ratio*round trip load). Strategy 1 rebalances monthly the returns of all funds available (the turnover ratio only accounts for buying the new born funds but ignores rebalancing within the portfolio). Strategy 2 buys all funds initially existing in 01/1993 and holds these for the period through 12/2009. Strategy 3 substitutes monthly all funds migrated to flow-deciles lower than 8 by funds ranked in decile 10. Strategy 4 substitutes bi-monthly the funds migrated to flow-deciles lower than 8 by funds ranked in decile 10.

| Bond funds | Average loads per transaction | 1. All funds monthly rebalanced | 2. Buy and hold initial funds | 3. Flow deciles monthly rebalanced | 4. Flow deciles bi-monthly rebalanced |
|------------|-------------------------------|--------------------------------|-------------------------------|-----------------------------------|-------------------------------------|
|            | Frond end | Rear end | Round trip | MER | MER - Loads | Turnover ratio* | St.dev. | MER | MER - Loads | Turnover ratio* | St.dev. | MER | MER - Loads | Turnover ratio* | St.dev. | MER | MER - Loads | Turnover ratio* | St.dev. |
| All        | 0.9146    | 0.3645   | 1.2791     | 0.1308 | 0.1227 | 0.63 | 0.9571 | 0.1309 | 1.0138 | 0.2149 | -0.2462 | 36.05 | 0.9298 | 0.1960 | -0.0511 | 38.63 | 0.9485 |
| Corp       | 0.8865    | 0.3345   | 1.2211     | 0.1567 | 0.1478 | 0.73 | 1.0419 | 0.1531 | 1.2112 | 0.2408 | -0.2272 | 38.32 | 1.0524 | 0.2234 | -0.0225 | 40.27 | 1.0920 |
| Gov        | 0.8634    | 0.3277   | 1.1912     | 0.1153 | 0.1089 | 0.54 | 0.9356 | 0.1323 | 0.9832 | 0.1447 | -0.3705 | 43.25 | 0.9805 | 0.1414 | -0.1272 | 45.10 | 0.9555 |
| MBS        | 0.9739    | 0.3221   | 1.2960     | 0.1596 | 0.1538 | 0.44 | 0.7510 | 0.1433 | 0.7758 | 0.2191 | -0.2130 | 33.34 | 0.8865 | 0.2020 | -0.0271 | 35.30 | 0.8520 |
| Muni       | 0.9778    | 0.4127   | 1.3906     | 0.0922 | 0.0858 | 0.46 | 1.2017 | 0.1045 | 1.2647 | 0.1190 | -0.3530 | 33.94 | 0.9562 | 0.1116 | -0.1415 | 36.41 | 1.0108 |
| General    | 0.9451    | 0.6766   | 1.6217     | 0.1694 | 0.1462 | 1.43 | 1.3899 | 0.1399 | 1.4423 | 0.2818 | -0.1601 | 27.25 | 1.3979 | 0.2642 | 0.0143 | 30.82 | 1.4060 |
| Equity funds |                      |                                |                              |                                |                                  |                                  |                                  |                                  |                                  |                                  |                                  |                                  |                                  |
| All        | 1.2537    | 0.3935   | 1.6472     | 0.4036 | 0.3849 | 1.13 | 4.5269 | 0.3814 | 4.4598 | 0.4656 | -0.0151 | 29.18 | 4.9602 | 0.4516 | 0.1957 | 31.06 | 4.8085 |
| AGG        | 1.3868    | 0.4596   | 1.8464     | 0.3647 | 0.3412 | 1.27 | 4.7550 | 0.3926 | 5.0633 | 0.4843 | -0.0752 | 30.30 | 5.3015 | 0.4635 | 0.1525 | 33.70 | 5.1313 |
| Growth     | 1.3573    | 0.3756   | 1.7329     | 0.3334 | 0.3132 | 1.16 | 4.5397 | 0.3393 | 4.5149 | 0.3772 | -0.1363 | 29.48 | 5.0829 | 0.3728 | 0.1024 | 31.21 | 4.9237 |
| GRI        | 1.2020    | 0.3679   | 1.5700     | 0.3530 | 0.3372 | 1.01 | 4.0211 | 0.3426 | 4.0382 | 0.4001 | -0.0310 | 27.26 | 4.0759 | 0.3965 | 0.1741 | 28.33 | 4.0507 |
| Mid        | 1.2445    | 0.4284   | 1.6728     | 0.5165 | 0.4876 | 1.73 | 5.2671 | 0.4057 | 5.4806 | 0.7627 | 0.2100 | 33.04 | 5.7144 | 0.7077 | 0.4196 | 34.44 | 5.6198 |
| Small      | 1.1057    | 0.4202   | 1.5260     | 0.5643 | 0.5478 | 1.08 | 5.4632 | 0.5232 | 5.3911 | 0.7530 | 0.2727 | 31.47 | 5.6719 | 0.7005 | 0.4409 | 34.03 | 5.6234 |
| Money market funds |                |                                      |                          | -0.0272 | -0.0276 | 0.34 | 0.0341 | -0.0326 | 0.0341 | 0.0029 | -0.0739 | 65.00 | 0.0312 | -0.0006 | -0.0390 | 65.00 | 0.0314 |
Appendix

Investment strategies based on flow-deciles, e.g. small cap equity

Investment strategy three is based upon monthly substituting the funds migrated to deciles lower than 8 by funds ranked in flow-decile 10. Portfolio turnover and weights are shown in the table below.

Table A1. Strategy 3 – small cap equity funds

This table shows the warm up phase (< t0) of strategy 1 as well as the constant (bold) portfolio weights, portfolio return and turnover ratio in and after t0 for small cap funds. Returns are denoted in % p.m., weights are denoted in %, and turnover is denoted in % p.m.

| Month | Portfolio turnover | Portfolio composition |
|-------|-------------------|-----------------------|
|       | Substitution      | Decile | Weight | Decile return | Weighted return |
| t-7   |                   | D8     | 0.00   | 0.7513       | 0.00            |
|       |                   | D9     | 0.00   | 0.6244       | 0.00            |
|       |                   | D10    | 100.00 | 0.7938       | 0.7938          |
|       |                   |        |        |              | 100.00          |
| t-6   | D1-7 → D10        | 26.46  | D8     | 7.36         | 0.7513          |
|       |                   |        | D9     | 19.03        | 0.6244          |
|       |                   |        | D10    | 73.61        | 0.7938          |
|       |                   |        |        |              | 100.00          |
| t-5   | D1-7 → D10        | 30.19  | D8     | 10.55        | 0.7513          |
|       |                   |        | D9     | 21.04        | 0.6244          |
|       |                   |        | D10    | 68.41        | 0.7938          |
|       |                   |        |        |              | 100.00          |
| t-4   | D1-7 → D10        | 31.22  | D8     | 11.28        | 0.7513          |
|       |                   |        | D9     | 21.20        | 0.6244          |
|       |                   |        | D10    | 67.53        | 0.7938          |
|       |                   |        |        |              | 100.00          |
| ≥ t0  | D1-7 → D10        | 31.47  | D8     | **11.44**    | 0.7513          |
|       |                   |        | D9     | **21.19**    | 0.6244          |
|       |                   |        | D10    | **67.37**    | 0.7938          |
|       |                   |        |        |              | 100.00          |
|       |                   |        |        |              | **0.7530**      |

The variance of the portfolio is calculated using the empirical covariances between the flow-decile returns and the portfolio weights shown in the above table.

Table A2. Flow-decile covariances, small cap equity funds

|       | D1  | D2  | D3  | D4  | D5  | D6  | D7  | D8  | D9  | D10 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| D1    | 0.32|     |     |     |     |     |     |     |     |     |
| D2    | 0.30| 0.30|     |     |     |     |     |     |     |     |
| D3    | 0.30| 0.30| 0.30|     |     |     |     |     |     |     |
| D4    | 0.30| 0.29| 0.30| 0.31|     |     |     |     |     |     |
| D5    | 0.31| 0.29| 0.30| 0.30| 0.31|     |     |     |     |     |
| D6    | 0.30| 0.29| 0.29| 0.30| 0.30| 0.30| 0.32|     |     |     |
| D7    | 0.32| 0.30| 0.30| 0.31| 0.32| 0.32| 0.35|     |     |     |
| D8    | 0.32| 0.29| 0.30| 0.31| 0.32| 0.32| 0.34| 0.35|     |     |
| D9    | 0.31| 0.29| 0.29| 0.30| 0.31| 0.31| 0.32| 0.33| 0.32|     |
| D10   | 0.30| 0.28| 0.29| 0.30| 0.31| 0.31| 0.32| 0.33| 0.32| 0.32|
Investment strategy 4 is based upon substituting the funds migrated to deciles lower than 8 by funds ranked in flow-decile 10 only every second month.

### Table A3. Strategy 4 – small cap equity funds

This table shows the warm up phase (< t0) of strategy 2 as well as the constant (bold) portfolio weights, portfolio return and turnover ratio in and after t0 for small cap funds. Returns are denoted in % p.m., weights are denoted in %, and turnover is denoted in % per 2 months.

| Month | Portfolio turnover | Portfolio composition |
|-------|-------------------|----------------------|
|       | Substitution | Turnover | Decile | Weight | Decile return | Weighted return |
| t-8   | D1               | 0.00      | 0.3242 | 0.0000 |
|       | D2               | 0.00      | 0.4108 | 0.0000 |
|       | D3               | 0.00      | 0.3720 | 0.0000 |
|       | D4               | 0.00      | 0.5437 | 0.0000 |
|       | D5               | 0.00      | 0.5264 | 0.0000 |
|       | D6               | 0.00      | 0.5612 | 0.0000 |
|       | D7               | 0.00      | 0.5131 | 0.0000 |
|       | D8               | 0.00      | 0.7513 | 0.0000 |
|       | D9               | 0.00      | 0.6244 | 0.0000 |
|       | D10              | 100.00    | 0.7938 | 0.7938 |
|       |                  |          | 100.00 | 0.7938 |
| t-7   | D1               | 8.13     | 0.3242 | 0.0264 |
|       | D2               | 3.01     | 0.4108 | 0.0124 |
|       | D3               | 2.20     | 0.3720 | 0.0082 |
|       | D4               | 2.16     | 0.5437 | 0.0117 |
|       | D5               | 2.62     | 0.5264 | 0.0138 |
|       | D6               | 3.47     | 0.5612 | 0.0195 |
|       | D7               | 4.87     | 0.5131 | 0.0250 |
|       | D8               | 7.36     | 0.7513 | 0.0553 |
|       | D9               | 19.03    | 0.6244 | 0.1188 |
|       | D10              | 47.15    | 0.7938 | 0.3742 |
|       |                  |          | 100.00 | 0.6653 |
| t-6   | D1 → D10        | 7.49     | D1     | 0.00    | 0.3242   | 0.0000 |
|       | D2 → D10        | 3.09     | D2     | 0.00    | 0.4108   | 0.0000 |
|       | D3 → D10        | 2.72     | D3     | 0.00    | 0.3720   | 0.0000 |
|       | D4 → D10        | 2.69     | D4     | 0.00    | 0.5437   | 0.0000 |
|       | D5 → D10        | 3.21     | D5     | 0.00    | 0.5264   | 0.0000 |
|       | D6 → D10        | 4.15     | D6     | 0.00    | 0.5612   | 0.0000 |
|       | D7 → D10        | 5.63     | D7     | 0.00    | 0.5131   | 0.0000 |
|       | D8               | 8.49     | 0.7513 | 0.0638 |
|       | D9               | 19.08    | 0.6244 | 0.1191 |
|       | D10              | 72.43    | 0.7938 | 0.5749 |
|       |                  |          | 29.00  | 0.7578 |
| t-5   | D1               | 7.57     | 0.3242 | 0.0245 |
|       | D2               | 3.31     | 0.4108 | 0.0136 |
|       | D3               | 2.62     | 0.3720 | 0.0097 |
|       | D4               | 2.57     | 0.5437 | 0.0140 |
|       | D5               | 3.27     | 0.5264 | 0.0172 |
|       | D6               | 4.45     | 0.5612 | 0.0250 |
|       | D7               | 6.71     | 0.5131 | 0.0344 |
|       | D8               | 10.74    | 0.7513 | 0.0807 |
|       | D9               | 21.02    | 0.6244 | 0.1312 |
|       | D10              | 37.75    | 0.7938 | 0.2996 |
|       |                  |          | 100.00 | 0.6500 |

...
Table A3. Strategy 4 – small cap equity funds (continued)

| Month (t0) | Substitution | Turnover | Decile | Weight | Decile return | Weighted return |
|------------|--------------|----------|--------|--------|---------------|-----------------|
| D1         | 6.89         |          | D1     | 0.00   | 0.3242        | 0.0000          |
| D2         | 3.62         |          | D2     | 0.00   | 0.4108        | 0.0000          |
| D3         | 3.06         |          | D3     | 0.00   | 0.3720        | 0.0000          |
| D4         | 3.15         |          | D4     | 0.00   | 0.5437        | 0.0000          |
| D5         | 4.06         |          | D5     | 0.00   | 0.5264        | 0.0000          |
| D6         | 5.40         |          | D6     | 0.00   | 0.5612        | 0.0000          |
| D7         | 7.82         |          | D7     | 0.00   | 0.5131        | 0.0000          |
|            |              |          | D8     | 11.93  | 0.7513        | 0.0896          |
|            |              |          | D9     | 20.43  | 0.6244        | 0.1276          |
|            |              |          | D10    | 67.65  | 0.7938        | 0.5369          |
|            |              |          |        | 34.01  |               |                 |
| t+1        |              |          | D1     | 7.46   | 0.3242        | 0.0242          |
|            |              |          | D2     | 3.37   | 0.4108        | 0.0139          |
|            |              |          | D3     | 2.70   | 0.3720        | 0.0100          |
|            |              |          | D4     | 2.67   | 0.5437        | 0.0145          |
|            |              |          | D5     | 3.43   | 0.5264        | 0.0181          |
|            |              |          | D6     | 4.70   | 0.5612        | 0.0264          |
|            |              |          | D7     | 7.19   | 0.5131        | 0.0369          |
|            |              |          | D8     | 11.44  | 0.7513        | 0.0859          |
|            |              |          | D9     | 21.09  | 0.6244        | 0.1317          |
|            |              |          | D10    | 35.94  | 0.7938        | 0.2852          |
|            |              |          |        | 100.00 |               | 0.6469          |
|            |              |          |        |        |               | 0.7005          |

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Conflicts of Interest

The author declares no conflict of interest.

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