Conceptualising Style Drift

Abstract

This study aims to match the understanding of the concept of style drift among regulators, investors and the industry by adding more objectivity to the current definition of style drift. We do this by introducing the concept of 'style enhancement' and 'style detachment' and by proposing deviations up to a threshold level of ϒe to be categorized as style enhancement, deviations between ϒe and ϒd as style drift and deviations beyond ϒd as style detachment. We differentiate between different levels of deviations, as not every deviation is equal and different strategies lend themselves to different levels of risk. This study assesses the presence of a threshold level that separates 'style detachment' from 'style enhancement' and 'style drift'. To determine the presence of such a threshold level, I hypothesize a concave relationship between tracking error and fund performance. I then analyse the effect of tracking error on the performance of a fund by using quadratic regression analysis technique on a sample of 3675 open-ended U.S equity mutual funds over the period 1988-2017. The main results of our regression for the sample period 1988-2017 are inconsistent with respect to the usage of different performance metrics. Hence, we are unable to suggest any fixed relationship that is, whether a concave relationship or a convex relationship exists between the risk-adjusted returns and tracking error. However, the results from Fama MacBeth regression analysis depict a consistent concave relationship between the variables of interest across four out of six regression models, suggesting that a threshold level of tracking error does exist.

Keywords

Mutual Funds, Style Drift, Style Enhancement, Style Detachment, Investment Style, Performance, Tracking Error

1.1. Introduction

The term ‘style drift’ has come to signify not only the issue of trust between fund managers and investors within the mutual funds industry but also the issue that is gaining increased attention by the regulators as well. This is due to growth in the number of litigation cases brought forward by the disgruntled investors. However, to date, it is legally unclear when the money manager is accountable for overriding the set investment objectives. This is because since the inception of the term ‘style drift’, the concept of drift remains somewhat vague. It is, however, clear what is style drift about, that is, the deviation of funds from their stated investment behaviour. However, it is not yet clear that how much degrees of deviation from the priced style factors? Should it be one basis point, two basis point or more than that? In addition, should fund managers be accountable for every level of deviation in a court of law? My research aims to fill this void and attempts to articulate an objective definition of ‘style drift’[1].

Compliance with the stated investment objectives is amongst the primary duties of a fund manager. This responsibility to comply with the offering documents sits alongside the expectations of fund managers to generate superior returns, expectations that are not always consistent. This is because deviations from the benchmark is a way for managers to make use of their skills and time market shifts. Just consider a case, if a fund manager invested most of their clients’ money in only internet or tech companies in the mid ‘90s, but forecasts the dotcom bubble and took their holdings out of these stocks to avoid huge losses for their clients even though the fund by policy dictated to stick with those stocks. On the other side, what if some of the fund managers did not get out of these sectors only because the focus of the fund by policy was to stick to those sectors. This essentially means that all the exponential gains would have wiped out for those who stuck with it after 1999 and 2000 owing huge losses to investors. In addition, if a fund manager identifies an opportunity in the market, he may shift his strategy to take its advantage and meet the expected returns of a fund. Hence, some form of deviation from the benchmark is essential because otherwise it would be unlikely to benefit from manager’s skill.

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[1]Style drift is also referred as style volatility, style shift, style inconsistency, style switching, and style misclassification in literature.

In addition, fund managers are human and the exciting predictions that they make may not always come true, and this style shifting activity can bring either an expected utility gain or an expected utility loss to the fund investors. Literature has shown investors to be more sensitive to losses than to the gains in their wealth; a phenomenon termed in literature as loss aversion. Tversky and Kahneman [1979] founders of prospect theory, report individuals to be more distraught by prospective losses than happy by equivalent gains .Tversky and Kahneman [1992] and many others have shown the tendency of people to weigh losses twice as intensely as gains. Clarke, Kraise & Statman (1994) suggest that investors regret from underperformance is greater than their pride from outperformance creating behavior irrationality on the part of fund investors who might want to take legal actions when faced with poor investment returns alone.

On the other hand, regulatory authorities do not certainly consider every level of deviation from stated objectives as 'style drift' rather they only regard 'material' drift without prior consent and/or notification to fund investors as fraud (Jacobs, 1973). Securities and Exchange Commission (SEC) establishes Rule 10b-5 that grants right for action of a fraud relating to 'material' omissions and misrepresentations only, that is, a 'strategy/style drift' is material only when its disclosure would cause an investor to either sell or make an investment based on that information. Section 18(a) of the Act also explicitly states that a person making misleading or false statements with respect to 'material' facts will be accountable to those who relied on their statements. Although, Section 13(a) of ICA forbids deviation from funds' policy as stated in funds' prospectus, but section 35(d)(1) gives the fund manager flexibility to invest 20% of its assets other than the asset type and/or geographic location as highlighted by the fund's name. This means ABC Small Cap Growth Fund is legally responsible to invest 80% of its assets in small cap stocks but fund managers do have the flexibility to invest the remaining 20% elsewhere[2]. Still, SEC defines style drift as a deviation of funds actual portfolio holdings from the stated investment strategy of the fund as per its offering documents (U.S Securities and Exchange Commission).

Hence, surely different participants of the mutual funds industry understand the term differently. This mismatch between the understanding of drift among regulators, investors and the industry.

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[2]For more information, please visit Final Rule: Investment Company Names

gives us the opportunity to conceptualize style drift in a more objective manner than at present. We propose a new definition of style drift by incorporating the level of flexibility to be allowed to fund managers while managing their clients' portfolio. We do this to differentiate between different levels of deviations, as not every deviation is equal and different strategies lend themselves to different levels of risk. For this, disintegration to take place, we introduce the concept of 'style enhancement' and 'style detachment'. We propose deviations up to a threshold level of Υ_e to be categorized as style enhancement, deviations between Υ_e and Υ_d as style drift and deviations beyond Υ_d as style detachment. We do this to bring different participants of the mutual funds industry on same page and to limit the psychological biases of fund investors.

Deviation that fall under the phenomenon of style enhancement gives the fund manager flexibility to utilize their skill without having to worry about legal implications. These deviations are allowed by mandate, for example, when a small cap manager discloses that a fund may invest in certain large cap investments for hedging purposes. It is similar to the disclosure found in Fidelity Magellan Fund's prospectus, which states that a fund manager may choose to underweight or overweight certain securities with limits disclosed within the fund prospectus. Managers exhibiting style enhancement exhibit superior performance often by reducing diversifiable risk. However, when a fund manager pushes the boundaries of style enhancement, they then enter the region of style drift. We separate style enhancement from style drift because the purpose of deviating from the benchmark for some managers might not just be to add value to the fund but rather to act opportunistically and alter the risk of a portfolio in a way that may lead to sub-optimal performance (Huang et.al, 2011). Money managers who drift change the balance amongst the assets within the client's portfolio by often by increasing exposure to diversifiable risk and decreasing exposure to non-diversifiable risk, as a result, style-drifting portfolios are unlikely to sustain capital markets overt time. This is because as soon as the fund crosses the bounds of style drift (Υ_d), it then enters in the region of style detachment , which is expected to occur when a fund has deviated so much from its intended style that it is no longer meaningful to categories it under that style. For example, when a fund is expected to invest in real estate but it is instead buying commodities. Money managers should hence be ready to either re-balance their client's portfolio to account for drift or in an extreme case scenario to be fired.

The current empirical study assesses the presence of a threshold level that separates ‘style detachment’ from ‘style enhancement’ and ‘style drift’. For this purpose, I use tracking error as a measure of style volatility and examine its relationship with various performance metrics by fitting the quadratic regression equation of a parabola. Using this quadratic regression analysis, we determine the presence of a threshold level of tracking error. I find mixed evidence for the presence of such a threshold level at this point. It is only where the dependent variable is active returns that the relationship between performance and tracking error indicates the presence of such a threshold level. The associated empirical results imply that initially when the tracking error is zero basis point the relationship between the tracking error and performance is such that the performance of a fund would increase by 0.02 basis points with every one basis point increase in tracking error. However, this gain decreases by 0.01 basis point and even becomes negative after the threshold level of tracking error reaches.

The Fama MacBeth regression analysis results indicate the presence of such a threshold level in four out of six-regression models used. When the dependent variable is either active returns or alpha generated from CAPM, 3-factor model or four-factor model, we find evidence that supports our null hypothesis however; it is only statistically significant when the dependent variable is active returns. On the other hand, when dependent variable is either raw returns or the certainty-equivalent returns we find opposite results.

This research contributes to literature in four ways. First, it just not argues that leeway needs to be given to the fund managers to execute their skills and knowledge like other researches but goes a step ahead by trying to establish that how much leeway should be granted to them. Second, literature have directly moved on exploring relationship between fund characteristics such as fund flows, fund fees, fund performance and/or actions of the fund managers with respect to style drift (diBartolomeo and Witkowski, 1997; Ainsworth et al., 2008; Frijns et al. ,2016; Brown et al., 2012). To date researchers have failed to objectively classify and mark a difference between style enhancement and style drift. Third, the establishment of this objective investment criterion will help investors achieve their investment goals and limit psychological biases. Fourth, unreasonable actions can be limited and/or avoided on the part of investors as well as the fund managers.

The remaining portion of the chapter is arranged as follows: Section 1.2 discusses the related literature on various current definitions of style drift, style drift and the regulatory environment and style drift and performance. Section 1.3 discusses sample construction, variable selection and the methodology used; Section 1.4 presents the discussion of empirical results. Section 1.5 concludes the entire chapter.

1.2. Literature Review & Hypothesis Development

1.2.1. Review of Studies

There is evidence that fund managers are often not keen in paying attention to the stated investment style because of the freedom in decision making involved (Chan et al. 2002) ultimately affecting the style of the funds overtime. A study conducted by diBartolomeo and Witkowski (1997) found 40% of the funds to be representative of some other investment style rather than the stated ones. Kim et al. (2000), in their study found only 46% of the funds adhering to their investment mandates. Standard & Poor's Indices Versus Active scorecard found almost half of the U.S equity funds to experience the style shifting behaviour during 2005-2009 (S&P Financial Services, 2013).

According to Huang et al. (2011), the motivation behind straying from the stated investment style can be twofold. First, it can be due to the agency relationship between the fund manager and the investors. This is when the fund managers put their own interests ahead to those of their clients. In such a case, fund managers should avoid style deviations as they may prove to be detrimental for the fund investors. Additionally, these deviations may also result from the fund managers desire to make use of their skill and ability to time market shifts. Given this, style-shifting funds might perform better and generate superior returns, which in turn promotes the view of allowing flexibility to the fund managers.

Some of the literature that talks about the motivation related to the agency relationship is that of Goetzmann, Ingersoll, Spiegel, and Welch (2007) who suggest that managers may deviate from benchmarks to manipulate the performance numbers of their portfolio. Koski and Pontiff (1999), Brown, Harlow, and Starks (1996) and Chevalier and Ellison (1997) state that the motivation behind style shifting may also be that of attracting more fund flows and generating higher income.

Fund manager's might also be tempted to shift to an asset-class expected to outperform in the short-run (Brown, Harlow and Starks, 1996) – for example, when a fund manager of small-cap stocks assumes dwindling performance of these stocks and starts selling small-cap stocks and buying large-cap stocks with an expectation to beat small-cap benchmarks. Guo (2017) states it to be an indication of low skill managers lacking expertise in a specific style wishing to improve the likelihood of producing extreme returns. This opportunistic style drifting behaviour of the fund managers hinders the fund managers to concentrate on their actual investment goal that is to invest in the promising securities and generate maximum returns for their clients.

On the other hand, style drift, while controversial; have also found to be important to fund managers. Cremers and Petajisto (2009) and Kacperczyk, Sialm, and Zheng (2005) suggest active management to be a sign of having superior investment ability. This is because it gives access to a greater pool of investments from which to choose from and take advantage from potentially profitable opportunities present in the market (Schwienbacher, 2004). Hence, when the motivation behind style drifting behaviour is to take advantage from fund managers stock selection and/or timing abilities, then it might benefit investors. Huang et al. (2011) have also laid attention to the fact that risk-shifting behaviours of the fund managers might not always be harmful for investors because it might not necessarily hurt the clients' portfolio and is a way for managers to use their skill for stock selection and timing abilities. Ainsworth (2002) justified style drift based on reaping higher returns related to these high styles shifting stocks.

Cremers and Petajisto (2009), Wermers (2010) as well as Amihud and Goyenko (2013) have laid attention to the importance of style drift by proving that more management activity actively makes use of the managers' skill and is the only way through which a fund can beat its benchmark by showing less style consistent funds to outperform. Wermers (2010) demonstrated that higher levels of style drift lead to superior future portfolio performance due to active manager's better stock picking ability even after considering higher trading costs. Wermers (2002) in his study computed an information ratio of 0.37 for high-drift managers and only 0.18 for low-drift managers highlighting the stock-picking ability of the managers. This is because fund managers have different capture ratios (the percentage of index return produced by active managers in up and down market conditions) which relates to style adherence decision and as a result, fund managers that drift more than others might perform better in certain market conditions. Correspondingly, Brown and Harlow (2009), Wermers, (2012) and Brown et al., (2012) argue that it is not possible for a fund manager to stick to the labelled style 100% of the time and support the idea giving flexibility to the fund managers within limits, as drifting too far from the stated style may introduce unexpected risks to the investors' portfolio.

Given the benefit of these deviations from benchmark, it is essential to grant leeway to the fund managers in their pursuit of generating positive active returns. Yet, assigning a limit to this flexibility is also important because of the presence of agency issues within the mutual fund industry (Chevalier and Ellison (1997), Huang, Wei, and Yan (2007) and Sirri and Tufano (1998)). Given this, many studies fail to objectively define style drift at all and the reader is left thinking how much leeway is important and to be given to the fund managers.

The current literature uses various terms to define style drift including style switching, style shift, style volatility, risk shifting, style inconsistency and style misclassification.

Brown, Harlow and Zhang (2012) defines style drift as "the degree to which the portfolio's investment style characteristics shift over time because of how the manager chooses to implement the fund's style mandate" so that funds experiencing higher (lower) style drift are those with reduced (more) implementation of their style objective. Hunag et al. (2011) defines it as a substantial shift in the total risk level of a portfolio over time. Loick (2017) defines style inconsistency to occur when realised returns of a fund are different from the returns of the stated investment style. Wermers (2010) defined it as a shift in loadings on priced style factors (e.g., Fama and French (1993)) or style characteristics (e.g., Daniel and Titman (1997)) for a portfolio over time. Kurniawan, How, & Verhoeven (2016) defined it as a funds deviation from its stated style objective to some other investment style. We believe these definitions' to be ineffective and subjective, as these do not allow for any flexibility to the fund managers. There is no limit assigned to the size of maximum allowable deviations from the benchmark and at present, the industry regards every level of deviation as drift. A good definition should encompass visible, so that those who are accountable for it know whether they are succeeding in it or not (Allen & Wood, 2006). Hence, the question remains how much should be the maximum allowable deviations from the benchmark to differentiate style enhancement from style drift. Should it be one basis point, two basis point or one hundred basis point?

Devising an objective criterion is important because style drift is subject to control by regulatory authorities such as the Securities and Exchange Commission (SEC) and the regulatory environment gives the flexibility to stray from the stated investment style if investment in other styles remain less than twenty percent. That is, regulators do not penalise every level of deviation from stated objectives in a court of law and hence do not regard every deviation as style drift. Although, the Securities Act (1933) makes it a legal responsibility of a mutual fund company for the information provided in their prospectus including the investment style that a fund states to pursue. Section 13(a) of ICA forbids deviation from funds' policy as stated in funds' prospectus, but section 35 (d) (1) only makes it compulsory to have 80% of the fund holdings according to the asset type and/or geographic location as highlighted by the fund's name. This means ABC Small Cap Growth Fund may invest 80% of its assets in small cap stocks but the fund managers have the flexibility to invest the remaining 20% elsewhere. Rule 10b-5 establishes right for action of a fraud relating to material omissions and misrepresentations only. Section 18(a) of the Act also explicitly states that a person making misleading or false statements with respect to material facts will be accountable to those who relied on their statements.

Victor Zimmerman, partner at Curtis, Mallet-Prevost, Colt & Mosle states style drift to be subjective in a sense that how regulators will react to it and make a decision based on what they think is materially misleading. To date, there are no guidelines to determine this level of materiality and at what level a drift becomes material is up to the regulatory bodies to decide. That is why despite reforms in this area, there had still been numerous litigation cases pertaining to style drift in the mutual funds industry. Christopher and Stuart (2003) in their study analysing 100 hedge fund failures for past 20 years concluded 18% of the failures from investment misrepresentations to investors. Castle Hall Alternatives (2009) reviewed 327 hedge fund failures and established that 8% of the failures occurred due to marketing misrepresentation and 6% due to strategy misrepresentation.

Some of the legal cases pertaining to style drift include the following.

The lawsuit against Manhattan Investment Fund in 2000 where the fund manager invested more than 25% in technology stocks even though the offering documents allowed no more than 25% in any given sector incurred losses and inflated funds accounts to disguise investors. In 2002, the investors' accused Beacon Hill Asset Management over the charges of misrepresentation and fraudulent statements as the marketing material of the fund promoted a market neutral hedging strategy to protect the fund from interest rate movements but in fact, the fund invested absolutely in interest rate floaters, which are not market neutral. The lawsuit against Lancer Management in 2003 is another example where investors took legal actions when they discovered misrepresentations made in offering memorandum, which stated the investments in listed stocks only, but on the contrary, most of the shares were in unlisted exchanges.

Having referred to the law literature and analysing legal cases, we found out that regulators have no one way to measure the degree of drift rather it depends on case-by-case basis. At times, this may become frustrating for investors as in a court of law a plaintiff must prove that the defendant both intentionally or carelessly misrepresenting facts and was aware of the falsity of the statements when made. Investors must also be able to prove that the misstatement made by the fund manager led them to consume a loss and that the investors' damage was a direct result of the fund managers' immoral acts. On the other hand, regulatory investigations may also lead to costly delays. Hence, it would make more sense to have a system of checks and balances at first place and establishing legal boundaries that are acceptable to the regulators and the investors both rather than getting involved in time consuming regulatory investigations.

Hence, researchers should focus on devising a definition that is objective enough to embrace all the cases of drift brought forward by discontented investors in a court of law rather than analysing them on case-by-case basis. However, none of the present definitions of style drift embrace these attributes, only talks about shift / deviation/movement from the stated strategy, and fails to address, by how much? We believe that the appropriate approach to devise a more concrete and objective definition of style drift would be to first distinguish between the acceptable levels of deviation from the unacceptable ones, find the maximum allowable deviations from the benchmark and then differentiate between style enhancement and style drift. These unacceptable levels of deviation can then be categorised as style drift while the acceptable ones as the pursuit of style enhancement alone.

1.2.2. Hypothesis Development

The purpose of this research is to propose an objective definition of 'style drift' to bring different participants of the mutual funds industry on same page. The current definition gives an impression that every level of deviation from one basis point to several hundred basis points comes under the phenomenon of 'style drift', due to which investors may regard deviating even one basis point from stated objectives as a 'breach of contract'. However, practitioners and academia as well as the regulatory authorities have already recognised the importance of deviating from benchmark within limits. I therefore attempt to incorporate this level of flexibility while proposing a new and more objective definition of 'style drift'. We do this by disintegrating the level of deviations an investor can accuse in a court of law versus deviations that investors cannot accuse in a court of law and by introducing the concept of style enhancement. I define 'style enhancement' as deviations up to a pre-determined threshold level that investors cannot accuse in a court of law and 'style drift' as deviations beyond this threshold level that investors may accuse in a court of law. We do this by answering the following research questions:

What should be the threshold level of deviation from actual style mandate of the fund that separates style enhancement from style drift?

We therefore propose the following hypotheses.

H_0: There exists a threshold level of deviations from the benchmark

H_1: There exists no threshold level of deviations from the benchmark

We further propose how to determine the value of this threshold level, if there exists a threshold level of deviations from the benchmark.

1.3. Data, Definition and Methodology

1.3.1. Variable Selection

1.3.1.1. Measuring Style Drift

There might be several ways of determining the threshold level; I will present a few of those within this study by first identifying different approaches of measuring style deviation of a fund.

We can identify mutual fund style deviation using two distinct approaches and these include the return-based approach and the holding-based approach. Hence, we can proxy style drift of a fund using any of these two approaches.

The first approach uses fund returns to the returns of numerous style-based indexes and attempts to infer about portfolio's style deviation by matching portfolio returns to the returns of those indexes. . Sharpe (1992) first introduced this approach of style analysis by segregating funds return into different investment categories and calculating loadings with respect to a set of different benchmark indices. He did this by regressing historical returns of the fund on the passively constructed reference portfolio returns in order to determine the factor loadings associated with these benchmark indices. Sharpe's approach can be used to determine the style drift of a fund since, the value of these factor loadings is the effective asset mix of a portfolio and 'style drift' of a portfolio is the evolution of these asset class coefficients over time. Hence, any researcher can easily perform style analysis using this approach given that he/she is successful to obtain historical returns data on the portfolio under investigation and on passive indexes. Researchers including Fama and French (1992, 1993), Busse (1999), Chan et al. (2002) and Brown and Harlow (2005) have extensively used Sharpe's approach.

Other measures of return-based approach include Idzorek and Bertsch's (2004) style drift score (SDS) which measures the style deviation of a fund in a single statistic. This score makes use of return-based style analysis technique as introduced by Sharpe to examine numerous rolling windows and then calculates the variance of the asset class coefficients over time to approximate style drift score as the square root of the sum of these variances. High style drift score highlights high degree of style drift and low SDS highlights vice versa. . It is calculated using the following formula:

$$SDS = \sqrt{\sum_{k=1}^{k} \sigma_k^2}$$

Where

σ_k^2 = Var [$c_{k,1}$, $c_{k,2}$, $c_{k,3}$, ……., $c_{k,T}$] (that is, variance of the *k*th asset class coefficient)

Tracking error relative to the benchmark index is another return-based style deviation measure to estimate style drift of a fund. It is estimated as the funds' volatility in returns relative to its benchmark index returns. More specifically, it is the time-series standard deviation of the active returns of a fund, where the active returns of a fund is simply the difference between the return of a fund and the benchmark index return. It is calculated as follows;

$$Tracking\ Error = \sigma\ (R_{fund} - R_{benchmark\ index})$$

We can also estimate the style drift of a fund using the holding-based approach. This approach attempts to determine fund style drift through its portfolio holdings at different points in time. The researcher ranks these securities according to different characteristics (such as, book-to-market ratio and market capitalization) which defines their style and then aggregates them together at fund level to assess the style of a fund as a whole. Researchers including Grinblatt and Titman (1989), Wermers (2012) and Brown et al. (2015) measure style volatility using this approach.

This study will only explore tracking error, a traditional return-based style deviation measure to estimate style drift of a fund. I calculate it, as the time-series standard deviation of the daily active returns of a fund for each month, where the active returns of a fund is simply the difference between the daily return of a fund and its primary prospectus benchmark index return.

Tracking error is calculated using the following formula;

$$Tracking\ Error = \sigma\ (Active\ Return)$$

That is,

$$Tracking\ Error = \sigma\ (R_{fund} - R_{primary\ prospectus\ benchmark\ index})$$

Where R_{fund} represents daily return of fund and $R_{primary\ prospectus\ benchmark\ index}$ is the daily return of the primary prospectus benchmark index.

Low levels of tracking error indicates a better match between the fund and the associated benchmark index (Buncic,Eggins & Hill, 2013) which in turn highlights low levels of style drift. We may therefore regard higher levels of tracking error as lesser match between the fund and the associated benchmark index indicating higher levels of style drift. Tracking error serves as a reasonable proxy for style bets (Cremers & Petajisto, 2009) and is a good reference point to examine whether a fund deviated from its declared investment style. We use tracking error as our proxy for measuring style drift for two main reasons. Firstly, it is much easier for an amateur investor to understand relative to other style drift measures. Second, tracking error is a measure that is generally used within the industry and fund managers usually face constraints on tracking error in real world rather than constraints on style drift score or any other measure. Because, we wish to make the suggested threshold level of deviation a part of investment management mandate, we therefore use a proxy with the most practical implementation.

1.3.1.2. Risk adjusted performance:

This study employs six different performance measures. For each fund under analysis, I start by examining the relationship between raw returns of a fund and tracking error. Next, I consider the impact of tracking error on active returns as well as certainty-equivalent returns of a fund. Lastly, I calculate risk-adjusted performance of a fund using the alpha scores generated after regressing excess returns of a fund over the risk-free rate by either the one-factor capital asset pricing model (CAPM), the Fama and French (1993) three factor model ,and the Carhart (1997) four-factor model. We estimate each of these performance measures using the following specifications.

I. Raw Returns directly taken from Morningstar;

II. $AR_{i,t} = R_{i,t} – R_{b,t}$ Active Returns;

III. $CER = \left(\{(1-\Upsilon)\bar{U}\}^{\left(\frac{1}{(1-\gamma)}\right)}\right) - 1$ Certainty-Equivalent Returns;

IV. $R_{i,t} - R_{ft} = \alpha_{i,t} + \beta_1(R_m-R_f)_t + \varepsilon_{i,t}$ CAPM model;

V. $R_{i,t} - R_{ft} = \alpha_{i,t} + \beta_1(R_m-R_f)_t + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_{i,t}$ Fama-French model;

VI. $R_{i,t} - R_{ft} = \alpha_{i,t} + \beta_1(R_m-R_f)_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 MOM_t + \varepsilon_{i,t}$ Carhart Four-factor model;

In equation II, $AR_{i,t}$ represents active returns of fund i for day t, $R_{i,t}$ denotes $R_{b,t}$ daily return of fund i for day t and $R_{b,t}$ symbolizes daily return of the primary prospectus benchmark return of fund i for day t.

In equation III, $CER_{i,t}$ denotes the certainty equivalent returns of a fund for fund i in month t, ϒ represents the risk-aversion factor and is equal to 5 while $\overline{U}$ represents the average utility of a fund calculated for each fund on monthly basis using daily returns data and by employing the following formula;

$$U = \frac{(1+r)^{1-\Upsilon}}{1-\Upsilon}$$

The dependent variable for the last three equations represents the difference between the daily return of fund i (R_i) and the risk-free rate (R_f) for day t, while the independent variables are specified by the daily return series of the zero-investment factor portfolios. The terms (R_m-R_f), SMB, HML and MOM denotes excess return of the market portfolio over the risk-free rate, the return differential amongst small and large capitalization stocks, the return differential of high and low book-to-market stocks and the return differential of positive momentum and negative momentum stocks respectively. β_1, β_2, β_3 and β_4 represent expected fund loadings associated with each factor. The error term $\varepsilon_{i,t}$ represents the proportion of returns unexplained by these four factors. The intercept term of this regression that is, α, correspond to the alpha scores of a fund and is a measure of risk-adjusted performance of a fund. These alpha scores are calculated using daily data for each fund on monthly basis. I thus require each fund to have a minimum of one month of daily data for the alpha score estimation. The positive values of alpha indicates excess risk-adjusted performance and negative values indicates deficient risk-adjusted performance. More explanations of these models is outside the scope of this study.

1.3.2. Data Cleaning and Sample Construction

We construct our data by identifying all active US equity (open-ended) mutual funds from the Morningstar Direct database for the period January 1988 to December 2017. We then include only those funds that have fund size greater than $10 million and have an associated primary prospectus benchmark as defined by Morningstar (which corresponds to the offering memorandum of a fund). We then collect data for each eligible fund that have daily returns data availability for itself and its associated benchmark for at least a month. We disregard the returns data for last two trading days of funds that ceased to exist during our examination period. Lastly, we trim our data set for daily returns beyond top and bottom eight standard deviations and winsorize the remaining observations at top and bottom 3.5 standard deviations to prevent potential impact from the extreme observations.

Further, within our analysis, we include only the oldest available equity share class in order to prevent double counting of multiple share classes' and use data for both dead and alive funds to eliminate survivorship bias. After applying this screening criterion, we have a sample of 3675 funds and 399,315 observations[4].

For each of these funds, we calculate monthly tracking error and monthly risk-adjusted returns using the daily returns data of the fund and the benchmark indices. The data related to the control variables: age, expense ratio, total net assets and turnover ratio is extracted from Morningstar o monthly basis[5].

1.3.3. Model Selection and Empirical Analysis

1.3.3.1. Model Selection

I will start with a very simple and naïve method to determine this level of flexibility, by making use of the return-based style approach. We know that mutual funds chase the returns of the benchmark index, which is also a part of the funds' prospectus. Given the current definition of drift, people may think about drift, as whether investment return is different from the benchmark return. Hence, they would expect the correlation between the returns of the benchmark index and the returns of the fund under investigation to be equal to one. However, in real world, there is noise and there is no guarantee that this correlation would equal one.Also, we have already made a case that some form of deviation from the benchmark is necessary for a fund manager to time market shifts, use his skill and generate superior performance. However, one should keep in mind that outperformance and drift are two different things. It is very much possible that a fund

[4]Note the data set in consideration is an unbalanced panel data set and some funds only come in for a very short period than others.

[5]I estimate the regression models on monthly basis and therefore assign annual expense ratio and turnover ratio to all months in that year.

may have a lot of outperformance but less deviation from the benchmark. That is, even if the fund returns are not exactly mimicking the benchmark returns but rather the fund outperforms its benchmark by 10 basis points every month and you calculate the correlation coefficient between the fund and benchmark returns, it would still be one.This is because; adding a constant to any equation does not affect the outcome of that equation. It is only when this outperformance is random that it will affect the outcome and the correlation coefficient would no longer be one. The more random this outperformance the more affect it will have on the correlation coefficient.

We therefore propose the investment committee to put some relaxation in advance, by making it part of the investment management mandate and mentioning in advance to the fund investors that we expect the fund to maintain a correlation coefficient of say, for example, 80 per cent or more at any point in time. Interested parties can then use it as a monitoring tool by detecting at any point in time that whether this correlation is less than, equal to or greater than 80 per cent. If it is equal to or greater than 80 per cent a fund manager may not be liable for any consequences in a court of law but if it is less than 80 percent then a fund manager can be penalised in a court of law, if required by fund investors. Implementing such limits will assure that if deviations occur, they have limited impact on fund investors. Hence, given this hypothetical scenario, we would define style drift as when deviation of a fund's correlation coefficient (rho) is less than 80 percent (that is when rho< 0.80). We regard a fund to pursue style enhancement when the funds correlation coefficient with the benchmark is equal to or greater than 80 percent but less than 100 percent (that is when 0.8<rho<1). However, when rho it is equal to 100 percent (that is, rho=1, perfectly correlated) then the fund strictly follows its stated investment style and there is neither style enhancement nor style drift.

However, the previous approach did not discuss how to determine this threshold level of 80 percent. Therefore, I would now present a more precise method to determine this threshold level of flexibility. One way to determine a threshold level is by fitting a quadratic regression equation of a parabola. I therefore regress various performance metrics of a fund on its tracking error both with and without the addition of control variables. By the addition of control variables, I mitigate any concern that the relationship between performance and tracking error may be due to their relationship with other characteristics of a fund. The control variables include fund age, fund expense ratio, fund size, and fund turnover ratio.

I specify the pooled cross-sectional regression as follows:

$Perf_{it} = \beta_1 + \beta_2 TE_{it} + \beta_3 TE2_{it} + Controls_{it} + e_{it}$

$Perf_{it}$ represents the alpha score (i.e. risk-adjusted return) of fund i in month t generated by using either that CAPM, Fama-French or the Carhart model. It also represents active returns and the certainty equivalent returns. TE denotes the tracking error of fund i in month t, while TE2 is calculated by squaring the value of tracking error of fund i in month t. The control variables include fund age, fund expense ratio, logarithm of total net assets of a fund and fund turnover ratio.

If β_3 is positive, the parabola shapes up (is convex) and when β_3 is negative the parabola shapes down (is concave). We are interested at the point where the effect of tracking error changes from positive to negative and regard this inflection point as the threshold level of tracking error. We therefore expect a concave relationship among our variables of interest and thus expect the coefficient of TE to be positive and TE2 to be negative. We can easily find this threshold level of tracking error using the following mathematical formula:

$$\text{TE-Value } (\Upsilon) = \frac{-\beta 2}{2\beta 3}$$

To gain a more intuitive feel for this threshold level, figure 2 graphs tracking error for a hypothetical fund over time. It uses the threshold level to separate style enhancement from style drift. I have created zones based on this threshold level of tracking error over time. The dotted line represents the threshold level of tracking error. When tracking error is zero, there is nether style enhancement nor style drift. When tracking error is between zero and this threshold level (zero $< TE < \Upsilon_T$), a fund manager is only pursuing style enhancement which is neither illegal nor unethical. However, when the tracking error of a fund manager is equivalent to or exceeds this threshold level (TE ≥ Υ_T) then he has entered into the zone of style drift, which is both illegal and unethical and can be penalized in a court of law. The investment committee may consider establishing another level of tracking error represented by (Υ_b) and a dashed line. Once the fund managers reach this level (that is, when TE ≥ Υ_b) then an alert should be raised to the fund managers that they are close to reaching the threshold level of tracking error (Υ_T) and should consider limiting their actions in order to avoid scrutiny from fund investors in a court of law. Fund managers actions within this zone can be thought of as unethical but not illegal.

1.4. Empirical Analysis

1.4.1. Descriptive Statistics

Table 1.1 shows mean statistics for our sample of funds at the fund-month level. Panel A reports summary statistics related to basic fund characteristics including raw returns, fund age, expense ratio, fund flows, total net assets and the turnover ratio. A typical fund generates 0.66% raw returns each month, is about 13.6 years old, incurs an expense ratio of 1.11%, and have $1474 million of assets under management, and a turnover ratio around 74%. High levels of standard deviation indicate large variability across the funds.

Panel B reports mean statistics for our sample of funds from first month of 1988 to the last month of 2017. We show observations at the year level by taking the average of monthly raw returns, fund age, expense ratio, fund flow, fund size and turnover ratio for the sample of funds in that particular year. We also show the number of funds present in any particular year denoted by N. For each year, the number of funds present varies with 116 funds in 1988 and 1,910 funds in 2017, which highlights an overall increasing trend. The number of funds decline between 2002 and 2004, highlighting the impact of dot.com bubble. The average age of the fund is around 17.7 years at the beginning of our sample period. It falls to 10.4 years in the early 2000s and tended to increase thereafter. A mutual fund investor on average incurs an average expense ratio of 1.12 from 1988 to 2017. The mean value of expense ratio varies during the initial period of the sample but shows a downward trend from 2009 to 2017. In 2009, average expense ratio was 116 basis points, or 116 cents for every $100 invested. By 2017, this value fell to 103 basis points, a decline of 13 cents for every $100 invested. Over 1988-2017, monthly fund flows increase from -2.61% in 1988 to 1.11% in 2017 and the time-series average for the whole sample period equals 1.71% for all the funds under consideration. The average value of fund size as indicated by total net assets of a fund increases from $785 million starting from the beginning of the period to $2068 million in 2017. The average turnover ratio for the entire sample of funds is around 74.23 from 1988 to 2017.The turnover ratio was relatively higher for the time-periods coinciding with the dot.com bubble and the global financial crisis.

To gauge how the overall fund tracking error change over time, I plot Figure 1.1 the yearly cross-sectional mean, median, standard deviation, as well as the values for upper and the lower quartiles of tracking error from 1988 to 2017. Table 1.2 reports summary statistics for tracking error related to figure 1.1. The average tracking error value is around 5.70% for the whole sample of funds with a standard deviation around 4.49%. There are two obvious spikes around 2000 and 2008 coinciding to the period of the dot.com bubble and the 2008 financial crisis.

Table I.3 demonstrates funds characteristics related to each style category for the sample of funds under consideration. We report the mean values for tracking error, raw returns, age, expense ratio, fund flow, total net assets, and turnover ratio for each style category. The tracking error is lowest (4.85%) for Large-cap value funds and highest (6.70%) for Small-cap growth funds. Overall, large cap funds experience lower tracking error relative to other style categories, that is, they closely follow their benchmark index as compared to others. On the other hand, all growth funds exhibit high tracking error that is, greater deviation from their stated style. The average annualized raw returns for the large-cap funds are poorer than small-cap and mid-cap funds. The highest relates to Small-cap value funds of 0.90 percent. The highest expense ratio of 1.27 percent is associated with Small-cap growth funds, while the lowest relates to Large-cap blend funds of 1.02 percent. Turnover ratio of 93.30 percent is the highest for Mid-cap growth funds followed by Small-cap growth funds of 92.46% and lowest for Large-cap value funds of 56.46 percent. The biggest fund size is associated with large-cap funds and the smallest fund size with small-cap funds and ranges between $1656m to $569m. Overall, higher levels of tracking error are associated with smaller fund size, higher expense ratio and higher turnover ratio.

Table 1.3 represents the correlation matrix between raw returns and tracking error, age, expense ratio, fund flow, total net assets and turnover ratio. The correlation coefficient between risk-adjusted returns and tracking error, expense ratio and turnover ratio is negative and significant. While, the relationship between risk-adjusted returns and size, age and fund flow is positive and significant. Overall, the correlation among the independent variables is quantitatively small, suggesting limited impact of multicollinearity.

1.4.2. Baseline Results

This section examines the relationship between performance and tracking error using multivariate regression analysis. It also examines the impact of tracking error on performance of a fund using Fama MacBeth regression. I test this relationship by regressing fund performance on tracking error both with and without controlling for fund characteristics that may affect fund performance and using time and fund fixed effects.

$$Perf_{it} = \beta_1 + \beta_2 TE_{it} + \beta_3 TE2_{it} + \beta_4 Age_{it} + \beta_5 ExpRatio_{it} + \beta_6 TNA_{it} + \beta_7 TurnRatio_{it} + Year_t + e_{it}$$

where $Perf_{it}$ represents either the raw return, active return, certainty equivalent return or the risk-adjusted return during month t under the CAPM, Fama-French three-factor model, or Carhart four factor model; TE_{it} is the tracking error of a fund related to month t; TE^2_{it} represents the squared of tracking error. Control variables include the Age_{it} of the fund age in month t; $ExpRatio_{it}$ represents the expense ratio of a fund in month t; TNA_{it} is the natural logarithm of total net assets (in million dollars) of the fund related to month t; $TurnRatio_{it}$ represents the turnover ratio in month t. $Year_t$ (year dummies) is indicative of year fixed effects accounting for cross-sectional dependence.

In each month, I regress different performance measures on tracking error (TE) and tracking error squared (TE2). A positive β_3 coefficient is indicative of a convex relationship between performance and tracking error while a negative β_3 coefficient is indicative of a concave relationship among the two. Since, we are interested in finding the inflection point where the effect of tracking error changes from positive to negative; we therefore expect β_2 to be positive and β_3 to be negative.

Panel A and Panel B of Table 1.4 shows the multivariate regression results for pooled cross-sectional regression for sample period 1988-2017 both with and without the impact of control variables. The model tends to examine how tracking error is related to risk-adjusted returns of a fund that is, the effect of deviating and moving away from the stated objectives on the performance of a fund. We introduce time fixed effects to limit the impact of any unobserved heterogeneity on the cross-section of funds due to the passage of time and fund fixed effects for controlling invariant and unobservable fund characteristics. In Panel A of Table 1.4, the dependent variable for first two columns is the raw returns of a fund, for the third and fourth column it is the active returns of a fund, and for the last two columns it is the certainty- equivalent returns of a fund. In Panel B of Table 1.4, the dependent variable for first two columns is the risk-adjusted return obtained through CAPM, the columns following the CAPM it is the risk-adjusted returns obtained through Fama French three-factor model and for the last two columns, it is the risk-adjusted returns from Carhart four-factor model. The focus is on the coefficient estimate of tracking error (TE) and tracking error squared (TE2) that is, β_2 and β_3 respectively.

The results indicate a concave relationship between tracking error and risk-adjusted returns of a fund, evident from negative parameter estimate for β_3 significant at 1% level of significance across all model specifications except where the dependent variable was obtained through the Fama French three factor model and the Carhart four-factor model. However, it is only where the dependent variable was active returns that the relationship between performance and tracking error changes from positive to negative that is, the coefficient estimate for β_2 is positive while β_3 is negative. This implies that initially when the tracking error is zero basis pointing the relationship between the tracking error and performance is such that the performance of a fund would increase by 0.02 basis points with every one basis point increase in tracking error. However, this gain decreases by 0.01 basis point and even becomes negative after the threshold level of tracking error reaches.

In order to best gauge the relationship among our variables of interest we should take into account the time-varying betas. Therefore, I further test the role of tracking error on performance of a fund on a cross sectional basis using the methodology proposed by Fama and MacBeth (1973). There are two main reasons to incorporate this approach. First, it accounts for time-varying betas and second, it estimates standard errors by eliminating the issue of heteroscedasticity and correlation among errors.

For each period, starting from 1988 to 2017, fund performance is regressed on tracking error and other control variables related to fund characteristics. We record the estimated coefficients generated from each period's cross-sectional regression. We then calculate the mean for each of the parameters from the time-series of these estimated coefficients. Table 1.5 represents the results obtained through Fama MacBeth regression analysis. The results of the Fama MacBeth regression support our hypothesis when the dependent variable is either active returns, risk-adjusted returns from CAPM, three-factor model or the four-factor model. However, these results are only significant from estimates obtained from active returns and CAPM at 5 percent and 10 percent level of significance respectively.

1.4.3. RobustnesTests

1.4.3.1. Post-crisis Analysis

In this section, I investigate if the main results change when I conduct the analysis using the post-crisis period. I therefore rerun the tests for the post-crisis period from 2009-2017.Panel A and Panel B of Table 1.5 reports the results. The results are very similar to the full sample when the dependent variable is active returns and three-factor returns. However, the results where the dependent variable is the four-factor risk-adjusted returns, the relationship has shifted from convex to concave. While when it is raw returns, certainty equivalent returns and CAPM the relationship has shifted from concave to convex.

1.4.3.2. Small Funds versus Large Funds

I further test the robustness of main results by partitioning the full sample into large and small funds. To partition funds in each month, I split the funds based on the sample median of the size for funds. I then define funds below the median size as small funds and funds above the median size as large funds.

The results related to this analysis are presented in Table 1.6. The results are similar to the main sample, except for small funds with three-factor model as the dependent variable, where it shows a negative coefficient for $\beta_{3,}$,but it is statistically insignificant.

1.5. Conclusion

In this study, I attempt to differentiate between the concepts of style enhancement and style drift by investigating the relationship between various performance metrics and tracking error. We do this by investigating the threshold level of tracking error by hypothesizing a concave relationship between performance and tracking error. We use a quadratic regression model and multivariate regression analysis along with the Fama MacBeth regression analysis to determine the presence of threshold level of tracking error.

The main results of our regression for the sample period 1988-2017 are inconsistent with respect to the usage of different performance metrics. Hence, we are unable to suggest any fixed relationship that is, whether a concave relationship or a convex relationship exists between the risk-adjusted returns and tracking error. However, the results from Fama MacBeth regression analysis, depict a consistent concave relationship between the two variables of interest across four of the six regression models, and suggest that a threshold level of tracking error does exist.

Owing to these findings, I suggest investors, industry and the regulators to regard deviations up to the threshold level of tracking error as the pursuance of style enhancement alone and only the deviations that are beyond this threshold level to fall under the definition of style drift. Fund managers pursuing style enhancement should not be penalised to deviate from benchmark. I further recommend this threshold level to be made part of the investment management mandate, so that fund managers can utilise their skill freely without worrying about being penalised in a court of law.

1.6 References

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Figures and Tables

Figure 1.1: The Time Trend of Tracking Error

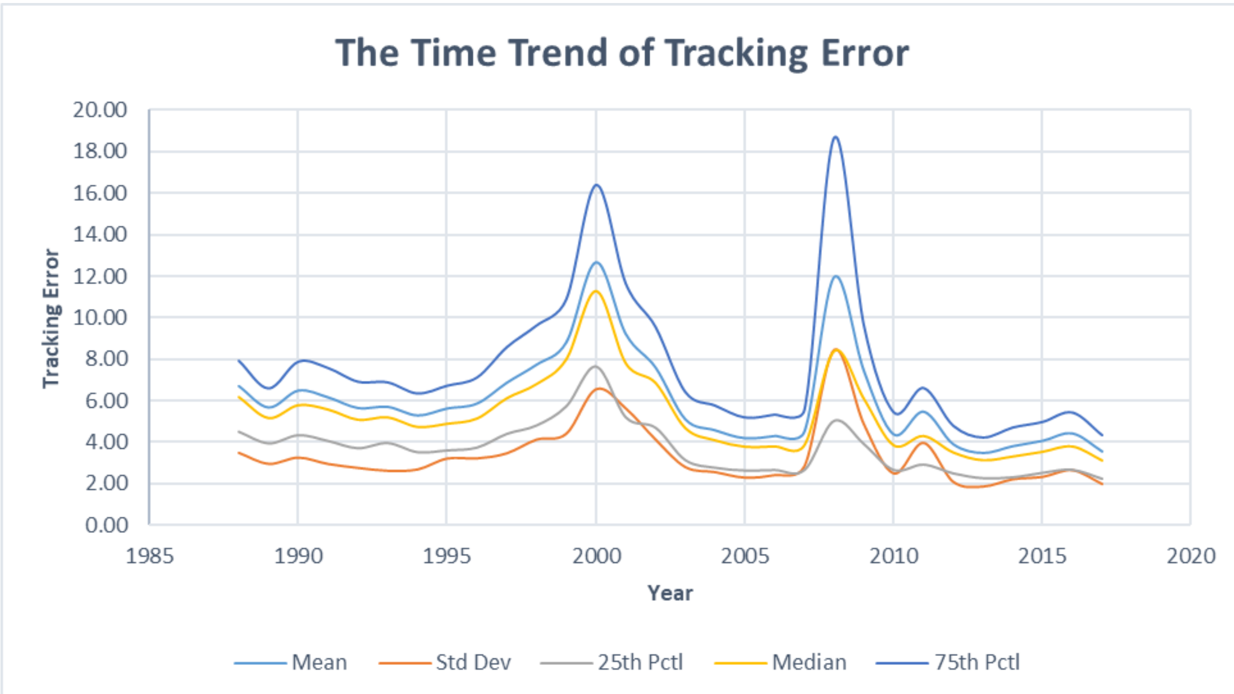

Figure 1.2: Style Enhancement versus Style Drift

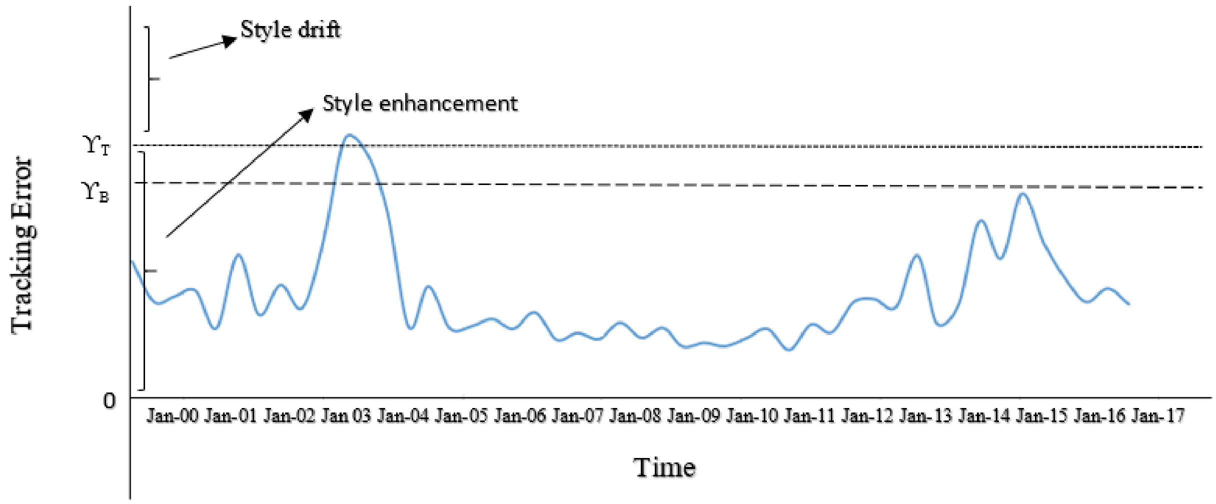

Table 1.1: Summary Statistics

This table represents summary statistics that include the mean, the standard deviation, the 25th percentile, the median and the 75th percentile. This study makes use of 2688 U.S actively managed funds over the period 1988-2017.

Fund Characteristics	Mean	StdDev	25th	Median	75^{th}
Fund Net Return (%)	0.66	3.58	-1.19	0.95	2.80
Fund Age (year)	43.11	12.88	34.58	39.92	47.00
Fund Flow (%)	1.71	8.22	-2.39	1.13	4.77
Fund total net assets ($ million)	1474.60	5561.97	59.20	247.90	975.45
Expense ratio (%)	1.11	0.39	0.87	1.06	1.30
Turnover ratio (%)	74.23	62.99	30.65	57.00	97.20

Table 1.2: Mutual Fund Characteristics Over Time

This table represents summary statistics over the sample period 1988-2017.The cross-sectional mean values are calculated for fund characteristics that include the number of funds existing each year, average net fund returns (in percentage terms), fund's age (in years),expense ratios (in percentage terms), total net assets (in million dollars),turnover ratio (in percentage terms).

Year	N	MR (%)	Age (Year)	Exp Ratio (%)	TNA ($ million)	Turn Ratio (%)
1988	116	1.79	17.72	1.15	785.41	72.22
1989	122	0.73	17.70	1.15	881.79	69.25
1990	133	-0.07	17.91	1.16	933.53	70.68
1991	218	1.86	17.19	1.15	671.29	72.15
1992	247	0.65	16.48	1.12	779.61	64.43
1993	319	0.82	14.93	1.12	858.74	66.84
1994	387	-0.03	13.10	1.14	826.33	73.02
1995	509	1.83	12.70	1.16	977.18	77.94
1996	561	1.22	12.48	1.14	1222.12	82.13
1997	643	1.57	12.41	1.14	1466.02	83.26
1998	734	1.05	11.74	1.13	1664.62	86.70
1999	823	1.49	11.64	1.15	1831.34	88.33
2000	915	0.25	11.45	1.15	1962.61	93.10
2001	1001	0.38	11.80	1.15	1585.64	90.20
2002	1201	-1.40	11.21	1.18	1201.00	85.68
2003	654	1.90	10.40	1.22	1137.28	86.37
2004	948	0.88	12.06	1.13	1661.99	74.82
2005	1554	0.54	11.83	1.15	1425.83	74.13
2006	1702	0.82	11.83	1.13	1493.43	76.63
2007	1824	0.49	12.17	1.11	1611.93	76.96
2008	1936	-2.13	12.45	1.12	1225.35	87.69
2009	2023	1.80	12.95	1.14	931.35	89.68
2010	2046	1.14	13.57	1.12	1133.38	76.25
2011	2015	0.28	13.97	1.11	1279.02	72.12
2012	1996	0.97	14.47	1.09	1313.29	66.31
2013	1963	1.91	14.99	1.06	1594.72	63.80
2014	2002	0.56	15.21	1.05	1810.42	61.26
2015	2008	-0.04	15.78	1.05	1836.51	61.23
2016	1964	0.73	16.50	1.04	1789.83	60.90
2017	1910	1.17	17.19	1.02	2068.16	57.84
1988-2017	2688	0.66	13.63	1.11	1474.60	74.23

Table 1.3: Mutual Fund Characteristics By Style

This table reports mean values for mutual fund characteristics grouped by style for the full sample period 1988-2017. I report nine style classifications that include large-cap blend (LB), large-cap growth (LG), large-cap value (LV), mid-cap blend (MB), mid-cap growth (MG), mid-cap value (MV), and small-cap blend (SB), small-cap growth (SG) and small-cap value (SV).

Style category	Perf	TEV	Age	Exp Ratio	Flow	TNA	Turn Ratio
LB	0.74	4.88	15.42	1.02	1.59	1655.98	68.20
LG	0.78	5.61	16.03	1.08	1.56	2277.73	79.42
LV	0.73	4.85	14.24	0.97	1.59	2017.71	56.46
MB	0.82	6.45	10.39	1.22	1.85	687.05	75.69
MG	0.84	6.55	13.78	1.18	1.68	1012.98	93.30
MV	0.84	5.83	10.12	1.10	2.08	1426.32	67.45
SB	0.85	6.08	9.86	1.20	2.00	569.18	70.70
SG	0.89	6.70	12.14	1.27	1.78	616.35	92.46
SV	0.90	6.41	10.43	1.22	2.09	644.19	63.52

Table 1.4: The Time Trend of Tracking Error

This table summarizes the cross-sectional mean, standard deviation, 25th percentile, median and the 75th percentile for tracking error at the end of each year as well as over the entire sample period from 1988-2017.

Year	Mean	Std Dev	25th Pctl	Median	75th Pctl
1988	6.73	3.50	4.52	6.18	7.93
1989	5.70	2.98	3.97	5.17	6.60
1990	6.51	3.27	4.36	5.79	7.89
1991	6.18	2.97	4.08	5.58	7.58
1992	5.67	2.78	3.73	5.08	6.93
1993	5.73	2.65	3.98	5.20	6.89
1994	5.32	2.71	3.55	4.74	6.36
1995	5.65	3.23	3.63	4.89	6.74
1996	5.89	3.24	3.76	5.14	7.13
1997	6.89	3.48	4.42	6.12	8.59
1998	7.76	4.14	4.82	6.81	9.63
1999	8.83	4.42	5.74	8.01	10.90
2000	12.68	6.55	7.64	11.30	16.40
2001	9.22	5.62	5.21	7.80	11.64
2002	7.62	4.14	4.71	6.86	9.55
2003	5.13	2.82	3.17	4.68	6.42
2004	4.60	2.58	2.80	4.09	5.77
2005	4.22	2.32	2.67	3.78	5.20
2006	4.33	2.44	2.69	3.80	5.34
2007	4.55	2.86	2.70	3.86	5.58
2008	11.97	8.43	5.05	8.41	18.68
2009	7.44	4.86	3.93	6.08	9.61
2010	4.41	2.52	2.69	3.85	5.45
2011	5.50	3.98	2.95	4.30	6.62
2012	3.93	2.12	2.53	3.50	4.80
2013	3.52	1.89	2.30	3.13	4.24
2014	3.84	2.24	2.34	3.31	4.72
2015	4.10	2.35	2.56	3.54	4.99
2016	4.45	2.67	2.70	3.79	5.44
2017	3.59	2.01	2.27	3.12	4.35
1988-2017	5.70	4.49	2.93	4.36	6.74

Table 1.5: Panel Regression with time and fund fixed effects for Sample Period (1988-2017)

This table inspects the relationship between tracking error and performance of funds. The dependent variable in first two columns of Panel A include raw return, the next two columns report results with active return as the dependent variable and the last two columns report results where certainty-equivalent return is the dependent variable. Panel B report risk-adjusted returns through CAPM as the dependent variable in the first two columns. It then uses risk-adjusted returns through Fama French 3-factor model. The last two columns use the risk-adjusted returns based Carhart 4-factor model as dependent variable. I control for the age of the fund, expense ratio, natural logarithm of total net assets and the turnover ratio of the fund .I further control for time and fund fixed effects. I report t-values in the parenthesis. Asterisks *, ** and *** represent statistical significance at the level of 10%, 5% and 1% level, respectively.

$$Perf_{it} = \beta_1 + \beta_2 TEit + \beta_3 TE2_{it} + \beta_4 Age_{it} + \beta_5 ExpRatio_{it} + \beta_6 TNAit + \beta_7 TurnRatio_{it} + Year_t + e_{it}$$

Panel A	Raw Return		Active Return		Certainty-Equivalent Return	
TE	-2.1271***	-1.9745***	0.0231***	0.0223***	-0.1734***	-0.1656***
	(-20.10)	(-18.64)	(10.70)	(10.28)	(-34.05)	(-32.48)
TE2	-1.2193***	-1.3623***	-0.0084***	-0.0084***	-0.580***	-0.0656***
	(-19.57)	(-21.82)	(-6.56)	(-6.62)	(-19.36)	(-21.82)
Age		0.8186***		0.0018***		0.0436***
		(32.01)		(3.36)		(35.47)
Exp Ratio		0.2913***		0.0008		0.0185***
		(5.31)		(0.67)		(7.00)
Log(Size)		0.0149***		-0.0037***		0.0004
		(1.82)		(-22.11)		(1.09)
Turn Ratio		0.00059***		-0.0000069*		0.000033***
		(3.17)		(-1.80)		(3.71)
Time and Fund Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.1195	0.1219	0.0164	0.0178	0.1567	0.1595
Panel B	**CAPM**		**3-Factor Alpha**		**4-Factor Alpha**	
TE	-0.0218***	-0.0244***	-0.0163***	-0.0176***	-0.0329***	-0.0347***
	(-9.29)	(-10.35)	(-8.62)	(-9.30)	(-17.39)	(-18.31)
TE2	-0.0115***	-0.0101***	0.0032***	0.0038***	0.0160***	0.0170***
	(-8.27)	(-7.26)	(2.90)	(3.42)	(14.40)	(15.24)
Age		-0.0055***		-0.0026***		-0.0048***
		(-9.71)		(-5.73)		(-10.58)
Exp Ratio		0.0041***		0.0001		0.0010
		(3.35)		(-0.14)		(1.02)
Log(Size)		-0.0033***		-0.0028***		-0.0031***
		(-18.41)		(-19.28)		(-20.93)
Turn Ratio		-0.000046		-0.000011***		-0.000018***
		(-1.10)		(-3.38)		(-5.28)
Time and Fund Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.0350	0.0362	0.0227	0.0237	0.0196	0.0211

Table 1.6: Fama-MacBeth Multivariate Regression for Sample Period (1988-2017)

This table inspects the relationship between tracking error and performance of funds using Fama and MacBeth regression analysis The dependent variables include raw return, active return, certainty-equivalent return is the dependent variable in Panel A. Panel B report risk-adjusted returns through ,Fama French 3-factor model and the Carhart 4-factor model as dependent variable. I control for the age of the fund, expense ratio, natural logarithm of total net assets and the turnover ratio of the fund. I report t-values in the parenthesis. Asterisks *, ** and *** represent statistical significance at the level of 10%, 5% and 1% level, respectively.

$$Perf_{it} = \beta_1 + \beta_2 TEit + \beta_3 TE2_{it} + \beta_4 Age_{it} + \beta_5 ExpRatio_{it} + \beta_6 TNAit + \beta_7 TurnRatio_{it} + e_{it}$$

Panel A	Raw Returns		Active Returns		Certainty-Equivalent Return	
TE	-1.4760**	-1.7415**	0.0420***	0.0432***	-0.0943**	-0.1089**
	(-2.13)	(-2.37)	(2.81)	93.04)	(-2.53)	(-2.71)
TE2	0.3643	0.4719	-0.0302**	-0.0315**	0.0217	0.0102
	(0.82)	(1.07)	(2.17)	(-2.13)	(0.16)	(0.46)
Age		-0.0042***		-0.0001**		-0.0002***
		(-4.68)		(-2.05)		(-4.31)
Exp Ratio		0.2478***		-0.0018		0.0133***
		(3.95)		(-1.17)		(3.48)
Log(Size)		0.0260*		0.0001		0.0007
		(1.81)		(0.31)		(1.02)
Turn Ratio		0.00073		0.000017***		0.000009***
		(1.38)		(-2.63)		(3.38)
R2						

Panel B	CAPM		3-Factor Model		4-Factor Model	
TE	0.0156	0.0126	0.0055	0.0068	0.0032	0.0040
	(0.92)	(0.86)	(0.49)	(0.63)	(0.29)	(0.38)
TE2	-0.0229*	-0.0215*	-0.0048	-0.0054	-0.0058	-0.0058
	(-1.95)	(-1.99)	(-0.49)	(-0.56)	(-0.59)	(-0.59)
Age		-0.0001**		-0.0001***		-0.0001***
		(-2.69)		(-2.87)		(-4.69)
Exp Ratio		0.0012		-0.0012		-0.0018**
		(0.69)		(-1.19)		(-2.17)
Log(Size)		0.0000		0.0000		-0.0005*
		(-0.04)		(-0.01)		(-1.81)
Turn Ratio		-0.00000007		-0.0000012		-0.00003**
		(0.00)		(-0.06)		(-2.19)
R2						

Table 1.7: Panel Regression with time and fund fixed effects for Post Crisis Period (2009-2017)

This table inspects the relationship between tracking error and performance of funds. The dependent variable in first two columns of Panel A include raw return, the next two columns report results with active return as the dependent variable and the last two columns report results where certainty-equivalent return is the dependent variable. Panel B report risk-adjusted returns through CAPM as the dependent variable in the first two columns. It then uses risk-adjusted returns through Fama French 3-factor model. The last two columns use the risk-adjusted returns based Carhart 4-factor model as dependent variable. I control for the age of the fund, expense ratio, natural logarithm of total net assets and the turnover ratio of the fund .I further control for time and fund fixed effects. I report t-values in the parenthesis. Asterisks *, ** and *** represent statistical significance at the level of 10%, 5% and 1% level, respectively.

$$Perf_{it} = \beta_1 + \beta_2 TEit + \beta_3 TE2_{it} + \beta_4 Age_{it} + \beta_5 ExpRatio_{it} + \beta_6 TNAit + \beta_7 TurnRatio_{it} + Year_t + e_{it}$$

Panel A	Raw Return		Active Return		Certainty-Equivalent Return	
TE	-7.8222***	-7.4464***	0.0267***	0.0232***	-0.5041***	-0.4829***
	(-43.97)	(-41.79)	(9.07)	(7.85)	(-59.29)	(-56.74)
TE2	4.3273	4.2277***	-0.0198***	-0.0191***	0.2191***	0.2135***
	(33.06)	(32.33)	(-9.13)	(-8.84)	(35.02)	(34.19)
Age		0.8165***		-0.0077***		0.0462***
		(24.34)		(-13.77)		(28.83)
Exp Ratio		0.4287***		0.0061***		0.0273***
		(4.09)		(3.52)		(5.46)
Log(Size)		0.1827***		-0.0033***		0.0108***
		(11.27)		(-12.16)		(14.06)
Turn Ratio		-0.000014		0.00003***		0.000011
		(-0.04)		(-5.63)		(0.71)
Time and Fund Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.0556	0.0590	0.0210	0.0229	0.0668	0.0717

Panel B	CAPM		3-Factor Model		4-Factor Model	
TE	-0.0364***	-0.0396***	-0.0080***	-0.0136***	0.0190***	0.0154***
	(-10.92)	(-11.86)	(-3.00)	(-5.10)	(7.27)	(5.87)
TE2	0.0105***	0.0110***	0.0281***	0.0040**	-0.0255***	-0.0249***
	(4.27)	(4.50)	(1.44)	(2.02)	(-13.26)	(-12.93)
Age		-0.0076***		-0.0125***		-0.0080***
		(-12.12)		(-25.02)		(-16.18)
Exp Ratio		0.0071***		0.0060***		0.0038**
		(3.63)		(3.81)		(2.46)
Log(Size)		-0.0027***		-0.0042***		-0.0034***
		(-9.05)		(-17.22)		(-14.42)
Turn Ratio		-0.000036***		-0.000039***		-0.000034***
		(-5.90)		(-8.04)		(-7.21)
Time and Fund Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.0356	0.0371	0.0298	0.0348	0.0269	0.0295

Table 1.8: Panel Regression with time and fund fixed effects for Small and Large Funds (1988-2017)

This table inspects the relationship between tracking error and performance of funds. The dependent variable in first two columns of Panel A include raw return, the next two columns report results with active return as the dependent variable and the last two columns report results where certainty-equivalent return is the dependent variable. Panel B report risk-adjusted returns through CAPM as the dependent variable in the first two columns. It then uses risk-adjusted returns through Fama French 3-factor model. The last two columns use the risk-adjusted returns based Carhart 4-factor model as dependent variable. I control for the age of the fund, expense ratio, natural logarithm of total net assets and the turnover ratio of the fund .I further control for time and fund fixed effects. I report t-values in the parenthesis. Asterisks *, ** and *** represent statistical significance at the level of 10%, 5% and 1% level, respectively.

$$Perf_{it} = \beta_1 + \beta_2 TEit + \beta_3 TE2_{it} + \beta_4 Age_{it} + \beta_5 ExpRatio_{it} + \beta_6 TNAit + \beta_7 TurnRatio_{it} + Year_t + e_{it}$$

Panel A	Raw Returns		Active Returns		Certainty-Equivalent Return	
	Small	Large	Small	Large	Small	Large
TE	-1.8758***	-2.1820***	0.0126***	0.0376***	-0.1660***	-0.1728***
	(-12.24)	(-14.39)	(3.86)	(12.75)	(-22.58)	(-23.62)
TE2	-1.3235***	-1.4898***	-0.0007	-0.0223***	-0.0615***	-0.0730***
	(-14.96)	(-16.29)	(-0.40)	(-12.50)	(-14.48)	(-16.55)
Age	0.8837***	0.7643***	0.0000	0.0036***	0.0483***	0.0394***
	(23.58)	(21.85)	(0.04)	(5.27)	(26.84)	(23.38)
Exp Ratio	0.2530***	0.4401***	0.0001	-0.0029	0.0154***	0.0334***
	(3.6)	(3.58)	(0.10)	(-1.22)	(4.58)	(5.63)
Log(Size)	0.0322**	0.1159***	-0.0030***	-0.0052***	0.0014**	0.0056***
	(2.29)	(6.28)	(-10.24)	(-14.54)	(2.09)	(6.30)
Turn Ratio	0.00047*	0.00051	0.0000095*	-0.000021***	0.000037***	0.000016
	(1.79)	(1.63)	(-1.72)	(-3.41)	(2.98)	(1.11)
Time and Fund Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.1250	0.1243	0.0264	0.0194	0.1634	0.1616

	Small	Large	Small	Large	Small	Large
TE	-0.0249***	-0.0222***	-0.0117***	-0.0261***	-0.0252***	-0.0484***
	(-7.13)	(-6.78)	(-4.09)	(-10.19)	(-8.82)	(-18.82)
TE2	-0.0091***	-0.0141***	-0.0001	0.0080***	0.0095***	0.0269***
	(-4.51)	(-7.13)	(-0.06)	(5.15)	(5.77)	(17.37)
Age	-0.0061***	-0.0047***	-0.0022***	-0.0029***	-0.0041***	-0.0054***
	(-7.17)	(-6.24)	(-3.11)	(-4.89)	(-5.84)	(-9.18)
Exp Ratio	0.0030*	0.0022	0.0001	-0.0056***	0.0004	-0.0013
	(1.85)	(0.84)	(0.04)	(-2.70)	(0.30)	(-0.62)
Log(Size)	-0.0023***	-0.0048***	-0.0027***	-0.0029***	-0.0026***	-0.0037***
	(-7.09)	(-12.16)	(-10.21)	(-9.15)	(-10.15)	(-11.87)
Turn Ratio	-0.000008	-0.000018***	-0.000018***	-0.000015***	-0.000018***	-0.000028***
	(-1.36)	(-2.74)	(-3.70)	(-2.92)	(-3.68)	(-5.35)
Time and Fund Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.0458	0.0371	0.0302	0.0135	0.0283	0.0254

Variable Definitions

Perf =monthly return, active return, certainty-equivalent return or monthly alpha estimated over daily returns of the fund, based on either CAPM, the Fama French three-factor model and the Carhart four-factor model.

TE = monthly tracking error of a fund estimated as the standard deviation of the daily active returns of a fund

TE2 = the squared of the tracking error (TE)

Log (Age) = the natural logarithm of the age of the fund (in years)

Exp Ratio = the expense ratio (in %) of a fund

Log (TNA) = the natural logarithm of the total net assets of a fund (in millions of dollar)

Turn Ratio = the turnover ratio (in %) of a fund