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# Change is Good or the Disposition Effect Among Mutual Fund Managers

Li Jin and Anna Scherbina\*

February 15, 2005

\*Both Jin (ljin@hbs.edu) and Scherbina (ascherbina@hbs.edu) are from the Finance Unit, Harvard Business School. We thank seminar participants of the finance brown bag lunch seminar and Klaas Baks for comments, and Long Lee for excellent research assistance. We thank Morningstar for providing the managerial profiling data, and Russ Wermers for providing the MFLINK data. Research support from Harvard Business School Division of Research is gratefully acknowledged. All errors are our own.

# Change is Good or the Disposition Effect Among Mutual Fund Managers

## **Abstract**

We document that mutual fund managers exhibit the disposition bias, or the tendency to hold on too long to poorly performing stocks. We demonstrate this by showing that new managers who take over existing funds sell more momentum losers than continuing managers of similar funds. This effect is more pronounced when the outgoing manager is young. At the same time, new managers also disproportionately sell off momentum winners, indicating that they may also be susceptible to the disposition bias. Given that mutual funds hold a large fraction of the U.S. equity market, this finding may shed light on the origins of price momentum.

# I. Introduction

This paper investigates whether professional money managers exhibit the disposition effect. Disposition effect is an irrational tendency to hold on to poorly performing stocks too long and sell winning stocks too soon. It is irrational for several reasons. Most importantly, it has a negative impact on future expected returns because the past return performance tends to continue in the future. Jegadeesh and Titman (1993) document that stocks that have performed best (worst) the the past three months to a year continue to perform well (poorly) in the next three months to a year; they call this phenomenon price momentum. Additionally, holding on to losers and selling winners too soon is likely to increase the tax liability. The reason is that the capital gains taxes are higher on short-term than long-term investments, and taxes on short-term gains can be offset by short-term losses elsewhere in the portfolio. So, the effective tax management would dictate selling momentum losers quickly and holding on to winners longer. Finally, mutual fund managers may want to sell losers before reporting their portfolio holdings in order to hide their bad decisions from investors. This behavior is called window-dressing.

Disposition effect has been documented for the individual investors. We show that mutual fund managers are also subject to the disposition bias. This result is important because mutual funds control a large portion of the U.S. stock market, and this effect could have large-scale implications for stock prices and could shed light why price momentum has persisted in equity markets.

We document the disposition effect among mutual fund managers by studying instances of managerial change. Our hypothesis is that a new manager who “inherits” an investment portfolio is more likely to purge momentum losers from the portfolio than a continuing manager. The reason is that the disposition effect arises from the psychological cost associated with admitting ones’ mistakes. An investor who sells a stock that has lost money admits to having been wrong to purchase it in the first place. Consistently, Weber and Camerer (1998) show, both through theory

and experiments, that forcing investors to sell their entire portfolio at the end of the period and form a new portfolio from scratch greatly reduces the disposition effect.

We show that new managers indeed reduce holdings of poorly performing stocks more drastically than continuing managers. We show that a quarter after the new manager takes over, the median trade of a new manager sells off holdings in the bottom momentum decile completely, while the median trade of continuing managers sells off only 57.8% of such stocks. It turns out that new managers are not completely immune to the disposition effect. They still show a tendency to sell more momentum winners than stocks in median momentum deciles, but they sell more losers yet.

Managerial replacements therefore have a positive effect on the portfolio composition. A median fund that has experienced managerial change increases its value-weighted portfolio ranking one quarter after the replacement, while the median fund with continuing managers decreases its ranking. This finding indicates that change is good.

## **A. Prior literature**

The term “disposition effect” was coined by Shefrin and Statman (1985) to explain the widespread pattern of selling winners too soon and holding on to losers too long. This behavior is consistent with prospect theory of Kahneman and Tversky (1979), which states that investors are risk-loving with respect to losses but risk-averse with respect to gains, and narrow framing, which states that investors are prone to evaluate stock performance in isolation rather than in the context of a portfolio.

The effect has been documented in a variety of settings. Lakonishok and Smidt (1986) and Ferris, Haugen, and Makhija (1988) find higher abnormal trading volume for past winners than losers and Weber and Camerer (1998) provide experimental evidence. Odean (1998) shows that retail investors at a major U.S. discount brokerage house systematically sell a larger fraction of winners than losers from their portfolios. Haigh and List (2004) provide experimental evidence

for the disposition effect among professional traders at the Chicago Mercantile Exchange. Internationally, the disposition effect is documented by Shapira and Venezia (2001) among Israeli investors and by Grinblatt and Keloharju (2001) among Finnish investors. Interestingly, Grinblatt and Keloharju (2001) also document that sophisticated investors are less influenced by past returns in their trading decisions than the less sophisticated ones such as households, government and non-profit institutions. Finally, Grinblatt and Han (2004) link the disposition effect to larger asset pricing issues, in particular, the momentum effect. They argue that the disposition effect creates a spread between a stock's fundamental value and the equilibrium price that explains the underreaction of prices to new information. Spread convergence, arising from the random evolution of fundamental values and updating of reference prices, generates predictable equilibrium prices that are consistent with the momentum effect.

Existing research leaves open the question of whether the disposition effect exists among mutual fund managers. The answer is important for at least two reasons. First, it is not immediately obvious that the more sophisticated professional money managers will exhibit behavioral biases. Second, if they do, institutional behavioral biases will have much wider asset pricing implications since they control a large fraction of the U.S. equity market. Additionally, the disposition effect is more pronounced for large stocks, as demonstrated empirically by Ranguelova (2000), and mutual fund managers are more likely than individuals to hold relatively large stocks.

## **II. Data and Methodology**

We compare trading patterns of new fund managers with those of continuing managers in order to detect potential differences with respect to stocks at the extreme momentum deciles. One legitimate concern is that funds that replace managers have performed badly in the past and have accumulated disproportionately many losers. Indeed, Khorana (2001) and Khorana (1996) document that funds that have performed poorly are more likely to change managers. We try to control for these self-selection issues in several ways. First, in addition to documenting trades in

the number of shares, we also we quantify trades in per cent of the inherited shares. This way, if a fund initially has disproportionately many losers, it will not affect our sales metric. Second, in case that the new manager is likely to sell all stocks irrespective of their past performance, we measure differences in differences – differences between sales of stocks in the bottom and top momentum deciles for funds that have experienced managerial change and the control group of funds that have not change managers. Finally, in order to control for the fact that perhaps funds in the control group and test group have different stocks in the loser decile, we also match on individual stocks.

Mutual funds in our sample are often managed by more than one manager concurrently. Replacing only a subset of managers is likely to mask the disposition effect, therefore, we focus on instances when all of the previous managers have been replaced. We call these events “complete replacements.” We define *complete replacement* as:

Replacement of all of the initial fund managers through (potentially) a series of managerial changes, with each in the series of replacements occurring within 90 days of the immediately preceding replacement.

We broaden the time frame of managerial change in order to accommodate the possibility that not all changes happen on the same day. We want to make sure that we identify all of changes that occur in close sequence as one event to account for the possibility that potential managers could be tried out or temporary managers could be brought in before the permanent one is found. We explain the data source and methodology in detail below.

## **A. Data sources**

Morningstar has provided us with data on managerial changes. The dataset covers 10,211 funds, 7,998 managers, and over 30,000 managerial changes starting in 1924.<sup>1</sup> The dataset has survivorship bias: it only contains data for funds that exist today. To the extent that managers of the now

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<sup>1</sup>The earliest managerial change recorded is on July 29, 1924, the “Dean of Institutional Investors,” Paul Cabot, joined State Street Research Investment A. The last event was recorded on March 8, 2004.

distinct funds had the same propensity for the disposition effect as the managers of surviving funds, the survivorship bias should not affect our results.

Funds that are categorized as bond, government, munis, index, REIT, and convertible are excluded from our analysis. From the remaining data, we identify funds that undergo complete replacement, and they form our test group. Table I provides the summary statistics of our test group of funds.

We obtain fund stock holdings from the Thomson Financial mutual fund dataset, SP12. SP12 provides mutual fund common stock holdings since 1980, which in turn determines the starting date of our analysis. Note that SP12 provides quarterly information, but since mutual funds are only required to file N-30D report with the SEC twice a year, there may be gaps in reporting.<sup>2</sup> Sometimes Thomson Financial backfills gaps with information from previous quarters. *rdate* column in the SP12 dataset identifies the report date and thus allows us to eliminate observations that have been backfilled. We also exclude fund-quarters that show less than ten stocks in the report to keep our studies away from errors in database and underreporting issues.<sup>3</sup>

Stock prices, returns, and split adjustment factors are taken from the CRSP monthly stock file. We extract monthly returns with dividends and compile a trailing 12-month return for each stock on a quarterly basis (since SP12 reports every March, June, September, and December). Those stocks that do not have a valid trailing 12-month return or valid split adjustment factor for shares are thrown out of our studies. Every quarter we calculate the rank of each stock based on its return over the past 12 months, and then we categorize all the stocks into deciles, with rank = 1 being the worst performing decile, as in Jegadeesh and Titman (1993). We call this raw rank. As a robustness check, in Section 4 we will create another measure called relative rank that only focuses on return relative to other stocks in a fund's portfolio. Finally, we create a link to match

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<sup>2</sup>A Thomson Financial representative informed us that sometimes holding information is retrieved directly from the fund company (voluntary reporting) rather than from the SEC because of faster turn-around time. The integrity of voluntary reporting solely relies on the good faith of the fund companies. However, there is no indication of the source of information in the dataset.

<sup>3</sup>We also experimented with setting the critical number at 20 and 75 stocks, which does not substantially change the results.

funds in the Morning Star dataset to their holdings in the SP12 dataset. Details of the link file are discussed in the appendix.

## B. Methodology

We investigate what happens to mutual fund holdings after it changes management. *preCR* is the quarter before complete replacement started taking place (recall that it can last longer than a day when managers are sequentially replaced). In case no holding information is available as of that quarter, we use the holdings information for the quarter before *preCR*. If the holdings data are still missing, we go back as three quarters. If the data are still missing, we exclude this observation of complete replacement from our analysis.

*postCR* is the quarter immediately following a complete replacement. We track portfolio holdings up to four quarters after the complete replacement. The rationale for extending the window is that the new manager will sell the inherited holdings over an extended period of time. Additionally, some funds may not be reporting regularly, and this method will allow us to pick up changes when they do report. We are reluctant to extend the window of our analysis too much further since then the trading decisions are unlikely to be influenced by the disposition effect. For example, a new manager may initially sell a basket of losing stocks inherited from the old manager, and then buy them back 18 months later for an unrelated reason.

We employ the following measures of trade:

1) Percentage change in number of shares for stock  $i$ , calculated as  $\frac{N_t^i - N_{preCR}^i * \frac{Adj_{preCR}^i}{Adj_t^i}}{N_{preCR}^i * \frac{Adj_{preCR}^i}{Adj_t^i}}$ , where  $N_t^i$  = number of shares held in  $t$  quarter after the end of CR and  $N_{preCR}^i$  is the number of shares held pre-CR.  $Adj_t^i$  = CRSP shares adjustment factor for  $t$  quarter after the end of CR and  $Adj_{preCR}^i$  is the shares adjustment factor in the pre-complete replacement quarter.

2) Raw change in number of shares for stock  $i$ , calculated as  $N_t^i - N_{preCR}^i * \frac{Adj_{preCR}^i}{Adj_t^i}$ .

We also compute a measure of sales based on changes in relative weights of the stocks in the inherited portfolio. Results are qualitatively similar and are not reported. Both measures focus on the relative changes in holdings of the inherited stocks. We do not include the stocks that the new manager purchases in our analysis.

We have no reason to believe that trades are normally distributed. In fact, percentage changes have a lower bound at -100%, and one quarter after the managerial change, the median percentage change in the number of inherited shares is -100%. Therefore, despite the fairly large sample size of our dataset, we base our analysis on the median change.<sup>4</sup>

We compare the differential changes in holdings of the winning and losing stocks to that of a control group of funds that have experienced no managerial change (even if it is partial change) in the previous 12 months. For example, let's assume fund ABCXX has been in business since 1990, and in 2000 Q1 it adds a new manager. As a consequence, we exclude fund quarters 1999 Q1 to 2002 Q1 from our control group.<sup>5</sup>

We then match test group to the control group either on individual stocks or on stock deciles. In the first method, we simply identify all the stocks that belong to the same return rank group in the CRSP universe of stocks ( $r = 1$  to 10) in  $t$  quarter(s) post-complete replacement ( $t = 0$  to 4), based on raw return for the past 12 months. Then we aggregate all the holdings of such stocks over the funds in the control group. We then look at the changes in holdings in each of the stocks from the pre-CR quarter to the certain number of quarters after the complete replacement. For each of the stocks that was being held pre-complete replacement by a fund in the test group, we thus find the changes in holdings in the control group. We also find the difference in the change in holdings between the test and control groups. We then compute the medians of these variables in each momentum rank. In case there is little overlap between the stock holdings in the test group and the control group, we also match only on the stock rank. We aggregate all

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<sup>4</sup>Kolmogorov-Smirnov test for normality has been ran on all series. All tests return less than .01 p-value, rejecting the hypothesis that the sample is normally distributed.

<sup>5</sup>We rerun our tests with the specification of no managerial change in the control group within past 24 months, but find no significant difference in results.

stocks holdings within a rank (both for test and control group) and investigate median changes in holdings within a rank. Once again, we are interested in the “differences in differences” statistics, i.e. the difference between the change in holdings of winners and losers for the test group minus this difference for the control group of funds. These procedures are described in more detail in the appendix.

### **III. Empirical results**

#### **A. Main test**

Table II presents results on the differential trades of stocks in the winning and losing deciles based on the past 12 months of performance. Here, changes in each decile are analyzed based on stock-by-stock match. Table IIa presents the results in percentage changes of shares since the quarter immediately preceding complete replacement for both the test group and the control group of funds. Table IIb presents results on changes in the raw number of shares.

It is striking that consistent with the hypothesis of the disposition effect among mutual fund managers, the median sale of the stocks in the losing decile is 53.18% in the quarter immediately after the completion of the complete replacement. One quarter after that, the median trade gets rid of all the stocks in the losing decile (while the median trade in the control group gets rid of only 15.3% of the initial shares). Even after four quarters, the median trade in the control group gets rid of only 23.74% of shares. Table IIb shows that the median number of shares of stocks in the losing decile being sold is 2,452 in the quarter immediately after the replacement and 5,074 the quarter after, which is a large enough number to have pricing and liquidity implication on the stock being sold.<sup>6</sup>

As can be seen from Table IIa, new managers tend to sell all of the inherited stocks, but they sell more losers relative to winners (the Z-statistic on the median difference is highly significant

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<sup>6</sup>The raw numbers of shares sold are higher for the control group because all the trades are aggregated across all funds in the control group.

in all quarters. For each of the two measures of trade and five post-CR quarters, we compare the data representing the best and the worst deciles. Once again, neither the individual series nor the combined series passes the normality test. Hence, the standard two-sample Student's t-test, which has the normality assumption, is not our first choice for hypothesis testing. Instead, we conduct the hypothesis testing by the nonparametric Wilcoxon Rank-Sum (Mann-Whitney) test.<sup>7</sup> Additionally, the differences between the sales of losing and winning stocks in the test and control group, the “differences in differences” is also statistically significant.

Table III shows similar results when we compare trades in the test group to trades in the control group by the momentum ranking decile. Once again, we see that new managers are faster at getting rid of losing stocks than continuing managers, and the differences in the median trades are statistically significant. Interestingly, both tables show somewhat of a U-shape in trades in that both new and continuing managers sell more winners than stocks in the middle rankings. This result is consistent with the disposition effect with respect to winners for both types of managers (i.e. selling winners too quickly). In addition to rank1 versus rank10, we have also run other tests that compare combined ranks, such as rank1+rank2 versus rank9+rank10, rank1+rank2+rank3 versus rank8+rank9+rank10, and finally (rank1 to rank5) versus (rank6 to rank 10). All of these tests return promising results similar to those numbers in Table VI.

## **B. Does the age of replacee matter?**

A relevant question is whether young managers are more likely exhibit the disposition effect. It could be the case if young managers are more reluctant to admit their past mistakes or they are less aware of their inherent biases. To answer this question, we classify fund managers into two

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<sup>7</sup>In a nutshell, to use the Rank-Sum test on a two-sample problem, one would first rank all of data together and then sum up the ranks that are associated to the smaller size group. The sum is the test statistics, and if the size of both groups are less than 10, tables are available in a basic statistics text that cover nonparametric methods. If both groups have more than 10 data points, one can apply the central limit theory and simply refer to a standard normal table for critical values for the test.

age groups, above or below 45 years old.<sup>8</sup> Since there is no clear way to estimate the role of individual managers in a team-managed fund, we restrict this part of our analysis to CR in which only one manager is replaced. Results are listed on separate panels in Table IV.

Our results show that although both groups are subjected to disposition effect, but the higher Z-statistics (in magnitude) probably suggest that the younger, hence less experienced group seems is more vulnerable. One-to-one rank based results, not shown here, display similar divergence between the two camps.

### **C. Does the family size matter?**

One could argue that smaller fund families will be more severely affected by the disposition effect because the family-level controls could be more lax. Large fund families are more likely to have more resources to institute strict portfolio review boards to check fund portfolio choices. To check whether this is the case, at the beginning of each year, we subdivide fund families into two size groups. The family size is defined at the sum of total net assets of all the funds within the family. Our findings are presented in Table V. The table presents Z-statistics of the differences in the selling of losers and winners by new managers in each family size group. It appears that large fund families exhibit significant disposition effect, and the significance level is higher than that for the small families. But the latter could be driven by the smaller number of observation of managerial change within smaller families (which affects our Z-statistics). The differences in sample sizes happen by construction: smaller families have fewer funds and hence fewer managerial changes.

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<sup>8</sup>If available, we use the birthday provided in the Morningstar dataset to calculate managers' ages. Otherwise we assume managers get their undergraduate degrees at 21. If neither the birthday nor graduation year is available, we exclude that manager from this part of the analysis.

## **D. How managerial change affects portfolio composition**

Our main hypothesis is that a fund manager who “inherits” the predecessor’s portfolio is more likely to rid it of poorly performing stocks than a continuing manager. As a result, the portfolio of a new manager should increase its value-weighted momentum ranking relative to an otherwise similar fund that has experienced no change. Table VI shows that this is indeed the case. The median fund that has experienced complete management replacement has a higher change in its value-weighted portfolio rank relative to a median fund in the control group.<sup>9</sup> Difference in difference is the median difference between the change in the test group momentum ranking and the change in the average control group ranking, and is positive and significant in all five quarters following managerial change. This means that new managers more effectively take advantage of the momentum return predictability and improve the subsequent fund performance.

## **IV. Robustness Checks**

We perform a variety of robustness checks. To conserve space, detailed results from robustness check are not provided in the paper but are available upon request.

### **A. Relative Rank**

Nobody likes change. It is not a trivial decision to completely replace existing fund managers. Granted, some might have left voluntarily for whatever reasons, but we believe such cases are the exceptions rather than the norm. Thus, it is fair to argue that the main reason to completely replace existing managers is performance related. If that truly is the case, then previously shown results may just be the side-effect of lack of good performing stocks to sell. To show that our conclusion is not sensitive to possible asymmetry in portfolio pre-CR, we re-run our analysis, using relative rank instead of raw rank. Relative rank of a stock is calculated by comparing its trailing 12-month

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<sup>9</sup>The fact that the average rank has declined for all funds could be period-specific, i.e. the rise of the tech bubble. Notice that the pre-1995 change is in fact positive.

performance among those stocks that were also in the pre-CR portfolio. For example, suppose a fund holds stock S1, S2, , S10 in pre-CR quarter. In the first quarter immediately after the end of CR, S1 ranks in the 1st percentile, S2 in the 2nd percentile, , and S10 in the 10th percentile in performance, compare too all the stocks in CRSP dataset. If we use raw rank, all ten stocks are going to have a raw rank of 1. In that case, if any selling occurs, we are going to see negative percentage changes in number of shares, raw changes in number of shares, and weight changes in the worst performing decile but zero in all three statistics in the best performing decile. The results are clearly biased. However, if we compute the relative ranks of S1 to S10 and perform our analysis based on those numbers, the systematic bias can be avoided. Outcomes based on this unconventional ranking technique are qualitatively similar to Table VI. Therefore, even if asymmetry does indeed exist in the pre-CR portfolio and weaken our previous conclusion, we are now able to prove that statistically the existence of disposition effect on a relative basis.

## **B. Exclude CRs that lasted for more than 60 days**

Our analyses compare portfolio decisions before and after the event and ignore anything changes in between, and this raises the importance of the time it took to complete the CR. The thought about the length of the CR is that, if it takes a prolonged period of time to complete the replacement, many other things might have happened in the interim. While this is conservative in the sense that we definitely include everything that truly can be associated with the managerial change itself, we might pickup too much noise. For example, we may have examined non first-order post-CR portfolio changes if the event window stretched out long enough for the new managers to make multiple investment decisions on the stocks that were held pre-CR.

For these reasons, this second set of robustness test excludes CRs that lasted for more than 60 days. That translates into roughly 5% reduction in sample size. However, it does not reduce the strength of our previous conclusion. The Z scores are in the [fill in results] areas, just as persuasive as those scores reported in Table VI. In short, even after prolonged CRs have been

excluded from our analyses, disposition effects among mutual fund managers are still statistically significant.

### **C. Testgroup is matched by fund family size and trailing 12-month return**

Our final robustness check focuses on fund family sizes and trailing 12-month fund return.<sup>10</sup> Funds in different size categories have different concerns about turnovers. Some funds probably have enough assets to hold multiple times the average volume of a stock, while others may be able to liquidate the entire holdings in a few block trades without triggering a panic sell off in the market. We have to be careful not to pair up funds with disperse liquidation schemes. In addition to their accessibility to exit the market, fund managers' willingness to make changes in portfolio is of equal importance when we construct our control group. Funds that are outperforming the market may not have the urgency to sell loser stocks compare to those that are trailing the marketing. Controlling for trailing 12-month return should keep us safe from grouping funds that have different trading incentives.

It turns out that our analyses are not as sensitive to both family sizes and trailing 12-month return as we are concern. Although Z-scores for this set of data are not as extreme as those in Table VI, they do provide strong statistical evidence for the existence of disposition effect among mutual fund managers.

## **V. Conclusion**

In this paper we show that mutual fund managers, much like individual investors are subject to the disposition bias. But unlike individuals, mutual fund managers control a large chunk of the U.S. equity market. Therefore, their trading and holding patterns have a much more significant impact on asset prices. Disposition effect among professional money managers may potentially explain

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<sup>10</sup>Monthly performances and total net assets are obtained from CRSP. Then we compile the data into yearly series and rank them in deciles.

why price momentum has persisted in the U.S. stock market. Another possible extension of this result is to investigate whether managerial replacements have an immediate and predictable impact on asset prices and liquidity due to their predictable trading activities. Finally, this result suggest that mutual fund families stand to benefit from overseeing fund portfolios more closely and even periodically moving managers between similar funds in the family.

## **VI. Appendix**

### **A. Merging the Morningstar managerial dataset with the SP12 dataset**

The Morningstar dataset provides managerial turnover information while the SP12 dataset has mutual funds' quarterly holdings. We must merge the two together in order to carry out our analyses. Since there is no common fund identification between the two datasets, we create our own fundno-ticker link by combining the information from file8 of the SP12 dataset and a link file supplied by WRDS ("mflink"). File8 of the SP12 dataset contains NASDAQ ticker of funds and their corresponding internal fundno. The shortcoming is that the series has a starting date of 1999. Therefore, we backfill ticker information for a fund by matching names and fundnos pre and post 1999. We cannot backfill all the tickers solely by fundno because Spectrum reuses fundno. For example, if in 1999 fundno and ticker for Example Fund is 999 and XYZAX respectively, and if in 1998 fundno for Example Fund is also 999, we simply assume that its ticker is XYZAX. After the backfilling, we further update our link by using mflink. We ignore those conversions in mflink that are flagged by the creator to warn users of matching problem. Otherwise, we update our link if: a) file8 does not contain ticker for a particular fundno, or b) if discrepancy exists between the backfilling and mflink.

## **B. How to merge the test group with the control group?**

Our analysis is not complete if we do not examine the net changes in portfolio among the test group after controlling for the investment activities by funds that are "free" of managerial changes. As a result, we feel that it is important for our reader to get a clear picture of the mechanism behind the two matching schemes that are used for our study. Table A1, A2, and A3 together demonstrate a hypothetical example. On the left hand side of Table A1 we see holding information of the test group, while the information for the control group is displayed on the right. All the variables should be self-explanatory except `tgroupfund` on the right hand side. `tgroupfund` represents the fund in the test group that the control entry corresponds to, i.e. the CR in this test-control group relationship. To determine if a control group entry is a relevant match to the test group, three conditions must be satisfied. First, the control fund must have a new holding report in the pre-CR quarter. Second, they must be the same stock. Finally, there must be at least one quarter in the post-CR period that both funds have a new holding report. Once we have identified all the potential matching candidates in the control group, the remaining process is quite simple, especially in terms of computing time in SAS.

**One-to-One stock match:** For each entry in the test group, we locate entry(s) in the control group whose `tgroupfund`, `reportquarter`, and `stock` match the `fundno`, `pre-CR quarter`, and `stock` in the test group record. If multiple matches are found, such as the first and the fourth entry under the control group, which both match the first entry on the left hand side, we calculate and report the linear average in the new dataset. In our example, it comes to  $(500+0)/2 = 250$ , which is exactly the value of the mean from control group in Table A2. One can apply the rest of the logic to find matches for other entries in the test group.

**One-To-One rank match:** It is actually very similar to a stock match. Instead of matching by individual stocks, as the name suggests, we match by rank of those stocks. First, we average over all stocks in the same control fund that have the same rank, same `tgroupfund`, and the same `pre-CR quarter`. Then we compute the per fund average by grouping funds that have the same

tgroupfund, pre-CR, and rank together. Let's look at another example. The second and the third entry have the same rank, same tgroupfund, same report quarter, and they are in the same fund, so we average the two together. The fifth row has the same tgroupfund, report quarter, and stock rank as the averages that we just compute, so we take the average of the two funds and create a match for Q1 94 rank = 4 in the test group. The result is shown in the first row of Table A3.

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**TABLE I**  
**Complete Replacement of Mutual Fund Managers**

The following table summarizes the five most common type of complete replacements of mutual funds managers between January 1980 and February 2004. Complete Replacement is defined as the removal of all current managers in a series of managerial changes in which the last change happens within 90 calendar days of the second to last in the series. A change is either an addition or a subtraction of a fund manager. A fund is defined as team managed only if it was shown as team managed in the MorningStar dataset

| Type of Complete Replacement          | N           | Length of Time for complete replacement |             |                |                 |                 |                 |                 |
|---------------------------------------|-------------|---|-------------|----------------|-----------------|-----------------|-----------------|-----------------|
|                                       |             | %                                       | Mean        | Median         | 75th percentile | 90th percentile | 95th percentile | 99th percentile |
| One manager replaced by one manager   | 1211        | 57.20                                   | 2.15        | 0 <sup>†</sup> | 0               | 1               | 13              | 60              |
| Two managers replaced by one manager  | 118         | 5.57                                    | 7.31        | 0              | 0               | 31              | 61              | 89              |
| One manager replaced by two managers  | 192         | 9.07                                    | 6.68        | 0              | 0               | 29              | 59              | 90              |
| Two managers replaced by two managers | 123         | 5.81                                    | 17.59       | 0              | 30              | 65              | 83              | 90              |
| One manager replaced by Team          | 106         | 5.01                                    | 1.89        | 0              | 0               | 0               | 11              | 60              |
| The rest                              | 367         | 17.34                                   | 14.55       | 0              | 6               | 63              | 83              | 133             |
| <b>Total (all CR):</b>                | <b>2117</b> | <b>100</b>                              | <b>5.88</b> | <b>0</b>       | <b>0</b>        | <b>21</b>       | <b>55</b>       | <b>89</b>       |

†Zero length of time means the addition and subtraction of managers happened on the same day

**TABLE IIa**

**% CHANGES IN PORTFOLIO HOLDINGS AMONG FUNDS THAT UNDERGO COMPLETE REPLACEMENT (ON A PER STOCK BASIS)**

In these tables changes in portfolio are gauged by % change in number of shares =  $100 \times (S_t - S_{pre-CR}) / S_{pre-CR}$ ,  $S_t$  = number of shares held at quarter  $t$  post-CR,  $t = 0$  to 4, and  $S_{pre-CR}$  is number of shares held pre-CR (all shares information are splited-adjusted). E.g., in the first quarter after the end of CR, 6,462 stocks are held preCR and have the worst trailing 12-month performance (decile=1) compared to other stocks in the CRSP dataset (multiple observations of the same stock from different funds in the test group are treated individually). Among those stocks, median % change in number of shares from pre-CR is -100%. The following five panels illustrate results by  $t$ .

| The quarter in which complete replacement ends (t=0)     |   |  |   |  |  |
|--|---|--|---|--|--|
| Decile of individual holdings in 0 to 4 quarters post-CR | Number of stocks in this decile at the time of report | Median % change in number of shares (test group) | Median % change in number of shares (control group, matched by individual stocks) | Median % change in number of shares (test group - control group) | M statistics corresponds to $H_0$ : Median %change = 0 |
| 1  | 6073  | -53.18   | -12.65  | -45.23   | -948.5***  |
| 2  | 9336  | -19.19   | -6.23   | -32.31   | -1263.5***   |
| 3  | 12007   | -6.62  | -3.52   | -18.39   | -1458***   |
| 4  | 13091   | -3.00  | -0.90   | -16.26   | -1709.5***   |
| 5  | 13650   | 0.00   | -0.09   | -13.79   | -1658.5***   |
| 6  | 13263   | 0.00   | -0.36   | -11.08   | -1526.5***   |
| 7  | 13876   | 0.00   | -0.13   | -10.30   | -1505***   |
| 8  | 13787   | 0.00   | -0.51   | -8.79  | -1403***   |
| 9  | 13483   | 0.00   | -1.18   | -9.19  | -1292.5***   |
| 10   | 10152   | 0.00   | -3.30   | -10.36   | -915***  |

Decile 1 versus Decile 10 generates a Z-score of -13.32\*\*\*, which implies more reduction in holdings in decile 1 than in decile 10

| One quarter after the end of complete replacement (t=1) |       |        |         |         |            |
|---|-------|--------|---------|---------|------------|
| 1   | 6462  | -100   | -15.299 | -50.407 | -1376.5*** |
| 2   | 8904  | -0.5   | -7.438  | -49.484 | -1779***   |
| 3   | 11309 | -19.45 | -2.003  | -36.725 | -1865.5*** |
| 4   | 12720 | -17.37 | -0.152  | -34.869 | -2272.5*** |
| 5   | 12877 | -14.59 | 1.244   | -31.436 | -2283***   |
| 6   | 12522 | -10    | 1.284   | -26.965 | -1981***   |
| 7   | 12882 | -7.29  | 1.4     | -23.361 | -1939.5*** |
| 8   | 12160 | -5.53  | 0.644   | -19.816 | -1642***   |
| 9   | 11904 | -7.24  | 0       | -21.614 | -1612.5*** |
| 10  | 8903  | -12.29 | -0.377  | -23.974 | -1246.5*** |

Decile 1 versus Decile 10 generates a Z-score of -11.65\*\*\*, which implies more % reduction in holdings in decile 1 than in decile 10

Two quarters after the end of complete replacement (t=2)

| Decile of individual holdings in 0 to 4 quarters post-CR | Number of stocks in this rank group at the time of report | Median % change in number of shares (test group) | Median % change in number of shares (control group, matched by individual stocks) | Median % change in number of shares (test group - control group) | M statistics corresponds to H <sub>0</sub> : Median %change = 0 |
|--|---|--|---|--|---|
| 1  | 7288  | -100.00  | -24.05  | -52.77   | -1996.5***  |
| 2  | 9472  | -100.00  | -9.12   | -61.71   | -2275.5***  |
| 3  | 11763   | -100.00  | -1.84   | -60.11   | -2593.5***  |
| 4  | 12395   | -55.88   | 2.05  | -60.27   | -2790.5***  |
| 5  | 12250   | -42.16   | 2.65  | -55.39   | -2592***  |
| 6  | 11919   | -30.34   | 2.27  | -50.67   | -2400.5***  |
| 7  | 12375   | -27.39   | 3.32  | -45.88   | -2306.5***  |
| 8  | 12138   | -26.25   | 2.35  | -41.18   | -2134.5***  |
| 9  | 11169   | -26.67   | 0.00  | -39.05   | -1889.5***  |
| 10   | 8087  | -32.80   | -3.86   | -35.80   | -1300***  |

Decile 1 versus Decile 10 generates a Z-score of -11.46\*\*\*, which implies more % reduction in holdings in decile 1 than in decile 10

Three quarters after the end of complete replacement (t=3)

|    |       |        |         |         |            |
|----|-------|--------|---------|---------|------------|
| 1  | 6872  | -100   | -25.628 | -53.742 | -2057.5*** |
| 2  | 8852  | -100   | -9.341  | -62.283 | -2355***   |
| 3  | 10723 | -100   | -1.964  | -63.379 | -2701.5*** |
| 4  | 11755 | -100   | 1.265   | -67.284 | -3080.5*** |
| 5  | 11547 | -67.57 | 3.53    | -65.251 | -2794***   |
| 6  | 11027 | -65.04 | 1.262   | -60.434 | -2472.5*** |
| 7  | 11444 | -50.57 | 3.42    | -56.983 | -2493***   |
| 8  | 10992 | -46.15 | 1.167   | -54.924 | -2271.5*** |
| 9  | 10130 | -45.67 | 0.688   | -49.519 | -2096***   |
| 10 | 6744  | -55.77 | -3.296  | -48.606 | -1426.5*** |

Decile 10 versus Decile 1 generates a Z-score of 5.99\*\*\*, which implies more % reduction in holdings in decile 1 than in decile 10 (note below)

Four quarters after the end of complete replacement (t=4)

|   |       |         |        |        |            |
|---|-------|---------|--------|--------|------------|
| 1 | 6780  | -100.00 | -23.74 | -53.42 | -2075***   |
| 2 | 8456  | -100.00 | -6.51  | -65.16 | -2420.5*** |
| 3 | 10320 | -100.00 | 0.58   | -64.98 | -2834.5*** |
| 4 | 11036 | -100.00 | 5.64   | -68.54 | -3005***   |
| 5 | 11232 | -100.00 | 6.72   | -68.89 | -3102.5*** |
| 6 | 10561 | -86.33  | 6.00   | -66.49 | -2725.5*** |

|    |       |        |       |        |            |
|----|-------|--------|-------|--------|------------|
| 7  | 11191 | -62.75 | 6.21  | -63.96 | -2732***   |
| 8  | 10910 | -60.00 | 4.33  | -59.75 | -2542.5*** |
| 9  | 10184 | -61.74 | 1.67  | -56.54 | -2299***   |
| 10 | 7133  | -80.74 | -3.89 | -51.44 | -1549.5*** |

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Decile 1 versus Decile 10 generates a Z-score of -5.27\*\*\*, which implies more % reduction in holdings in decile 1 than in decile 10

Note: For this particular case, there are less stocks in decile 10 than in decile 1 (6744 versus 6872). PROC NPAR1WAY in SAS compute the Z test statistics based on the group with smaller sample size. In this case, that means at 1% significant level stocks with better trailing 12-month performance experience higher net % change in number of shares compare to the stocks in the worst performing decile

\*\*\*, \*\*, \* Statistically significant at the 1, 5, and 10 percent levels respectively, based on one-sample sign test (M statistics reported)

**TABLE IIb**

**RAW CHANGES IN PORTFOLIO HOLDINGS AMONG FUNDS THAT UNDERGO COMPLETE REPLACEMENT (ON A PER STOCK BASIS)**

In these tables changes in portfolio are gauged by raw changes in number of shares =  $(S_t - S_{pre-CR})$ ,  $S_t$  = number of shares held at quarter  $t$  post-CR,  $t = 0$  to 4, and  $S_{pre-CR}$  is number of shares held pre-CR (all shares information are splited-adjusted). E.g., in the first quarter after the end of CR, 6,462 stocks are held preCR and have the worst trailing 12-month performance (decile=1) compared to other stocks in the CRSP dataset (multiple observations of the same stock are treated individually). Among those stocks, median raw changes in number of shares from pre-CR is -5074. The following five panels illustrate results by  $t$ .

| The quarter in which complete replacement ends (t=0)     |   |  |   |  |   |  |
|--|---|--|---|--|---|--|
| Decile of individual holdings in 0 to 4 quarters post-CR | Number of stocks in this decile at the time of report | Median raw change in number of shares (test group) | Median raw change in number of shares (control group, matched by individual stocks) | Median raw change in number of shares (test group - control group) | M statistics corresponds to $H_0$ : Median raw change = 0 |  |
| 1  | 6073  | -2452  | -10748  | 499  | 89.5**  |  |
| 2  | 9336  | -1035  | -6543   | 302  | 83*   |  |
| 3  | 12007   | -504   | -4833   | 303  | 187***  |  |
| 4  | 13091   | -280   | -3889   | 300  | 208***  |  |
| 5  | 13650   | 0  | -3458   | 200  | 146.5***  |  |
| 6  | 13263   | 0  | -3650   | 525  | 342.5***  |  |
| 7  | 13876   | 0  | -3073   | 342  | 277.5***  |  |
| 8  | 13787   | 0  | -3453   | 792  | 552.5***  |  |
| 9  | 13483   | 0  | -4045   | 1020   | 589***  |  |
| 10   | 10152   | 0  | -5936   | 2369   | 735***  |  |

Decile 1 versus Decile 10 generates a Z-score of -6.93\*\*\*, which implies more raw reduction in holdings in decile 1 than in decile 10

| One quarter after the end of complete replacement (t=1) |       |       |        |      |          |  |
|---|-------|-------|--------|------|----------|--|
| 1   | 6462  | -5074 | -16818 | 741  | 81.5**   |  |
| 2   | 8904  | -2904 | -9765  | -480 | -102**   |  |
| 3   | 11309 | -1500 | -8096  | 482  | 141.5*** |  |
| 4   | 12720 | -1400 | -6934  | 209  | 81       |  |
| 5   | 12877 | -1100 | -6050  | 57   | 27       |  |
| 6   | 12522 | -600  | -5782  | 685  | 282***   |  |
| 7   | 12882 | -400  | -5370  | 1111 | 404***   |  |
| 8   | 12160 | -300  | -6094  | 1521 | 530***   |  |
| 9   | 11904 | -400  | -6983  | 1890 | 559.5*** |  |
| 10  | 8903  | -908  | -9601  | 3106 | 586***   |  |

Decile 1 versus Decile 10 generates a Z-score of -6.53\*\*\*, which implies more raw reduction in holdings in decile 1 than in decile 10

Two quarters after the end of complete replacement (t=2)

| Decile of individual holdings in 0 to 4 quarters post-CR | Number of stocks in this decile at the time of report | Median raw change in number of shares (test group) | Median raw change in number of shares (control group, matched by individual stocks) | Median raw change in number of shares (test group - control group) | M statistics corresponds to $H_0$ : Median raw change = 0 |
|--|---|--|---|--|---|
| 1  | 7288  | -11300   | -24451  | 947  | 68.5  |
| 2  | 9472  | -7000  | -15712  | 210  | 27  |
| 3  | 11763   | -5000  | -11803  | -500   | -90*  |
| 4  | 12395   | -4200  | -10511  | 25   | 16  |
| 5  | 12250   | -3400  | -8308   | -712   | -199.5***   |
| 6  | 11919   | -2500  | -7925   | -120   | -45   |
| 7  | 12375   | -2000  | -7250   | 300  | 99**  |
| 8  | 12138   | -1800  | -8342   | 584  | 169***  |
| 9  | 11169   | -2110  | -10020  | 969  | 229.5***  |
| 10   | 8087  | -3700  | -13285  | 2843   | 340.5***  |

Decile 1 versus Decile 10 generates a Z-score of -5.00\*\*\*, which implies more raw reduction in holdings in decile 1 than in decile 10

Three quarters after the end of complete replacement (t=3)

|    |       |        |        |       |           |
|----|-------|--------|--------|-------|-----------|
| 1  | 6872  | -14500 | -27188 | 1729  | 121.5***  |
| 2  | 8852  | -10000 | -18615 | -26   | -2.5      |
| 3  | 10723 | -7600  | -14633 | -592  | -90*      |
| 4  | 11755 | -7600  | -12801 | -1477 | -253.5*** |
| 5  | 11547 | -6000  | -11096 | -600  | -101*     |
| 6  | 11027 | -4800  | -10844 | -596  | -125.5**  |
| 7  | 11444 | -4339  | -10194 | -245  | -45       |
| 8  | 10992 | -3900  | -11670 | 1328  | 216.5***  |
| 9  | 10130 | -5000  | -13752 | 1681  | 231***    |
| 10 | 6744  | -5825  | -17242 | 3258  | 259***    |

Decile 10 versus Decile 1 generates a Z-score of 2.62\*\*\*, which implies more raw reduction in holdings in decile 1 than in decile 10 (note below)

Four quarters after the end of complete replacement (t=4)

|   |       |        |        |       |           |
|---|-------|--------|--------|-------|-----------|
| 1 | 6780  | -13600 | -26561 | 1737  | 117.5***  |
| 2 | 8456  | -11100 | -19310 | -1187 | -142.5*** |
| 3 | 10320 | -10300 | -17106 | -1441 | -182***   |
| 4 | 11036 | -8300  | -15891 | -1113 | -169***   |
| 5 | 11232 | -8000  | -13637 | -1096 | -172***   |
| 6 | 10561 | -7200  | -12626 | -1255 | -188.5*** |

|    |       |       |        |       |        |
|----|-------|-------|--------|-------|--------|
| 7  | 11191 | -5900 | -12031 | -1127 | -177   |
| 8  | 10910 | -5900 | -12563 | 197   | 28     |
| 9  | 10184 | -6400 | -14102 | 741   | 101**  |
| 10 | 7133  | -8800 | -18168 | 1179  | 85.5** |

Decile 1 versus Decile 10 generates a Z-score of -0.75, which implies insufficient of evidence to reject the hypothesis that changes in decile 1 equals to changes in decile 10

Note: For this particular case, there are less stocks in decile 10 than in decile 1 (6744 versus 6872). PROC NPAR1WAY in SAS compute the Z test statistics based on the group with smaller sample size. In this case, that means at 1% significant level stocks with better trailing 12-month performance experience higher net raw change in number of shares compare to the stocks in the worst performing decile

\*\*\*, \*\*, \* Statistically significant at the 1, 5, and 10 percent levels respectively, based on one-sample sign test (M statistics reported)

**TABLE IIIa**

**% CHANGES IN PORTFOLIO HOLDINGS AMONG FUNDS THAT UNDERGO COMPLETE REPLACEMENT (ON A PER FUND BASIS)**

In these tables changes in portfolio are gauged by % change in number of shares =  $100 \times (S_t - S_{pre-CR}) / S_{pre-CR}$ ,  $S_t$  = number of shares held at quarter  $t$  post-CR,  $t = 0$  to 4, and  $S_{pre-CR}$  is number of shares held pre-CR (all shares information are splited-adjusted). However, instead of averaging over the total number of stocks that fit the rank and quarter constraints, we calculate the average within each fund, and then analyze the per fund averages. E.g., in the first quarter after the end of CR, 836 stocks are held preCR and have the worst trailing 12-month performance (decile=1) compared to other stocks in the CRSP dataset (multiple observations of the same stock are treated individually). Among those stocks, median % change in number of shares from pre-CR is -100%. The following five panels illustrate results by  $t$ .

The quarter in which complete replacement ends (t=0)

| Decile of individual holdings in 0 to 4 quarters post-CR | Number of funds with stocks in this rank group at time of report | Median % change in number of shares (test group) | Median % change in number of shares (control group, matched by individual stocks) | Median % change in number of shares (test group - control group) | M statistics corresponds to $H_0$ : Median %change = 0 |
|--|--|--|---|--|--|
| 1  | 883  | -66.74   | -14.51  | -53.71   | -239.5***  |
| 2  | 1082   | -49.14   | -8.72   | -45.86   | -286.5***  |
| 3  | 1180   | -33.33   | -3.88   | -39.48   | -301.5***  |
| 4  | 1202   | -26.04   | -1.56   | -35.29   | -296***  |
| 5  | 1220   | -22.43   | -1.05   | -30.53   | -283.5***  |
| 6  | 1219   | -20.00   | -1.00   | -25.60   | -279.5***  |
| 7  | 1216   | -18.48   | -0.70   | -23.02   | -270***  |
| 8  | 1219   | -16.51   | -1.23   | -20.80   | -254.5***  |
| 9  | 1183   | -17.53   | -1.32   | -21.62   | -255***  |
| 10   | 1023   | -21.29   | -4.88   | -20.92   | -176.5***  |

Decile 1 versus Decile 10 generates a Z-score of -9.14\*\*\*, which implies more % reduction in holdings in decile 1 than in decile 10

One quarter after the end of complete replacement (t=1)

|    |      |         |        |        |           |
|----|------|---------|--------|--------|-----------|
| 1  | 836  | -100.00 | -21.55 | -57.82 | -260.5*** |
| 2  | 996  | -66.67  | -11.07 | -58.96 | -296***   |
| 3  | 1074 | -46.73  | -4.34  | -47.61 | -284***   |
| 4  | 1082 | -40.76  | -2.73  | -44.96 | -299***   |
| 5  | 1093 | -36.18  | 0.33   | -43.80 | -315***   |
| 6  | 1100 | -33.33  | -0.85  | -37.32 | -298***   |
| 7  | 1103 | -30.15  | 0.22   | -35.75 | -274***   |
| 8  | 1086 | -27.59  | -0.14  | -31.13 | -269.5*** |
| 9  | 1065 | -25.06  | 0.85   | -34.48 | -246.5*** |
| 10 | 910  | -30.38  | -2.16  | -32.42 | -185***   |

Decile 1 versus Decile 10 generates a Z-score of -6.10\*\*\*, which implies more % reduction in holdings in decile 1 than in decile 10

## Two quarters after the end of complete replacement (t=2)

| Decile of individual holdings in 0 to 4 quarters post-CR | Number of funds with stocks in this rank group at time of report | Median % change in number of shares (test group) | Median % change in number of shares (control group, matched by individual stocks) | Median % change in number of shares (test group - control group) | M statistics corresponds to $H_0$ : Median %change = 0 |
|--|--|--|---|--|--|
| 1  | 917  | -100.00  | -27.84  | -58.51   | -312***  |
| 2  | 1031   | -76.85   | -13.60  | -61.27   | -318.5***  |
| 3  | 1103   | -60.95   | -3.88   | -58.08   | -339.5***  |
| 4  | 1121   | -51.71   | -0.89   | -59.40   | -351***  |
| 5  | 1127   | -48.46   | 0.79  | -53.42   | -311.5***  |
| 6  | 1119   | -44.91   | 0.43  | -51.77   | -337.5***  |
| 7  | 1126   | -40.59   | 1.79  | -42.61   | -310.5***  |
| 8  | 1114   | -38.90   | 0.39  | -43.03   | -293***  |
| 9  | 1088   | -37.69   | -0.10   | -43.43   | -265***  |
| 10   | 937  | -50.00   | -4.50   | -45.71   | -243.5***  |

Decile 1 versus Decile 10 generates a Z-score of -4.77\*\*\*, which implies more % reduction in holdings in decile 1 than in decile 10

## Three quarters after the end of complete replacement (t=3)

|    |      |         |        |        |           |
|----|------|---------|--------|--------|-----------|
| 1  | 829  | -100.00 | -29.66 | -56.42 | -289***   |
| 2  | 970  | -80.72  | -11.38 | -64.28 | -322***   |
| 3  | 1042 | -65.57  | -3.90  | -61.32 | -329.5*** |
| 4  | 1046 | -60.30  | -1.86  | -64.31 | -332.5*** |
| 5  | 1056 | -52.04  | -0.61  | -56.89 | -333.5*** |
| 6  | 1042 | -51.66  | -1.19  | -56.76 | -330.5*** |
| 7  | 1053 | -47.23  | 0.68   | -51.98 | -319.5*** |
| 8  | 1038 | -46.10  | -0.07  | -50.21 | -296***   |
| 9  | 1011 | -48.09  | 0.35   | -49.26 | -291.5*** |
| 10 | 859  | -59.63  | -7.43  | -52.21 | -234.5*** |

Decile 1 versus Decile 10 generates a Z-score of -1.89\*, which implies more % reduction in holdings in decile 1 than in decile 10

## Four quarters after the end of complete replacement (t=4)

|   |      |         |        |        |           |
|---|------|---------|--------|--------|-----------|
| 1 | 831  | -100.00 | -25.57 | -55.60 | -290.5*** |
| 2 | 960  | -88.86  | -10.11 | -65.89 | -325***   |
| 3 | 1031 | -71.32  | -1.24  | -66.29 | -338.5*** |
| 4 | 1035 | -66.64  | -0.13  | -67.63 | -337***   |
| 5 | 1045 | -59.73  | 0.94   | -63.27 | -338***   |
| 6 | 1036 | -59.11  | 1.79   | -61.30 | -343.5*** |

|    |      |        |       |        |           |
|----|------|--------|-------|--------|-----------|
| 7  | 1043 | -55.79 | 3.55  | -59.18 | -326.5*** |
| 8  | 1030 | -54.10 | 4.38  | -59.03 | -303.5*** |
| 9  | 992  | -53.45 | 2.45  | -55.69 | -281***   |
| 10 | 873  | -68.47 | -1.41 | -56.81 | -269.5*** |

Decile 1 versus Decile 10 generates a Z-score of -0.86, which implies insufficient of evidence to reject the hypothesis that changes in decile 1 equals to changes in decile 10

\*\*\*, \*\*, \* Statistically significant at the 1, 5, and 10 percent levels respectively, based on one-sample sign test (M statistics reported)

**TABLE IIIb**

**RAW CHANGES IN PORTFOLIO HOLDINGS AMONG FUNDS THAT UNDERGO COMPLETE REPLACEMENT (ON A PER FUND BASIS)**

In these tables changes in portfolio are gauged by raw change in number of shares =  $(S_t - S_{pre-CR})$ ,  $S_t$  = number of shares held at quarter  $t$  post-CR,  $t = 0$  to 4, and  $S_{pre-CR}$  is number of shares held pre-CR (all shares information are splited-adjusted). The matching scheme is the same as table IIa. The following five panels illustrate results by  $t$ .

| The quarter in which complete replacement ends (t=0)     |  |  |   |  |   |  |
|--|--|--|---|--|---|--|
| Decile of individual holdings in 0 to 4 quarters post-CR | Number of funds with stocks in this rank group at time of report | Median raw change in number of shares (test group) | Median raw change in number of shares (control group, matched by individual stocks) | Median raw change in number of shares (test group - control group) | M statistics corresponds to $H_0$ : Median raw change = 0 |  |
| 1  | 883  | -30814   | -19404  | -14165   | -93***  |  |
| 2  | 1082   | -19800   | -13821  | -9164  | -88***  |  |
| 3  | 1180   | -15344   | -10889  | -7515  | -96***  |  |
| 4  | 1202   | -10819   | -9230   | -2829  | -61***  |  |
| 5  | 1220   | -10450   | -7984   | -4107  | -85.5***  |  |
| 6  | 1219   | -9748  | -8524   | -2470  | -38.5**   |  |
| 7  | 1216   | -8676  | -7785   | -2164  | -47.5***  |  |
| 8  | 1219   | -7073  | -8794   | -598   | -9.5  |  |
| 9  | 1183   | -8500  | -9362   | 496  | 12  |  |
| 10   | 1023   | -8878  | -12756  | 2673   | 46.5***   |  |

Decile 1 versus Decile 10 generates a Z-score of -6.92\*\*\*, which implies more raw reduction in holdings in decile 1 than in decile 10

| One quarter after the end of complete replacement (t=1) |      |        |        |        |          |  |
|---|------|--------|--------|--------|----------|--|
| 1   | 836  | -38210 | -31598 | -11135 | -50***   |  |
| 2   | 996  | -26990 | -21111 | -8807  | -71***   |  |
| 3   | 1074 | -20000 | -16108 | -6231  | -63***   |  |
| 4   | 1082 | -18205 | -14564 | -5986  | -67***   |  |
| 5   | 1093 | -16667 | -13224 | -7186  | -74***   |  |
| 6   | 1100 | -14278 | -12486 | -4584  | -39**    |  |
| 7   | 1103 | -14167 | -11917 | -2938  | -54.5*** |  |
| 8   | 1086 | -12157 | -13021 | -1701  | -33**    |  |
| 9   | 1065 | -10781 | -14313 | 75     | 2.5      |  |
| 10  | 910  | -13233 | -19479 | 3248   | 29*      |  |

Decile 1 versus Decile 10 generates a Z-score of -4.39\*\*\*, which implies more raw reduction in holdings in decile 1 than in decile 10

Two quarters after the end of complete replacement (t=2)

| Decile of individual holdings in 0 to 4 quarters post-CR | Number of funds with stocks in this rank group at time of report | Median raw change in number of shares (test group) | Median raw change in number of shares (control group, matched by individual stocks) | Median raw change in number of shares (test group - control group) | M statistics corresponds to $H_0$ : Median raw change = 0 |
|--|--|--|---|--|---|
| 1  | 917  | -45000   | -40814  | -7841  | -41.5*  |
| 2  | 1031   | -34820   | -27053  | -10182   | -67***  |
| 3  | 1103   | -30058   | -20825  | -13405   | -102.5***   |
| 4  | 1121   | -25409   | -19768  | -6923  | -71***  |
| 5  | 1127   | -23073   | -17071  | -9709  | -94.5***  |
| 6  | 1119   | -21663   | -17330  | -5335  | -50.5***  |
| 7  | 1126   | -17529   | -16326  | -4740  | -53***  |
| 8  | 1114   | -19800   | -17146  | -5239  | -63***  |
| 9  | 1088   | -18889   | -19824  | -3130  | -28*  |
| 10   | 937  | -24183   | -25247  | -959   | -11.5   |

Decile 1 versus Decile 10 generates a Z-score of -1.85\*\*, which implies more raw reduction in holdings in decile 1 than in decile 10

Three quarters after the end of complete replacement (t=3)

|    |      |        |        |        |          |
|----|------|--------|--------|--------|----------|
| 1  | 829  | -45910 | -40068 | -10706 | -29.5**  |
| 2  | 970  | -38781 | -30947 | -7702  | -52.5*** |
| 3  | 1042 | -30458 | -24355 | -8852  | -53***   |
| 4  | 1046 | -29793 | -23103 | -7442  | -64***   |
| 5  | 1056 | -24180 | -19249 | -8074  | -80***   |
| 6  | 1042 | -26227 | -20642 | -7494  | -78***   |
| 7  | 1053 | -22843 | -19880 | -5908  | -51.5*** |
| 8  | 1038 | -23193 | -20115 | -5939  | -53***   |
| 9  | 1011 | -25938 | -22187 | -6140  | -42.5*** |
| 10 | 859  | -29525 | -30549 | -492   | -4.5     |

Decile 1 versus Decile 10 generates a Z-score of -1.79\*, which implies more raw reduction in holdings in decile 1 than in decile 10

Four quarters after the end of complete replacement (t=4)

|   |      |        |        |       |          |
|---|------|--------|--------|-------|----------|
| 1 | 831  | -46563 | -43152 | -6777 | -31.5**  |
| 2 | 960  | -40354 | -34787 | -6449 | -27*     |
| 3 | 1031 | -33881 | -29607 | -9310 | -64.5*** |
| 4 | 1035 | -30664 | -27681 | -8195 | -46.5*** |
| 5 | 1045 | -30250 | -26074 | -6679 | -58.5*** |
| 6 | 1036 | -29773 | -25867 | -7772 | -43***   |
| 7 | 1043 | -28440 | -23342 | -8677 | -69.5*** |

|    |      |        |        |       |          |
|----|------|--------|--------|-------|----------|
| 8  | 1030 | -26625 | -25246 | -4732 | -41**    |
| 9  | 992  | -28261 | -26917 | -5889 | -37**    |
| 10 | 873  | -36455 | -31804 | -8100 | -42.5*** |

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Decile 1 versus Decile 10 generates a Z-score of 0.25, which implies insufficient of evidence to reject the hypothesis that changes in decile 1 equals to changes in decile 10

\*\*\*, \*\*, \* Statistically significant at the 1, 5, and 10 percent levels respectively, based on one-sample sign test (M statistics reported)

**TABLE IV**  
**STANDARDIZED TEST STATISTICS FOR TWO-SAMPLE RANKED SUM TEST, RANK 1 VERSUS RANK 10, BY REPLACEE'S AGE**

The following four panels give the standardized Z statistics generated by the Wilcoxon two-sample test to check whether the changes in portfolio in the worst performing decile are different in location from the best performing decile. The upper tables show result when the test and the control group are matched by individual stocks, while the lower tables show result when the two are matched on a per fund basis. We limit this set of analysis to all CR in which only one manager is replaced. Results for young managers, i.e., those that are less than 46 years old, are shown on the left hand side. Evidence of disposition effect fades after quarter 2 for both groups. However, for the first three quarters there is much stronger proof (lower Z score) of disposition effect among young managers. Inference procedures are the same as those in earlier tables.

**MATCHED BY INDIVIDUAL STOCKS**

| Quarters post-CR<br>(0 = quarter in<br>which CR ends) | young manager is replaced          |                                   |                    | old manger is replaced             |                                   |                    |
|---|------------------------------------|-----------------------------------|--------------------|------------------------------------|-----------------------------------|--------------------|
|   | % change in<br>number of<br>shares | Raw change in<br>number of shares | Weight change in % | % change in<br>number of<br>shares | Raw change in<br>number of shares | Weight change in % |
| 0   | -7.09***                           | -4.88***                          | -8.95***           | -2.43***                           | -3.12***                          | -2.72***           |
| 1   | -4.62***                           | -3.02***                          | -1.72*             | -2.51***                           | -2.35***                          | -1.83**            |
| 2   | -5.59***                           | -2.32**                           | -6.03***           | -2.32***                           | -1.28                             | -1.53              |
| 3   | -1.93*                             | -0.62                             | 0.5                | -0.7                               | -1.4                              | 0.34               |
| 4   | -2.58***                           | -1.14                             | 3.55***            | -1.23                              | 0.24                              | -1.61              |

**MATCHED BY FUND**

| Quarters post-CR<br>(0 = quarter in<br>which CR ends) | young manager is replaced          |                                   |                    | old manger is replaced             |                                   |                    |
|---|------------------------------------|-----------------------------------|--------------------|------------------------------------|-----------------------------------|--------------------|
|   | % change in<br>number of<br>shares | Raw change in<br>number of shares | Weight change in % | % change in<br>number of<br>shares | Raw change in<br>number of shares | Weight change in % |
| 0   | -6.13***                           | -5.1***                           | -8.03***           | 0.43                               | -1.70*                            | -0.97              |
| 1   | -1.76*                             | -1.8*                             | -4.32***           | -1.63                              | -1.84**                           | -1.87**            |
| 2   | -2.7***                            | -0.66                             | -4.35***           | 0.55                               | 0.37                              | -1.76*             |
| 3   | -0.85                              | -0.53                             | -0.89              | -0.67                              | -0.75                             | -1.22              |
| 4   | -0.95                              | -1.34                             | -1.51              | 1.94**                             | 0.5                               | -0.81              |

\*\*\*, \*\*, \* Statistically significant at the 1, 5, and 10 percent levels respectively, based on one-sample sign test (M statistic)

**Table V**  
**Median Changes in Value-Weighted Mutual Fund Momentum Portfolio Rank**

| quarters post-CR<br>(CR ends in qtr 0)      | number of funds | change in rank<br>(testgroup) | change in rank<br>(control group) | difference in<br>difference | difference in rank |
|---|-----------------|-------------------------------|-----------------------------------|-----------------------------|--------------------|
| pre-CR                                      | 1810            | n/a<br>(n/a)                  | n/a<br>(n/a)                      | n/a<br>(n/a)                | 0.51*<br>(42)      |
| 0   | 1259            | -0.54*<br>(-33.5)             | -0.51***<br>(-76.5)               | 0.19<br>(19)                | 0.92***<br>(48)    |
| 1   | 1131            | 0.21<br>(15.5)                | -0.62***<br>(-82)                 | 0.79***<br>(55)             | 1.08***<br>(58)    |
| 2   | 1156            | 0.12<br>(4)                   | -0.62***<br>(-90)                 | 1.44***<br>(60.5)           | 1.6***<br>(83.5)   |
| 3   | 1083            | -0.08<br>(-1.5)               | -0.95***<br>(-117)                | 0.78**<br>(39)              | 0.95***<br>(51)    |
| 4   | 1071            | -0.18<br>(-9.5)               | -1.19***<br>(-91)                 | 0.31<br>(14)                | 1.2***<br>(66)     |
| Complete replacement ended before 1995      |                 |                               |                                   |                             |                    |
| pre-CR                                      | 372             | n/a<br>(n/a)                  | n/a<br>(n/a)                      | n/a<br>(n/a)                | -0.21<br>(2)       |
| 0   | 265             | -0.16<br>(-3.5)               | 0.31<br>(10)                      | -0.2<br>(-3.5)              | 0.23<br>(1.5)      |
| 1   | 282             | 1.69***<br>(21)               | 0.811**<br>(21)                   | 0.71*<br>(15)               | 0.174<br>(-3)      |
| 2   | 254             | 1.7<br>(12)                   | 0.81*<br>(19)                     | 0.72*<br>(15)               | 1.17**<br>(18)     |
| 3   | 267             | 3.24**<br>(25.5)              | 1.29***<br>(30)                   | 1.5**<br>(20.5)             | 0.44<br>(13.5)     |
| 4   | 265             | 2.97**<br>(30.5)              | 1.74***<br>(34)                   | 0.68**<br>(16.5)            | 1.27**<br>(20.5)   |
| Complete replacement ended in or after 1995 |                 |                               |                                   |                             |                    |
| pre-CR                                      | 1438            | n/a<br>(n/a)                  | n/a<br>(n/a)                      | n/a<br>(n/a)                | 0.57**<br>(40)     |
| 0   | 994             | -0.67*<br>(-30)               | -0.6***<br>(-86.5)                | 0.3<br>(22.5)               | 0.91***<br>(46.5)  |
| 1   | 849             | -0.15<br>(-5.5)               | -0.76***<br>(-103)                | 0.82***<br>(40)             | 1.82***<br>(61)    |
| 2   | 902             | -0.24<br>(-8)                 | -0.75***<br>(-109)                | 1.26***<br>(45.5)           | 1.55***<br>(65.5)  |
| 3   | 816             | -1.2*<br>(-27)                | -1.58***<br>(-147)                | 0.29<br>(18.5)              | 1.27***<br>(37.5)  |
| 4   | 806             | -1.38***<br>(-40)             | -1.58***<br>(-125)                | -0.05<br>(-2.5)             | 0.96***<br>(45.5)  |

Note: This table presents median changes in the value-weighted momentum rank of a median fund's portfolio holdings over time. Portfolio momentum rank is determined as follows. In a given quarter, each stock in the CRSP universe is assigned to one of 100 groups based on the relative return during the past twelve months. Stocks that have less than twelve months of trading history are excluded. Value-weighted portfolio ranks are then calculated. *Quarters post-CR* is the number of quarters since the quarter immediately following complete managerial replacement. *Change in Rank* is the change in the value-weighted portfolio rank since the quarter immediately preceding managerial replacement. *Difference in Difference* is the difference between the rank change of the test group and the control group portfolios. *Difference in Rank* is the difference in the portfolio momentum ranking between the test and control group at the time of report.

\*\*\*, \*\*, \* Statistically significant at the 1, 5, and 10 percent levels respectively, based on one-sample sign test (M statistics reported)

Based on Shapiro-Wilk test, all samples are not normally distributed at the 1 percent level

**TABLE VI**  
**STANDARDIZED TEST STATISTICS FOR TWO-SAMPLE RANKED SUM TEST, RANK 1 VERSUS RANK 10,**  
**BY LOG(FAMILY SIZE)**

The following two panels give the standardized Z statistics generated by the Wilcoxon two-sample test to check whether net changes in portfolio in the worst performing decile are different in location from the best performing decile. We categorize our sample in two main groups according to funds family size. Funds size is determined by TNA in the quarter before CR. Funds without TNA and/or family information are excluded. Statistics on the left represent results if the test group and the control group is matched by individual stocks, whereas tables on the right show results if the two groups are matched by fund averages. Both matching schemes are discussed in the appendix

| <b>Small Fund Families</b>                            |                                     |                                       |                                      |                                     |                                       |                                      |
|---|-------------------------------------|---------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|--------------------------------------|
| Quarters post-CR<br>(0 = quarter in<br>which CR ends) | MATCHED BY INDIVIDUAL STOCKS        |                                       |                                      | MATCHED BY FUND                     |                                       |                                      |
|   | Net % change in<br>number of shares | Net raw change in<br>number of shares | Net individual weight<br>change in % | Net % change in<br>number of shares | Net raw change in<br>number of shares | Net individual weight<br>change in % |
| 0   | -1.40                               | -2.36***                              | -1.09                                | -1.95**                             | -1.4                                  | -1.41                                |
| 1   | -0.47                               | 1.20                                  | 0.52                                 | 0.59                                | 0.15                                  | 0.37                                 |
| 2   | -0.92                               | -0.46                                 | -1.72*                               | 1.19                                | -0.29                                 | -0.61                                |
| 3   | -0.16                               | -0.10                                 | -1.25                                | -0.41                               | -0.98                                 | -0.56                                |
| 4   | 2.05***                             | -0.97                                 | 0.90                                 | 0.13                                | -0.12                                 | 0.08                                 |

  

| <b>Large Fund Families</b>                            |                                     |                                       |                                      |                                     |                                       |                                      |
|---|-------------------------------------|---------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|--------------------------------------|
| Quarters post-CR<br>(0 = quarter in<br>which CR ends) | MATCHED BY INDIVIDUAL STOCKS        |                                       |                                      | MATCHED BY FUND                     |                                       |                                      |
|   | Net % change in<br>number of shares | Net raw change in<br>number of shares | Net individual weight<br>change in % | Net % change in<br>number of shares | Net raw change in<br>number of shares | Net individual weight<br>change in % |
| 0   | -7.85***                            | -1.99**                               | -8.89***                             | -7.66***                            | -5.53***                              | -8.2***                              |
| 1   | -8.05***                            | -3.64***                              | -5.14***                             | -4.46***                            | -1.47                                 | -5.49***                             |
| 2   | -10.79***                           | -2.82***                              | -6.37***                             | 3.51***†                            | -0.27†                                | 5.14***†                             |
| 3†  | 4.42***                             | -2.63***                              | -0.33                                | 0.87                                | -1.6                                  | 0.54                                 |
| 4†  | 2.98***                             | -0.51                                 | -4.78                                | -0.21                               | -1.44                                 | 0.21                                 |

\*\*\*, \*\*, \* Statistically significant at the 1, 5, and 10 percent levels respectively, based on one-sample sign test (M statistics reported)

† For these cases, there are less stocks in decile 10 than in decile 1. PROC NPAR1WAY in SAS compute the Z test statistics based on the group with smaller sample size. Therefore, sign of the Z-statistics is made reference to the location of stocks in decile 10. For example, three quarters after the end of CR, at 1% significant level (Z-statistics = 4.42) stocks with better trailing 12-month performance experience higher net % change in number of shares compare to the stocks in the worst performing decile

**TABLE A1. HOW MATCHING IS DONE BETWEEN THE TEST AND CONTROL GROUPS**

| Test Group |                |       |          |   | Control Group |             |                |       |          |   |
|------------|----------------|-------|----------|---|---------------|-------------|----------------|-------|----------|---|
| Fund       | pre-CR quarter | Stock | Raw Rank | Raw change in number of shares since pre-CR | Fund          | tgroup fund | report quarter | Stock | Raw Rank | Raw change in number of shares since pre-CR |
| 1          | Q1 94          | AAA   | 2        | -100  | 4             | 1           | Q1 94          | AAA   | 2        | 500   |
| 1          | Q1 94          | BBB   | 4        | 600   | 4             | 1           | Q1 94          | BBB   | 4        | 200   |
| 1          | Q1 94          | CCC   | 4        | 100   | 4             | 1           | Q1 94          | CCC   | 4        | 200   |
| 2          | Q2 99          | AAA   | 2        | -500  | 6             | 1           | Q1 94          | AAA   | 2        | 0   |
| 2          | Q2 99          | DDD   | 2        | 0   | 6             | 1           | Q1 94          | CCC   | 4        | 100   |
| 2          | Q2 99          | EEE   | 8        | 500   | 7             | 2           | Q2 99          | AAA   | 2        | 0   |
|            |                |       |          |   | 7             | 2           | Q2 99          | DDD   | 2        | 200   |
|            |                |       |          |   | 7             | 2           | Q2 99          | EEE   | 8        | -400  |

Notes: For illustration purposes, differences within each group are assumed to be available, We can also further assume that the above data are from quarter 0, the quarter in which complete replacement ends

**TABLE A2. ONE-TO-ONE STOCK MATCH**

| Fund | pre-CR quarter | Stock | Raw Rank | Raw change in number of shares from pre- | Ctrlgroup average Raw change in number of shares from pre-CR |
|------|----------------|-------|----------|--|--|
| 1    | Q1 94          | AAA   | 2        | -100                                     | 250  |
| 1    | Q1 94          | BBB   | 4        | 600                                      | 200  |
| 1    | Q1 94          | CCC   | 4        | 100                                      | 150  |
| 2    | Q2 99          | AAA   | 2        | -500                                     | 0  |
| 2    | Q2 99          | DDD   | 2        | 0  | 200  |
| 2    | Q2 99          | EEE   | 8        | 500                                      | -400   |

**TABLE A3. ONE-TO-ONE STOCK RANK MATCH**

| Fund | pre-CR quarter | Raw Rank | Raw change in number of shares from pre- | Ctrlgroup average Raw change in number of shares from pre-CR |
|------|----------------|----------|--|--|
| 1    | Q1 94          | 2        | -100                                     | 250  |
| 1    | Q1 94          | 4        | 350                                      | 150  |
| 2    | Q2 99          | 2        | -250                                     | 100  |
| 2    | Q2 99          | 8        | 500                                      | -400   |