Trading on Overshooting

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Abstract

This article studies a price component of individual stocks which, albeit stationary, has a mean shift at a low frequency. When investors underreact to an increase/decrease in the mean of the price component, they mistake it for negative/positive temporary shocks to the current price, and increase purchases/sales of the stocks. As a result, upward/downward mean shifts lead to overvaluation/undervaluation, which subsequently cause return reversals. I provide novel empirical evidence on profitability of trading strategies that exploit cross-sectional variations in the mean shifts. Buying/shortselling closed-end mutual funds with downward/upward mean shifts of the price-to-NAV ratio produces risk-adjusted returns of 3% to 8% per year. Overreaction might not explain these results: trading on past returns is less profitable than trading on overshooting.

JEL Classification Codes: G11, G12, G23.

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1. Introduction

Fama and French (1986) and Summers (1986), among others, propose that asset prices comprise both a random walk and a stationary component. Whereas shocks to the permanent component are not predictable, shocks to the stationary component result in predictable variations in expected returns (Fama and French, 1986, 1988). Stationary price ratios, such as price-to-earnings and price-to-dividend ratios, are often used to study time variations in expected returns. Yet, many studies find the predictability of price ratios for aggregate market returns weaker out of sample (e.g., Welch and Goyal, 2008). Lettau and Van Nieuwerburgh (2007) advance the idea that the aggregate price-to-dividend ratio has mean shifts at a low frequency, and show that taking into account the structural breaks improves the out-of-sample predictability. Such mean shifts can also provide profitable trading opportunities. When investors do not immediately believe the mean shift but only gradually learn about it, mispricing might occur. Yet, those opportunities are difficult to exploit at the aggregate level because the mean shift is so rare. Lettau and Van Nieuwerburgh find only one or two mean shifts of the aggregate price ratio in 78 years from 1927 to 2004.

This article applies a similar analysis to the return patterns of individual stocks. Provided that those structural changes are mostly idiosyncratic events, mean shifts of price ratios at the firm level should vary across stocks and spread over time. I present a simple model of mispricing due to an underreaction to mean shifts of price ratios. Then I provide novel empirical evidence on the profitability of trading strategies that exploit cross-sectional variations in the mean shifts.

The model shows that an underreaction to mean shifts of price ratios results in overshooting, followed by return reversals. Take Intel as an example in "End of an Era: Big Tech Stocks Move from Growth to Value" (Ryniec, 2019). Suppose Intel will be no longer a growth but value stock because of sluggish technological innovations, e.g., a decrease in the mean price-to-earnings ratio. Expected returns decrease amid the negative permanent shock, but it has no bearings on temporary shocks to the current price. Investors who are ignorant of the downward mean shift, nevertheless, infer a positive temporary shock to the price. This is because lower expected returns are generally associated with a price rise in the current period. As investors mistakenly believe the stock is overvalued, they increase (short) sales. As a result, the stock price decreases by more than the mean shift, and subsequently increases as investors gradually learn about the permanent shock.

It is important to note that such mispricing is driven by an underreaction to permanent shocks to the price component that is otherwise stationary. Considering the mean shifts is an essential element of the model. Both permanent and temporary shocks to the price ratio change expected returns. In asset pricing models without the permanent shocks, there are only fundamental growth shocks and temporary shocks to the price ratio. The latter shocks are negatively related to expected returns because the price ratio reverts to the mean. For example, Cochrane (2009) describes, "A price rise with no change in dividends results in lower subsequent returns." The price drops on average after a positive temporary shock to the price-to-dividend ratio. However, expected returns might also be lower because of a decrease in the mean price ratio. Such permanent shocks, albeit rare, are another source of variations in expected returns in my model.[1] Figure 1 illustrates the difference between temporary and permanent shocks to the price ratio. The y-axes and x-axes represent expected returns over the fundamental growths and temporary shocks to the price ratio, respectively. Because of mean reversion of the price ratio, the two variables are negatively related as shown by the negative slopes. In contrast, a mean shift of the price ratio shifts the relationships vertically, up (Figure A) or down (Figure B). Unlike the temporary shocks, mean changes of the price ratio have no bearings on the current price.

Misinterpreting permanent shocks to the price ratio as temporary shocks in the current period leads to mispricing and subsequent return reversals. Given an increase in the mean price ratio, expected returns are higher during the structural change (Figure 1 (A), solid line). Suppose uninformed investors cannot distinguish permanent and temporary shocks to the price ratio, and always relate deviations of expected returns from the fundamental growths to the temporary shocks (dashed line). In Figure 1 (A), given a higher expected return, they associate it with a lower temporary shock, i.e., the point on the dashed line that the horizontal arrow points at. As investors wrongly update that the stock is undervalued

[1] To focus on shocks to the stationary price component, I assume that the fundamental component is a random walk with an independent and identically distributed shock. As a result, the expected fundamental growth does not vary, and thus does not affect variations in the price-to-fundamentals ratio.

relative to their prior beliefs, they buy the stock, thereby increasing the price. As a result, the expected returns are even higher, e.g., the point on the solid line that the vertical arrow points at. Any point on the solid line moves in the north-west direction, leading to overshooting. Similarly, given a decrease in the mean price ratio (Figure 1 (B)), any point on the solid line moves in the south-east direction, causing undervaluation. This model provides an explanation of why future returns are negatively related to the component of stock returns that is orthogonal to the firm's fundamental growths (Daniel and Titman, 2006). Only with upward/downward mean shifts, stocks consistently outperform/underperform the fundamental growths. Without them, stock returns would converge to the fundamental growths.

The model is agnostic about the underlying causes of mean shifts of the price ratios and an underreactions to them. However, shocks to the price ratio, whether permanent or temporary, are not observable. Given that a mean shift of the price ratio is a rare event, investors cannot rely on historical data to forecast the new mean. Even researchers with complete data find it challenging to detect and analyze structural changes (see a review by Perron, 2008). Therefore, it is reasonable to assume incomplete information about the mean shift, either the timing or size of it. Moreover, the model assumes that investors are apathetic about (or underreact to) the mean shift because it is rare and difficult to forecast. This assumption is similar to attitudes toward catastrophic events that lead to loss of fundamentals, such as a dividend loss in Gabaix (2012) and a consumption loss in Wachter (2013). Several studies argue that investors underestimate such rare disasters (e.g., Hertwig et al., 2004; Taleb, 2007; Abdellaoui, L'Haridon, and Paraschiv, 2011; and Barberis, 2013).[2]

The overshooting model can be applied to the market price of any asset. Consider a nonstationary fundamental variable that has a cointegration relationship with the price (in logarithm). Given the long-run relation that ties the price and the fundamentals together, the price-to-fundamental ratio is the stationary price component. A trading strategy that identifies firms with a mean shift of the price-to-fundamentals ratio can exploit return reversals following the structural break. Stocks with a downward (upward) mean shift experience

[2] My model, however, focuses on mean shifts of the price ratio, not those of the fundamental growths. In the models of Lewis (1989) and Timmermann (2001), the growth rate of the fundamental component has mean shifts at a low frequency. Incorporating both mean shifts of the fundamental growth and the price ratio (e.g., the earnings growth and the price-to-earnings ratio, respectively) is an extension of my model.

higher (lower) returns on average in the subsequent periods. Buying stocks with a downward mean shift and shortselling stocks with an upward mean shift earns high expected returns.

Similar to corporate stocks, shares of closed-end mutual funds are publicly traded equities on the stock exchanges (87% on the New York Stock Exchange and 10% on the NYSE American, formerly AMEX) and cannot be purchased or redeemed to the funds. The fund's net asset value (NAV) is the market value of security holdings of the fund per share. The NAV is the fundamental component, and the price-to-NAV ratio is the stationary component.[3] Unlike corporate stocks, returns on the NAV are relatively transparent and reported at higher frequencies (usually weekly) than quarterly or annually. Therefore, I provide empirical evidence on profitability of trading strategies that exploit the cross-section of mean shifts of the price-to-NAV ratio of closed-end mutual funds.

To construct a proxy for mean shifts of a price-to-fundamental ratio, I rely on a prediction of the model; the component of returns that is orthogonal to the fundamental growths is not zero on average during a mean shift. Stocks are likely to experience upward/downward mean shifts when the returns consistently outperform/underperform the fundamental growths. Using panel data of the past 60 months, I estimate an unobservable fund-specific component in fund returns that is orthogonal to returns on the NAV (and fund characteristics) every month. This component is a proxy for mean shifts of the price-to-NAV ratio.[4] Indeed, funds with lowest/highest value of the proxy experience a sizable decrease/increase in the price-to-NAV ratio. I find that this proxy is negatively related to future returns. Funds with lower value of the proxy perform better on average in the future. The mean-shift proxy has a serial correlation of 0.7. Yet, an updated component in the proxy has better ability of predicting future returns than the lagged value of the proxy.

[3] The literature on closed-end mutual funds focuses on explaining the gap between the price and the NAV of the fund share. In Berk and Stanton's (2007) model, the price deviates from the NAV because of managerial skills and fees. Many studies find significant determinants of the price deviation from the NAV, such as size, expense ratios, liquidity benefits of closed-end mutual funds, and investor sentiment. See, for example, Boudreaux (1973), Malkiel (1977), Brauer (1988), Lee, Shleifer, and Thaler (1991), Kumar and Noronha (1992), DeLong and Shleifer (1992), Kim (1994), Pontiff (1997), Spiegel (1999), Gemmill and Thomas (2002), Ross (2002), Ferguson and Leistikow (2004), Berk and Stanton (2007), Cherkes, Sagi, and Stanton (2008), and Wu, Wermers, Zechner (2016). Also, Cherkes (2012) presents a survey of this literature.

[4] One might use growth of the price ratio to proxy for mean shifts of the ratio. Yet, this measure is correlated with returns on the fundamentals. Results using this measure are less significant, in particular, for long-term trading strategies (see Section 5.2. and Figure A1).

I sort funds by the mean-shift proxy to construct quartile portfolios of funds. Mispricing seems to occur over six months prior to the sorting month, followed by reversals in returns over the next one to two years. My trading strategy is to buy the bottom quartile and short sell the top quartile by the mean-shift proxy at the end of each month and to hold the portfolio for one month. The "low minus high" portfolio is rebalanced monthly. This zero-cost trading strategy does not incur high transaction costs because a quartile portfolio contains only about 105 funds on average.

The bottom quartile by the mean-shift proxy is highly profitable, but the average returns on the top quartile are lower or not significantly different from zero. As a result, the "low minus high" portfolio earns significantly high profits. The average returns are about 5.6% per annum and statistically significant at the 1% level. After adjusting for returns on well-known passive benchmarks, funds with upward mean shifts of the price ratio still underperform funds with downward mean shifts. The abnormal expected returns on the zero-cost portfolio are higher than the average returns without adjusting for risks. The average returns on the "low minus high" portfolio after controlling for the Fama and French's (1993) three factors are about 6.5% per year. When I add the momentum factor (Jegadeesh and Titman, 1993) as in Carhart (1997), the profitability increases to almost 7%. I also control for the betting-against-beta (BAB) factor, which captures the return premium for securities with low market beta (Frazzini and Pedersen, 2014). The portfolio earns the expected returns of 7.4% because the funds with upward mean shifts earn negative abnormal returns.

This trading strategy is still highly profitable when implemented with waiting periods. The benchmark-adjusted returns are between 3% and 6% with waiting periods of up to 12 months. Because the fund data are announced at least on a weekly basis, a strategy with a waiting period of even one month is feasible. In addition, the profitability is not limited to funds that invest mainly in certain asset classes. It earns similar abnormal expected returns when applied only to funds that invest in equities, bonds, or tax-preferred bonds.

When I estimate abnormal expected returns on the "low minus high" portfolio using a rolling method, the strategy is highly profitable throughout time. During the Great Recession, the average returns on the zero-cost portfolio were between 0.7% and 0.9% per month after controlling for Carhart's four factors (see Figure 3). It is reasonable to argue that trading on overshooting is highly profitable during recessions because cross-sectional dispersion of mean shifts of the price ratio tends to increase when economic activities slow down.

My results might also be consistent with a view that investors' overreactions to news lead to reversals in returns (e.g., De Bondt and Thaler, 1985; Barberis, Shleifer, and Vishny, 1998; and Daniel, Hirshleifer, and Subrahmanyam, 1998). Suppose investors systematically overreact to bad news about closed-end mutual funds. Then, funds with low past returns are predicted to have high returns as the price is adjusted. However, my findings are less supportive of investors' overreaction bias for good news. The excess returns over the risk-free rate on the funds with high past returns are positive and not statistically different from zero.

Moreover, "low minus high" portfolio based on past return data alone is 1% to 3% less profitable than the trading strategy based on the mean-shift proxy. To examine the overreaction hypothesis, I use past excess returns over the market to sort closed-end mutual funds (see De Bondt and Thaler, 1985). Trading based on past excess returns earns high returns on average, but the profitability substantially decreases during the Great Recession. Also, both economic magnitude and statistical significance decrease when the trading strategy is implemented with waiting periods. More importantly, the trading strategy does not lead to profitable returns for funds that mainly invest in equities or bonds. It is profitable for trading only tax-preferred funds. Daniel and Titman (2006) also argue that overreaction might not explain reversals in stock returns that are uncorrelated with the firm's fundamental growths.

The rest of the paper is organized as follows. Section 2 describes the overshooting model. Section 3 describes the empirical methods, and Section 4 presents the results for trading on overshooting. Section 5 discusses alternative trading strategies, and Section 6 concludes.

2. Overshooting model

This section presents a model in the context of closed-end mutual funds, but it also applies to any assets traded on the market. In the model (all variables in logarithm), the market price is the NAV plus the price-to-NAV ratio. To simplify, I assume that the NAV is a random walk with an independent and identically distributed (i.i.d.) shock, i.e., the expected NAV growth does not vary. On the other hand, the price ratio is a stationary first-order autoregressive process (AR(1)) that is orthogonal to NAV. Thus, the expected return on the stationary component is also an AR(1) process. This expected return does vary over time with the unconditional mean equal to zero. As a result, expected returns on the price vary only because of temporary shocks to the price ratio. In Section 2.2., the model also considers permanent shocks to the price ratio at a low frequency.

The model assumes that the price is observable and verifiable, reflecting all information, such as temporary shocks to each component and mean shifts (if any). Investors know the price process. They also observe the fundamental value and market's expected return (e.g., analyst reports and media), but cannot verify the values. For example, the NAV is based on the fund's report, which is often not verifiable. Investors cannot observe shocks to each component. Instead, using the price, NAV, and market's expected return, investors infer temporary shocks to the random walk and the price ratio. Based on their inference about the shocks to the price ratio, they can also form their own expectation of the returns. Their belief about expected returns is consistent with the market's expected returns. However, when the price ratio has a mean shift, investors misinterpret it as temporary shocks to the price ratio. As a result, their expected returns do not match the market's expected returns. Section 2.3. discusses how an underreaction to the mean shift leads to mispricing.[5] I first present a model without a mean shift.

2.1. Model without a mean shift

Variables in log are denoted with lower case letters; for example: $p_{i,t} \equiv \log P_{i.t}$ and $a_{i,t} \equiv \log NAV_{i,t}$. Without loss of generality, I assume $NAV_{i,t}$ is before dividend payments. Both $p_{i,t}$ and $a_{i,t}$ are nonstationary. I assume that the NAV growth is essentially unpredictable, and the two nonstationary variables are cointegrated with the coefficient of $(1, -1)$ in equilibrium (e.g., Berk and Stanton, 2007). Consider a cointegrating vector process,

$$a_{i,t} = a_{i,t-1} + e_{i,t} \tag{1}$$

$$p_{i,t} = a_{i,t} + u_{i,t}, \tag{2}$$

[5] Dornbusch (1976) develops an overshooting model in the international economics literature, in which the foreign exchange market overshoots a new equilibrium after a monetary policy change.

where $e_{i,t}$ is a constant drift plus a white noise process[6], $e_{i,t} = e_i + \eta^e_{i,t}$. The noise, $\eta^e_{i,t}$, is i.i.d. shocks to the fundamental growths. The second term in Equation (2), $u_{i,t} = p_{i,t} - a_{i,t}$, is the price-to-NAV ratio, the stationary price component. I assume that it has a mean equal to u_i and follows an AR (1) process with $0 \leq \phi < 1$:

$$u_{i,t} = u_i + \phi(u_{i,t-1} - u_i) + \eta_{i,t}, \tag{3}$$

where $\eta_{i,t}$ is a white noise process, independent of $\eta^e_{i,t}$. Note that $\eta_{i,t}$ is temporary shocks to the price-to-NAV ratio.

Equation (2) suggests that the return on the price, $r_{i,t} \equiv \Delta p_{i,t}$, depends on the contemporaneous return on the portfolio, $r^{NAV}_{i,t} \equiv \Delta a_{i,t} = e_{i,t} = e_i + \eta^e_{i,t}$:

$$r_{i,t} = r^{NAV}_{i,t} + u_{i,t} - u_{i,t-1} = r^{NAV}_{i,t} + (\phi - 1)(u_{i,t-1} - u_i) + \eta_{i,t}, \tag{4}$$

where the second equation follows from Equation (3). Note that the expected return on the random walk component is a constant, equal to the drift, $E_{t-1}[r^{NAV}_{i,t}] = e_i$.

I define the (market's) conditional expectation of the component of returns that is orthogonal to return on the NAV by

$$z_{i,t-1} \equiv E_{t-1}[r_{i,t} - r^{NAV}_{i,t}],$$

where the conditional expected value operator is defined as $E_{t-1}[\cdot] \equiv E[\cdot|\Theta_{t-1}]$ given all available information Θ_{t-1}. By Equation (4), the conditional and the unconditional expected excess returns over the NAV returns are given by

$$\begin{aligned} z_{i,t-1} &\equiv E_{t-1}[r_{i,t} - r^{NAV}_{i,t}] = (\phi - 1)(u_{i,t-1} - u_i) \text{ and} \\ E[z_{i,t}] &= E[r_{i,t} - r^{NAV}_{i,t}] = 0, \end{aligned}$$

respectively, where the second equation uses the law of iterated expectation. The unconditional mean of zero is consistent with Berk and Stanton's (2007) model, in which the

[6] A white noise has a mean zero and a finite variance unless specified otherwise.

expected excess return over the NAV return, $E_{t-1}[r_{i,t} - r_{i,t}^{NAV}]$, represents investors' return on managerial ability (net of fees). Berk and Stanton show that investors cannot benefit from the manager's potential to add value. This prediction is also consistent with Sias, Starks, and Tiniç (2001). The expected excess return over the NAV growths follows an AR (1) process with the same coefficient ϕ:

$$z_{i,t-1} = \phi z_{i,t-2} + (\phi - 1)\eta_{i,t-1}. \tag{5}$$

Note that the shocks to the expected excess return over the NAV return, $(\phi - 1)\eta_{i,t-1}$, are negatively related to temporary shocks to the price-to-NAV ratio, $\eta_{i,t-1}$, because $\phi < 1$. Therefore, a positive/negative shock to the price ratio becomes a negative/positive shock to the expected excess return over the NAV returns, $z_{i,t-1} \equiv E_{t-1}[r_{i,t} - r_{i,t}^{NAV}]$.

2.2. Model with a mean shift in the price ratio

We extend the model to consider a mean shift of the price-to-NAV ratio, $u_{i,t}$, by δ_i (from u_i to $u_i + \delta_i$) in the period S. The stationary price component, price-to-NAV ratio, in Equation (3) changes to

$$u_{i,t} = u_i + \delta_i D_{i,t} + \phi(u_{i,t-1} - u_i - \delta_i D_{i,t-1}) + \eta_{i,t}, \tag{6}$$

where

$$D_{i,t} = 0 \text{ for } t < S \text{ and } D_{i,t} = 1 \text{ for } t \geq S. \tag{7}$$

Then the conditional expected excess return $z_{i,t-1}$ follows an AR (1) process:

$$z_{i,t-1} = \delta_i(D_{i,t} - D_{i,t-1}) + \phi(z_{i,t-2} - \delta_i(D_{i,t-1} - D_{i,t-2})) + (\phi - 1)\eta_{i,t-1}, \tag{8}$$

which is reduced to Equation (5) without a mean shift, i.e., $\delta_i = 0$. By Equation (8), the expected excess return, $z_{i,t-1} \equiv E_{t-1}[r_{i,t} - r_{i,t}^{NAV}]$, has a non-zero mean in the period S:

$$E[z_{i,t-1}] = E[E_{t-1}[r_{i,t} - r_{i,t}^{NAV}] = E[r_{i,t} - r_{i,t}^{NAV}] = \delta_i \text{ for } t = S \text{ and} \quad (9)$$
$$= 0 \text{ for } t \neq S, \quad (10)$$

where the second equality uses the law of iterated expectation.

2.3. Overshooting

This section discusses how investors overshoot the expected returns in an equilibrium with a mean shift of the price-to-NAV ratio. Consider a mean price ratio shifting upward (i.e., a positive permanent shock) in the following period. This leads to a higher expected return in excess of the fundamental performance (Equation (9)). Suppose investors always rely on the model in Equation (5), which has no changes in the mean price ratio. Then investors mistakenly infer that the higher expected return is due to lower temporary shocks to the price-to-NAV ratio because of a negative relationship between the temporary shocks and the expected return. While mistaking a positive permanent shock for a negative temporary shock in the current period, investors increase purchases of the fund. This results in overvaluation, followed by low subsequent returns. Similarly, funds earn high returns on average, subsequent to undervaluation amid a downward shift in the mean price ratio.

I illustrate overshooting for a case with $\phi = 0$ and $\delta_i > 0$ (upward shift of the mean) without loss of generality. Equation (8) becomes

$$z_{i,t-1} = \delta_i - \eta_{i,t-1} \text{ for } t = S \text{ and} \quad (11)$$
$$= -\eta_{i,t-1} \text{ for } t \neq S, \quad (12)$$

where $z_{i,t-1}$ is the conditional expected excess return over the NAV return ($z_{i,t-1} \equiv E_{t-1}[r_{i,t} - r_{i,t}^{NAV}]$), and $\eta_{i,t-1}$ is temporary shocks to the price ratio. The expected excess return also shifts upward by δ_i when the mean price ratio increases by δ_i as shown in Equation (11).

Suppose temporary shocks to the price-to-NAV ratio, $\eta_{i,S-1}$, are realized as some positive value, for example, the same as the mean shift δ_i, i.e., $\eta_{i,S-1} = \delta_i$. By Equation (11), the expected excess return over the NAV return is equal to zero, $z_{i,S-1} = 0$. As a result, the initial values are $\eta_{i,S-1} = \delta_i$ and $z_{i,S-1} = 0$. However, when investors ignore the mean shift, they mistakenly update their beliefs about the temporary shock to the price-to-NAV ratio by Equation (12). Given $z_{i,S-1} = 0$, investors infer that the temporary shock is equal to zero ($\eta_{i,S-1} = 0$). As investors update that the fund is undervalued relative to their prior beliefs, they increase purchases of the shares. Because of $\eta_{i,S-1} = 0$, the expected excess return increases to $z_{i,S-1} = \delta_i$ by Equation (11). Figure 1 (A) illustrates this upward overshooting. The x-axis and y-axis represent shocks to the price ratio, η, and the expected excess return, z, respectively. The solid line plots the two variables in the transition equilibrium, and the dashed line represents the variables without the mean shift, which investors always believe. After $\eta = \delta$ is realized, the initial equilibrium value is $(\delta, 0)$ by Equation (11). However it changes to $(0, \delta)$ because investors mistakenly infer $\eta = 0$, which increases the expected excess return from 0 to δ. An equilibrium moves in a north-west direction in the transition equilibrium (the solid line), no matter where it starts: upward overshooting. Similarly, Figure 1 (B) presents downward overshooting. Any initial equilibrium moves along the solid line in a south-east direction when the mean price ratio decreases.

More generally, suppose the temporary shocks to the price ratio are realized as η_t and the mean shift in the following period is given by δ. The expected return in the period $t+1$ is equal to $-\eta_t + \delta$, i.e., the pair of shocks to the price ratio and the expected returns is $(\eta_t, -\eta_t + \delta)$. However, when investors underestimate the mean shift of δ by λ, their expectation of the returns is $-\eta_t + (\delta - \lambda)$. By observing the market's expected returns given by $-\eta_t + \delta$, investors update their belief about the temporary shocks to the price ratio from η_t to $\eta_t - \lambda$. The very right side of Equation (13) shows investors' updated belief. Therefore, the expected excess return over the NAV return,

$$z_{i,t} = -\eta_t + \delta = -\underbrace{(\eta_t - \lambda)}_{\text{shocks } \eta_t} + \underbrace{(\delta - \lambda)}_{\text{mean shift } \delta} \tag{13}$$

increases by λ to $-(\eta_t - \lambda) + \delta$.

2.4. Trading on overshooting

Funds with downward mean shifts of the price ratio outperform funds with upward mean shifts on average in the subsequent periods. The trading strategy is to buy the first funds and short sell the second funds. The return reversal in returns must be short-lived, but could last for multiple periods while investors gradually learn about the mean shift. Also, the transition period during which overshooting occurs might span multiple periods. The challenge is to find a proxy to identify the mean shift. The model predicts that expected returns in excess of returns on the NAV are low/high for funds with downward/upward mean shifts. Therefore, I use the return component that is orthogonal to returns on the NAV to proxy for mean shifts of the price-to-NAV ratio. Section 3.2. discusses the mean shift proxy.

3. Empirical methods

3.1. Data

I use Morningstar Direct to obtain monthly data on closed-end mutual funds from January 1980 to December 2017. The data include the market price, net asset value (NAV), return on the market price, return on NAV, price premium (discount), total net assets (TNA), and expense ratio. The model in Section 2 uses variables in logarithm, but I use regular variables in the empirical analysis. Price premium of a fund i in a month t is defined as

$$premium_{i,t} = \frac{P_{i,t}}{NAV_{i,t}} - 1, \tag{14}$$

i.e., the price-to-NAV ratio minus one, and the premium growth is defined as the growth of the price-to-NAV ratio minus one,

$$premium\ growth_{i,t+1} = \frac{\frac{P_{i,t+1}}{NAV_{i,t+1}}}{\frac{P_{i,t}}{NAV_{i,t}}} - 1. \tag{15}$$

The expense ratio in a given month is equal to the annual expense ratio that applies to that month. For example, if the fund's financial year ends in April 2010, I use the expense ratio reported in the annual report for the period from May 1999 to April 2010.

I define the age of a fund as the time since the inception date. I use funds' inception date provided by Morningstar Direct. If it is missing, I use the first month that the fund's monthly return or TNA data are available. I also use data on the fund's advisor and aggregate TNA of all funds in the same fund family to define the fund family's asset.

Table 1 (A) presents descriptive statistics of the variables of closed-end mutual funds. The total number of monthly observations is 125,171. The monthly return on the market price is 0.65% on average. The monthly growth rate of the NAV is slightly lower, 0.57%. The market price is discounted by more than 4% (Equation (14)). A typical fund has \$353 million of assets under management and charges about 1.3% of expense ratio per year. A fund is about 12.6 years old on average. Average TNA of the fund family that a fund belongs to is about \$11 billion.

Morningstar Direct also classifies closed-end mutual funds based on the asset class that the fund typically invests in. The main types are equity, bond, and tax-preferred funds. These funds cover about 90% of the total number of monthly observations of my sample. Closed-end equity mutual funds yield about 0.81% of monthly returns on average. The returns on the equity holdings are almost 0.7%. The equity funds' price is about 6.8% lower than their NAV. Such a level of discount is higher than other types of closed-end mutual funds. Fund size is \$389 million on average. The average expense ratio and the average age are 1.6% and 15 years, respectively; on the other hand, bond funds' average returns on the price and on the NAV are about 0.62% and 0.55%, respectively. The discount in the price compared to the NAV is about 3.6%. The average fund size is slightly larger than that of closed-end equity mutual funds. Closed-end bond mutual funds charge for expenses about 30 basis point less than equity funds per year. There are more tax-preferred funds than equity or bond funds. Tax-preferred funds are smaller, only about \$259 million on average. They also charge the lowest expense ratio (about 1%) and have lowest average monthly return on the price and the NAV. The discount in the price is also the smallest, about 3%.

Table 2 presents estimates of correlation coefficients between the fund variables (the p-values in parentheses). The market return of closed-end mutual funds is highly correlated with the return on the security holdings. The estimate is about 0.7 and statistically significant at the 1% level. Returns on the NAV have serial correlation of 0.14, which is statistically significant. Autocorrelation of the return on the price is only 0.04. The price premium is positively related with the return on the price (the correlation coefficient is about 0.11). It is also positively correlated with the return on the portfolio, but the magnitude is only about 0.02. A higher expense ratio is associated with higher returns on the price and on the portfolio but is negatively related to the price premium and the fund size. The relationships are statistically significant, but the estimates are small. Panels (B) to (D) show closed-end funds that mainly invest in only stocks, bonds, tax-preferred bonds, respectively.

3.2. A proxy for the mean shift

Section 2 suggests that investors might misprice closed-end mutual funds when the market price relative to the NAV has a shift of the mean. Such a mean shift leads to returns that consistently outperform or underperform the NAV returns as discussed in Section 2. Therefore, I construct a proxy for the mean shift by estimating an unobservable fund-specific component in the fund return that is orthogonal to returns on the NAV and fund characteristics and that varies over time. I estimate fund-specific intercept in the panel regression of returns on the market price on fund characteristics and the return on the NAV using a rolling method:

$$r_{i,t} = \alpha_{i,\tau} + \beta_{1,\tau} r_{i,t}^{NAV} + \beta_{2,\tau} \exp_{i,t} + \beta_{3,\tau} \log(TNA_{i,t}) + \beta_{4,\tau} \log(age_{i,t}) + \beta_{5,\tau} \log(family_{i,t}) + \gamma_{t,\tau} + \varepsilon_{i,t}, \quad (16)$$

where $r_{i,t}$ and $r_{i,t}^{NAV}$ are the return on the market price and the return on the NAV, respectively, of a fund i in a month t and $t = \tau - 59$, $\tau - 58, ..., \tau$. The period τ denotes the final period of the sample for the regression. The first estimate of $\alpha_{i,\tau}$ uses the sample from January 1994 to December 1998, and τ is given by December 1998.[7] I then move the sample period forward by one month at a time and run the regression with a sample of 60 months (i.e., from February 1994 to January 1999 for the second estimate). Only funds with at least 30 monthly observations are included in the sample. This step provides a time series of $\alpha_{i,\tau}$ from December 1998 to December 2017.

[7] Only a small number of closed-end funds have monthly variables before 1994.

To verify the predictive ability of my proxy for the mean shift, I use the estimate $\alpha_{i,\tau}$ as an explanatory variable for the future return on closed-end funds. I run a panel regression over the period from January 1999 to December 2017:

$$r_{i,t} = \delta\widehat{\alpha}_{i,t-1} + \beta_1 r_{i,t}^{NAV} + \gamma_t + \varepsilon_{i,t}, \tag{17}$$

and an extended version with fund characteristics contemporaneous with the return:

$$r_{i,t} = \delta\widehat{\alpha}_{i,t-1} + \beta_1 r_{i,t}^{NAV} + \beta_2 \text{exp}_{i,t} + \beta_3 \log(TNA_{i,t}) + \beta_4 \log(age_{i,t}) + \beta_5 \log(family_{i,t}) + \gamma_t + \varepsilon_{i,t}, \tag{18}$$

where $\widehat{\alpha}_{i,t-1}$ is an estimate of the fund-specific unobservable component using the data of the prior 60 months up to the period $t-1$, as estimated by Equation (16).

Columns (1) and (2) in Table 3 show the panel regression results in Equation (17) without the mean-shift proxy. Standard errors are clustered by fund in column (1) and by time (year-month) in column (2) (Petersen (2009)). The return on the market price increases with the return on the portfolio on average. Columns (3) and (4) present the regression with the mean-shift proxy in Equation (17). A 10% increase in the growth rate of the portfolio value is associated with about a 9% increase in the market price of closed-end mutual funds. More importantly, the results show that future returns on the market price is negatively related to the proxy for the mean shift of the price ratio. A 10% increase in the measure of the mean shifts leads to a decrease in the market price by about 2% in the following month. The results support the prediction that investors overshoot the expected excess returns amid the mean shift of the price ratio, which causes return reversals.

The results for Equation (18) are presented in the columns (5) and (6). The proxy for the mean shift stays significant both economically and statistically after controlling for fund characteristics. Fund age and family size also seem to be significantly related to the return on the market price, but the magnitudes are small.

Given that $\widehat{\alpha}_{i,\tau}$ is obtained by a rolling method, it is not surprising that $\widehat{\alpha}_{i,\tau}$ has significant serial correlation. The magnitude is about 0.7. I take a first difference of the estimate $\widehat{\alpha}_{i,t-1}$

and decompose it by

$$\widehat{\alpha}_{i,t-1} = \widehat{\alpha}_{i,t-2} + \Delta\widehat{\alpha}_{i,t-1}, \tag{19}$$

where the first difference $\Delta\widehat{\alpha}_{i,t-1} \equiv \widehat{\alpha}_{i,t-1} - \widehat{\alpha}_{i,t-2}$ can be viewed as an update of the mean shift. When there is no update, the component $\Delta\widehat{\alpha}_{i,t-1}$ is equal to zero. I replace the estimate $\widehat{\alpha}_{i,t-1}$ in (18) using Equation (19):

$$r_{i,t} = \delta_1\widehat{\alpha}_{i,t-2} + \delta_2\Delta\widehat{\alpha}_{i,t-1} + \beta_1 r_{i,t}^{NAV} + \beta_2\text{exp}_{i,t} + \beta_3\log(TNA_{i,t}) + ... + \gamma_t + \varepsilon_{i,t}. \tag{20}$$

The last two columns, (7) and (8), in Table 3 show the results of the regression in (20). When I decompose the fund-specific unobservable component, I find the component of updates $\Delta\widehat{\alpha}_{i,t-1}$ is more important than $\widehat{\alpha}_{i,t-2}$. The magnitude is about seven times as large as the component $\widehat{\alpha}_{i,t-2}$. When the update in the mean shift increases by 0.1, the return on the fund's market price decreases by more than 0.14. The estimate is also statistically significant whether I cluster standard errors by time (year-month) or fund. The results suggest that the mean shift is a main determinant of the future return on closed-end mutual funds.

4. Empirical results

4.1. Quartile portfolios by the proxy for the mean shift

The time-varying unobservable component in fund returns represents expected excess returns on the market price over returns on NAV. I use it as a proxy for the mean shift of the price ratio. I rank closed-end mutual funds according to the mean-shift proxy at the end of the prior month and form quartile portfolios. The portfolios are equally weighted and rebalanced every month from January 1999 to December 2017 (228 months of 19 years total).

First, I compare funds in the quartile portfolios by fund returns and characteristics, such as size (TNA) and age. Table 4 provides the time-series average (228 months) of the average returns and characteristics of the closed-end mutual funds in each quartile. The t-statistics for the difference between the bottom and the top quartiles use Newey and West's (1987) standard errors with 12 lags. Given that the quartile portfolios are formed based on the unobservable component in fund returns, it is not surprising that the return on the funds are significantly different between the bottom and the top quartiles. The top quartile funds earn more than 1% in the prior month on average but the bottom quartile funds earn less than 0.3%. Funds in the top quartile portfolio also have lowest discount in the price compared to the NAV of the portfolio. The average discount is less than 2%. Funds with lowest value of the mean-shift proxy have a discount of more than 6.5% on average.

Funds ranked by the proxy for the mean shift do not seem different in terms of portfolio returns, expense ratio, and age. In particular, the top quartile funds have slightly higher returns on the portfolio, but the difference from funds in the bottom quartile is not statistically significant. This might not be surprising given that the proxy is estimated after controlling for those variables. On the other hand, funds with lowest value of the mean-shift proxy appear to be largest in size. The average TNA of such funds is $454 million, which is almost double the average size of funds in the top quartile of the proxy for the mean shift. The negative relationship between fund size and the proxy for mean shifts of the price ratio appears related to decreasing returns to scale documented by many studies, such as Chen et al. (2004) and Berk and Green (2004). The proxy is based on expected returns on the price over returns on the NAV. I also find that funds in the lowest quartile tend to belong to the largest fund families.

I also compare the quartile portfolios of funds in terms of returns, premium in fund share price as defined in Equation (14), and premium growth as defined in Equation (15) in the following month. Consistent with the panel regressions for determinants of fund returns (Table 3), funds in the lowest quartile by mean shifts of the price ratio have highest average returns in the next month. Those funds earn about 0.92% on average whereas funds in the top quartile portfolios earn only 0.45%. The difference of almost 0.5% is statistically significant. In contrast, the mean-shift proxy does not seem to predict returns on the NAV. There is no statistically significant difference in the portfolio return in the next month between the bottom and the top quartile funds according to the proxy for mean shifts of the price ratio. In addition, funds in the bottom quartile still have highest discounts in the price relative to the NAV in the next month. However, the bottom quartile funds have the highest premium growth. The share price of those funds is still heavily discounted relative to their portfolio value, but the price-the NAV ratio improves in the following month. In contrast, funds in the top quartile have the lowest discount in the price, but the gross discount decreases by 15 basis point on average in the following month. As a result, the difference in the premium growth between the bottom and top quartiles is about 0.45%. It contributes to the return dispersion because

$$r_{i,t+1} = \frac{P_{i,t+1}}{P_{i,t}} - 1 = \frac{NAV_{i,t+1}}{NAV_{i,t}} \frac{\frac{P_{i,t+1}}{NAV_{i,t+1}}}{\frac{P_{i,t}}{NAV_{i,t}}} - 1, \tag{21}$$

which suggests that the difference in the future return is driven by the growth of the price-to-NAV ratio when the return on the NAV is similar between the bottom and top quartile funds.

Panels (B) to (D) show that the statistical differences in the future return and characteristics of closed-end mutual funds are similar across different asset classes. The proxy for mean shifts provide significant variations in future returns and premium growth on average.

Figure 2 (A) and (B) plot time-series of premium in the market price relative to the NAV over 60 months prior to and after the month when funds are sorted by the mean-shift proxy. Funds in the bottom and the top quartiles by the mean-shift proxy experience significant changes in the premium. The premium of funds with downward mean shifts (bottom quartile) dramatically decreases up to the sorting month. In particular, the slope is even more negative over six months prior to the event month 0. Similarly, Figure (C) plots the event time series of the premium growth. Recall that the premium growth roughly represents the excess return on the market price over the return on the NAV (Equation (21)). It is most negative right before the sorting month. Following the sorting month, the premium growth gradually reverses until the premium reaches a constant. In contrast, funds in the top quartile by the mean-shift proxy have a significant increase in the premium. It exhibits upward mean shifts six months prior to the sorting month, after which it reverses. On the other hand, funds in other quartiles do not have such dramatic premium growth and subsequent reversals around the sorting month. Only funds in the bottom and the top quartiles experience substantial changes in premium (growth). These patterns are consistent with shifts in the premium (discount).

Figure (D) shows investors' overshooting of expected returns on funds with extreme values of the mean-shift proxy. The average returns on funds in the bottom quartile decrease about six months prior to the sorting period, after which the returns reverse. In contrast, funds in the top quartile experience an increase in returns on the market price prior to the sorting month and subsequently earn negative returns. These time-series patterns confirm that the fund-specific unobservable component of fund returns, orthogonal to returns on the NAV and fund characteristics, is a good proxy to identify investors' overshooting of expected excess returns over returns on the NAV. On the other hand, returns on NAV are similar across different funds sorted on the proxy as shown in Figure (E). In other words, the reversals in returns on funds in the bottom and the top quartiles are due to the reversals in excess returns on the price relative to returns on the NAV. Figure (F) plots the excess returns on the price over the NAV returns. Consistent with the model's prediction and the empirical results in Sias, Starks, Tiniç (2001), closed-end mutual fund investors do not earn more than the returns on the portfolio on average (see the dashed line labeled "all"). However, my proxy for the mean shift identify the funds that experience significant returns on the market price in excess of the returns on the underlying assets. More importantly, such funds show reversals in the excess returns in the subsequent periods. Finally, I show that the bottom and the top quartiles of the mean-shift proxy do not consist of funds of significantly different ages in Figure (G). Overall, funds with downward mean shifts is older than funds with upward mean shifts, but the difference is only a few years.

4.2. Trading strategy by the proxy for the mean shift

The previous sections show that the proxy for mean shifts of the price ratio is negatively related to future returns on closed-end mutual funds. Funds in the bottom quartiles portfolio by the mean-shift proxy outperform funds in the top quartiles portfolio in the next month. The empirical results are consistent with the prediction of the model that mispricing amid mean shifts of the price ratio leads to reversals in returns on the market price. Funds with downward mean shifts earn higher returns than funds with upward mean shifts. The monthly difference is almost 0.5% and statistically significant at the 1% significance level. I use a zero-cost trading strategy that buys shares of funds in the bottom quartile portfolio and short sells those in the top quartile portfolio. The "low minus high" portfolio is equally weighted and rebalanced every month from January 1999 to December 2017. Given a small number of closed-end mutual funds, my monthly trading strategy does not incur high transaction costs. Each quartile portfolio has only about 105 funds on average.

Figure 3 shows the monthly return on the "low minus high" portfolio. Figure (A) adds the market factor by the Capital Asset Pricing Model (CAPM) by Sharpe (1964), Lintner (1965), and Black (1972), and (B) adds the momentum factor by Jegadeesh and Titman (1993). The factors are obtained on Kenneth French's website. The figures show that the return on trading on overshooting roughly moves in the opposite direction of the factors. My zero-cost portfolio was also profitable during the recent financial crisis, when the cross-sectional dispersion of mean shifts are more likely, whereas both factors incurred large losses.

I also vary my trading strategy by the waiting period until trading: no waiting, 1 month, 2 months, 3 months, 6 months, and 12 months. A no-waiting strategy trades on the mean-shift proxy estimated in the prior month. On the other hand, with one-month waiting period, trading starts one month later. For example, I estimate the proxy using data for 60 months up to December 1998. I rank closed-end mutual funds based on the proxy for mean shifts of the price ratio and form quartile portfolios. Then I buy shares of funds in the bottom quartile portfolio and short sell those in the top quartile at the end of January 1999 and maintain the positions for one month, until the end of February 1999. I rebalance the portfolios at the end of February 1999 based on the mean-shift proxy, which is estimated using data for 60 months up to January 1999. For other waiting periods, I apply the same trading strategy except that I use the mean-shift proxy lagged by the same number of periods as the waiting periods. All trading strategies are feasible except for the one with no waiting period. In general, closed-end mutual fund data, such as the portfolio return and the price, are publicly available at least on a weekly basis. Therefore, one month or more is enough time for investors to form portfolios and trade as I suggest.

4.3. Profitability of trading on overshooting

I calculate average returns on the strategy of trading on overshooting. I also estimate risk-adjusted returns using the CAPM, Fama and French's (1993) three-factor model (FF), and Carhart's (1997) four-factor model (Carhart). The intercept α_p in this regression is my estimate of risk-adjusted returns:

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,1} MKT_t + \beta_{p,2} SMB_t + \beta_{p,3} HML_t + \beta_{p,4} MOM_t + \epsilon_{p,t}, \qquad (22)$$

where $R_{p,t}$ is monthly returns on the zero-cost portfolios (varied by the waiting period) and $R_{f,t}$ is the risk-free return (U.S. three-month Treasury Bill rate). On the right-hand side, MKT is the market factor in CAPM, SMB is the size factor in FF, HML is the value factor in FF, and MOM is the momentum factor (Jegadeesh and Titman, 1993). I obtained data for these factors on Kenneth French's website.

In addition to the four factors in (22), I add Pastor-Stambaugh's (2003) tradable liquidity factor to control for liquidity premium:

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,1} MKT_t + \beta_{p,2} SMB_t + \beta_{p,3} HML_t + \beta_{p,4} MOM_t + \beta_{p,5} PS_t + \epsilon_{p,t}, \qquad (23)$$

where PS is the liquidity factor obtained on Lubor Pastor's website. I also control for the betting-against-beta (BAB) factor suggested by Frazzini and Pedersen (2014). The authors argue that stocks with high market beta have lower expected returns because borrowing-constrained investors demand such stocks:

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,1} MKT_t + \beta_{p,2} SMB_t + \beta_{p,3} HML_t + \beta_{p,4} MOM_t + \beta_{p,5} BAB_t + \epsilon_{p,t}, \qquad (24)$$

where the BAB factor is available on the website of AQR Capital Management.

The sample period for estimating the risk-adjusted returns depends on the waiting period. Without a waiting period, the sample starts in January 1999. On the other hand, if the trading occurs two months after forming the quartile portfolios (i.e., two-month waiting period), for example, then the sample starts in March 1999.

I first present profits on the trading strategy with no waiting period in Table 5. Average returns on the quartile portfolios by the mean-shift proxy show that closed-end mutual funds in the bottom quartile are the most profitable: about 9.3% per year. Funds in other quartiles have much lower returns. In particular, funds in the top quartile earn only 3.7% on average per annum. The difference between the bottom and the top quartiles is about 5.6% per year and is statistically significant at the 1% level.

Closed-end mutual funds with the lowest value of the mean-shift proxy also have the highest risk-adjusted returns. When controlling for the market factor (CAPM), the equally weighted portfolio of the bottom quartile funds earns about 6.9% per annum. The bottom quartile portfolio is still profitable after controlling for other factors. In particular, its Carhart's four-factor alpha is about 7.6% per year. In contrast, the top quartile portfolio by the mean-shift proxy earns only 0.6% on average after controlling for the four factors. The risk-adjusted return is not statistically significant. As a result, the zero-cost strategy to buy the bottom quartile funds and short sell the top quartile funds has the Carhart alpha of almost 7% per year. This strategy has negative loadings on the market and momentum factors. I also control for the BAB factor given that my zero-cost portfolio has a negative loading on the market factor. I find that my strategy's risk-adjusted returns are still significantly profitable, about 7.4% per year, after controlling for the BAB factor. Similarly, adding the PS factor does not reduce the profitability. The alpha is about 7.3% after controlling for Carhart's four factors and the PS factor.

I also estimate the risk-adjusted average returns using a rolling method. I run the regressions in (22) and (24) using the prior 60 months starting in December 2013. In other words, the first estimate of the abnormal expected returns uses the sample of 60 months from January 1999 to December 2013. Figure 4 (A) to (C) plot the time series of average returns adjusted for Fama and French's three factors, Carhart's four factors and five factors including the BAB factor, respectively, from December 2013 to December 2017. The figures also plot the confidence intervals with the significance level of 10% using dashed lines. The "low minus high" portfolio based on my proxy for mean shifts is highly profitable. The monthly abnormal expected returns are almost always significantly different from zero and positive. In particular, the strategy produced almost 1% of monthly risk-adjusted returns during the recent financial crisis. It is reasonable to argue that mispricing is dominant due to downward mean shifts in the price relative to the NAV during tough times.

Table 6 provides risk-adjusted returns of trading on overshooting with a waiting period of one month. It is a feasible strategy since closed-end mutual funds' data are announced at least on a weekly basis. Overall, the profits of the strategy of buying the bottom quartile funds and short selling the top quartile funds is still significant both economically and statistically. The risk-adjusted returns are between 4% and 6% per year. In particular, Carhart's four-factor alpha and the BAB alpha are 5.2% and 6.1% per annum, respectively, because of high average returns on the funds with lowest value of the mean-shift proxy. The average returns on the bottom quartile portfolio are about 8.5% per annum. Annualized CAPM, FF, Carhart, and PS alphas are 6.1%, 5.7%, 6.6%, and 6.1%, respectively. Controlling for the BAB factor reduces the profitability of the bottom quartile to 4.8%. In contrast, investing in funds in the top quartile by the mean-shift proxy does not appear profitable at all. The average return and the risk-adjusted returns are not statistically different from zero at the 10% significance level.

I present profitability of the trading strategy with various waiting periods in Table 7. When trading two months after sorting closed-end mutual funds by the mean-shift proxy, average returns and risk-adjusted returns are about 4%-6% per year. This is similar to those of the strategy with one-month waiting period. However, the profitability decreases to 3%-5% when the waiting period is three months or more. All risk-adjusted returns are still statistically significant at the 1% level. For example, if I buy the bottom quartile funds and short sell the top-quartile funds based on the mean-shift proxy one year ago, the zero-cost portfolio yields about 4.5% per year after controlling for Carhart's four factors.

The trading strategies for equity, bond, and tax-preferred funds are presented in the Appendix A1-A3. The results show that profitability of my strategy to buy funds with low value of the mean-shift proxy and short sell funds with high value of the mean-shift proxy is not limited to funds that invest in certain asset classes. The trading strategy is still profitable when applied to closed-end mutual funds that mainly invest in stocks, bonds, or tax-preferred bonds. In particular, the zero-cost portfolio of closed-end bond mutual funds yields about 6%-7% risk-adjusted returns per year. Equity or tax-preferred closed-end mutual funds have slightly lower profitability, about 3%-4% per year after controlling for the risk factors. The estimated alphas are statistically significant at the 1% level.

Table 8 presents the results for equity, bond, and tax-preferred closed-end mutual funds with waiting periods of 3 months and 12 months, respectively. The profitability of trading equity funds some months after sorting the funds is similar to the profitability without waiting periods, about 4%-5%. On the other hand, the zero-cost portfolio of closed-end bond mutual funds is less profitable when trading on the mean-shift proxy that is estimated three months ago. The risk-adjusted returns decrease to about 3% per year. However, when the waiting period is 12 months, the profitability is higher, about 7%-8%.

5. Results for alternative trading strategies

5.1. Trading on past return data alone

The results in Section 4 are also consistent with investors' overreaction to bad news. In such cases, low past residual returns predict high average returns in the future due to return reversal. On the other hand, the results seem less consistent with investors' overreaction to good news. Excess returns of the funds in the top quartile by the mean shift proxy are statistically indistinguishable from zero on average.

To examine the overreaction hypothesis, I use excess returns over the market ($r_{i,t} - MKT_t$) for the past 60 months as the sorting variable (see De Bondt and Thaler (1985)) and replicate the trading strategies based on the mean-shift proxy. Since the market return is fixed in each month, the trading strategy based on excess returns over the market is equivalent to ordering closed-end funds by the estimate $\alpha_{i,\tau}$ in the panel regression with time fixed effect:

$$r_{i,t} = \alpha_{i,\tau} + \gamma_{t,\tau} + \varepsilon_{i,t}, \tag{25}$$

which is similar to the regression equation (16) but without the explanatory variables.

Table 9 presents the results for all closed-end mutual funds. Overall, the trading strategy based on past returns alone is profitable. Yet, the profitability is 1-3% lower than the trading strategies based on the mean-shift proxy. When the strategy based on past returns is implemented with a waiting period, the profitability becomes statistically insignificant. For instance, when trading occurs one month after sorting the stocks based on past returns, the average return on the zero-cost portfolio is about 3.5% per annum but statistically indistinguishable from zero at the 10% level. Figure 5 plots the time series of the rolling estimates of the average returns after controlling for Fama and French's (1993) three factors. Unlike the trading strategy based on the mean-shift proxy (Figure 4 (A)), using past return data alone does not earn consistent profits. In particular, the profitability substantially decreases during the Great Recession. The trading strategy based on past returns is essentially a contrarian strategy and has a negative loading on the momentum factor (factor loadings not reported). The Carhart's alpha is higher, about 4.5%, because of underperformance of the momentum strategy.

I also report profitability of the trading strategy for closed-end mutual funds that mainly invest in equities, bonds, or tax-preferred bonds. Table 10 shows that it is profitable only for tax-preferred funds. We cannot predict reversal in the price of closed-end equity or bond mutual funds based on past returns alone. The (risk-adjusted) average returns on the zero-cost portfolio are either negative or statistically indifferent from zero.

5.2. Trading on the premium growth

Instead of the component of fund returns that is orthogonal to returns on the NAV, I use past average of premium growth as a proxy for mean shifts of the price-to-NAV ratio. This proxy is based on a decomposition of fund returns in Equation (21). The proxy is simple to construct and does not require a regression. Yet, premium growth is correlated with the returns on the NAV so might not be a good proxy for mean shifts of the price ratio.

I compare risk-adjusted returns of trading on the mean-shift proxy and trading on premium growth over the past 5 years and 1 year. I vary the waiting periods from 0 to 12 months. The results are presented in Figure A1 in the Appendix. The solid lines represent alphas, and the dashed lines are the 95% confidence intervals. Figure A1 (A) shows that trading on overshooting is significant both economically and statistically throughout various waiting periods. However, using premium growth results in risk-adjusted returns that are not statistically significant, in particular, with waiting periods of 3 months or longer. The profitability of trading on the premium growth is short-term, in particular, when using premium growth over the past one year as shown in Figure A1 (B).

6. Conclusion

This paper presents a model that explains a negative relationship between future stock returns and past stock returns that are not explained by growth on the fundamentals. When the price-to-fundamentals ratio (the stationary price component) has an upward/downward shift of the mean but investors ignore or underreact to the mean shift, they underestimate/overestimate shocks to the price-to-fundamentals ratio. As a result, they update that the stock is undervalued/overvalued and increase purchases/(short) sales of the stock. Therefore, an upward/downward mean shift of the price ratio causes overvaluation/undervaluation, followed by a reversal in returns in the subsequent periods.

My trading strategy is to exploit the return reversals of stocks by identifying individual stocks with mean shifts. Consistent with the overshooting model, I provide novel empirical evidence of the profitability, using closed-end mutual funds. The fundamental price component is the net asset value (NAV), and the stationary price component is the price-to-NAV ratio. I estimate a proxy for the mean shift of the price ratio as an unobservable fund-specific component in past returns that is orthogonal to returns on the NAV and fund characteristics over the past 60 months. Consistent with the model's prediction, I find that my proxy is negatively related to future returns of closed-end mutual funds. I show that trading strategies based on the proxy for the mean shift are highly profitable. Buying funds with downward mean shifts and short selling funds with upward mean shifts by my proxy produces highly significant abnormal expected returns between 3% and 8% per year over my sample period from January 1999 to December 2017.

One might argue that the empirical evidence is consistent with overreaction to news. To examine the overreaction hypothesis, I replicate the zero-net investment strategy using past excess returns over the market as the sorting variable. The trading strategy based on past return data alone is less profitable in terms of both economic magnitude and statistical significance than the trading strategy based on the proxy for mean shifts of the price ratio.

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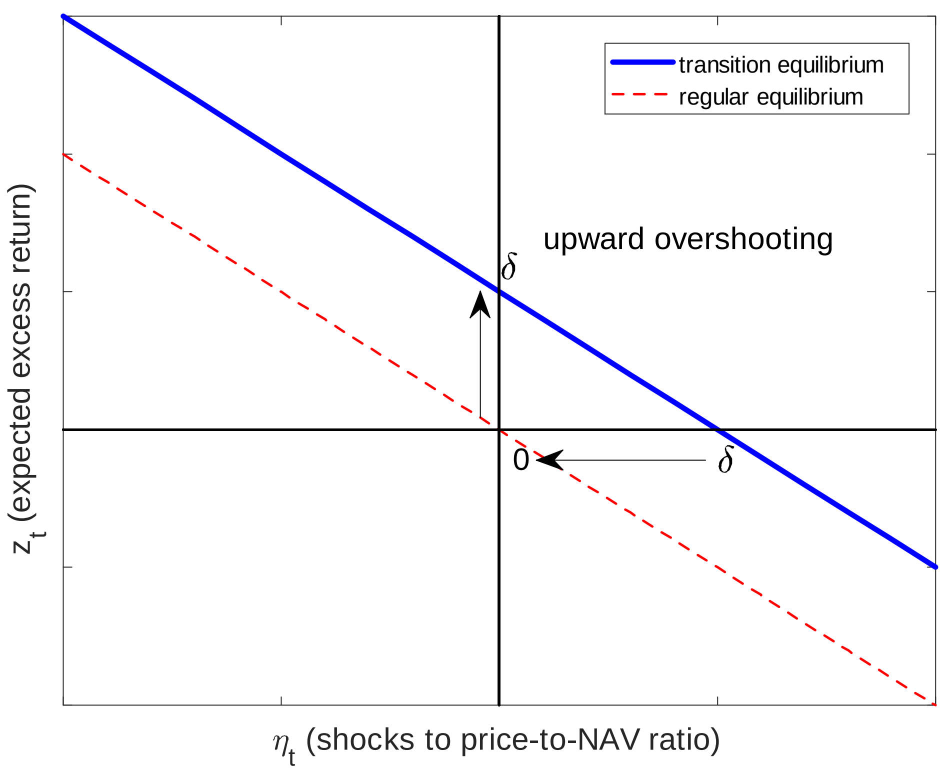
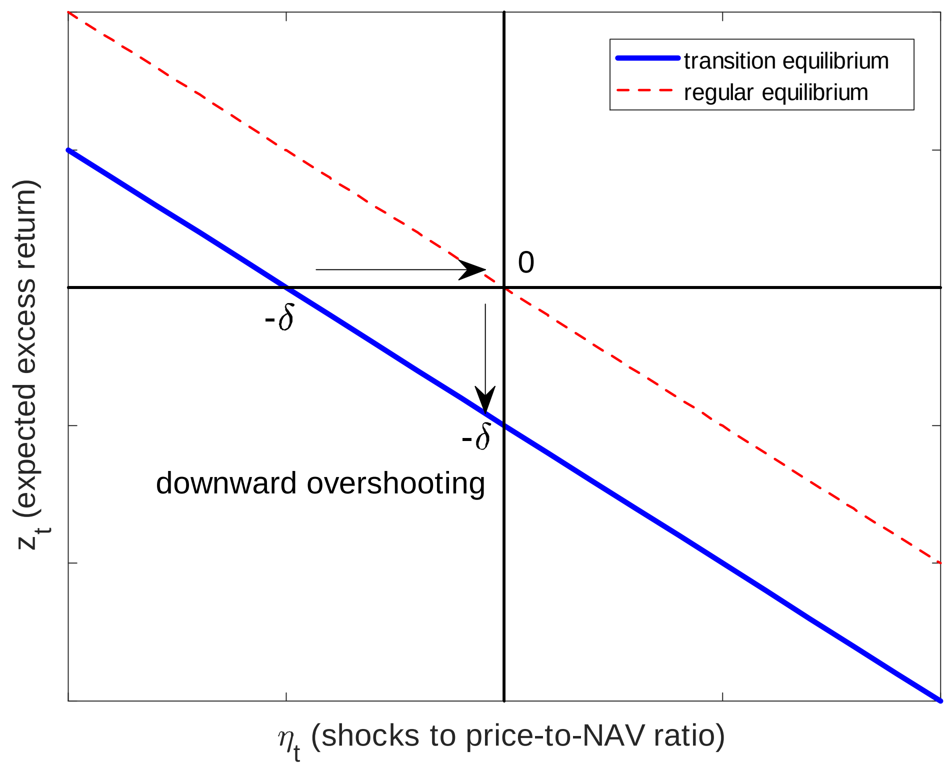
Figure 1
Overshooting model

Equilibrium is represented by a pair (η_t, z_t) on the x-axis and y-axis, where η_t is shocks to the price-to-NAV ratio in the period t and z_t is expected excess return on the price over the return on the NAV in the period $t+1$, conditional on the information in t. In (A) and (B), the dashed lines plot the equilibrium in regular periods: $z_t = -\eta_t$. The solid lines plot the equilibrium during transition periods with a mean shift of the price-to-NAV ratio by $\delta > 0$ (upward) and $-\delta < 0$ (downward shift): $z_t = \delta - \eta_t$ and $z_t = -\delta - \eta_t$ in (A) and (B), respectively. When investors ignore the mean shift, any equilibrium on the solid line moves upward in (A) and downward in (B). For example, after the shocks η_t are realized as a value equal to δ and $-\delta$ in (A) and (B), respectively, the original equilibria $(\delta, 0)$ and $(-\delta, 0)$ move to $(0, \delta)$ and $(0, -\delta)$ in (A) and (B), respectively.

(A)



(B)

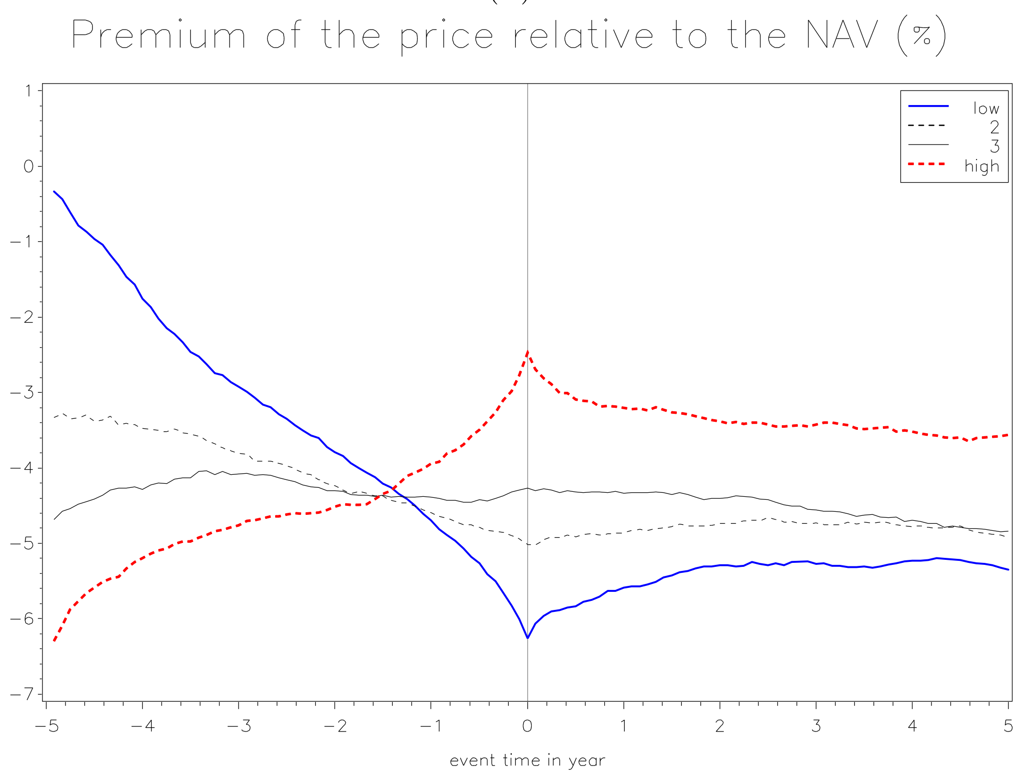


transition equilibrium
regular equilibrium
0
-δ
-δ
downward overshooting
z_t (expected excess return)
η_t (shocks to price-to-NAV ratio)

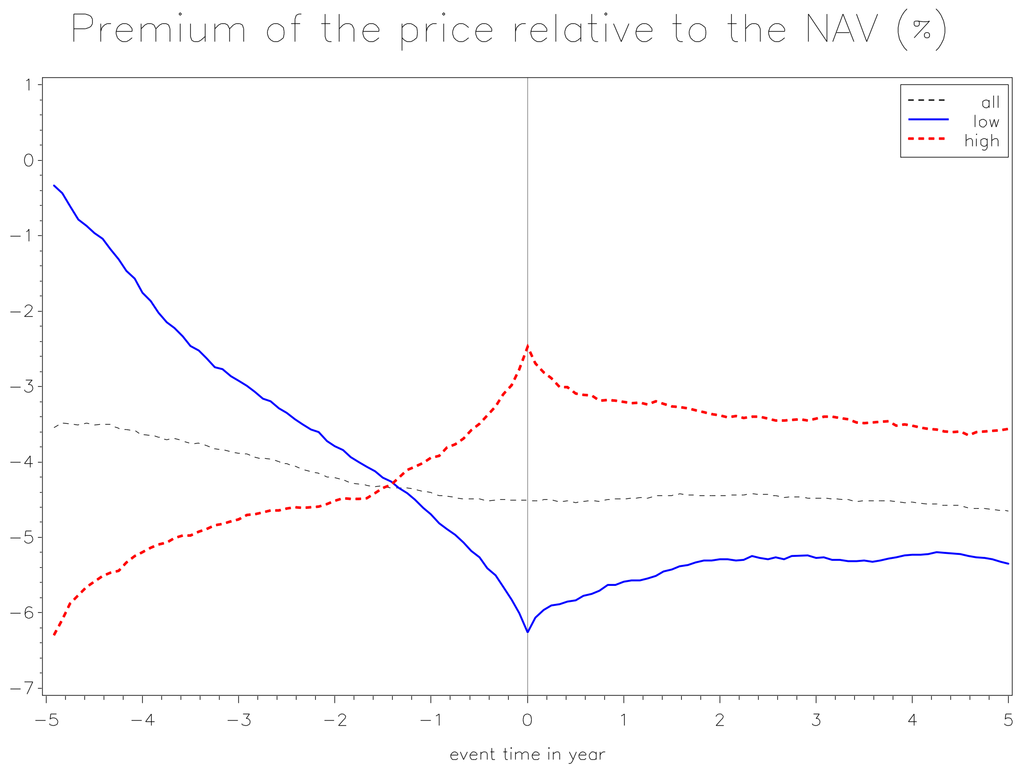
Figure 2
Sorting closed-end mutual funds by the proxy for mean shifts of the price ratio

Closed-end mutual funds are sorted based on the proxy for mean shifts of the price-to-NAV ratio at the end of each month and grouped into quartiles. The bottom and the top quartiles are labeled as low and high, respectively. Figures (A) and (B) present averages of premium (%) of the market price relative to the NAV in each quartile, respectively, over 60 months before and after funds are sorted (the event time 0). The growth of the premium is plotted in Figure (C). Figures (D) to (F) present returns on the market price (%), returns on the NAV (%), and returns on the market price minus returns on the NAV (%), respectively. Figure (G) plots the cumulative distribution of fund age in years for the bottom and the top quartiles.

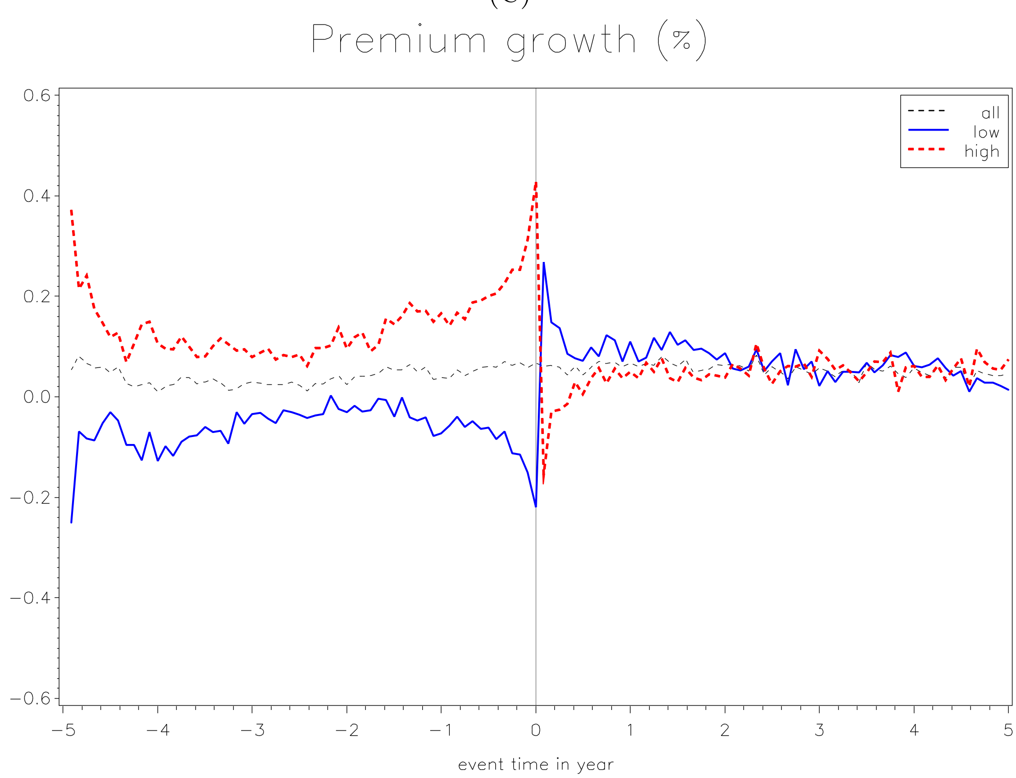
(A)



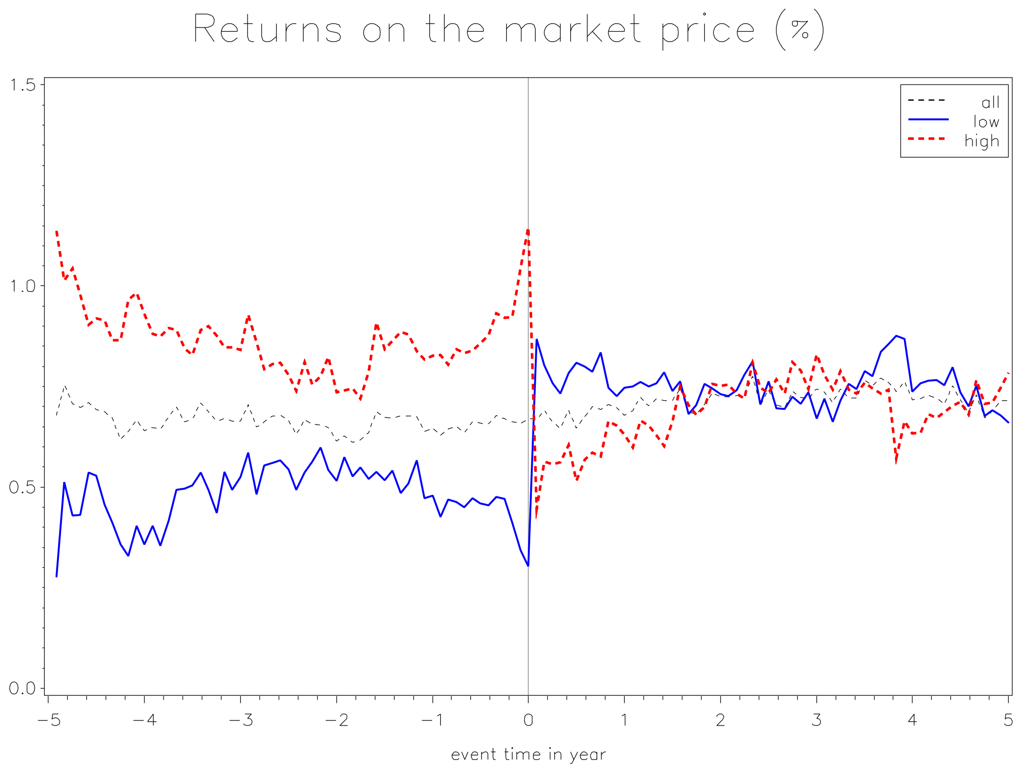
(B)


Premium of the price relative to the NAV (%)
all
low
high
1
0
−1
−2
−3
−4
−5
−6
−7
−5
−4
−3
−2
−1
0
1
2
3
4
5
event time in year

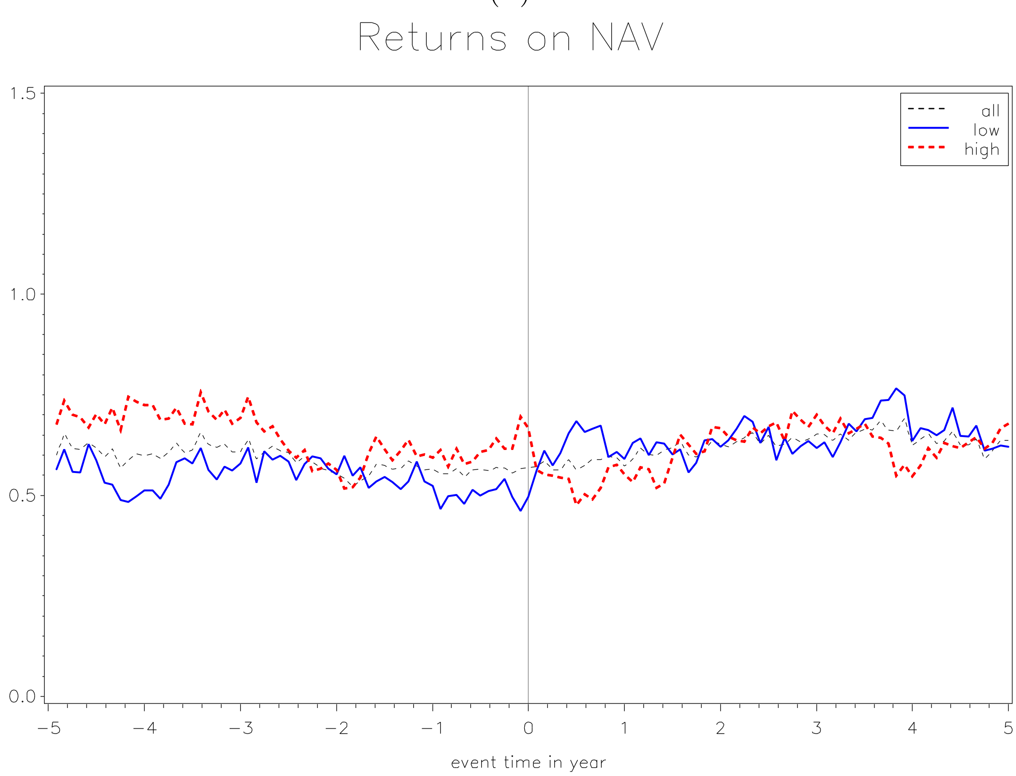
(C)


Premium growth (%)
all
low
high
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−5
−4
−3
−2
−1
0
1
2
3
4
5
event time in year

(D)


Returns on the market price (%)
all
low
high
1.5
1.0
0.5
0.0
−5
−4
−3
−2
−1
0
1
2
3
4
5
event time in year

(E)


Returns on NAV
all
low
high
1.5
1.0
0.5
0.0
−5
−4
−3
−2
−1
0
1
2
3
4
5
event time in year

(F)


Excess return on the price over return on NAV
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−5
−4
−3
−2
−1
0
1
2
3
4
5
event time in year
all
low
high

(G)

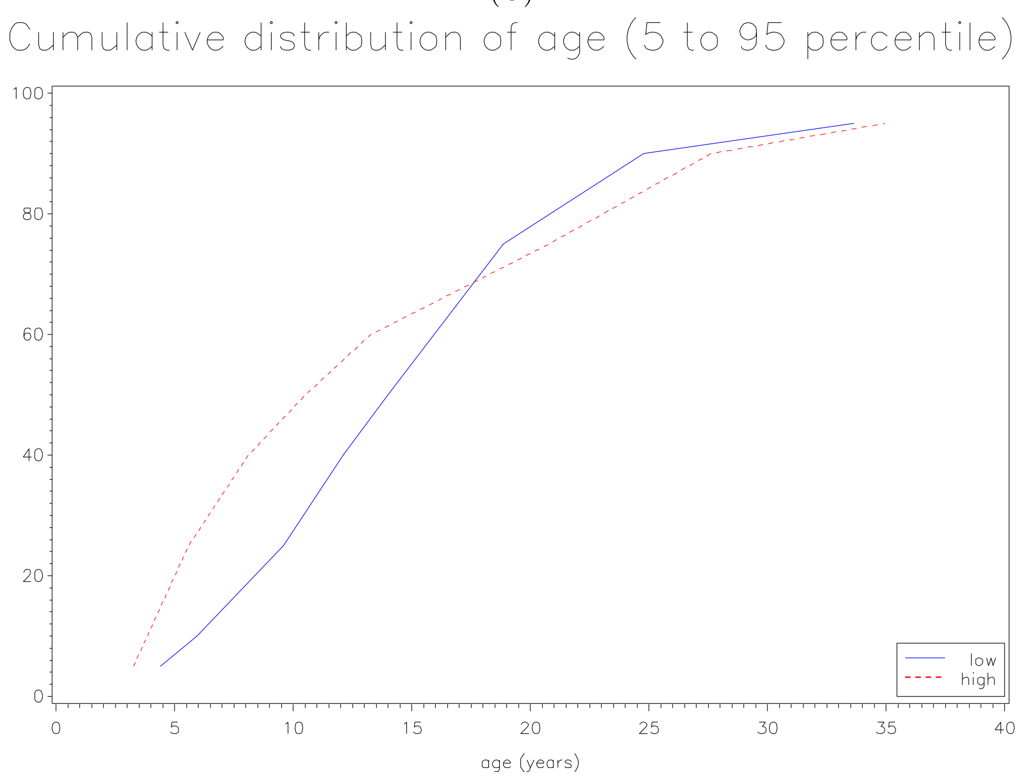
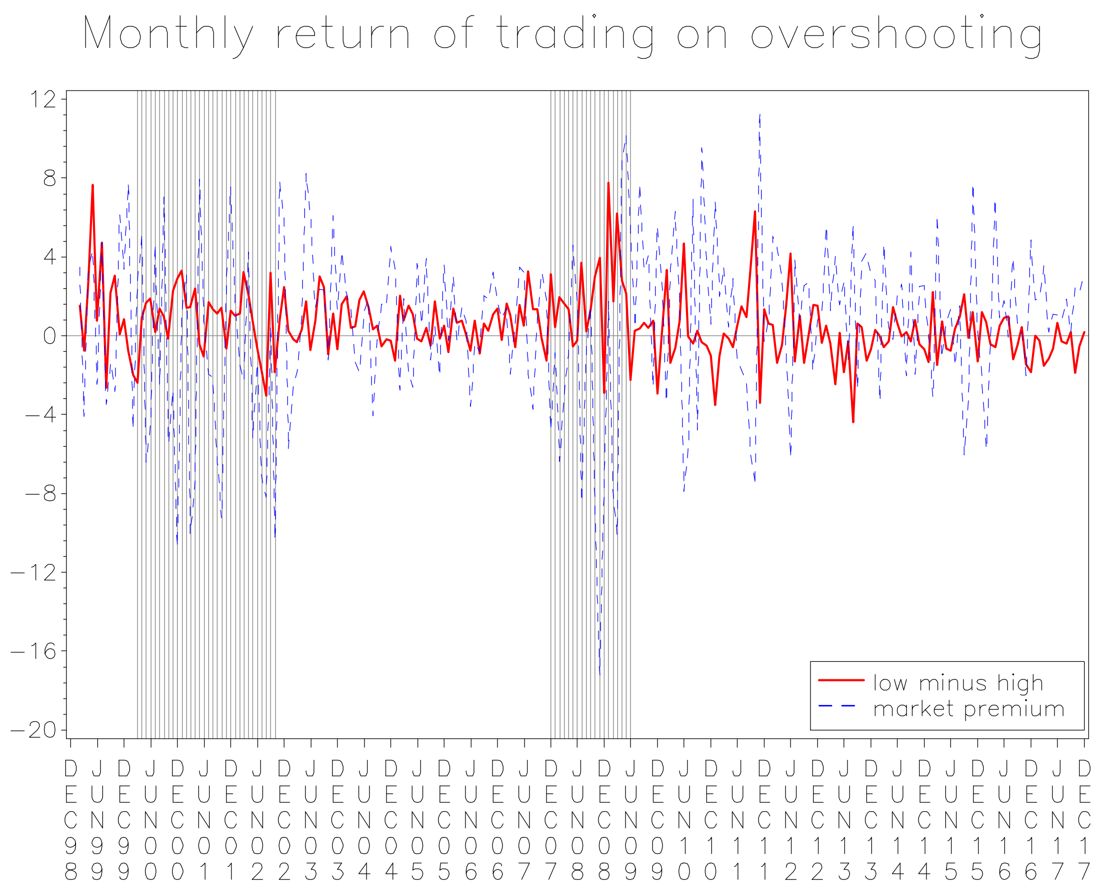

Cumulative distribution of age (5 to 95 percentile)
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
age (years)
low
high

Figure 3
Monthly returns on trading on overshooting

The figures plot the monthly returns (%) on the zero-cost portfolio that buys closed-end mutual funds in the bottom quartile and short sells closed-end funds in the top quartile ("low minus high") based on the proxy for mean shifts of the price-to-NAV ratio. Figures (A) and (B) also plot the market factor and the momentum factor, respectively. The shaded areas represent economic recessions according to the National Bureau of Economic Research. The proxy for the mean shift is estimated at the end of the prior month as a fund-specific unobservable component in monthly fund returns for the past 60 months, orthogonal to returns on the NAV and fund characteristics. Only funds with at least 30 monthly observations are included in the sample. The data period is from January 1994 to December 2017. The first proxy for the mean shift is obtained at the end of December 1998 using the sample from January 1994 to December 1998. The monthly "low minus high" return is from January 1999 to December 2017.

(A)



(B)

Monthly return of trading on overshooting

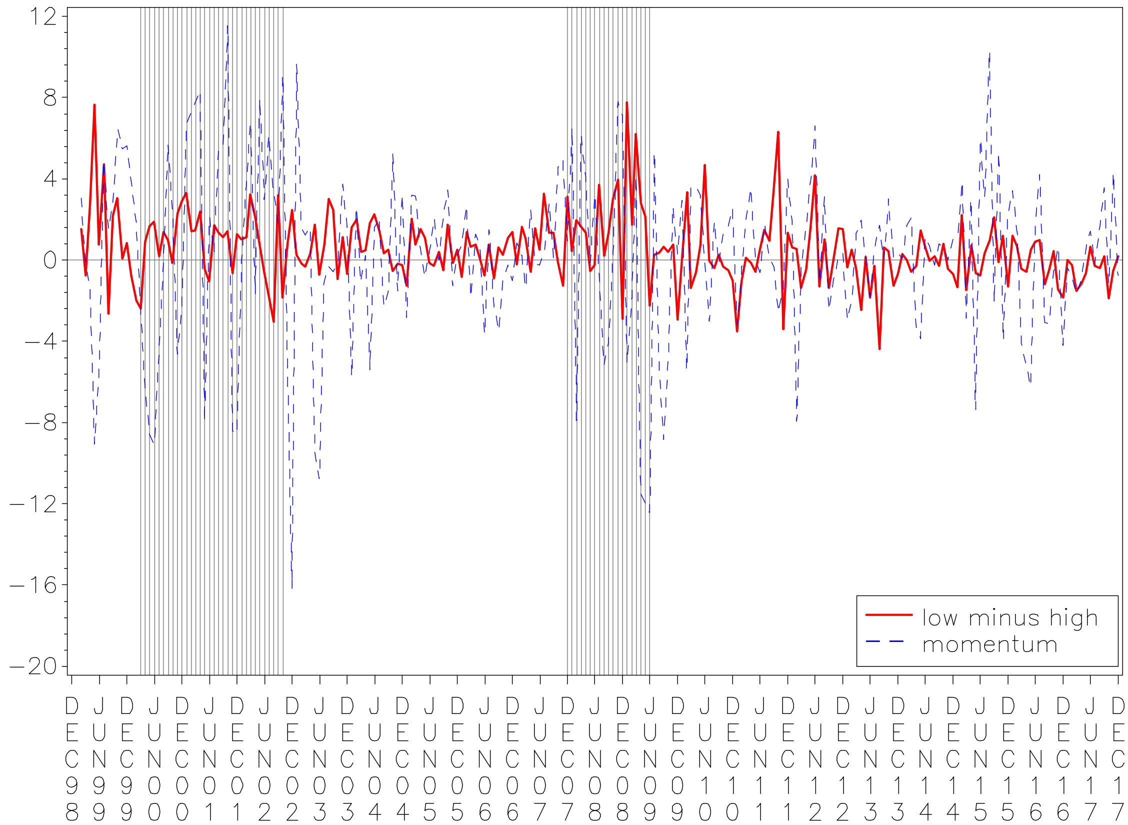
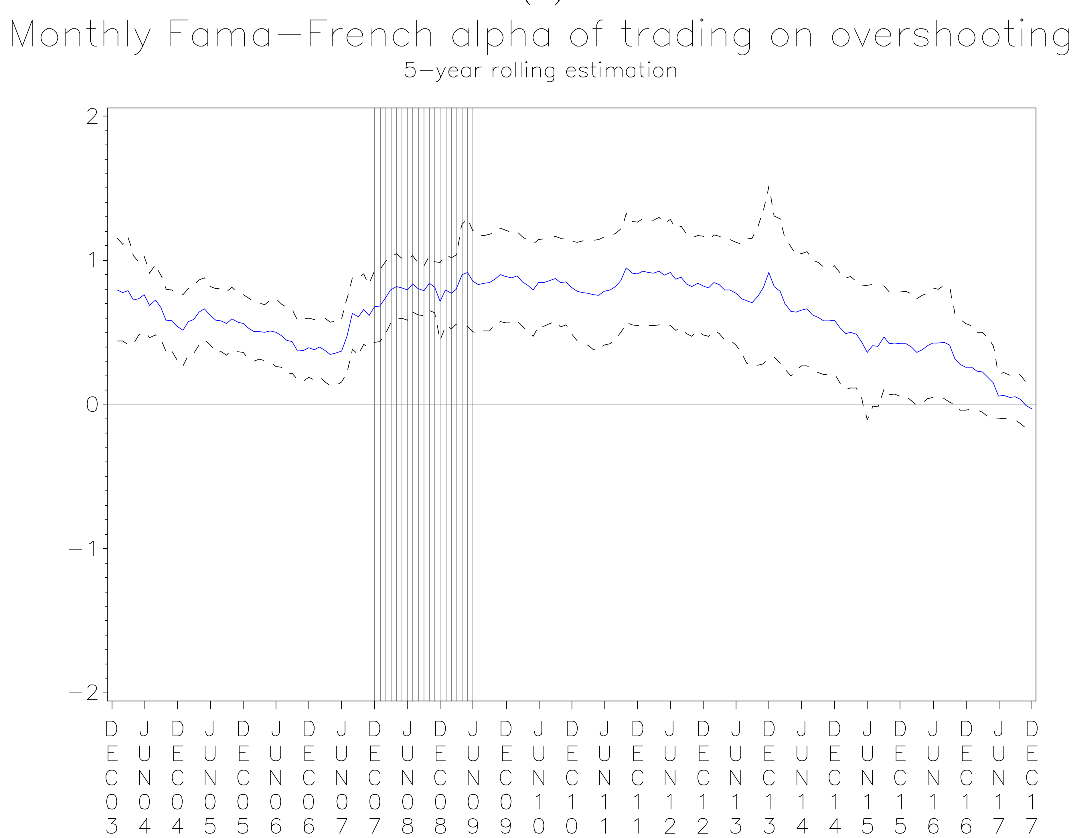


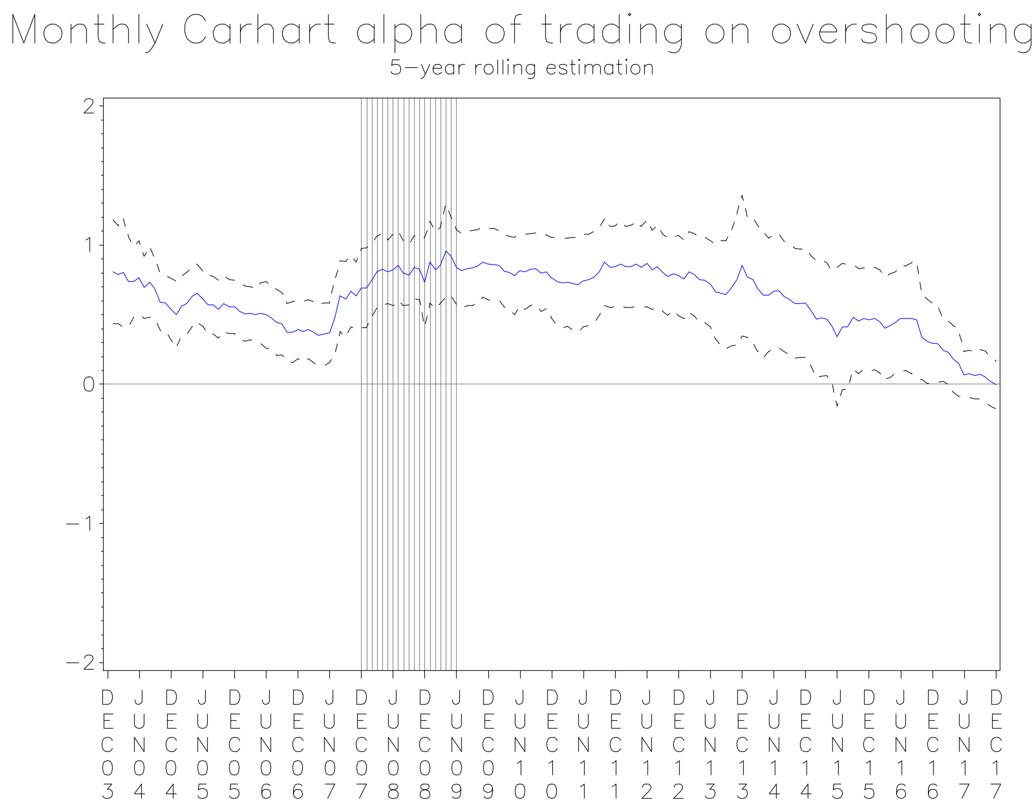
Figure 4
Monthly risk-adjusted returns (alpha) on trading on overshooting

The figures plot the monthly risk-adjusted returns (%) on the zero-cost portfolio that buys closed-end mutual funds in the bottom quartile and short sells closed-end funds in the top quartile ("low minus high") based on the proxy for mean shifts of the price-to-NAV ratio. Figure (A) to (C) use Fama and French's (1993) three factors, Carhart's (1997) four factors, and Carhart's four factors and the betting-against-beta factor (BAB) by Frazzini and Pedersen (2014), as benchmark returns. The dashed lines represent the confidence intervals with the significance level of 10%. Risk-adjusted returns are estimated as the intercept (alpha) of the time-series regressions of the "low minus high" returns on the factors using a rolling method with the sample of the past 60 months. The shaded areas represent economic recessions according to the National Bureau of Economic Research. The data period is from January 1994 to December 2017. The first estimate of the proxy for the mean shift is obtained in December 1998 using the sample from January 1994 to December 1998. The monthly "low minus high" return is from January 1999 to December 2017. The first estimates of the alphas are obtained in December 2003 using the sample of 60 months from January 1999 to December 2003.

(A)

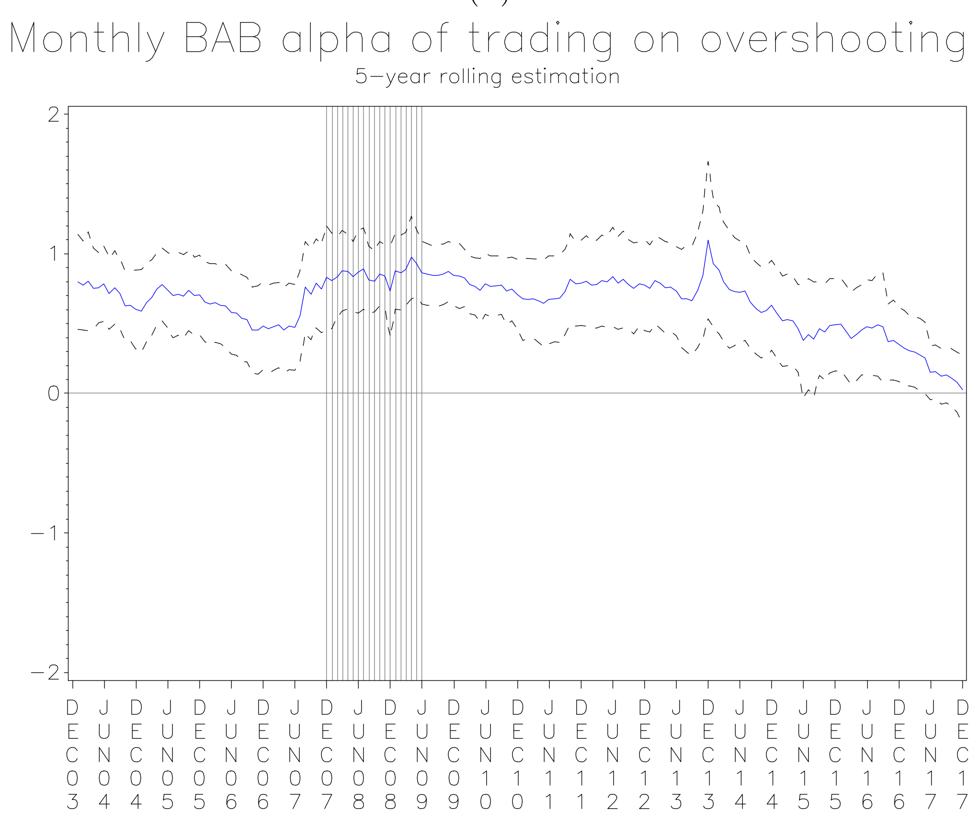


(B)



Monthly Carhart alpha of trading on overshooting
5−year rolling estimation

(C)



Monthly BAB alpha of trading on overshooting
5−year rolling estimation

Figure 5
Monthly risk-adjusted returns (alpha) on trading on past returns

The figure plots the monthly risk-adjusted returns (%) on the zero-cost portfolio that buys closed-end mutual funds in the bottom quartile and short sells closed-end funds in the top quartile ("low minus high") based on excess returns over the market for the past 60 months. It uses Fama and French's (1993) three factors as benchmark returns. The dashed lines represent the confidence intervals with a significance level of 10%. Abnormal expected returns are estimated as the intercept (alpha) of the time-series regressions of the "low minus high" returns on the factors using a rolling method with the sample of the past 60 months. The shaded areas represent economic recessions according to the National Bureau of Economic Research. The data period is from January 1994 to December 2017. The first estimate of the excess returns is obtained in December 1998 using the sample from January 1994 to December 1998. The monthly "low minus high" return is from January 1999 to December 2017. The first estimates of the alphas are obtained in December 2003 using the sample of 60 months from January 1999 to December 2003.

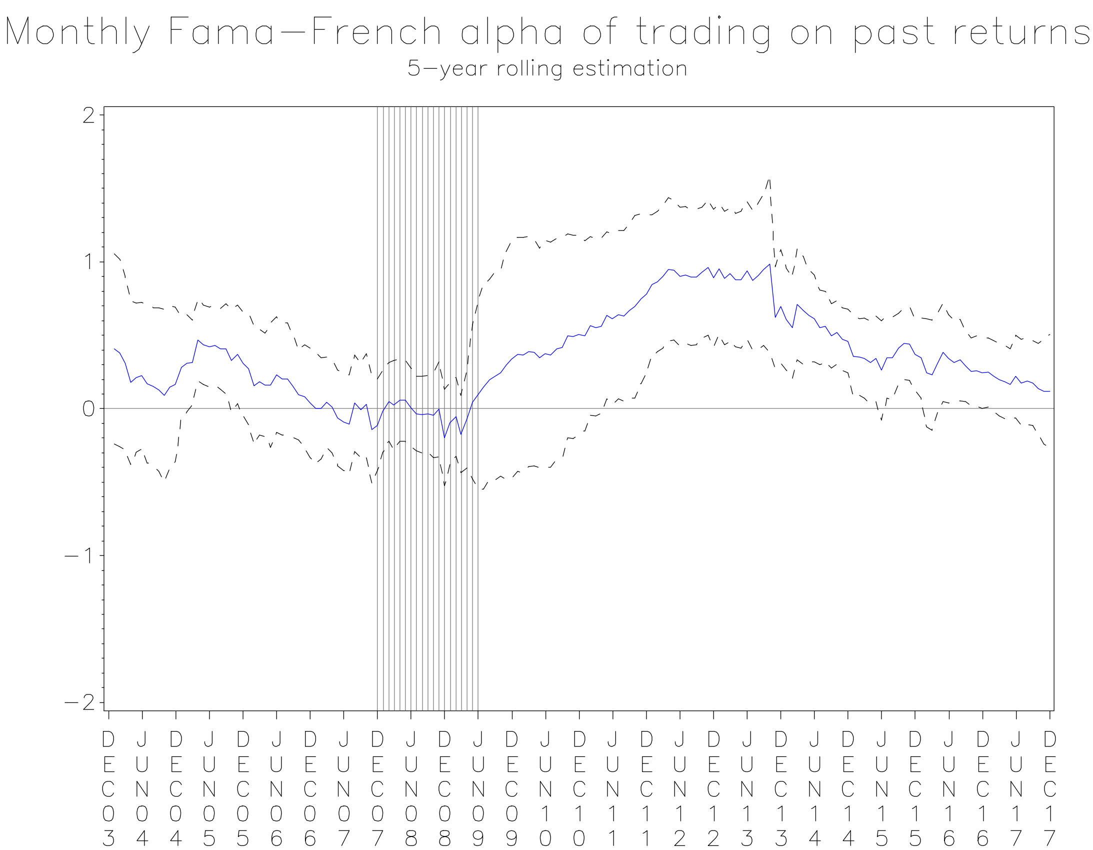


Table 1
Descriptive statistics

Table 1 presents descriptive statistics of closed-end mutual funds (CEF). Panel (A) includes all closed-end mutual funds, and Panels (B) to (D) include closed-end funds that mainly invest in only stocks, bonds, and tax-preferred bonds, respectively. Return is the monthly return on the price of the fund in the market. NAV return is the monthly return on the net asset value (NAV) of the fund. Premium is defined as price-to-NAV ratio minus one, i.e., the market price of the fund divided by the NAV minus one. Premium growth is the growth of the price-to-NAV ratio. Price and NAV are measured at the end of the month. Assets ($M) are the total net assets (TNA) of the fund in million dollars. Family assets ($M) or family are the sum of TNA of the closed-end mutual funds that belong to the fund family in million dollars. Expense ratio is the annual expense ratio that is disclosed in the fund annual report and is effective for the month. Age is the number of years since the inception date of the fund (or the first month that TNA or return data are available for the fund). Obs is the total number of monthly observations. The sample period is from January 1980 to December 2017. The data are from Morningstar Direct.

	obs	mean	std	p1	median	p99
(A) all CEF						
return (%)	125,171	0.648	5.745	-16.018	0.822	15.599
return on NAV (%)	125,171	0.570	4.050	-12.642	0.725	11.405
premium (%)	125,169	-4.422	9.600	-23.686	-5.433	25.301
premium growth (%)	117,125	0.039	3.619	-9.768	0.028	10.042
assets ($M)	125,171	353	416	17	215	2,015
family assets ($M)	125,171	11,429	13,274	30	4,038	42,268
expense ratio (%)	113,665	1.297	0.583	0.540	1.180	3.260
age (years)	125,171	12.648	10.609	0.288	10.677	54.310
(B) equity CEF						
return (%)	26,795	0.814	8.900	-22.015	1.001	21.930
return on NAV (%)	26,795	0.695	6.726	-19.627	1.059	17.844
premium (%)	26,795	-6.767	13.659	-30.798	-9.465	48.744
premium growth (%)	24,842	0.064	4.611	-12.873	-0.026	13.759
assets ($M)	26,795	389	462	7	218	2,099
family assets ($M)	26,795	3,855	8,092	7	1,219	39,812
expense ratio (%)	25,029	1.626	0.780	0.450	1.480	4.640
age (years)	26,795	15.089	15.396	0.263	11.230	83.636
(C) bond CEF						
return (%)	32,340	0.618	4.808	-14.663	0.768	13.732
return on NAV (%)	32,340	0.548	3.208	-10.273	0.702	8.603
premium (%)	32,339	-3.643	8.953	-19.236	-5.266	26.296
premium growth (%)	30,174	0.028	3.472	-9.879	0.006	10.803
assets ($M)	32,340	403	406	39	267	2,001
family assets ($M)	32,340	7,694	11,530	79	2,298	42,123
expense ratio (%)	28,549	1.293	0.520	0.600	1.180	3.040
age (years)	32,340	12.789	9.718	0.263	10.674	42.463
(D) tax preferred CEF						
return (%)	52,860	0.577	3.765	-10.640	0.791	9.469
return on NAV (%)	52,860	0.521	2.300	-7.655	0.654	6.360
premium (%)	52,859	-3.018	6.692	-16.634	-3.588	15.944
premium growth (%)	49,625	0.033	2.843	-7.966	0.068	7.819
assets ($M)	52,860	259	292	19	167	1,367
family assets ($M)	52,860	18,217	13,421	147	17,097	42,619
expense ratio (%)	47,980	1.106	0.323	0.540	1.080	2.090
age (years)	52,860	11.748	6.628	0.422	11.260	27.167

,

Table 2
Correlation coefficients

Table 2 presents estimates and p-values (in parentheses) of correlation coefficients between the variables in the first row and the first column. See Table 1 for the variable descriptions. Lag represents the variable in the prior month. The sample period is from January 1980 to December 2017. The data are from Morningstar Direct.

	return	lag return	NAV return	lag NAV return	premium	lag premium	premium growth	assets	family assets	expense
return	1.000									
lag return	0.036	1.000								
	(0.000)									
NAV return	0.703	0.133	1.000							
	(0.000)	(0.000)								
lag NAV return	0.141	0.703	0.149	1.000						
	(0.000)	(0.000)	(0.000)							
premium	0.108	0.075	0.024	0.045	1.000					
	(0.000)	(0.000)	(0.000)	(0.000)						
lag premium	-0.117	0.108	0.024	0.025	0.933	1.000				
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)					
premium growth	0.656	-0.090	0.002	0.051	0.178	-0.175	1.000			
	(0.000)	(0.000)	(0.459)	(0.000)	(0.000)	(0.000)				
assets ($M)	0.012	0.014	0.016	0.022	-0.058	-0.057	-0.008	1.000		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)			
family assets ($M)	-0.010	-0.011	-0.004	-0.003	0.058	0.057	-0.009	0.063	1.000	
	(0.000)	(0.000)	(0.136)	(0.277)	(0.000)	(0.000)	(0.002)	(0.000)		
expense ratio	0.020	0.018	0.023	0.022	-0.018	-0.015	0.012	-0.115	-0.218	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
age (years)	0.010	0.011	0.009	0.012	-0.093	-0.095	0.005	0.079	-0.088	-0.105
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.067)	(0.000)	(0.000)	(0.000)

Table 3
Panel regressions of returns on closed-end mutual funds

Table 3 presents estimates, standard errors (in parentheses), and p-values (in parentheses) of panel regressions of monthly returns of closed-end mutual funds on fund variables and the proxy for mean shifts of the price-to-NAV ratio. See Table 1 for the variable descriptions. Columns (1) to (2) include fund fixed effect and time (year-month) fixed effect. Columns (3) and (8) include time (year-month) fixed effect (refer to the regression equation (18)-(21)). The variable "mean shift" is a proxy for mean shifts of the price-to-NAV ratio and represents an unobservable fund-specific component in fund returns that is orthogonal to returns on the NAV and fund characteristics. It is estimated in the prior month by panel regressions of monthly returns on fund variables using the sample of the prior 60 months (refer to the regression equation (17)). Lag 2 "mean shift" is the proxy for the mean shift estimated two months prior to the current month. Lag update "mean shift" is the difference between Lag "mean shift" and Lag 2 "mean shift" (refer to the equation (20)). Only funds with at least 30 monthly observations are included in the sample. The sample period is from January 1994 to December 2017. Only a small number of funds have monthly variables before 1994. For the regressions including the lagged "mean shift", the sample period is from January 1999 to December 2017 because the estimate of the effect uses the prior 60 months (i.e., 60 months from January 1994 to December 1998 for the first estimate of the unobservable effect in December 1998).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
return on NAV	1.005	1.005	0.904	0.904	0.938	0.938	0.939	0.939
	(0.011)	(0.036)	(0.012)	(0.016)	(0.010)	(0.016)	(0.010)	(0.016)
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lag mean shift			-0.202	-0.202	-0.241	-0.241		
			(0.013)	(0.013)	(0.121)	(0.069)		
			(0.000)	(0.000)	(0.046)	(0.001)		
lag 2 mean shift							-0.201	-0.201
							(0.115)	(0.068)
							(0.080)	(0.003)
lag update of mean shift							-1.440	-1.440
							(0.236)	(0.285)
							(0.000)	(0.000)
expense ratio					0.011	0.011	0.056	0.056
					(0.025)	(0.045)	(0.024)	(0.049)
					(0.644)	(0.802)	(0.019)	(0.254)
log TNA					0.007	0.007	0.040	0.040
					(0.020)	(0.024)	(0.018)	(0.026)
					(0.732)	(0.777)	(0.027)	(0.121)
log age					-0.073	-0.073	-0.011	-0.011
					(0.023)	(0.040)	(0.020)	(0.039)
					(0.002)	(0.070)	(0.577)	(0.770)
log family size					-0.039	-0.039	-0.022	-0.022
					(0.009)	(0.017)	(0.009)	(0.017)
					(0.000)	(0.025)	(0.011)	(0.216)
clustering	fund	time	fund	time	fund	time	fund	time
adjusted R square	0.497		0.583		0.655		0.657	
observations	112,077		104,933		90,242		89,623	
fixed effect	fund and time		time		time		time	

Table 4
Returns and characteristics of funds in each quartile of the proxy for mean shifts of the price ratio

Table 4 presents sample mean of the variables of closed-end mutual funds in each quartile of the proxy for mean shifts of the price-to-NAV ratio. All variables are in % unless otherwise specified. Sample mean is the average of the time series of the monthly cross-sectional averages. The proxy for the mean shift is a fund-specific component in fund returns that is orthogonal to returns on the NAV and fund characteristics and that varies over time. It is estimated in each month by panel regressions of monthly returns on fund variables using the sample of the prior 60 months, including the current month t (refer to the regression equation (21)). See Table 1 for the variable descriptions. Panel (A) includes all closed-end mutual funds, and Panels (B) to (D) include closed-end funds that mainly invest only in stocks, bonds, and tax-preferred bonds, respectively. L-H represents the difference between the bottom quartile (L) and the top quartile (H). The t-statistics for low-high use Newey and West's (1987) adjusted standard errors with 12 lags. The sample period is from January 1994 to December 2017. The first estimate of the unobservable effect uses the 60 months from January 1994 to December 1998. The average of the time series of the monthly cross-sectional averages is from December 1998 to December 2017.

	$return_t$	$premium_t$	NAV $return_t$	premium. $growth_t$	$expense_t$	age_t (year)	$assets_t$ ($M)	$family_t$ ($M)	$return_{t+1}$	prem-ium_{t+1}	NAV $return_{t+1}$	premium $growth_{t+1}$
(A) all												
L	0.289	-6.533	0.533	-0.212	1.295	15.357	454	16015	0.920	-6.309	0.598	0.301
2	0.551	-5.126	0.547	-0.040	1.218	14.051	358	13745	0.659	-5.108	0.569	0.066
3	0.679	-4.039	0.559	0.086	1.263	13.217	302	9411	0.609	-4.076	0.556	0.009
H	1.063	-1.942	0.618	0.407	1.365	14.099	259	7534	0.452	-2.191	0.560	-0.150
L-H	-0.774	-4.591	-0.085	-0.619	-0.069	1.258	195	8481	0.468	-4.118	0.038	0.451
(tstat)	(-4.320)	(-4.213)	(-0.618)	(-7.122)	(-1.216)	(0.629)	(3.109)	(2.307)	(2.854)	(-3.956)	(0.306)	(4.537)
(B) equity												
L	0.324	-8.437	0.648	-0.162	1.626	17.188	495	8855	1.097	-8.128	0.689	0.428
2	0.767	-8.447	0.677	-0.002	1.598	15.438	388	4682	0.842	-8.340	0.679	0.184
3	0.664	-8.188	0.616	0.253	1.575	15.433	340	2981	1.081	-8.026	0.817	0.260
H	1.529	-1.651	0.798	0.695	1.770	18.100	300	1730	0.756	-1.917	0.851	-0.113
L-H	-1.205	-6.786	-0.151	-0.857	-0.144	-0.912	195	7126	0.341	-6.211	-0.162	0.541
(tstat)	(-4.360)	(-3.183)	(-0.888)	(-4.972)	(-1.735)	(-0.333)	(2.915)	(2.950)	(1.753)	(-2.911)	(-0.955)	(3.736)
(C) bond												
L	0.271	-5.371	0.530	-0.213	1.322	13.434	483	13328	0.897	-5.131	0.569	0.306
2	0.649	-4.337	0.601	0.019	1.250	13.801	391	9095	0.641	-4.331	0.556	0.059
3	0.707	-2.725	0.551	0.130	1.271	13.402	356	5971	0.596	-2.791	0.582	-0.009
H	1.098	-0.466	0.646	0.376	1.339	14.451	313	5283	0.408	-0.784	0.568	-0.238
L-H	-0.811	-4.858	-0.121	-0.563	-0.015	-1.049	171	8143	0.466	-4.315	0.002	0.527
(tstat)	(-4.923)	(-7.168)	(-1.484)	(-5.239)	(-0.235)	(-0.502)	(2.114)	(2.340)	(3.232)	(-6.705)	(0.030)	(3.886)
(D) tax-preferred												
L	0.364	-5.668	0.497	-0.193	1.113	14.252	447	21823	0.664	-5.565	0.479	0.140
2	0.447	-4.200	0.480	-0.097	1.078	14.113	317	19257	0.514	-4.226	0.474	0.005
3	0.601	-2.223	0.512	-0.022	1.106	13.227	223	13980	0.480	-2.314	0.481	-0.056
H	0.826	0.350	0.531	0.227	1.082	11.302	172	11338	0.327	0.074	0.511	-0.222
L-H	-0.463	-6.018	-0.034	-0.420	0.031	2.950	275	10485	0.337	-5.639	-0.032	0.362
(tstat)	(-5.102)	(-8.311)	(-0.662)	(-5.906)	(0.741)	(2.607)	(4.001)	(2.918)	(4.230)	(-8.304)	(-0.722)	(4.209)

Table 5

Performance of quartile portfolios by the proxy for mean shifts of the price ratio and the zero-cost portfolio

Table 5 presents estimates, standard errors (in parentheses), and p-values (in parentheses) of average returns and risk-adjusted average returns on closed-end mutual funds in each quartile by the proxy for mean shifts of the price-to-NAV ratio (see Table 4 for the description). Closed-end mutual funds are sorted based on the proxy at the end of each month. The portfolios are formed with equal weights, held for the next month, and rebalanced monthly. L-H represents a zero-cost portfolio that buys closed-end mutual funds in the lowest quartile (L) and short sells closed-end mutual funds in the highest quartile (H). Average represents the average monthly excess returns on the portfolios multiplied by 12 (annualized). Risk-adjusted average returns are estimated as the intercept of time-series regressions of the monthly portfolio returns on the factors (refer to the regression equations (23) to (25)), multiplied by 12. CAPM represents the average returns adjusted for the Capital Asset Pricing Model's market factor (MKT) in Sharpe (1964), Lintner (1965), and Black (1972). FF represents the average returns adjusted for Fama and French's (1993) three factors, including the market factor (MKT), the value factor (HML), and the size factor (SMB). Carhart, BAB, and PS include the momentum factor (MOM) in Jegadeesh and Titman (1993), the betting-against-beta factor (BAB) in Frazzini and Pedersen (2014), and the liquidity factor (LIQ) in Pastor and Staumbaugh (2003), respectively. The columns for the factors present estimates, standard errors (in parentheses), and p-values (in parentheses) of the loadings on the factors. The standard errors use Newey and West's (1987) adjusted standard errors with 12 lags. The first estimate of unobservable effect uses the 60 months from January 1994 to December 1998. The sample period for the regressions is from January 1999 to December 2017.

	average	CAPM	FF	Carhart					BAB		PS	
	a*12	a*12	a*12	a*12	MKT	HML	SMB	MOM	a*12	BAB	a*12	LIQ
L	9.300	6.887	6.503	7.557	0.309	-0.009	0.135	-0.173	5.591	0.265	6.896	0.131
	(2.757)	(2.310)	(2.102)	(1.938)	(0.054)	(0.103)	(0.052)	(0.051)	(2.048)	(0.094)	(2.073)	(0.083)
	(0.001)	(0.003)	(0.002)	(0.000)	(0.000)	(0.931)	(0.011)	(0.001)	(0.007)	(0.005)	(0.001)	(0.116)
2	6.171	4.336	4.164	4.949	0.240	-0.023	0.076	-0.129	2.493	0.331	4.281	0.095
	(2.598)	(2.179)	(2.110)	(1.957)	(0.052)	(0.106)	(0.047)	(0.049)	(1.696)	(0.099)	(2.191)	(0.099)
	(0.018)	(0.048)	(0.050)	(0.012)	(0.000)	(0.827)	(0.111)	(0.009)	(0.143)	(0.001)	(0.052)	(0.334)
3	5.566	3.342	2.939	3.686	0.306	0.034	0.104	-0.123	1.052	0.355	2.871	0.075
	(2.793)	(2.205)	(2.093)	(1.956)	(0.056)	(0.101)	(0.047)	(0.049)	(1.678)	(0.098)	(2.101)	(0.104)
	(0.047)	(0.131)	(0.162)	(0.061)	(0.000)	(0.740)	(0.027)	(0.013)	(0.531)	(0.000)	(0.173)	(0.474)
H	3.687	0.499	0.036	0.575	0.481	0.043	0.120	-0.089	-1.845	0.326	-0.392	0.084
	(3.196)	(2.170)	(2.012)	(1.957)	(0.072)	(0.080)	(0.059)	(0.042)	(1.802)	(0.086)	(2.126)	(0.088)
	(0.250)	(0.818)	(0.986)	(0.769)	(0.000)	(0.588)	(0.043)	(0.038)	(0.307)	(0.000)	(0.854)	(0.342)
L-H	5.613	6.388	6.467	6.983	-0.172	-0.052	0.016	-0.085	7.435	-0.061	7.288	0.048
	(1.967)	(1.697)	(1.632)	(1.581)	(0.065)	(0.047)	(0.041)	(0.033)	(1.514)	(0.023)	(1.503)	(0.043)
	(0.005)	(0.000)	(0.000)	(0.000)	(0.008)	(0.270)	(0.700)	(0.011)	(0.000)	(0.008)	(0.000)	(0.266)

Table 6

Performance of quartile portfolios by the proxy for mean shifts of the price ratio and the zero-cost portfolio with a waiting period of one month

See the note for Table 5. The only difference is that trading occurs one month after sorting the funds into quartile portfolios by the proxy for mean shifts of the price-to-NAV ratio. The first estimate of unobservable effect uses the 60 months from January 1994 to December 1998. The zero-cost portfolio buys (short sells) closed-end mutual funds in the lowest (highest) quartile at the end of January 1999 and holds the positions until the end of February 1999. The portfolio is rebalanced monthly. The sample period is from January 1994 to December 2017. The sample period for the regressions is from February 1999 to December 2017.

	average	CAPM	FF	Carhart					BAB		PS	
	a*12	a*12	a*12	a*12	MKT	HML	SMB	MOM	a*12	BAB	a*12	LIQ
L	8.479	6.073	5.689	6.637	0.325	-0.006	0.131	-0.160	4.826	0.240	6.055	0.117
	(2.754)	(2.257)	(2.045)	(1.961)	(0.058)	(0.094)	(0.053)	(0.051)	(2.243)	(0.097)	(2.149)	(0.080)
	(0.002)	(0.008)	(0.006)	(0.001)	(0.000)	(0.947)	(0.015)	(0.002)	(0.033)	(0.014)	(0.005)	(0.146)
2	6.433	4.671	4.419	5.286	0.227	-0.011	0.088	-0.146	2.719	0.340	4.597	0.098
	(2.648)	(2.246)	(2.171)	(1.972)	(0.052)	(0.106)	(0.048)	(0.050)	(1.662)	(0.090)	(2.182)	(0.092)
	(0.016)	(0.039)	(0.043)	(0.008)	(0.000)	(0.921)	(0.068)	(0.004)	(0.103)	(0.000)	(0.036)	(0.288)
3	5.918	3.751	3.415	4.074	0.312	0.017	0.094	-0.111	1.563	0.333	3.279	0.080
	(2.702)	(2.155)	(2.040)	(1.920)	(0.054)	(0.100)	(0.047)	(0.049)	(1.715)	(0.091)	(2.029)	(0.097)
	(0.030)	(0.083)	(0.096)	(0.035)	(0.000)	(0.867)	(0.049)	(0.024)	(0.363)	(0.000)	(0.108)	(0.411)
H	4.380	1.271	0.863	1.429	0.478	0.024	0.114	-0.095	-1.278	0.359	0.443	0.100
	(3.275)	(2.158)	(2.075)	(1.964)	(0.075)	(0.097)	(0.057)	(0.044)	(1.740)	(0.101)	(2.112)	(0.104)
	(0.182)	(0.557)	(0.678)	(0.468)	(0.000)	(0.805)	(0.049)	(0.030)	(0.464)	(0.000)	(0.834)	(0.339)
L-H	4.100	4.802	4.826	5.208	-0.154	-0.030	0.017	-0.064	6.104	-0.119	5.612	0.017
	(1.929)	(1.649)	(1.655)	(1.638)	(0.070)	(0.065)	(0.043)	(0.038)	(1.509)	(0.029)	(1.605)	(0.053)
	(0.035)	(0.004)	(0.004)	(0.002)	(0.029)	(0.640)	(0.692)	(0.088)	(0.000)	(0.000)	(0.001)	(0.742)

Table 7

Performance of quartile portfolios by the proxy for mean shifts of the price ratio and the zero-cost portfolio with various waiting periods

See the note for Table 6. The only difference is that the waiting period is 2 months, 3 months, 6 months, and 12 months. The sample period is from January 1994 to December 2017. The first estimate of unobservable effect uses the 60 months from January 1994 to December 1998. The sample period for the regressions starts from March 1999, April 1999, July 1999, and January 2000 for the waiting periods of 2 months, 3 months, 6 months, and 12 months, respectively, and ends in December 2017.

	average	CAPM	FF	Carhart	BAB	PS	average	CAPM	FF	Carhart	BAB	PS
	2-month waiting period						3-month waiting period					
L	8.186	5.882	5.457	6.250	4.071	5.770	7.282	5.018	4.688	5.515	3.525	5.103
	(2.717)	(2.211)	(1.985)	(1.876)	(1.954)	(2.019)	(2.658)	(2.196)	(1.978)	(1.860)	(1.832)	(1.989)
	(0.003)	(0.008)	(0.006)	(0.001)	(0.038)	(0.005)	(0.007)	(0.023)	(0.019)	(0.003)	(0.056)	(0.011)
2	6.284	4.523	4.346	5.212	2.495	4.574	6.558	4.866	4.567	5.478	2.866	4.869
	(2.630)	(2.271)	(2.190)	(1.997)	(1.921)	(2.225)	(2.620)	(2.184)	(2.083)	(1.887)	(1.734)	(2.089)
	(0.018)	(0.048)	(0.048)	(0.010)	(0.195)	(0.041)	(0.013)	(0.027)	(0.029)	(0.004)	(0.100)	(0.021)
3	5.801	3.704	3.247	3.951	0.951	3.040	6.070	3.965	3.621	4.334	1.462	3.425
	(2.720)	(2.169)	(2.064)	(1.927)	(1.604)	(2.044)	(2.772)	(2.256)	(2.116)	(1.947)	(1.737)	(2.098)
	(0.034)	(0.089)	(0.117)	(0.042)	(0.554)	(0.138)	(0.030)	(0.080)	(0.088)	(0.027)	(0.401)	(0.104)
H	4.052	0.886	0.395	1.168	-1.951	0.086	4.199	1.193	0.773	1.552	-1.611	0.553
	(3.408)	(2.312)	(2.291)	(2.142)	(1.829)	(2.285)	(3.429)	(2.370)	(2.361)	(2.175)	(1.716)	(2.302)
	(0.236)	(0.702)	(0.863)	(0.586)	(0.287)	(0.970)	(0.222)	(0.615)	(0.744)	(0.476)	(0.349)	(0.810)
L-H	4.134	4.997	5.062	5.082	6.022	5.683	3.083	3.825	3.915	3.964	5.137	4.550
	(2.022)	(1.745)	(1.763)	(1.746)	(1.658)	(1.702)	(1.829)	(1.585)	(1.601)	(1.531)	(1.340)	(1.575)
	(0.042)	(0.005)	(0.004)	(0.004)	(0.000)	(0.001)	(0.093)	(0.017)	(0.015)	(0.010)	(0.000)	(0.004)
	6-month waiting period						12-month waiting period					
L	7.854	5.615	5.476	6.415	4.263	5.987	8.310	6.279	6.400	6.963	4.314	6.617
	(2.820)	(2.250)	(2.093)	(1.977)	(1.999)	(2.125)	(2.687)	(2.219)	(2.103)	(1.927)	(1.866)	(1.990)
	(0.006)	(0.013)	(0.010)	(0.001)	(0.034)	(0.005)	(0.002)	(0.005)	(0.003)	(0.000)	(0.022)	(0.001)
2	6.662	4.985	4.727	5.626	2.805	4.990	7.248	5.618	5.478	6.012	2.943	5.445
	(2.672)	(2.296)	(2.196)	(1.981)	(1.787)	(2.197)	(2.526)	(2.173)	(2.008)	(1.909)	(1.979)	(2.131)
	(0.013)	(0.031)	(0.032)	(0.005)	(0.118)	(0.024)	(0.005)	(0.010)	(0.007)	(0.002)	(0.138)	(0.011)
3	5.963	3.819	3.483	4.276	1.529	3.468	6.987	4.896	4.699	5.346	1.674	4.506
	(2.771)	(2.264)	(2.129)	(1.956)	(1.769)	(2.101)	(2.901)	(2.378)	(2.207)	(2.088)	(2.138)	(2.269)
	(0.032)	(0.093)	(0.103)	(0.030)	(0.388)	(0.100)	(0.017)	(0.041)	(0.034)	(0.011)	(0.435)	(0.048)
H	4.337	1.230	0.676	1.577	-1.144	0.566	5.204	2.129	1.720	2.500	-0.845	1.318
	(3.220)	(2.142)	(2.061)	(1.843)	(1.718)	(2.017)	(3.367)	(2.133)	(1.994)	(1.915)	(2.052)	(2.084)
	(0.179)	(0.567)	(0.743)	(0.393)	(0.506)	(0.779)	(0.124)	(0.319)	(0.389)	(0.193)	(0.681)	(0.528)
L-H	3.517	4.386	4.800	4.839	5.408	5.421	3.107	4.149	4.680	4.463	5.159	5.299
	(1.899)	(1.631)	(1.621)	(1.578)	(1.672)	(1.686)	(1.809)	(1.426)	(1.420)	(1.504)	(1.650)	(1.603)
	(0.065)	(0.008)	(0.003)	(0.002)	(0.001)	(0.002)	(0.087)	(0.004)	(0.001)	(0.003)	(0.002)	(0.001)

Table 8

Performance of quartile portfolios by the proxy for mean shifts of the price ratio and the zero-cost portfolio of closed-end equity, bond, and tax-preferred bond funds with various waiting periods

See the note for Table 7. The only difference is that the sample includes only closed-end mutual funds (CEF) that mainly invest in equity, bonds, or tax-preferred bonds.

	average	CAPM	FF	Carhart	BAB	PS	average	CAPM	FF	Carhart	BAB	PS
	(A) equity CEF with a 3-month waiting period						(B) equity CEF with a 12-month waiting period					
L	10.152	4.360	2.918	3.781	2.140	3.432	9.752	4.527	3.570	4.206	1.710	3.912
	(4.729)	(3.161)	(2.510)	(2.387)	(2.519)	(2.266)	(4.681)	(3.022)	(2.572)	(2.367)	(2.311)	(2.135)
	(0.033)	(0.169)	(0.246)	(0.115)	(0.396)	(0.131)	(0.038)	(0.136)	(0.167)	(0.077)	(0.460)	(0.068)
2	10.448	5.247	4.079	5.346	3.313	4.612	10.513	5.060	3.864	4.503	1.644	3.998
	(4.844)	(3.108)	(2.678)	(2.340)	(2.205)	(2.140)	(4.856)	(3.638)	(3.084)	(2.994)	(3.147)	(2.796)
	(0.032)	(0.093)	(0.129)	(0.023)	(0.135)	(0.032)	(0.031)	(0.166)	(0.212)	(0.134)	(0.602)	(0.154)
3	10.522	4.296	3.778	4.253	1.668	3.120	10.242	4.085	3.288	3.856	0.939	3.072
	(5.607)	(3.655)	(3.422)	(3.426)	(3.818)	(3.417)	(5.704)	(3.400)	(2.977)	(2.923)	(2.922)	(2.957)
	(0.062)	(0.241)	(0.271)	(0.216)	(0.663)	(0.362)	(0.074)	(0.231)	(0.271)	(0.189)	(0.748)	(0.300)
H	5.225	-1.364	-1.847	-1.049	-3.630	-1.730	6.050	-0.170	-0.338	0.593	-2.689	-0.801
	(5.760)	(2.604)	(2.373)	(2.208)	(1.791)	(2.278)	(5.590)	(2.558)	(2.480)	(2.400)	(2.613)	(2.260)
	(0.365)	(0.601)	(0.437)	(0.635)	(0.044)	(0.449)	(0.280)	(0.947)	(0.892)	(0.805)	(0.305)	(0.723)
L-H	4.927	5.725	4.765	4.830	5.771	5.162	3.702	4.698	3.908	3.613	4.399	4.713
	(2.801)	(2.731)	(2.324)	(2.337)	(2.123)	(2.316)	(2.594)	(2.325)	(1.980)	(2.005)	(2.026)	(1.835)
	(0.080)	(0.037)	(0.042)	(0.040)	(0.007)	(0.027)	(0.155)	(0.045)	(0.050)	(0.073)	(0.031)	(0.011)

	average	CAPM	FF	Carhart	BAB	PS	average	CAPM	FF	Carhart	BAB	PS
	(C) bond CEF with a 3-month waiting period						(D) bond CEF with a 12-month waiting period					
L	7.402	5.194	4.562	5.642	2.526	5.164	9.736	7.633	7.295	7.990	4.996	7.868
	(3.326)	(2.766)	(2.583)	(2.304)	(1.981)	(2.454)	(3.052)	(2.653)	(2.490)	(2.258)	(2.142)	(2.341)
	(0.027)	(0.062)	(0.079)	(0.015)	(0.204)	(0.037)	(0.002)	(0.004)	(0.004)	(0.000)	(0.021)	(0.001)
2	7.331	5.226	4.693	5.578	2.572	5.072	7.112	5.010	4.507	4.908	1.522	4.431
	(3.215)	(2.618)	(2.371)	(2.240)	(1.986)	(2.434)	(2.935)	(2.422)	(2.232)	(2.182)	(1.991)	(2.361)
	(0.024)	(0.047)	(0.049)	(0.014)	(0.197)	(0.038)	(0.016)	(0.040)	(0.045)	(0.026)	(0.445)	(0.062)
3	5.879	3.674	3.115	4.048	1.089	3.337	6.541	4.134	3.549	4.420	0.263	3.625
	(3.374)	(2.894)	(2.649)	(2.473)	(2.585)	(2.718)	(3.629)	(3.118)	(2.731)	(2.566)	(2.732)	(2.783)
	(0.083)	(0.206)	(0.241)	(0.103)	(0.674)	(0.221)	(0.073)	(0.186)	(0.195)	(0.086)	(0.923)	(0.194)
H	4.340	2.090	1.419	2.336	-1.313	1.548	2.980	0.322	0.089	0.838	-3.836	-0.034
	(3.819)	(3.307)	(3.183)	(2.903)	(2.518)	(3.076)	(4.533)	(3.795)	(3.624)	(3.430)	(3.257)	(3.671)
	(0.257)	(0.528)	(0.656)	(0.422)	(0.602)	(0.615)	(0.512)	(0.932)	(0.980)	(0.807)	(0.240)	(0.993)
L-H	3.260	3.259	3.298	3.493	3.967	3.810	6.672	7.198	7.071	7.023	8.692	7.789
	(1.379)	(1.438)	(1.517)	(1.469)	(1.667)	(1.448)	(2.302)	(2.286)	(2.239)	(2.218)	(2.374)	(2.389)
	(0.019)	(0.024)	(0.031)	(0.018)	(0.018)	(0.009)	(0.004)	(0.002)	(0.002)	(0.002)	(0.000)	(0.001)
	(E) tax preferred CEF with a 3-month waiting period						(F) tax preferred CEF with a 12-month waiting period					
L	4.805	4.552	4.633	5.321	2.863	4.815	6.210	5.935	6.346	6.785	4.175	6.428
	(2.601)	(2.592)	(2.620)	(2.488)	(2.242)	(2.754)	(2.368)	(2.364)	(2.342)	(2.274)	(2.349)	(2.484)
	(0.066)	(0.080)	(0.078)	(0.034)	(0.203)	(0.082)	(0.009)	(0.013)	(0.007)	(0.003)	(0.077)	(0.010)
2	4.754	4.550	4.717	5.510	2.733	4.981	5.391	5.090	5.541	6.038	2.918	5.555
	(2.569)	(2.571)	(2.611)	(2.465)	(2.276)	(2.761)	(2.421)	(2.460)	(2.457)	(2.415)	(2.595)	(2.731)
	(0.065)	(0.078)	(0.072)	(0.026)	(0.231)	(0.073)	(0.027)	(0.040)	(0.025)	(0.013)	(0.262)	(0.043)
3	4.139	3.887	3.972	4.703	1.839	4.109	5.537	5.200	5.614	6.200	2.658	5.652
	(2.597)	(2.614)	(2.651)	(2.543)	(2.348)	(2.849)	(2.486)	(2.517)	(2.524)	(2.455)	(2.557)	(2.760)
	(0.112)	(0.138)	(0.136)	(0.066)	(0.434)	(0.151)	(0.027)	(0.040)	(0.027)	(0.012)	(0.300)	(0.042)
H	4.254	3.983	3.907	4.681	1.600	3.953	5.244	4.864	5.018	5.582	2.192	5.045
	(2.604)	(2.706)	(2.751)	(2.657)	(2.466)	(3.114)	(2.538)	(2.579)	(2.582)	(2.548)	(2.698)	(2.936)
	(0.104)	(0.142)	(0.157)	(0.079)	(0.517)	(0.206)	(0.040)	(0.061)	(0.053)	(0.030)	(0.417)	(0.087)
L-H	0.551	0.569	0.726	0.640	1.262	0.862	0.967	1.072	1.328	1.203	1.983	1.383
	(0.795)	(0.889)	(0.925)	(0.961)	(1.141)	(1.182)	(0.730)	(0.759)	(0.841)	(0.866)	(1.032)	(1.064)
	(0.489)	(0.523)	(0.433)	(0.506)	(0.270)	(0.466)	(0.187)	(0.159)	(0.116)	(0.167)	(0.056)	(0.195)

Table 9

Performance of quartile portfolios by past returns and the zero-cost portfolio with various waiting periods

See the note for Tables 5-7. The only difference is that the trading strategy is based on sorting closed-end mutual funds by excess returns over the market for the past 60 months or, equivalently, the time-varying fund-specific intercept in Equation (28).

	average	CAPM	FF	Carhart	BAB	PS	average	CAPM	FF	Carhart	BAB	PS
	no waiting period						1-month waiting period					
L	9.217	5.832	5.145	6.600	4.526	6.028	8.968	5.840	5.225	6.634	4.676	6.180
	(3.364)	(2.443)	(2.179)	(1.850)	(1.908)	(1.919)	(3.415)	(2.474)	(2.273)	(1.926)	(1.874)	(2.029)
	(0.007)	(0.018)	(0.019)	(0.000)	(0.019)	(0.002)	(0.009)	(0.019)	(0.022)	(0.001)	(0.013)	(0.003)
2	6.279	4.832	4.528	5.374	2.948	4.872	6.181	4.782	4.472	5.230	2.761	4.685
	(2.548)	(2.261)	(2.201)	(2.048)	(1.784)	(2.278)	(2.460)	(2.183)	(2.112)	(1.997)	(1.824)	(2.227)
	(0.014)	(0.034)	(0.041)	(0.009)	(0.100)	(0.034)	(0.013)	(0.029)	(0.035)	(0.009)	(0.132)	(0.037)
3	4.162	2.736	2.536	3.219	0.725	2.410	4.680	3.137	2.929	3.559	1.099	2.771
	(2.457)	(2.212)	(2.142)	(2.003)	(1.707)	(2.256)	(2.473)	(2.226)	(2.109)	(1.968)	(1.814)	(2.194)
	(0.092)	(0.217)	(0.238)	(0.109)	(0.671)	(0.287)	(0.060)	(0.160)	(0.166)	(0.072)	(0.545)	(0.208)
H	5.115	1.755	1.516	1.666	-0.837	0.449	5.467	2.134	1.874	2.124	-0.612	0.863
	(3.265)	(2.205)	(2.089)	(2.076)	(2.039)	(2.227)	(3.281)	(2.168)	(2.066)	(2.041)	(2.014)	(2.166)
	(0.119)	(0.427)	(0.469)	(0.423)	(0.682)	(0.840)	(0.097)	(0.326)	(0.365)	(0.299)	(0.762)	(0.691)
L-H	4.102	4.077	3.630	4.934	5.362	5.579	3.501	3.705	3.351	4.510	5.288	5.317
	(2.184)	(2.081)	(2.043)	(1.750)	(1.697)	(1.725)	(2.168)	(2.033)	(2.010)	(1.729)	(1.670)	(1.742)
	(0.062)	(0.051)	(0.077)	(0.005)	(0.002)	(0.001)	(0.108)	(0.070)	(0.097)	(0.010)	(0.002)	(0.003)
	6-month waiting period						12-month waiting period					
L	8.376	5.882	5.485	6.538	4.149	6.199	9.244	6.984	6.829	7.272	4.622	6.724
	(3.266)	(2.344)	(2.299)	(1.986)	(1.571)	(2.054)	(2.797)	(2.074)	(2.028)	(1.883)	(1.519)	(1.817)
	(0.011)	(0.013)	(0.018)	(0.001)	(0.009)	(0.003)	(0.001)	(0.001)	(0.001)	(0.000)	(0.003)	(0.000)
2	6.795	5.501	5.159	6.115	3.412	5.453	6.745	5.499	5.513	6.064	2.922	5.408
	(2.561)	(2.279)	(2.248)	(2.029)	(1.801)	(2.271)	(2.372)	(2.132)	(2.079)	(1.986)	(2.024)	(2.194)
	(0.009)	(0.017)	(0.023)	(0.003)	(0.059)	(0.017)	(0.005)	(0.011)	(0.009)	(0.003)	(0.150)	(0.015)
3	4.312	2.551	2.279	3.132	0.466	2.176	5.824	4.153	4.073	4.839	1.296	4.027
	(2.636)	(2.355)	(2.190)	(2.031)	(2.009)	(2.238)	(2.794)	(2.486)	(2.360)	(2.195)	(2.322)	(2.451)
	(0.103)	(0.280)	(0.299)	(0.124)	(0.817)	(0.332)	(0.038)	(0.096)	(0.086)	(0.029)	(0.577)	(0.102)
H	5.381	1.822	1.525	2.201	-0.526	1.278	5.802	2.150	1.759	2.528	-0.904	1.620
	(3.259)	(2.447)	(2.257)	(2.183)	(2.279)	(2.300)	(3.794)	(2.595)	(2.388)	(2.393)	(2.683)	(2.576)
	(0.100)	(0.457)	(0.500)	(0.314)	(0.818)	(0.579)	(0.128)	(0.408)	(0.462)	(0.292)	(0.737)	(0.530)
L-H	2.995	4.060	3.960	4.336	4.675	4.921	3.442	4.834	5.070	4.745	5.526	5.105
	(2.034)	(2.202)	(2.266)	(2.108)	(2.105)	(2.115)	(2.164)	(2.196)	(2.340)	(2.494)	(2.601)	(2.554)
	(0.142)	(0.067)	(0.082)	(0.041)	(0.027)	(0.021)	(0.113)	(0.029)	(0.031)	(0.059)	(0.035)	(0.047)

Table 10

Performance of quartile portfolios by past returns and the zero-cost portfolio of closed-end equity, bond, tax-preferred bond funds with no or 1-month waiting periods

See the note for Table 9. The only difference is that the sample includes only closed-end mutual funds (CEF) that mainly invest in equity, bonds, or tax-preferred bonds.

	average	CAPM	FF	Carhart	BAB	PS	average	CAPM	FF	Carhart	BAB	PS
	(A) equity CEF with no waiting period						(B) equity CEF with a 1-month waiting period					
L	8.120	1.680	0.549	1.982	0.623	1.134	8.664	2.327	1.074	2.577	1.165	2.060
	(5.187)	(3.331)	(3.038)	(2.864)	(3.038)	(2.644)	(4.867)	(3.369)	(3.057)	(2.871)	(3.032)	(2.770)
	(0.119)	(0.614)	(0.857)	(0.490)	(0.838)	(0.668)	(0.076)	(0.490)	(0.726)	(0.370)	(0.701)	(0.458)
2	9.832	3.443	2.618	3.655	1.315	2.442	7.270	1.444	0.291	1.038	-1.247	-0.494
	(4.302)	(2.526)	(2.197)	(2.305)	(2.683)	(2.149)	(4.992)	(3.345)	(2.611)	(2.702)	(2.791)	(2.671)
	(0.023)	(0.174)	(0.235)	(0.114)	(0.625)	(0.257)	(0.147)	(0.666)	(0.911)	(0.701)	(0.655)	(0.853)
3	11.025	5.582	4.706	5.399	3.456	4.558	8.520	3.101	2.153	2.817	0.397	1.679
	(4.258)	(2.872)	(2.364)	(2.274)	(2.526)	(2.116)	(4.753)	(2.910)	(2.294)	(2.314)	(2.535)	(2.331)
	(0.010)	(0.053)	(0.048)	(0.018)	(0.173)	(0.032)	(0.074)	(0.288)	(0.349)	(0.225)	(0.876)	(0.472)
H	8.774	2.234	1.752	2.222	0.137	1.093	9.609	3.205	2.716	3.263	1.085	2.229
	(5.204)	(2.632)	(2.441)	(2.389)	(2.463)	(2.226)	(5.286)	(2.685)	(2.488)	(2.431)	(2.627)	(2.320)
	(0.093)	(0.397)	(0.474)	(0.353)	(0.956)	(0.624)	(0.070)	(0.234)	(0.276)	(0.181)	(0.680)	(0.338)
L-H	-0.446	-0.426	-1.058	-0.090	0.636	0.143	-1.317	-0.946	-1.694	-0.750	0.141	-0.246
	(3.131)	(3.008)	(3.011)	(2.909)	(2.917)	(2.847)	(3.317)	(3.155)	(3.146)	(3.059)	(3.059)	(3.083)
	(0.887)	(0.887)	(0.726)	(0.975)	(0.827)	(0.960)	(0.692)	(0.765)	(0.591)	(0.806)	(0.963)	(0.936)

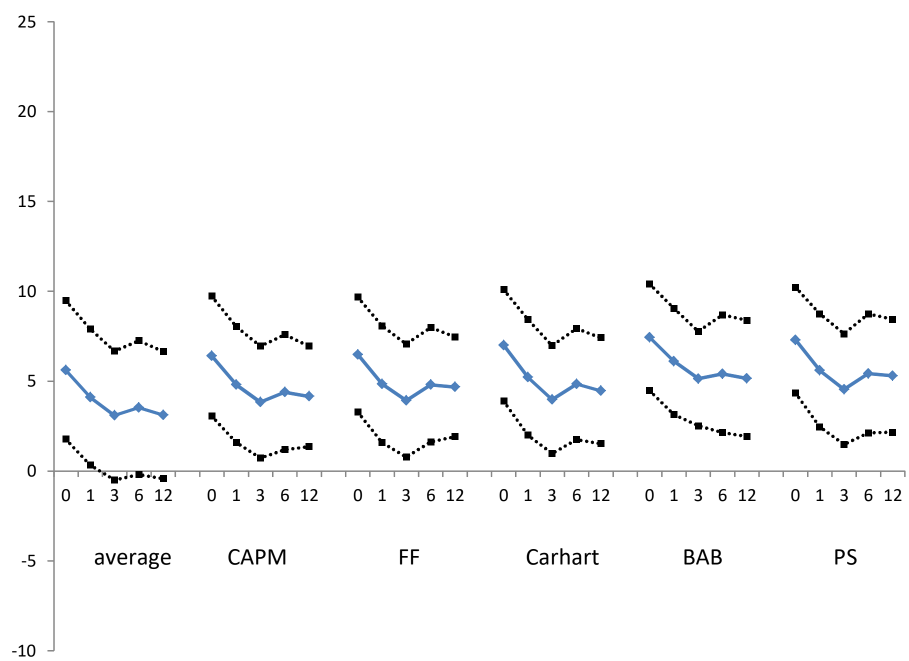
	average	CAPM	FF	Carhart	BAB	PS	average	CAPM	FF	Carhart	BAB	PS
	(C) bond CEF with no waiting period						(D) bond CEF with a 1-month waiting period					
L	7.630	4.719	4.056	5.336	2.471	4.383	7.629	4.776	4.157	5.514	2.515	4.580
	(4.086)	(3.268)	(3.016)	(2.724)	(2.549)	(2.979)	(4.105)	(3.282)	(3.058)	(2.719)	(2.575)	(2.973)
	(0.063)	(0.150)	(0.180)	(0.051)	(0.333)	(0.143)	(0.064)	(0.147)	(0.175)	(0.044)	(0.330)	(0.125)
2	7.498	5.512	5.071	5.902	3.495	5.723	6.494	4.642	4.052	4.805	2.260	4.416
	(2.994)	(2.620)	(2.430)	(2.252)	(2.059)	(2.418)	(2.781)	(2.421)	(2.202)	(2.072)	(1.973)	(2.211)
	(0.013)	(0.036)	(0.038)	(0.009)	(0.091)	(0.019)	(0.020)	(0.057)	(0.067)	(0.021)	(0.253)	(0.047)
3	4.919	3.159	2.716	3.450	0.788	2.892	5.797	3.920	3.389	4.049	1.621	3.726
	(2.813)	(2.428)	(2.315)	(2.124)	(1.683)	(2.202)	(2.757)	(2.390)	(2.178)	(2.002)	(1.759)	(2.147)
	(0.082)	(0.195)	(0.242)	(0.106)	(0.640)	(0.190)	(0.037)	(0.102)	(0.121)	(0.044)	(0.358)	(0.084)
H	4.934	2.520	2.081	2.512	-0.424	1.654	5.134	2.787	2.276	2.719	-0.344	1.868
	(3.152)	(2.669)	(2.487)	(2.366)	(2.023)	(2.632)	(3.272)	(2.755)	(2.613)	(2.457)	(2.031)	(2.694)
	(0.119)	(0.346)	(0.404)	(0.289)	(0.834)	(0.530)	(0.118)	(0.313)	(0.385)	(0.270)	(0.866)	(0.489)
L-H	2.696	2.199	1.975	2.824	2.895	2.729	2.494	1.990	1.881	2.796	2.860	2.712
	(1.754)	(1.653)	(1.615)	(1.432)	(1.488)	(1.431)	(1.806)	(1.691)	(1.657)	(1.493)	(1.709)	(1.505)
	(0.126)	(0.185)	(0.223)	(0.050)	(0.053)	(0.058)	(0.169)	(0.241)	(0.257)	(0.063)	(0.096)	(0.073)
	(E) tax preferred CEF with no waiting period						(F) tax preferred CEF with a 1-month waiting period					
L	6.925	6.794	6.990	7.977	5.402	7.387	6.063	5.830	6.071	7.035	4.405	6.470
	(2.769)	(2.720)	(2.803)	(2.744)	(2.264)	(2.823)	(2.718)	(2.639)	(2.715)	(2.607)	(2.094)	(2.719)
	(0.013)	(0.013)	(0.013)	(0.004)	(0.018)	(0.010)	(0.027)	(0.028)	(0.026)	(0.007)	(0.037)	(0.018)
2	5.074	4.888	4.945	5.717	3.123	5.105	5.088	4.914	5.016	5.755	3.091	5.151
	(2.687)	(2.676)	(2.744)	(2.632)	(2.221)	(2.901)	(2.588)	(2.595)	(2.661)	(2.556)	(2.232)	(2.820)
	(0.060)	(0.069)	(0.073)	(0.031)	(0.161)	(0.080)	(0.051)	(0.060)	(0.061)	(0.025)	(0.168)	(0.069)
3	3.264	3.044	3.122	3.761	1.300	3.080	4.078	3.835	3.975	4.580	2.093	3.899
	(2.516)	(2.595)	(2.610)	(2.523)	(2.244)	(2.915)	(2.535)	(2.594)	(2.616)	(2.530)	(2.241)	(2.900)
	(0.196)	(0.242)	(0.233)	(0.137)	(0.563)	(0.292)	(0.109)	(0.141)	(0.130)	(0.072)	(0.351)	(0.180)
H	0.687	0.418	0.198	0.682	-2.322	0.590	1.720	1.435	1.266	1.883	-1.047	1.552
	(2.975)	(3.024)	(3.034)	(2.954)	(2.752)	(3.312)	(2.981)	(3.029)	(3.018)	(2.876)	(2.699)	(3.257)
	(0.818)	(0.890)	(0.948)	(0.818)	(0.400)	(0.859)	(0.565)	(0.636)	(0.675)	(0.513)	(0.698)	(0.634)
L-H	6.394	6.501	6.926	7.177	7.480	6.350	3.887	3.942	4.272	4.462	4.699	3.923
	(1.673)	(1.803)	(1.922)	(1.918)	(1.773)	(1.766)	(1.355)	(1.482)	(1.556)	(1.580)	(1.476)	(1.519)
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)	(0.008)	(0.007)	(0.005)	(0.002)	(0.011)

Appendix

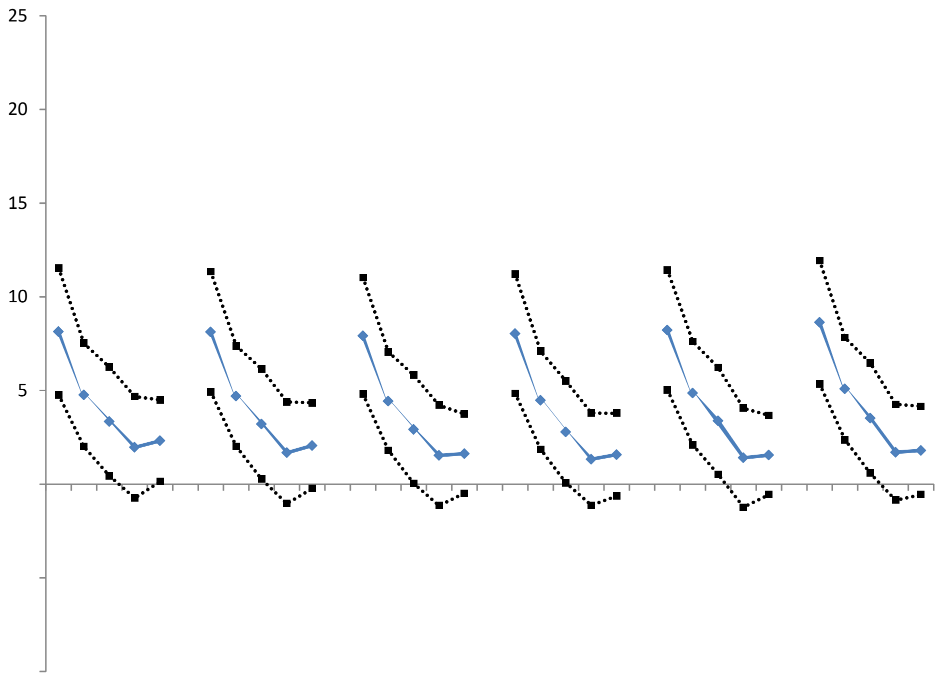
Figure A1
Risk-adjusted average returns on trading on the proxy for mean shifts of the price ratio and premium growth

Figure (A) plots the annualized average and risk-adjusted returns (%) on the zero-cost portfolio that buys closed-end mutual funds in the bottom quartile and short sells closed-end mutual funds in the top quartile ("low minus high") based on the proxy for mean shifts of the price-to-NAV ratio. The benchmark returns are market excess returns (CAPM), Fama-French's three factors (FF), Carhart's four factors (Carhart), Carhart's four factors plus Frazzini and Pedersen's (2014) betting-against-beta factor by (BAB), and Carhart's four factors plus Pastor and Stanbaugh's (2003) liquidity factor (PS). The x-axes represent waiting periods in months after sorting closed-ended mutual funds into quantile. Figures (B) and (C) use the past 5-year and past 1-year premium growth to sort closed-end mutual funds, respectively. The dashed lines are 95% confidence intervals. The return period for annualized average and risk-adjusted returns (%) is December 1998 to December 2017. The data period is from January 1994 to December 2017. The first estimate of the proxy for the mean shift is obtained in December 1998 using the 5-year sample from January 1994 to December 1998.

(A) Risk-adjusted returns on trading on overshooting



(B) Risk-adjusted returns on trading on past 5-year premium growth



(C) Risk-adjusted returns on trading on past 1-year premium growth

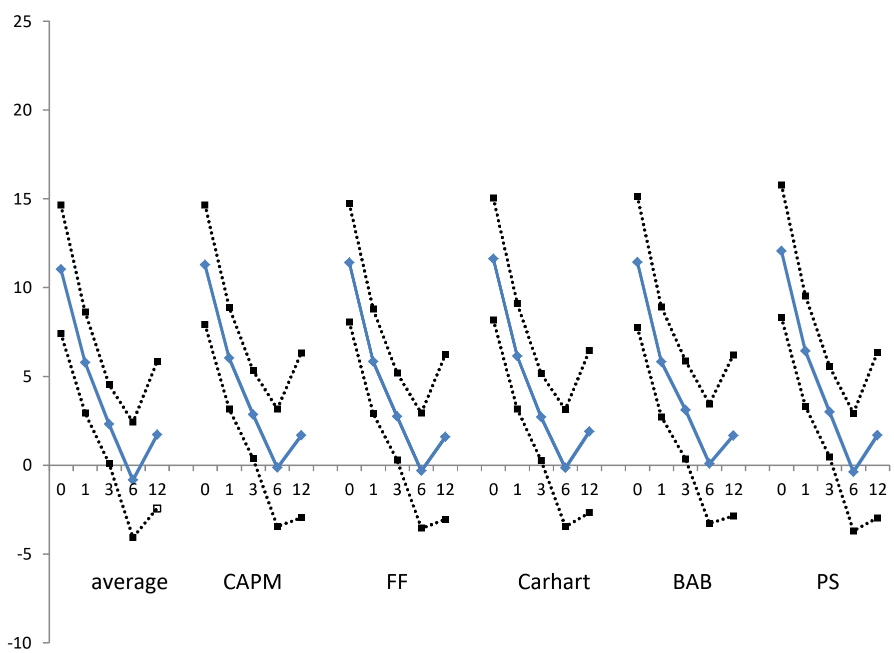


Table A1

Performance of quartile portfolios by the proxy for mean shifts of the price ratio and the zero-cost portfolio of closed-end equity funds

See the note for Table 5. The only difference is that the sample includes only closed-end mutual funds that mainly invest in equities.

	average	CAPM	FF	Carhart					BAB		PS	
	a*12	a*12	a*12	a*12	MKT	HML	SMB	MOM	a*12	BAB	a*12	LIQ
L	11.429	5.314	3.904	5.008	0.916	0.223	0.282	-0.182	3.364	0.222	4.222	0.165
	(5.064)	(3.459)	(2.928)	(2.865)	(0.080)	(0.085)	(0.061)	(0.042)	(3.263)	(0.112)	(2.838)	(0.081)
	(0.025)	(0.126)	(0.184)	(0.082)	(0.000)	(0.009)	(0.000)	(0.000)	(0.304)	(0.048)	(0.138)	(0.043)
2	8.366	2.111	1.259	2.114	0.963	0.098	0.205	-0.141	0.319	0.242	1.413	0.149
	(5.216)	(2.834)	(2.630)	(2.511)	(0.074)	(0.071)	(0.077)	(0.041)	(2.482)	(0.063)	(2.458)	(0.043)
	(0.110)	(0.457)	(0.633)	(0.401)	(0.000)	(0.173)	(0.009)	(0.001)	(0.898)	(0.000)	(0.566)	(0.001)
3	11.234	4.542	4.073	5.119	1.037	0.036	0.122	-0.172	3.597	0.205	4.613	0.136
	(5.074)	(3.295)	(3.097)	(2.958)	(0.064)	(0.088)	(0.073)	(0.049)	(3.147)	(0.088)	(2.923)	(0.056)
	(0.028)	(0.169)	(0.190)	(0.085)	(0.000)	(0.684)	(0.094)	(0.001)	(0.254)	(0.021)	(0.116)	(0.017)
H	7.335	0.723	0.237	0.877	1.027	-0.044	0.213	-0.105	-1.157	0.274	-0.210	0.164
	(5.189)	(2.540)	(2.362)	(2.336)	(0.068)	(0.088)	(0.057)	(0.044)	(2.626)	(0.069)	(2.151)	(0.076)
	(0.159)	(0.776)	(0.920)	(0.708)	(0.000)	(0.622)	(0.000)	(0.019)	(0.660)	(0.000)	(0.922)	(0.032)
L-H	4.094	4.591	3.667	4.131	-0.111	0.266	0.069	-0.076	4.521	-0.053	4.432	0.000
	(2.335)	(2.348)	(2.032)	(1.998)	(0.042)	(0.054)	(0.053)	(0.032)	(2.103)	(0.057)	(2.073)	(0.052)
	(0.081)	(0.052)	(0.072)	(0.040)	(0.010)	(0.000)	(0.197)	(0.017)	(0.033)	(0.355)	(0.034)	(0.997)

Table A2

Performance of quartile portfolios by the proxy for mean shifts of the price ratio and the zero-cost portfolio of closed-end bond funds

See the note for Table 5. The only difference is that the sample includes only closed-end mutual funds that mainly invest in bonds (excluding tax-preferred bonds).

	average	CAPM	FF	Carhart					BAB		PS	
	a*12	a*12	a*12	a*12	MKT	HML	SMB	MOM	a*12	BAB	a*12	LIQ
L	9.023	6.686	6.008	7.031	0.299	0.077	0.158	-0.168	4.289	0.370	6.480	0.111
	(3.323)	(2.752)	(2.520)	(2.325)	(0.057)	(0.121)	(0.061)	(0.066)	(2.089)	(0.109)	(2.495)	(0.097)
	(0.007)	(0.016)	(0.018)	(0.003)	(0.000)	(0.523)	(0.010)	(0.012)	(0.041)	(0.001)	(0.010)	(0.255)
2	5.950	3.799	3.484	4.292	0.298	0.038	0.067	-0.133	1.402	0.390	3.696	0.082
	(3.245)	(2.752)	(2.614)	(2.427)	(0.067)	(0.104)	(0.052)	(0.051)	(2.084)	(0.102)	(2.658)	(0.096)
	(0.068)	(0.169)	(0.184)	(0.078)	(0.000)	(0.716)	(0.201)	(0.011)	(0.502)	(0.000)	(0.166)	(0.396)
3	5.420	3.279	2.795	3.656	0.284	0.053	0.113	-0.142	0.911	0.370	3.078	0.056
	(3.336)	(2.804)	(2.673)	(2.501)	(0.062)	(0.113)	(0.065)	(0.054)	(2.175)	(0.091)	(2.653)	(0.087)
	(0.106)	(0.243)	(0.297)	(0.145)	(0.000)	(0.639)	(0.080)	(0.010)	(0.676)	(0.000)	(0.247)	(0.523)
H	3.177	0.353	-0.156	0.613	0.389	0.091	0.102	-0.126	-2.493	0.431	-0.218	0.086
	(3.863)	(3.398)	(3.151)	(2.969)	(0.082)	(0.114)	(0.068)	(0.056)	(2.469)	(0.125)	(3.180)	(0.103)
	(0.412)	(0.917)	(0.961)	(0.837)	(0.000)	(0.425)	(0.133)	(0.026)	(0.314)	(0.001)	(0.945)	(0.402)
L-H	5.592	5.924	5.854	6.102	-0.080	-0.015	0.043	-0.041	6.567	-0.065	6.424	0.022
	(1.730)	(1.827)	(1.853)	(1.856)	(0.040)	(0.034)	(0.034)	(0.020)	(1.890)	(0.031)	(1.842)	(0.026)
	(0.001)	(0.001)	(0.002)	(0.001)	(0.045)	(0.657)	(0.212)	(0.046)	(0.001)	(0.036)	(0.001)	(0.399)

Table A3

Performance of quartile portfolios by the proxy for mean shifts of the price ratio and the zero-cost portfolio of closed-end tax-preferred bond funds

See the note for Table 5. The only difference is that the sample includes only closed-end mutual funds that mainly invest in tax-preferred bonds.

	average	CAPM	FF	Carhart					BAB		PS	
	a*12	a*12	a*12	a*12	MKT	HML	SMB	MOM	a*12	BAB	a*12	LIQ
L	6.232	6.040	6.230	6.954	-0.028	-0.103	0.022	-0.119	4.574	0.321	6.372	0.092
	(2.588)	(2.561)	(2.590)	(2.461)	(0.055)	(0.117)	(0.052)	(0.059)	(2.131)	(0.108)	(2.684)	(0.106)
	(0.017)	(0.019)	(0.017)	(0.005)	(0.612)	(0.378)	(0.670)	(0.044)	(0.033)	(0.003)	(0.019)	(0.386)
2	4.434	4.331	4.478	5.189	-0.044	-0.100	0.035	-0.117	2.695	0.336	4.755	0.074
	(2.538)	(2.547)	(2.585)	(2.486)	(0.059)	(0.114)	(0.053)	(0.058)	(2.219)	(0.115)	(2.748)	(0.121)
	(0.082)	(0.090)	(0.085)	(0.038)	(0.454)	(0.382)	(0.510)	(0.047)	(0.226)	(0.004)	(0.085)	(0.543)
3	4.019	3.823	3.899	4.556	-0.026	-0.085	0.047	-0.108	1.995	0.345	3.998	0.081
	(2.502)	(2.533)	(2.580)	(2.493)	(0.058)	(0.110)	(0.051)	(0.057)	(2.167)	(0.108)	(2.838)	(0.124)
	(0.110)	(0.133)	(0.132)	(0.069)	(0.647)	(0.439)	(0.356)	(0.058)	(0.358)	(0.002)	(0.160)	(0.513)
H	2.191	1.781	1.679	2.443	0.003	-0.035	0.062	-0.126	-0.002	0.330	1.814	0.071
	(2.614)	(2.681)	(2.677)	(2.607)	(0.068)	(0.098)	(0.060)	(0.048)	(2.332)	(0.098)	(3.069)	(0.115)
	(0.403)	(0.507)	(0.531)	(0.350)	(0.968)	(0.720)	(0.300)	(0.010)	(0.999)	(0.001)	(0.555)	(0.538)
L-H	4.041	4.258	4.552	4.511	-0.031	-0.068	-0.040	0.007	4.575	-0.009	4.558	0.021
	(0.955)	(1.017)	(1.111)	(1.180)	(0.031)	(0.038)	(0.028)	(0.015)	(1.167)	(0.031)	(1.286)	(0.017)
	(0.000)	(0.000)	(0.000)	(0.000)	(0.329)	(0.078)	(0.157)	(0.652)	(0.000)	(0.777)	(0.000)	(0.208)