Threshold Effect of Scale and Skill in Active Mutual Fund Management

Chong, Terence Tai Leung and Lee, Nayoung and Sio, Chan-Ip

30 July 2018

Threshold Effect of Scale and Skill in Active Mutual Fund Management

Terence Tai-Leung Chong[a], Nayoung Lee[b], and Chan-Ip Sio[c]

July 2018

Abstract

In this paper, we apply threshold estimation techniques to study the size-performance relation in the US mutual fund industry. The existing studies have found diseconomies scale, and we add our contribution to this by considering possible non-linear decreasing returns to scale caused by fund age and manager tenure. We find significant threshold effects of both fund age and manager tenure at approximately three to four years in the size-performance relation. Compared with younger funds, older funds have severe decreasing returns to scale as the industry size increases.

JEL Classifications: C24, G11, G23, J24
Keywords: Active mutual funds management, Returns to scale, Threshold estimation

---

[a] Terence Tai-Leung Chong: Department of Economics, The Chinese University of Hong Kong, email: chong2064@cuhk.edu.hk
[b] Nayoung Lee: Department of Economics, University of Cincinnati, email: nayoung.lee.econ@gmail.com
[c] Chan-Ip Sio: Department of Economics, The Chinese University of Hong Kong, email: chanip.sio@link.cuhk.edu.hk

1. Introduction

The size effect on active mutual fund performance has long been studied, and a number of studies have reported decreasing returns to scale. At the fund level, Berk and Green (2004) argue that fund performance deteriorates because of the increase in various trading costs and of the decrease in returns to scale brought by huge capital inflow. Chen et al. (2004) find an evidence of fund-level decreasing returns and argue that low liquidity is the major cause of the diseconomies of scale. Pástor et al. (2015) first investigate industry-level size effect and conclude decreasing returns to scale as the fund industry size grows.

In this paper, we focus on the threshold effect of industry size on fund performance. We explore potential difference in fund size effects with respect to fund age and tenure of fund managers. This is motivated by the findings in Pástor et al. (2015) that younger funds outperform older funds with better skills. Pástor et al. argue that active mutual fund industry has become more skilled over time but the upward trend in skill coincides with industry growth which makes it harder for fund managers to outperform.

If younger funds have superior features including the avoidance of competition by new strategies that differ from those of incumbents, younger funds may experience lesser degrees of erosion in a crowded industry than older funds. We examine this hypothesis by investigating the difference in the returns to scale between young and old funds based on the threshold model (Hansen, 1999). In particular, we use fund age and manager tenure as threshold variables and

estimate a threshold model for the US actively managed equity mutual fund market from 1979 to 2013. The advantage of our model is that it can define young and old funds endogenously.

Our results show that the thresholds exist for both fund age and manager tenure at approximately three to four years. More importantly, young funds experience less performance erosion than old funds in all regression specifications and samples. These findings are consistent with the hypothesis that new entrants are managed by a more knowledgeable investment team than existing funds are. Young funds tend to be less affected by an increasing industry size compared with old funds. Such results remain statistically significant after controlling for fund size and other fund liquidity factors. Hence, differences in liquidity characteristics could not fully explain the lower sensitivity of young funds to the increase in industry size. Our findings are consistent with the studies which argue required skills in financial industry (e.g. Philippon and Reshef, 2012); young funds may benefit from better education and knowledge about relevant technology of fund management experts.

The rest of this paper is organized as follows. Section 2 introduces our main methodology. Section 3 describes the data. Section 4 presents our empirical results and discusses related issues. Section 5 concludes the paper.

2. Methodology

2.1 Fixed Effect Model

We first consider a fixed effect (FE) model without threshold to investigate the size-performance:

$$GrossR_{it} = a_i + \beta InduSize_{t-1} + \varepsilon_{it},$$

where $GrossR_{it}$ is the monthly return of fund i in period t that is adjusted on the basis of the three-factor model of Fama and French (1997), plus the monthly expense ratio.[1] $InduSize_{t-1}$ is the size of the active mutual fund industry and measured by the lagged ratio of the sum of assets under management (AUM) of all funds to the aggregate asset value of the US stock market. Here, a_i is the fixed effect, which measures investment skill of fund managers. The effects of industry size on mutual fund performance is therefore captured by β. A negative β represents inverse relationship between the scale of industry size and fund returns.

Fund size can be added to the model to control for the fund size effect:

$$GrossR_{it} = a_i + \beta_1 InduSize_{t-1} + \beta_2 FundSize_{it-1} + \varepsilon_{it},$$

where $FundSize_{it-1}$ is the lagged value of the AUM of fund i. The reason for introducing a_i in previous models is to control for unobserved characteristics of funds. If ordinary least squares (OLS) specifications without fund FEs a_i are used, omitted variable bias emerges because of the potential relation between the unobserved effects of skills of fund managers and fund flows.[2] The FE model reduces the effects of this problem. However, another bias related to β_2 may exist because of the demeaning procedures in the OLS-FE model, as

[1] The expense ratio reflects the raw performance of a fund in the market before distribution to clients.
[2] The omitted variable bias has been observed in many studies. See Chen et al. (2004) and Reuter and Zitzewitz (2010).

mentioned by Chen et al. (2004). To address the second bias, Pástor et al. (2015) employ the recursive demeaning (RD) method by Hjalmarsson (2010). Such bias will not be discussed in the study given that the effect of fund size is not our core interest. This RD approach is used only when fund size is included in the regression.[3]

2.2 Threshold Model

Our key interest is to investigate the difference in the performance erosion of young and old funds under industry competition. To define young and old funds endogenously, we apply the threshold model of Hansen (1999). Our threshold model is as follows:

$$GrossR_{it} = a_i + \beta_1 InduSize_{t-1} \cdot I(d_{it-1} \le \gamma) + \beta_2 InduSize_{t-1} \cdot I(d_{it-1} > \gamma) + \varepsilon_{it},$$

where d_{it-1} is either the fund age or fund manager tenure measurement for distinguishing between young and old funds. Thus, β_1 and β_2 represent the effects of industry size on the performance of a fund before and after the threshold γ, respectively.

Fund age refers to the period since a fund was launched. It is a common measurement of how old a fund is. Manager tenure (denoted by *MgrTenure*) refers to how long a manager manages a fund. Every new management is considered as a form of rebirth because a new manager may alter fund portfolios according to his or her investment philosophy. Therefore, a

[3] This approach is also performed in the threshold model. Specifically, we first estimate the threshold value in the FE model. Then we use the RD method with the estimated threshold known a priori. Therefore, the negative bias of fund size in the fixed effect model will be resolved, and the RD approach is still used in a linear model setting.

fund can be regarded as a young fund when management changes. The period when a current manager takes control is thus used as another fund age measurement.

MgrTenure is, however, not an ideal measurement of a fund manager's experience, which should be related closely to the individual's age, education, or experience in the financial industry. In the succeeding sections, *MgrTenure* cannot yield robust conclusions in some cases. Considering the data availability, *MgrTenure* remains a candidate for age measurement.

Our threshold effect is embedded in the original FE model. The FE model identifies the variation of performance and size within a fund. In the FE model, the coefficients β_1 and β_2 represent the effects of industry size on a fund's performance before and after the threshold, respectively. According to this identification strategy, when fund age exceeds the threshold, industry size effect significantly affects fund returns. Such effect can be measured by the difference between β_1 and β_2.

The estimation is implemented on the basis of the work of Hansen (1999). γ is estimated as

$$\hat{\gamma} = \arg\min_{\gamma} S(\gamma),$$

where S(γ) is the sum of squared errors (SSE) of the OLS estimation. To obtain the estimate, we sort the value of the threshold variables in our sample and obtain 400 quantiles in increasing order. Using these quantiles as thresholds, we estimate an OLS regression and select γ that yields

the smallest value of *SSE*. Finally, the estimators of betas are evaluated at the estimated threshold:

$$\hat{\beta} = \hat{\beta}(\hat{\gamma}).$$

3. Data

The mutual fund data that support the findings of our study are obtained from the CRSP Survivor-Bias-Free US Mutual Fund Database which is openly available in the center for research in security Prices (CRSP) at http://www.crsp.com/products/research-products/crsp-survivor-bias-free-us-mutual-funds. We mainly follow the steps implemented by Pástor et al. (2015) in cleaning the data[4], except for the merging of the two data sets (CRSP and Morningstar databases) and determining their commonalities.[5]

We first select observations of open-end active management funds in the US equity market. Only observations in CRSP with documented fund styles, *cap-based domestic equity* and *style-based domestic equity,* are selected in our sample to reflect the overall situation of equity mutual fund market. Bond funds, money market funds, international funds, funds of funds, and retirement target funds are excluded from the sample because our priority is to focus on the

[4] Pástor et al. (2015) followed the data cleaning procedures of Berk and Van Binsbergen (2015), who presented more than 20 pages of data cleaning procedures. Both cleaning procedures are used as references.

[5] We only have access to CRSP; thus, discrepancies may occur between our data and theirs. A cleaner data set can be part of our improvement effort in the future. However, many previous studies, such as Chen et al. (2004), have only used the CRSP data set to construct their mutual fund data. Hence, the CRSP data set is temporarily used in this paper.

domestic equity mutual fund industry. The index funds are further excluded by cleaning fund names and fund observations with an expense ratio of below 0.1% per annum. Monthly observations with fund sizes of less than $15 million in 2013 dollars are also excluded to avoid incubation bias.[6]

TABLE 1 HERE

Table 1 shows the summary statistics. Considering data availability, we mainly choose observations in the period between 1993 and 2013. Meanwhile, the period from 1979 to 2013 is treated as the extended sample period. Therefore, we update the sample of Pástor et al. (2015) with two recent years. Our final data set consists of 3,936 actively managed mutual funds with monthly unbalanced panel data. The correlations between fund characteristics variables are reported in Panel B.

In the entire sample period, the number of active equity mutual funds increased from approximately 100 funds in 1979 to approximately 2,500 funds in 2013, as presented in Panel A of Figure 1. More than one fund operates in the market at any given month, and so their competition for limited opportunities always exists in the stock market.

[6] Incubation bias and its remedies have been documented in many previous studies, such as Chen et al. (2004) and Elton et al. (2001). This issue will be revisited in Section 5.

FIGURE 1 HERE

Our key variables are gross return (*GrossR*), fund size (*FundSize*), industry size (*InduSize*), fund age (*FundAge*), and manager tenure (*MgrTenure*).

GrossR is the monthly return of the fund after adjusting performance by the monthly expenses ratio and on the basis of the three-factor model of Fama and French (1997). *GrossR* measures a manager's performance before distribution to clients.

FundSize is the monthly AUM of the fund, which is inflated by multiplying the ratio of the aggregate stock market value in December 2013 and the corresponding value of the present month.

InduSize is the ratio of the sum of AUM of all funds to the aggregate asset value of the US stock market. The asset values of all stocks listed on the US equity market are included to reflect the industry size of the active equity fund market, which matches our universe of domestic equity funds. In the process of computation for industry size, we fill the missing fund size values by referring to the fund returns in the specific month. *InduSize* measures the percentage of values of total assets owned by the mutual fund market in the aggregate asset value of the US stock market. The growth of industry size is presented in Panel B in Figure 1, in which the market share of

mutual funds in the US stock market is shown to increase from below 1% to approximately 10% of stocks in the past 30 years.

In terms of age variables, *FundAge* is the length of time since the fund was launched, while *MgrTenure* is the length of time since the beginning of the control of the current management. Although we can easily compute *FundAge* using the current date and the date when the fund was launched in CRSP, *MgrTenure* should be obtained carefully because CRSP does not directly provide manager tenure data. We use the fund header history data in CRSP to generate *MgrTenure* by searching for changes in fund manager information over time. All the changes are documented to calculate the tenure of each manager.[7]

4. Results

4.1 Returns to Scale at Industry Level

In Table 2, we report the results of decreasing returns to scale on performance at the industry level, which is consistent with Pástor et al. (2015). In particular, a 1 percentage point increase in industry size is associated with 0.0312% decrease in monthly performance, which equates to 37 basis points (bps) per year. Note that the 1 percentage point increase in industry size takes

[7] Note that some mutual funds are managed by multiple managers. These funds only disclose their management information as "team-managed", without naming the specific managers. For these funds, we have no detailed information regarding the change of the team manager. As documented in Massa et al. (2010), CRSP tends to misclassify funds as "team-managed", without naming the specific managers, compared to Morningstar database. This brings noises to our manager-tenure variable. We will discuss more on the data problem of *MgrTenure* in Section 4.

approximately 3.5 years in the sample.

TABLE 2 HERE

If the variable, fund size, is controlled for, we still observe a significantly inverse relationship between size and performance at the industry level, as shown in Column 2. In addition, in the FE model, the fund size effect is significantly negative. However, the fund size effect becomes insignificant when the bias-free RD method is used, as shown in Column 3.[8]

The decreasing returns to scale at the industry level is consistent with the efficient market hypothesis. Most mutual funds are institutional investors in the market. The market becomes increasingly efficient over time as the asset value of the mutual fund increases.

4.2 Threshold Effect on Size-Performance Erosion

Now we consider threshold effects on size-performance erosion. We use two different age measurement thresholds to investigate the effects of industry size on active mutual fund performance: *MgrTenure* and *FundAge*. These results are reported in Table 3 and Table 4 respectively. Our goal is to investigate if there is any statistical difference of the effects of industry size on a fund's performance before and after the thresholds.

[8] Throughout this paper, the estimate of fund size effect is negative and statistically significant when it is included in the FE model. However, the effect becomes insignificant if we use the RD method instead. Although the estimate in the RD method is sensitive to the choice of sample and it may fluctuate above or below zero, this unbiased method shows that we cannot reject the null hypothesis that the fund size effect equals zero.

Manager tenure as a threshold

Table 3 reports the results of using manager tenure (i.e. *MgrTenure)* as a threshold variable for both the main and the extended samples.

TABLE 3 HERE

Column 1 presents the threshold and the coefficient estimates of gross returns on industry size without controlling for any variables. Column 2 extends the results by controlling for the fund size. In Columns 1 and 2 of Panel A, the threshold estimates for manager tenure are close to 1,600 days, approximately 4.4 years. The plot of likelihood ratio is shown in Figure 2. We follow the method of Hansen (1999) in plotting the likelihood ratio and computing the 95% confidence interval. On the basis of the asymptotic distribution of threshold estimates, we find the 95% confidence intervals of [1587, 1603] and [1588, 1604], which are close to the threshold point estimates for roughly one month.

FIGURE 2 HERE

A fund younger than 4.4 years has smaller decreasing returns to scale of industry size than a fund over the aforementioned period; the difference is 0.01%, which is equal to 12 bps per year

and is statistically significant at the 1% level.[9] It suggests that young funds suffer less erosion of performance as a result of increasing industry competition than old funds. Such difference is also observed in the extended sample, as listed in Panel B of Table 3. Although the scale is different, the difference between young and old funds remains at 0.01% regardless of the samples and the presence of control variable, fund size. The estimated threshold is also used to perform the RD method for fund size, and the results are shown in Column 3. The difference between young and old funds remains significant despite the insignificant fund size effect.

Fund age as a threshold

Table 4 presents the results of using *FundAge* as a threshold. In Column 1, the threshold estimate is 1,608 days (4.4 years), which is close to the value estimated with manager tenure as a threshold. After controlling for fund size at the same time, the threshold reverts to 1,209 days (3.3 years), as shown in Column 2. Similar to the case of using manager tenure as a threshold, changes in industry size cause less performance erosion of young funds (10 to 25 bps) than of old funds. In Column 1 of Panel A, a young fund shows rising returns to scale of 0.01% per month, whereas an old fund shows decreasing returns to scale. In Column 2, the difference between the two coefficients is approximately 0.02. The RD method is applied when fund size is included, and the results are shown in Column 3. The difference in performance erosion of young

[9] See below and Table 5 for our test on the threshold effect. Given that the fund sizes are large on average in the market (with a mean of 1.5 billion US dollars), the 0.01% difference in return is also presumed to be economically significant.

and old funds remains even when using the bias-free method. Similar patterns of difference are also observed in our extended sample, which is listed in Panel B of Table 4.

TABLE 4 HERE

Test for the threshold effect

To show that the threshold effect is statistically significant[10], we test the following hypothesis:

$$H_0 : \beta_1 = \beta_2$$

The likelihood ratio for the test is

$$F_1 = (S_0 - S_1(\hat{\gamma})) / \hat{\sigma}^2 .$$

We do not theoretically derive a standard asymptotic distribution of F_1 because the threshold is endogenously determined; instead, we bootstrap the p-value for the test statistics.[11] The results are presented in Table 5. Columns 1, 2, 3, and 4 show the test results of the regressions in Columns 1 and 2 of Tables 3 and 4. In all of the threshold model specifications, large F_1 and small p-value are found. The null hypothesis is rejected at the 1% significance level. Therefore, threshold effects of fund age and manager tenure exist in the size-performance relation. In

[10] Note that the confidence intervals of the industry size effect on young and old funds overlap in some cases. For example, in Column 2 of Table 3, the confidence intervals for young and old funds are [-0.0492, -0.0266] and [-0.0580, -0.0356] respectively. However, the overlap of confidence interval does not mean there is no statistically significant difference between the groups. It is required to use a further test on the difference of the two groups.

[11] Similar to Drukker et al. (2005), this paper employs the clustered bootstrap method to perform unbalanced panel residual bootstrapping with 200 replications.

addition, R-squared notably increases when the threshold model is employed. Although R-squared remains small in the original FE regression, it increases by at least five times when the threshold model is used instead.[12]

TABLE 5 HERE

To summarize, considering both manager tenure and fund age, threshold effects are found in the relation between industry size and fund performance. For a fund with more than four-year history, expanding industry size brings a more negative effect on its performance. This observation suggests that a fund's performance is likely to worsen as the industry size increases, particularly when a fund exceeds the age threshold. Therefore, a young fund will experience a lesser degree of performance erosion compared with an old fund.

TABLE 6 HERE

We further explore the different results between the two thresholds, *MgrTenure* and *FundAge.* Table 6 presents the statistics of young and old funds, and Figure 3 specifies the proportion of

[12] As indicated by Pástor et al. (2015), the R-squared of the regression of the gross return on industry size is small at only 0.0005. Therefore, gross return should not be significantly correlated with industry size. We arrive at similar results in our work. Still, R-squared increases five times from 0.0002 to 0.001 when threshold effect is included.

young funds in the industry. Considering the threshold of manager tenure, the percentage of young funds in the sample decreases from 80% to approximately 55%. Considering the threshold of fund age, the percentage decreases from 50% to 30%. Figure 3 shows that the proportion of young funds is declining over time, especially in the 2000s. Therefore, the net entry (entry minus exit) of mutual funds decreases as the industry develops.

FIGURE 3 HERE

TABLE 7 HERE

The estimation results for *MgrTenure* and *FundAge* are not completely identical. However, the threshold estimates are similar, and young funds continue to experience a lesser degree of performance erosion than old funds. These findings can be explained by the statistics of *MgrTenure* and *FundAge*. The frequencies of changes in fund managers over time are shown in Table 7. Approximately 50% of the recorded funds have no changes in fund managers. For these funds, *FundAge* equals *MgrTenure*, indicating a partial overlap. Therefore, the threshold estimates using *FundAge* and *MgrTenure* are considerably close.

4.3 Controlling for Other Fund Liquidity Factors

Why do young and old funds differ in terms of returns to scale? To test the hypothesis that liquidity constraint is a major reason for the negative size-performance relationship at the fund

and industry levels, we control for liquidity characteristics to examine whether or not the threshold effect between young and old funds is driven by their difference in liquidity.

We consider three liquidity factors: small-cap fund indicator (*I(Sml)*), turnover ratio (*Turn*), and abnormal return standard error (*Std(AbnRet)*). Small-cap funds largely invest in small-cap stocks, thus exerting a large effect on the prices. The turnover ratio measures how actively a fund allows changes to the portfolio. Abnormal return standard error measures how volatile the active portfolios are, given that an abnormal return is the return adjusted by a benchmark.

TABLE 8 HERE

Table 8 presents the results of the threshold regression with liquidity factors. The small-cap fund indicator, turnover ratio, and abnormal return standard error are interacted with the industry size in our threshold models. First, liquidity constraint still explains the decreasing returns to scale. In Columns 1, 2, and 3, the liquidity constraint holds because all the coefficients are negative and significant. This result indicates that funds with lower liquidity tend to suffer a higher level of decreasing returns to scale. Second, young funds still experience less erosion of performance than old funds after controlling for liquidity factors. A young small-cap fund suffers less decreasing returns to scale than an old small-cap fund; the same is true for the turnover ratio and average abnormal return cases. Although only *MgrTenure* is used as the threshold in Table 8,

consistent results can be obtained when *FundAge* is used. The difference still holds when the fund liquidity characteristics are included, indicating that the liquidity difference cannot explain why the two groups differ.

4.4 Management Skills and Trading Strategies

A possible explanation for the young and old fund difference with respect to the size-performance is that new entrants can be better equipped. First, young funds might benefit from talented fund managers with knowledge on new technology. Young funds can have superior knowledge of stock selection and thus be less affected by increasing competition in the industry. This is consistent with the findings that the financial industry is packed with highly skilled financial talents in recent years.[13] With relatively sound academic background and better knowledge of technology, new fund managers are better at identifying financial products that are undervalued but with good quality.

Second, a young fund needs to have good and stable performance to win the AUM from incumbents. Wahal and Wang (2011) find that the competition has become fiercer in the US mutual fund market. Thus, new entrants must possess excellent skills when entering the market to overtake some of the existing funds. For the sake of reputation, new funds have a high incentive to outperform others, and an increasing industry size will not result in considerable

[13] See Philippon and Reshef (2012).

performance erosion. This situation also explains why new funds have relatively smaller negative (or even positive) size-performance relationship compared with that of old funds.

To test the aforementioned hypothesis, we implement a trading strategy to compare the performance of young and old funds. We first classify the funds by young and old portfolios on the basis of the estimated thresholds of fund age and manager tenure. To construct the portfolios, we buy young funds and sell old funds. Our estimation is based on lagged values, and hence, at the beginning of each month, the two portfolios are rebalanced by the fund age or the manager tenure of the preceding month end. Thereafter, we identify the differences among returns in the current month and repeat such exercise in the subsequent months to obtain a series of returns. The gross and adjusted net returns for calculation of the profits of the trading strategy are computed. Rather than using point estimates, we employ the confidence intervals, and 180 days before and after the threshold estimates are used to construct broad definitions of the thresholds. Funds between ages of zero and the lower bound of the thresholds are young funds, whereas those at ages above the upper bound of the thresholds are old funds.

Pástor et al. (2015) implement similar age-based hypothetical trading strategies to examine the age-performance relation across funds. However, both young and old funds in the aforementioned studies are arbitrarily defined according to four age groups, without explicit evidence namely, 0 to 3, 3 to 6, 6 to 10, and above 10 years. In this paper, we improve the foregoing measurement and perform a trading strategy by using the estimated thresholds to

construct the portfolios of young and old funds. Tables 9 and 10 present the results of our trading strategy based on *FundAge* and *MgrTenure*. When *FundAge* is used, results of Panels A and B in Table 9 imply that new entrants to the mutual fund industry have superior performance. Returns are shown in all eight cases; six of these cases are statistically significant at the 5% level, except the extended sample with the gross return measured for which the positive returns are significant at the 10% level. In our main sample, the strategy of buying young funds and selling old funds yields an average of 0.045% monthly gross return and 0.05% monthly net return. These figures are approximately 0.5% and 0.6% of the annual gross and net returns, respectively, and are both significant at the 5% level. These results also hold regardless of whether the fees before measurement (gross return) or fees after measurement (adjusted net return) are used to represent performance in both our samples.

TABLE 9 HERE

TABLE 10 HERE

However, we have different results when using *MgrTenure* as the threshold. Table 10 shows that when *MgrTenure* is used to identify young and old funds and to perform trading strategies, the differences between young and old funds are statistically insignificant in all cases. The "buy young, sell old" strategy even yields a negative average return in the main sample.

The insignificant result of the *MgrTenure* trading strategy might be due to the data limitation of manager tenure and limitations of our treatments in the study. First, fund managers' years of relevant work experience, which is not available in our sample, would be better measurements. For example, a fund manager who manages a new fund is likely to have relevant working experience in the industry. However, such individuals are treated as a brand new manager in our sample. Second, as documented in Massa et al. (2010), CRSP has noise in the fund management data, which may affect the accuracy of our calculation. For example, CRSP treats a fund as having no change of management if the fund is documented as "team-managed". A further study on the effects of turnover of management of funds with more accurate data is necessary to decide whether such change has significant impact on fund performance. Lastly, a fund manager with either good or bad performance can leave a fund for various reasons. Therefore, the implementation of the trading strategy based on *MgrTenure* might not provide useful insights.

The difference between young and old funds in terms of performance is not the result of their difference in risk levels. Young funds may hold riskier portfolios to outperform old funds and succeed by accident. However, Chevalier and Ellison (1999) find that compared with older managers, younger managers tend to be more conservative and have more conventional portfolios for job security. The "buy young, sell old" strategy also yields positive returns after the risk levels of funds are controlled for because the Fama-French three-factor alpha is used to

implement the trading strategy, as discussed in Section 4.4. To consider other risk factors, the Carhart four-factor alpha (Carhart, 1997) is also used to evaluate the returns of the trading strategy. Table 11 shows that the trading strategy still generates significant positive returns.

TABLE 11 HERE

In conclusion, significant and positive returns are obtained with *FundAge* as a threshold by employing the "buy young, sell old" trading strategy. Again, this result is not valid if *MgrTenure* is used instead of *FundAge*.

4.5 Attractiveness of Old Funds

The results presented in Section 4.3 show that young funds outperform old funds and experience a smaller degree of performance erosion as the industry size grows. Why do people still prefer old funds and not completely switch to young funds? Table 6 and Figure 3 show that old funds have been taking up a large percentage in the industry, whereas young funds have covered a smaller percentage since the 2000s. The number of old funds is also increasing as the industry size grows. This scenario is contrary to our findings regarding fund performance. Two explanations are provided. One explanation pertains to risk aversion. Young funds have shorter track records of their profitability. It would be risky for investors to switch to young funds, even though they show better returns in their first three to four years. In this circumstance, investors

are more likely to invest in old funds. Another explanation is that some institutional investors may have inertia to fund performance, particularly that of pension plan assets. Several studies have determined that pension plan assets in mutual funds are sticky and not discerning.[14] As discussed by these studies, pension plan assets in the mutual fund market are sticky and insensitive to past fund performance. Pension plan participants tend to employ naive investment strategies; they also rebalance and trade their portfolios infrequently because of their long horizons and different tax concerns. Consequently, these pension plan participants may hold a fund for a long period, which may explain why old funds are still popular in the mutual fund market.

TABLE 12 HERE

To see whether institutional investors take up a large percentage in the mutual fund industry, Table 12 examines the number of young and old funds across time. Institutional funds aim at attracting institutional investors, such as pensions, foundations, and endowments. Institutional funds often have low expenses and loads but require a minimum investment share. In the CRSP database, the information on whether the fund is institutional only covers the period after 1999; thus, we summarize the number among young and old funds (with fund age as the threshold)

[14] For example, see Benartzi and Thaler (2001) and Dahlquist and Martinez (2015).

with the available data in the selected year-ends. We classify a fund as "institutional" if one of the share classes of the fund is documented as an institutional fund in the database. As shown in Table 12, young funds have a similarly large percentage of institutional funds, although the number and the percentage are smaller compared with those of old funds.

However, it should be noted that the data only cover the period since 1999; thus, several data are missing compared with our full sample of funds. In addition, Pan et al. (2014) determine that institutional funds claimed in fund prospectuses are not ideal measures of institutional ownership; the researchers find that almost 50% of institutional investors' holdings are retail funds. This result suggests that their investment decisions are not based on whether funds are institutional. Therefore, the results shown in Table 12 may be biased. Further tests are necessary to verify our explanations.

4.6 Robustness

In this section, we examine the robustness of the threshold effect and the different degrees of performance erosion of young and old funds. Our results are robust to different samples after controlling for fund size in the explanatory variables. Section 4 presents the results of both the main sample (1993–2013) and the extended sample (1979–2013). In both samples, our threshold estimates and the differences between young and old funds remain consistent. When fund size is added as an explanatory variable, the threshold estimates and the differences between young and old funds do not change.

Another concern is incubation bias. Evans (2010) finds that mutual fund families start multiplying small-size funds privately and only release those with good performance to the public at the end of an evaluation period. The incubation funds may have inflated performance in the early stage because they are allowed to use their historical performance as track record. This scenario makes our inference on the difference between young and old funds biased.

TABLE 13 HERE

To solve the aforementioned problem, observations of funds with sizes smaller than $15 million are excluded during the data learning stage. As a robustness check, the first two years of records since the funds' inception are also excluded to examine the threshold estimates and the difference in parameters, following the methods of Evans (2010). Table 13 shows the results. The difference between young and old funds in terms of industry size erosion remains robust. Young funds still have less performance erosion than old funds; the former even have positive returns to scale. The threshold estimates remain approximately four years; the exception is in Panel B, Column 1, which notes an increase to five years. The increment is the result of the data trimming of the first two years. This step considerably reduces the number of observations that lie before the threshold estimate. Regardless of the change in the point estimate, the confidence interval

remains close to four years. These results suggest that our threshold effects and the difference between young and old funds are not affected by incubation bias.

5. Conclusion

In this study, we analyze the nonlinear effect of the decreasing returns to scale of industry size on mutual fund performance. We apply the threshold model to estimate the effects of industry size on fund performance in the US mutual fund market. Threshold estimates of critical fund age and manager tenure are obtained in our sample. This result is in line with those of the studies on mutual performance persistence. We also acquire evidence that young funds suffer less from industry size erosion than old funds. Such difference between young and old funds still holds when fund liquidity characteristics are controlled for. We argue that the difference in the degrees of performance erosion is caused by the superior features of young funds. This hypothesis is tested by employing a "buy young, sell old" trading strategy on the basis of our threshold estimations. This strategy yields significant and positive returns over the years, indicating that young funds are better equipped than old funds. We also explore the issue of investors' continuous investment in old funds despite the inferior performance of such funds and explain it by the loyalty effect and investment inertia in the mutual fund market.

References

Benartzi, S., and Thaler, R. H. (2001). Naive diversification strategies in defined contribution saving plans. *The American Economic Review*, 91(1), 79-98.

Berk, J. B., and Van Binsbergen, J. H. (2015). Measuring skill in the mutual fund industry. *Journal of Financial Economics*, 118(1), 1-20.

Berk, J. B., and Green, R. C. (2004). Mutual fund flows and performance in rational markets. *Journal of Political Economy*, 112(6), 1269-1295.

Carhart, M. M. (1997). On persistence in mutual fund performance. *The Journal of Finance*, 52(1), 57-82.

Chen, J., Hong, H., Huang, M., and Kubik, J. D. (2004). Does fund size erode mutual fund performance? The role of liquidity and organization. *The American Economic Review*, 94(5), 1276-1302.

Chevalier, J., and Ellison, G. (1999). Career concerns of mutual fund managers. *The Quarterly Journal of Economics*, 114(2), 389-432.

Chong, T. T. L. (2000). Estimating the differencing parameter via the partial autocorrelation function. *Journal of Econometrics*, 97(2), 365-381.

Chong, T. T. L., Lu, L., and Ongena, S. (2013). Does banking competition alleviate or worsen credit constraints faced by small and medium enterprises? Evidence from China, *Journal of Banking and Finance*, 37(9), 3412-3424.

Dahlquist, M., and Martinez, J. V. (2015). Investor inattention: A hidden cost of choice in pension plans? *European Financial Management*, 21(1), 1-19.

Drukker, D., Gomis-Porqueras, P., and Hernandez-Verme, P. (2005). Threshold effects in the relationship between inflation and growth: A new panel-data approach. Working Paper, No. 38225. Munchen: Munich Personal RePEc Archive (MPRA).

Elton, E. J., Gruber, M. J., and Blake, C. R. (2001). A first look at the accuracy of the CRSP mutual fund database and a comparison of the CRSP and Morningstar mutual fund databases. *The Journal of Finance*, 56(6), 2415-2430.

Evans, R. B. (2010). Mutual fund incubation. *The Journal of Finance*, 65(4), 1581-1611.

Fama, E. F., and French, K. R. (1997). Industry costs of equity. *Journal of Financial Economics*, 43(2), 153-193.

Hansen, B. E. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. *Journal of Econometrics*, 93(2), 345-368.

Hjalmarsson, E. (2010). Predicting global stock returns. *Journal of Financial and Quantitative Analysis*, 45(1), 49-80.

Massa, M., Reuter, J., and Zitzewitz, E. (2010). When should firms share credit with employees? Evidence from anonymously managed mutual funds. *Journal of Financial Economics*, 95(3), 400-424.

Pan, X. N., Wang, K., and Zykaj, B. B. (2014). Does institutional ownership predict mutual fund performance? An examination of undiscovered holdings within 13(f) reports. Working paper.

Pástor, Ľ., Stambaugh, R. F., and Taylor, L. A. (2015). Scale and skill in active management. *Journal of Financial Economics*, 116(1), 23-45.

Philippon, T., and Reshef, A. (2012). Wages and human capital in the U.S. finance industry: 1909–2006. *The Quarterly Journal of Economics*, 127(4), 1551-1609.

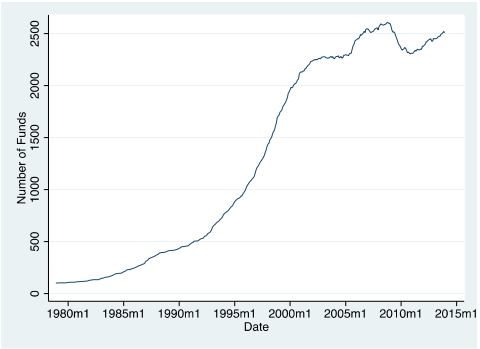
Reuter, J., and Zitzewitz, E. (2010). How much does size erode mutual fund performance? A regression discontinuity approach. Working paper, No. 16329. Cambridge: National Bureau of Economic Research.

Wahal, S., and Wang, A. Y. (2011). Competition among mutual funds. *Journal of Financial Economics*, 99(1), 40-59.

Figure 1: Number of Funds and Industry Size

These figures show the change of the US equity active mutual fund market from 1979 to 2013. Panel A shows the number of funds by month since 1979. Panel B shows the industry size, which is the ratio of the sum of assets under management (AUM) of all funds to the aggregate asset value of the stock market.

Panel A: Number of Funds



Panel B: Industry Size

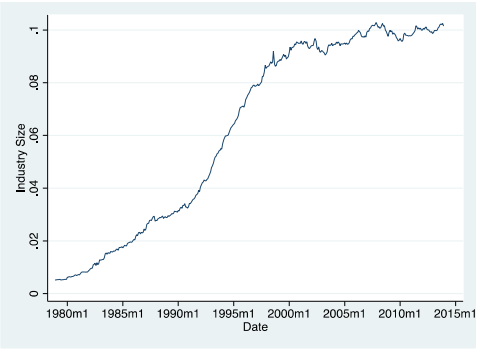
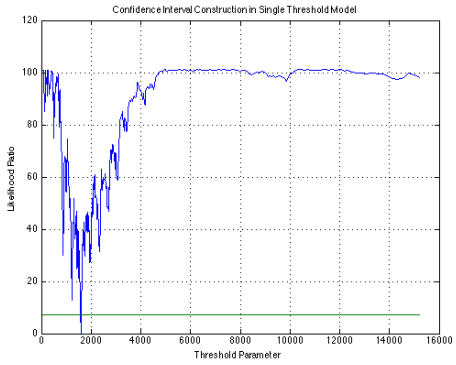


Figure 2: Construction of Confidence Interval

These figures show the likelihood ratio of thresholds. Panels A and B use *MgrTenure* and *FundAge*, respectively, as thresholds to construct confidence intervals. We follow the method of Hansen (1999) in plotting the graph and determining the 95% confidence intervals. The horizontal line is used to indicate the confidence interval.

Panel A: MgrTenure



Panel B: FundAge

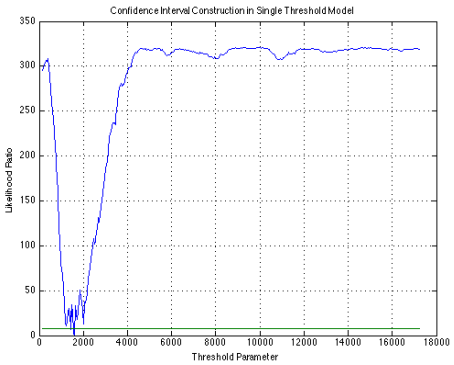
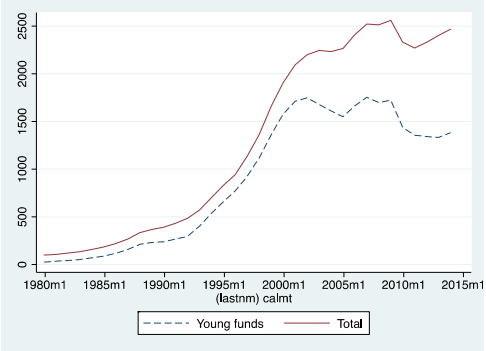


Figure 3: Proportion of Young Funds

These figures show the proportion of young funds from 1979 to 2013. Young funds are defined as funds that are younger than the threshold estimates. We particularly use 1,600 days for both *MgrTenure* and *FundAge* for comparison.

Panel A: Proportion of Young Funds by MgrTenure



Panel B: Proportion of Young Funds by FundAge

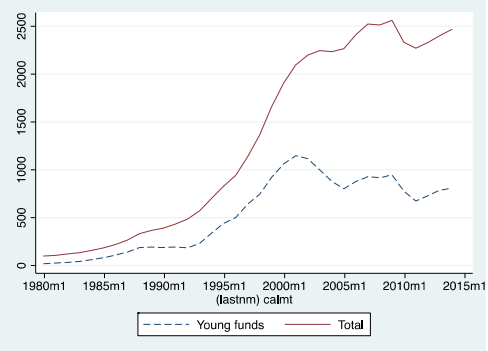


Table 1: Summary Statistics

This table shows the summary statistics. *Net return* is the monthly net return of management fees and related operation fees. *Adj. return* is the net return adjusted for the Fama-French three-factor model. *GrossR* is the adjusted return plus expense ratio, which is the monthly expense (i.e., *Expense*) on fund management and operation. *IndustrySize* is the ratio of the sum of assets under management of all funds to the aggregate asset value of the US stock market. *FundSize* is the net asset of a fund at each month end, adjusted to the dollar rate in December 2013. *MgrTenure* is the manager tenure, which is calculated by the days elapsed since the current manager took control. *FundAge* is the age since the start of a fund. *Turnover* is the adjusted-to-month turnover of aggregated sales or aggregated purchases of securities divided by the average 12-month total net assets. *1(SmlCap)* is used to indicate whether a fund is a small capitalization fund, defined as funds with parameters of small-minus-big factor (Fama-French three-factor model) over 0.5. *Std(AbnRet*) is the standard deviation of the adjusted returns (or the alpha of funds) in the Fama-French three-factor model. Correlations between fund characteristics are presented in Panel B.

Panel A: Cross-sectional mean, standard deviation, and percentiles

				Percentiles				
	Obs	Mean	Std	1%	25%	50%	75%	99%
Net return	459861	0.0074	0.0531	-0.1527	-0.0190	0.0114	0.0378	0.1314
Adj. return	459861	-0.0008	0.0206	-0.0546	-0.0100	-0.0010	0.0081	0.0561
GrossR	409031	0.0003	0.0197	-0.0533	-0.0090	0.0001	0.0093	0.0572
Expense	409498	0.0011	0.0004	0.0002	0.0009	0.0011	0.0014	0.0022
IndustrySize	465478	0.0837	0.0214	0.0109	0.0856	0.0919	0.0957	0.0984
FundSize	398539	1521	5843	16	81	283	1020	20332
MgrTenure (days)	460372	1505	1523	30	485	1034	1977	7421
FundAge (days)	460372	3265.42	2895.96	36	1124	2463	4563	13604
Turnover	382626	0.8340	0.6800	0.0600	0.3551	0.6525	1.1000	3.3800
1(SmlCap)	468206	0.2209	0.4149	0	0	0	0	1
Std(AbnRet)	464439	0.0179	0.0107	0.0054	0.0120	0.0169	0.0219	0.0452

Panel B: Correlation matrix of fund characteristics

	FundSize	*InduSize*	*Expense*	*FundAge*	*MgrTenure*	*Std(AbnRet)*	*Turnover*	*1(Sml)*
FundSize	1.000							
InduSize	-0.034	1.000						
Expense	-0.143	-0.065	1.000					
FundAge	0.280	0.141	-0.063	1.000				
MgrTenure	0.032	0.115	-0.091	0.279	1.000			
Std(AbnRet)	-0.011	-0.126	0.331	0.107	0.076	1.000		
Turnover	-0.020	0.002	0.197	-0.052	-0.053	0.194	1.000	
1(Sml)	-0.070	-0.012	0.166	-0.036	-0.006	0.351	0.044	1.000

Table 2: *GrossR* on Sizes

This table shows the results of *GrossR* on sizes. *IndustrySize* is the ratio of the sum of assets under management of all funds to the aggregate asset value of the US stock market. *FundSize* is the net asset of a fund at each month end, adjusted to the dollar rate in December 2013. RD is the recursive demeaning method proposed by Hjalmarsson (2010). We use the standard error clustered by fund and report the t-statistics in the parentheses. The results on *FundSize* are multiplied by 10^6 for enhanced readability.

Main Sample	(1)	(2)	(3)
	FE	FE	RD
IndustrySize	-0.0312***	-0.0473***	-0.0275***
	(-6.089)	(-8.27)	(-8.86)
FundSize		-0.131**	-0.050
		(-2.49)	(-1.17)
Observations	376,574	344,925	354,996

Table 3: Threshold Regressions (*MgrTenure*)

This table shows the threshold regressions of *GrossR* on *InduSize*, with *MgrTenure* as the threshold. γ is the threshold parameter used to separate young and old funds. We also report the 95% confidence intervals, which are calculated by the likelihood ratio. *InduSize* is the ratio of the sum of assets under management of all funds to the aggregate asset value of the US stock market. I(*MgrTenure* < γ) and I(*MgrTenure*$\geqslant\gamma$) are the parameters of young and old funds, respectively. *FundSize* is the net asset of a fund at each month end, adjusted to the dollar rate in December 2013. RD is the recursive demeaning method proposed by Hjalmarsson (2010); our estimation treats the thresholds as given in Column 3. We use the standard error clustered by fund and report the t-statistics in the parentheses. The results on *FundSize* are multiplied by 10^6 for enhanced readability. We report the results of both the main and the extended samples.

Panel A: Main Sample (1993–2013)

	(1)	(2)	(3)
	FE	FE	RD
γ (days)	1,603 (4.4 yr)	1,604 (4.4 yr)	1,604
95% CI	[1587, 1603]	[1588, 1604]	
*InduSize**I(*MgrTenure*<γ)	-0.0216***	-0.0379***	-0.0351***
	(-4.172)	(-6.589)	(-7.44)
*InduSize**I(*MgrTenure* $\geqslant$ γ)	-0.0314***	-0.0468***	-0.0448***
	(-6.111)	(-8.204)	(-9.89)
FundSize		-0.127**	0.184
		(-2.442)	(1.10)
Observations	376,574	344,925	341,221

Panel B: Extended Sample (1979–2013)

	(1)	(2)	(3)
	FE	FE	RD
γ *(days)*	1,595 (4.4 yr)	1,602 (4.4 yr)	1,602
95% CI	[1595, 1595]	[1585, 1602]	
*InduSize**I(*MgrTenure*<γ)	-0.0264***	-0.0216***	-0.0222***
	(-8.534)	(-5.460)	(-7.12)
*InduSize**I(*MgrTenure* $\geqslant$ γ)	-0.0356***	-0.0308***	-0.0314***
	(-11.49)	(-7.761)	(-9.98)
FundSize		-0.112***	-0.0478
		(-3.259)	(-0.97)
Observations	408,946	358,717	354,996

Table 4: Threshold Regressions (*FundAge*)

This table shows the threshold regressions of *GrossR* on *InduSize*, with *FundAge* as the threshold. γ is the threshold parameter used to separate young and old funds. We also report the 95% confidence intervals calculated by the likelihood ratio. *InduSize* is the ratio of the sum of assets under management of all funds to the aggregate asset value of the US stock market. I(*MgrTenure* $< \gamma$) and I(*FundAge*$\geqslant\gamma$) are the parameters of young and old funds, respectively. *FundSize* is the net asset of a fund at each month end, adjusted to the dollar rate in December 2013. RD is the recursive demeaning method proposed by Hjalmarsson (2010); our estimation treats the thresholds as given in Column 3. We use the standard error clustered by fund and report the t-statistics in the parentheses. The results on *FundSize* are multiplied by 10^6 for enhanced readability. We report the results of both the main and the extended samples.

Panel A: Main Sample (1993–2013)

	(1)	(2)	(3)
	FE	FE	RD
γ *(days)*	1,608 (4.4yr)	1,209 (3.3yr)	1,209
95% CI	[1569, 1608]	[1171, 1248]	
*InduSize**I(*FundAge*$<\gamma$)	0.0115**	-0.00843	-0.0043
	(1.993)	(-1.380)	(-0.77)
*InduSize**I(*FundAge* $\geqslant$ γ)	-0.00722	-0.0268***	-0.0237***
	(-1.389)	(-4.769)	(-4.84)
FundSize		-0.123**	0.174
		(-2.430)	(-1.05)
Observations	376,574	344,925	341,221

Panel B: Extended Sample (1979–2013)

	(1)	(2)	(3)
	FE	FE	RD
γ *(days)*	1,568 (4.3 yr)	1,209 (3.3 yr)	1,209
95% CI	[1568, 1607]	[1170, 1247]	
*InduSize**I(*FundAge* $<\gamma$)	-0.00540	0.000850	-0.00285
	(-1.482)	(0.192)	(-0.87)
*InduSize**I(*FundAge* $\geqslant$ γ)	-0.0230***	-0.0181***	-0.0190***
	(-7.465)	(-4.652)	(-6.10)
FundSize		-1.12***	-0.0430
		(-3.331)	(-0.87)
Observations	408,946	358,717	354,996

Table 5: Bootstrap Results

This table shows the bootstrap results for the test on the significance of the threshold effects. Columns 1, 2, 3, and 4 are the test results of the regressions in Columns 1 and 2 of Tables 3 and 4. F_1 is the likelihood ratio of the threshold estimates. The p-values are bootstrapped following the method of Hansen (1999). The critical values are the top 95% quantiles of the likelihood ratio across our bootstrap replications.

Main Sample	Bootstrap Results			
	MgrTenure		*FundAge*	
	(1)	(2)	(3)	(4)
F_1	140.04	124.98	140.87	125.67
P-value	0.000	0.000	0.000	0.000
Critical values 95%	11.992	11.73	11.73	11.206

Table 6: Number of Young and Old Funds

This table shows the number of young and old funds from 1993 to 2013. Young funds are defined as funds that are younger than the threshold estimates. We particularly use 1,600 days for both *MgrTenure* and *FundAge* for comparison.

Year	*MgrTenure*			*FundAge*		
	Young	Old	%Young	Young	Old	%Young
1993	538	164	77%	339	363	48%
1994	659	172	79%	442	389	53%
1995	773	170	82%	501	442	53%
1996	927	210	82%	641	496	56%
1997	1119	246	82%	746	619	55%
1998	1361	300	82%	924	737	56%
1999	1579	327	83%	1063	843	56%
2000	1712	383	82%	1148	947	55%
2001	1749	451	80%	1116	1084	51%
2002	1679	567	75%	999	1247	44%
2003	1611	623	72%	880	1354	39%
2004	1550	716	68%	802	1464	35%
2005	1666	745	69%	878	1533	36%
2006	1754	769	70%	928	1595	37%
2007	1699	815	68%	917	1597	36%
2008	1724	838	67%	948	1614	37%
2009	1438	895	62%	777	1556	33%
2010	1357	914	60%	675	1596	30%
2011	1342	990	58%	730	1602	31%
2012	1333	1071	55%	788	1616	33%
2013	1383	1086	56%	808	1661	33%

Table 7: Change of Management

This table shows the number of funds based on the number of management changes, the data on which are obtained from the CRSP database.

Change of Manager	0	1	2	3	4	⩾5
Funds	1789	755	473	286	168	226
Percentage	48%	20%	13%	8%	5%	6%

Table 8: Threshold Regression with Liquidity Factors

This table shows the threshold regressions of *GrossR* on sizes and liquidity factors, with *MgrTenure* as the threshold in the main sample. We treat the threshold estimation as given. *IndustrySize* is the ratio of the sum of assets under management of all funds to the aggregate asset value of the US stock market. *FundSize* is the net asset of a fund at each month end, adjusted to the dollar rate in December 2013. The interaction terms are formed by *InduSize* and *FundSize* with *I(sml)*, *Turn*, and *Std*, which represent the indicator of small-cap funds, turnover ratio, and standard deviation of abnormal return, respectively. We use "*_yng*" and "*_old*" to mark the coefficients of the young and old funds, respectively. We use the standard error clustered by fund and report the t-statistics in the parentheses. The results on *FundSize* are multiplied by 10^6 for enhanced readability.

Main Sample	(1)	(2)	(3)
InduSize_yng	-0.00594	0.0425***	0.142***
	(-1.130)	(3.120)	(8.300)
*InduSize*I(sml)_yng*	-0.0756***		
	(-4.849)		
*InduSize*Turn_yng*		-0.0774***	
		(-4.623)	
*InduSize*Std_yng*			-8.593***
			(-8.568)
InduSize_old	-0.0138***	0.0341**	0.144***
	(-2.658)	(2.479)	(8.536)
*InduSize*I(sml)_old*	-0.0828***		
	(-5.399)		
*InduSize*Turn_old*		-0.0789***	
		(-4.646)	
*InduSize*Std_old*			-9.263***
			(-9.376)
Observations	376,574	375,918	376,531

Table 9: Trading Strategy (*FundAge*)

This table shows the result of the "buy young, sell old" trading strategy. At the beginning of each month, we rebalance the two equally weighted portfolios by the fund age of the preceding month end. Thereafter, we obtain the differences in the returns in the current month, repeat this process every month, and compile a series of returns. We use the gross and net returns adjusted with the Fama-French three-factor model for evaluation. We report the means and t-statistics of both portfolios and the difference between the complete strategies, as shown in Columns 1, 2, and 3. The significance level is based on the t-test. We use 180 days before and after the threshold and the confidence interval to provide broad definitions of young and old funds.

Panel A: 180 days before and after the FundAge threshold

Main Sample	Younger Funds (%)	Older Funds (%)	Difference (%)
Gross Return	0.0483	0.00292	0.0453**
	(1.28)	(0.08)	(2.04)
Net Return	-0.0569	-0.107***	0.0502**
	(-1.51)	(-2.86)	(2.22)
Extended Sample	Younger Funds (%)	Older Funds (%)	Difference (%)
Gross Return	0.101***	0.0578*	0.0427*
	(3.09)	(1.96)	(1.90)
Net Return	-0.00692	-0.0489*	0.0419**
	(-0.23)	(-1.68)	(2.15)

Panel B: 95% Confidence interval as the FundAge threshold

Main Sample	Younger Funds (%)	Older Funds (%)	Difference (%)
Gross Return	0.0486	0.00118	0.0473**
	(1.30)	(0.03)	(2.09)
Net Return	-0.0572	-0.109***	0.0515**
	(-1.53)	(-2.91)	(2.24)
Extended Sample	Younger Funds (%)	Older Funds (%)	Difference (%)
Gross Return	0.100***	0.0568*	0.0435*
	(3.08)	(1.93)	(1.92)
Net Return	-0.0064	-0.0497*	0.0432**
	(-0.22)	(-1.72)	(2.21)

Table 10: Trading Strategy (*MgrTenure*)

This table shows the result of the "buy young, sell old" trading strategy. At the beginning of each month, we rebalance the two equally weighted portfolios by the manager tenure of the preceding month end. Thereafter, we obtain the differences in the returns in the current month, repeat this process every month, and compile a series of returns. We use the gross and net returns adjusted with the Fama-French three-factor model for evaluation. We report the means and t-statistics of both portfolios and the difference between the complete strategies, as shown in Columns 1, 2, and 3. The significance level is based on the t-test. We use 180 days before and after the threshold and the confidence interval to provide broad definitions of young and old funds.

Panel A: 180 days before and after the MgrTenure threshold

Main Sample	Younger Funds (%)	Older Funds (%)	Difference (%)
Gross Return	0.0160	0.00194	-0.00348
	(0.43)	(0.52)	(-0.24)
Net Return	-0.0915**	-0.0894***	-0.00212
	(-2.49)	(-2.39)	(-0.13)
Extended Sample	Younger Funds (%)	Older Funds (%)	Difference (%)
Gross Return	0.0833***	0.0620**	0.02132
	(2.64)	(2.115)	(1.20)
Net Return	-0.0239	-0.0428	0.0200
	(-0.81)	(-1.52)	(1.27)

Panel B: 95% Confidence interval as the MgrTenure threshold

Main Sample	Younger Funds (%)	Older Funds (%)	Difference (%)
Gross Return	-0.09242	0.01637	-0.00119
	(0.41)	(0.44)	(-0.089)
Net Return	-0.0924**	-0.09202**	-0.000398
	(-2.51)	(-2.48)	(-0.026)
Extended Sample	Younger Funds (%)	Older Funds (%)	Difference (%)
Gross Return	0.0871**	0.0595**	0.0276
	(2.04)	(2.03)	(1.61)
Net Return	-0.00236	-0.0465	0.0229
	(-0.80)	(-1.62)	(1.522)

Table 11: Trading Strategy Adjusted for More Risk (*FundAge*)

This table shows the result of the "buy young, sell old" trading strategy based on *FundAge*. At the beginning of each month, we rebalance the two equally weighted portfolios by the manager tenure of the preceding month end. Thereafter, we obtain the differences in the returns in the current month, repeat this process every month, and compile a series of returns. We use the returns adjusted with the Carhart four-factor model for evaluation. We report the means and t-statistics of both portfolios and the difference between the complete strategies, as shown in Columns 1, 2, and 3. The significance level is based on the t-test. We use a confidence interval to provide broad definitions of young and old funds.

Main Sample	Younger Funds (%)	Older Funds (%)	Difference (%)
4-Factor Adj. Return	-0.61**	-0.70**	0.093***
	(-2.27)	(-2.56)	(2.91)
Extended Sample	Younger Funds (%)	Older Funds (%)	Difference (%)
4-Factor Adj. Return	-0.59***	-0.67***	0.075***
	(-2.81)	(-3.15)	(3.27)

Table 12: Percentage of Institutional Funds, Selected Years

This table shows the number of mutual funds with institutional classes among young funds and old funds in selected years. Young funds and old funds are defined by the threshold estimate in Table 4, with *FundAge* as the threshold. Institutional funds are documented in the CRSP data set as fund header information.

Year	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013
Old Funds	915	1420	1466	1469	1486	1486	1535	1532	1534	1569
- Institutional Funds	652	1038	1078	1091	1112	1104	1154	1159	1173	1163
Percentage	71%	73%	74%	74%	75%	74%	75%	76%	76%	74%
Young Funds	801	557	554	562	585	579	492	554	564	556
- Institutional Funds	509	381	388	406	422	415	325	370	355	382
Percentage	64%	68%	70%	72%	72%	72%	66%	67%	63%	69%

Table 13: Robustness Check with First Two Years Removed

This table shows the results of the threshold regressions when we exclude the first two years of observations in the main sample. γ is the threshold parameter used to separate the young and old funds. We also report the 95% confidence intervals, which are calculated by the likelihood ratio. *IndustrySize* is the ratio of the sum of assets under management of all funds to the aggregate asset value of the US stock market. *InduSize**I(*MgrTenure*<γ) or *InduSize**I(*FundAge*<γ) is the parameter of the young funds. *FundSize* is the net asset of a fund at each month end, adjusted to the dollar rate in December 2013. We use the standard error clustered by fund and report the t-statistics in the parentheses. The results on *FundSize* are multiplied by 10^6 for enhanced readability.

Panel A: MgrTenure as the threshold (Main Sample)

	(1)	(2)
	FE	FE
γ (days)	1,603 (4.4 yr)	1,605 (4.4 yr)
95% CI	[1586, 1603]	[1589, 1605]
*InduSize**I(*MgrTenure*<γ)	-0.0193***	-0.0375***
	(-3.505)	(-6.211)
*InduSize**I(*MgrTenure* $\geq\gamma$)	-0.0281***	-0.0454***
	(-5.144)	(-7.580)
FundSize		-0.123**
		(-2.411)
Observations	341,410	313,588

Panel B: FundAge as the threshold (Main Sample)

	(1)	(2)
	FE	FE
γ (days)	2,006 (5.5 yr)	1,583 (4.3 yr)
95% CI	[2006, 2006]	[1583, 1989]
*InduSize**I(*FundAge*<γ)	0.0138**	-0.00992
	(2.327)	(-1.544)
*InduSize**I(*FundAge*$\geq\gamma$)	-0.00396	-0.0265***
	(-0.727)	(-4.470)
FundSize		-0.119**
		(-2.398)
Observations	341,410	313,588