Why Do Active Mutual Funds Invest in Passive ETFs?

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Abstract

Investing in exchange-traded funds (ETFs) instead of directly in the underlying basket securities is costly for mutual funds. Why then do mutual funds ever invest in ETFs? Actively managed open-end equity funds (OEFs) that do so tend to take short positions in securities, and to short ETFs more than other securities if they short. By investigating the overlap in portfolio composition between OEFs and the ETFs they hold, this study can differentiate competing explanations for their ETF investments. Hedging appears to be the primary reason that equity funds invest in ETFs. Although equity funds cannot enhance four-factor information ratios by investing in ETFs, they can reduce overall portfolio volatility relative to the market.

Keywords: Portfolio Divergence; ETFs; Mutual Funds

JEL Classification: G10; G23

I. Introduction

The demand for exchange-traded funds (ETFs) has grown markedly in the past decade. With the increase in demand, sponsors have offered more ETFs targeted to a greater variety of investment objectives. As of year-end 2017, the number of U.S. ETFs had grown to 1,832, holding total net assets of more than $3.4 trillion, according to the Investment Company Institute. The explosive growth of ETFs has attracted attention from researchers and regulators, in an attempt to define hidden risks to which ETF investors are exposed and any potential threat that ETFs pose to market stability.

ETFs allow investors to invest at low cost in liquid securities. ETF sponsors disseminate net asset values (NAVs) every 15 to 60 seconds throughout the trading day with the aim of minimizing tracking error.[1] Ramaswamy (2011) voices a concern that ETFs may exacerbate systemic risks in the financial system, especially with increased product complexity and synthetic replication schemes. Low trading costs and the availability of information have made arbitraging ETFs against the NAV popular. Ben-David, Franzoni, and Moussawi (2018) show that ETF ownership amplifies stock volatility because of these arbitrage trades. Da and Shive (2013) find that ETF ownership has a positive effect on the comovement of stocks in the same basket.

Cheng, Massa, and Zhang (2013) present evidence that ETFs provide cheap funding resources to affiliated banks, but are then exposed to banks' risk of distress. ETFs might also help affiliated open-end equity funds to engage in cross-trades with them. Such behavior creates a potential conflict of interest between ETF investors and the sponsoring financial groups.

Israeli, Lee, and Sridharan (2017) show that increases in ETF ownership undermine pricing efficiency for the underlying securities. ETFs can offer "transactional utility" to noise traders in ways that passive index funds cannot. Pan and Zeng (2017) document how liquidity mismatch between bond ETFs and the underlying bonds makes ETF authorized participants subject to arbitrage fragile and results in large relative mispricing. Bhattacharya and O'Hara (2017) show that when the underlying assets of ETFs are hard to trade, the underlying market

[1] See the 2018 Investment Company Fact Book published by the Investment Company Institute. Some market participants for whom a 15- to 60-second lag is too long use their own computer programs to estimate the underlying value of the ETF on a more real-time basis.

makers can learn information from ETF prices. As a result, imperfect inter-market learning leads to propagation of shocks unrelated to fundamentals, which causes market instability.

All these issues—excessive volatility, conflicts of interest, and increased market fragility—are the dark side of ETF investing.

Yet some actively managed open-end mutual funds continue to invest in ETFs. Given the transparency of ETFs' underlying assets, investing in ETFs instead of directly in the underlying basket securities is costly for mutual funds because ETFs charge management fees. More important, active mutual funds should be open to shareholder question if they charge a higher fee but invest in passive ETFs. One would assume that mutual funds are reluctant to take positions in ETFs except when they can benefit significantly from ETF investments.

This study posits three hypotheses for the possible benefits of ETF investments by U.S. equity funds, and makes an attempt to determine the primary reason that U.S. equity funds invest in ETFs. They are hypotheses related to flow management, substitution, and hedging.

An index-based ETF provides a mutual fund a convenient financial vehicle for participating in broad movements in the stock market or in a particular market sector. In today's fast-moving markets, implementing decisions quickly is critical. For giant mutual funds and pension funds eager to keep assets fully invested, shifting billions around through ETFs might be easier than trying to identify individual stocks to buy and sell. ETFs give a fund manager fast and cost-effective exposure to the market while the manager is looking for good investment ideas for the portfolio. Using ETFs may also allow a fund manager to possibly manage hot money flow more efficiently. The *flow management* hypothesis posits that mutual funds tend to increase positions in ETFs right after a surge of fund inflows and to reduce positions after a persistent exodus of fund flows.

According to Subrahmanyam (1991), mutual fund managers satisfying the liquidity needs of their clients are discretionary liquidity traders. Thus fund managers will trade a basket instead of individual securities in order to minimize adverse selection costs, particularly when the underlying assets are hard to trade. Securities and Exchange Commission (SEC) guidelines require mutual funds to limit their investments in illiquid assets to 15% of a fund's total net asset

value.[2] Thus, a liquidity concern suggests the *substitution* hypothesis that liquid ETFs are a preferred venue for mutual funds to invest in hard-to-trade assets that underlie in the ETFs.

An index-based ETF also provides a convenient and liquid financial instrument for mutual funds to hedge against adverse movements in the broad stock market or in a particular market sector. Unlike futures, ETFs do not constantly expire and are traded in stock exchanges. These two unique features make the index-based ETF an ideal instrument to short. The financial press has reported short-sellers flocking to ETFs for bearish bets (see McDonald, 2005). The *hedging* hypothesis is that mutual funds with positions in ETFs tend to short securities.[3]

The three hypotheses are not mutually exclusive. To pin down the main motive for a mutual fund to trade ETFs, I look at the degree of overlap in portfolio composition between the mutual fund and the ETFs that the fund holds. According to the Investment Company Institute 2018 Factbook, ETF-owning households are more willing to take investment risk than all US households together or than mutual fund-owning households. ETF-owning households also tend to have higher education levels and greater financial assets. Thus, it is not unreasonable to expect that retail investors actively contribute to short interest on ETFs. Relying simply on the aggregate short interest in an ETF without examining specific mutual fund positions in the ETF, one cannot be sure whether the mutual fund really shorts the ETF, and cannot differentiate the competing hypotheses.

If a mutual fund's ETF investment substitutes for hard-to-trade assets, the fund would take more long positions in ETFs whose underlying securities overlap less with the fund's holdings. If a mutual fund's ETF investment is motivated by flow management, its ETF investments vary with fund flows, regardless of the overlapping in portfolio composition. If a mutual fund's ETF investment is motivated by hedging, the fund would short more ETFs whose underlying securities overlap more with the fund's holdings.

[2] An illiquid asset defined as one that cannot be sold at or near its carrying value within seven days. See Revisions of Guidelines to Form N-1A of SEC Release No. IC-18612 (March 20, 1992).

[3] Registered investment companies are allowed to enter into short sales of securities in reliance on the segregation principles outlined in Release 10666. See *Securities Trading Practices of Registered Investment Companies*, Investment Company Act Rel. No. 10666, 44 Fed. Reg. 25128, 25129 (April 18, 1979), at *https://www.sec.gov/divisions/investment/imseniorsecurities/ic-10666.pdf.* In a no-action letter issued to Robertson Stephens Investment Trust, the SEC did not object to an arrangement in which the investment company segregated assets equal to the market value of the securities sold short. See Robertson Stephens Investment Trust, SEC No-Action Letter, 1995 SEC No-Act. LEXIS 682 (Aug. 24, 1995), at *https://www.sec.gov/divisions/investment/imseniorsecurities/robertsonstephens040395.pdf*.

The evidence is that mutual funds holding securities that overlap less with ETFs tend subsequently to reduce both long and short positions in ETFs. Thus, the *substitution* hypothesis is not supported. When mutual funds experience increased fund flows, they subsequently reduce long positions and increase short positions in ETFs. When mutual funds experience volatile fund flows, they subsequently reduce both long and short positions in ETFs. Thus, the *flow management* hypothesis is not supported either.

Mutual funds holding securities that overlap more with ETFs tend to subsequently reduce long positions and increase short positions in ETFs. Thus the results support the assertion that *hedging* is the primary reason that equity funds invest in ETFs.

Despite substantial attention to ETFs from retail investors, no study documents how professional money managers actually use them.[4] Why do actively managed equity funds include passively managed equity ETFs in their portfolios? I analyze the bright side of ETF investment by mutual funds, and present evidence that mutual funds use ETFs to take short positions to hedge against broad movements in the stock market or in the sector of the investment style that mutual funds reside.

The paper proceeds as follows. Section II describes the data. Section III presents activities of ETF investments by OEFs. Section IV tests the three hypotheses to explain why actively managed open-end equity funds invest in ETFs. Section V examines whether OEFs can enhance performance or reduce risk by investing in ETFs. Section VI performs forecasting logistic regressions to further understand why mutual funds invest in ETFs. Section VII concludes.

II. Data

The Center for Research in Security Prices (CRSP) stock return files and the CRSP Survivor-Bias-Free Mutual Fund database constitute the main data sources.[5] The total net assets under

[4] Huang, O'Hara, and Zhong (2018) examine how institutional investors use industry ETFs to facilitate the hedge of industry-specific risks. By linking overall short interest in an industry ETF to increases in the ETF constituent stocks held by hedge funds, they conclude that hedge funds engage in a "long-the-underlying/short-the-ETF" strategy. The institutional holdings in the Thomson Reuters 13F data that they use include neither ETFs nor short positions in a stock, however. Huang et al. describe no direct hedging activities in which a specific institutional investor shorted industry ETFs.

[5] In 2010, CRSP switched its holdings source from Thomson-Reuters and Lipper to Lipper's Global Holdings Feed alone. Data irregularity appears in CRSP mutual fund holdings, particularly prior to 2010. Stocks with a change in

exchange-traded fund (ETF) management have grown exponentially since 2009, giving import to research on why mutual funds invest in ETFs. Schwarz and Potter (2016) document that portfolio positions of mutual funds on CRSP are inaccurate prior to 2008. Eliminating the year 2008 guards against results driven by the financial crisis. As a result, my sample period starts in January 2009 and ends in March 2018.

I consider only U.S. domestic, actively managed equity funds and U.S. domestic, passively managed equity ETFs in this study.[6] To identify passively managed equity ETFs, I use information in CRSP return files for all securities that have the historical share code of 73 and in the CRSP mutual fund database for all funds with "F" in the variable *et_flag* and "B," "D," or "E" in the variable of *index_fund_flag*. I link both data sets by CUSIPs and ticker symbols, in conjunction with visual confirmation to finalize the sample of passively managed equity ETFs.[7]

Mutual fund families introduced different share classes in the 1990s. Because different share classes have the same holdings composition, I aggregate all the observations pertaining to different share classes into one observation. For the qualitative attributes of funds (e.g., objectives and year of origination), I retain the observation of the oldest fund. For total net asset (TNA) under management, I sum the TNA of the different share classes. Finally, for the quantitative attributes of funds (e.g., returns and expenses), I take the weighted average of the attributes of the individual share classes, where the weights are the lagged TNA of the individual share classes.

To address the incubation bias documented by Elton, Gruber, and Blake (2001) and Evans (2010), following the procedure proposed by Kacperczyk, Sialm, and Zheng (2008), I exclude observations whose year is prior to the reported fund-starting year and observations in which names of funds are missing from the CRSP database. In addition, I include newly established funds in the calculation only after they first reach at least US$5 million in assets

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CUSIPs in CRSP stock files are commonly duplicated, causing errors in portfolio holdings. I confirm these errors with actual holdings disclosures available on the SEC Edgar website and correct the data.

[6] Domestic equity funds have "E" and "D" in the first two characters of the CRSP Style Code (variable: *crsp_obj_cd*), where CRSP maps the objective codes of Strategic Insights, Wiesenberger, and Lipper into a continuous series. The third character "S" in the variable—*crsp_obj_cd*—indicates a sector fund. Some mutual funds switch between sector funds and non-sector funds. I identify portfolios of non-sector funds using their style codes at the beginning of each calendar quarter. Although I exclude sector funds from OEFs, I include ETFs that might track certain sector indexes. I use the CRSP variable *index_fund_flag* to separate actively managed funds from passively managed funds.

[7] When the CRSP Mutual Fund Database changed its data provider in 2010, many *crsp_portno* changed for the same fund. The CRSP_PORTNO_MAP table is used to link the old CRSP_P *crsp_portno* to the new *crsp_portno* for the same fund in this study.

under management. Once they reach the first threshold of $5 million, they remain in the sample until the end. [8]

The Figure graphs the quarterly portfolios of all domestic, actively managed open-end equity funds (OEFs) and passively managed equity ETFs in the CRSP database. Although the median OEF was about $100 million larger in TNA than the median ETF in the early years, the median ETF rose above OEF TNA in 2018. The median OEF charges about twice the expense ratios and has double the turnover rates than its counterpart in ETF. While the median OEF in age was about six years older than the median ETF in the early years, the age gap is about two years now.

III. Investment in ETFs by OEFs

Investing in an exchange-traded fund (ETF), which typically tracks a certain index, is costly for an open-end equity fund (OEF) because the mutual fund can invest directly in the underlying securities without paying management fees to the ETF. Nor are professional money managers likely unaware of the dark side of ETF investment documented by recent studies. How often do actively managed open-end domestic equity funds invest in passively managed domestic equity ETFs?

Table 1 reports differences in attributes of total assets under management, expense ratios, fund ages, and turnover rates of OEFs that invest in at least one ETF versus OEFs that do not. OEFs that do not hold any ETFs are much larger—they manage about $100 million more than their peers that invest in at least one ETF (in terms of median comparisons). OEFs that invest in ETFs are typically younger and trade more actively. OEFs that invest in ETFs could possibly pass the higher cost of ETF investment on to shareholders by charging higher fees in the early years of the sample period, but that is much more difficult recently because of stiff competition in the mutual fund industry. Furthermore, the median annual turnover rate varies at about 70% for OEFs that invest in ETFs compared to about 42% for OEFs that do not invest in ETFs.

Table 2 classifies OEFs by Lipper classification codes. The result clearly shows that OEFs investing in ETFs have a substantial presence in small-cap core and small-cap value funds

[8] To mitigate the incubation bias, Cici, Gibson, and Moussawi (2010) and Kacperczyk, Sialm, and Zheng (2008) exclude funds with assets of less than $5 million in the previous month. This filter might unintentionally exclude Ameritor Security Trust (crsp_fundno: 005371; Ticker: ASTRX) from the calculations in January - May 1996 because its TNA was below $5 million in the previous months, although it was a seasoned fund. Its inception date was December 1939, and its initial TNA $49 million was first recorded in December 1961.

(by both observations and net assets). Since small-cap stocks are more volatile and could be hard to trade, an index-based ETF gives equity funds primarily investing in small-cap stocks an effective financial instrument for managing their portfolios. [9]

As holding passive ETFs instead of the underlying basket of securities directly is costly for mutual funds, the reason might be for hedging. A passive ETF gives mutual funds a convenient and liquid financial instrument for hedging against adverse movements in the broad stock market or a market sector. A mutual fund that shorts individual stocks is also likely to take a long position in ETFs for hedging. As a result, the *hedging* hypothesis predicts that mutual funds having positions on ETFs tend to short securities.

Table 3 reports the aggregate percentage of total net assets (%TNA) in all short positions in a given OEF portfolio.[10] OEFs that invest in ETFs tend to take short positions in a stock. As I compare Table 3 to Table 1, more than 32% of all OEFs investing in ETFs take short positions, while less than 25% of all OEFs not investing in ETFs take short positions. In the fourth quarter of 2017, for example, 205 OEFs invested in ETFs and shorted at least one security; that represents 35.3% of the 581 OEFs that invested in ETFs. 756 OEFs did not invest in ETFs but shorted at least one security; that represents 24.9% of the 3036 OEFs that did not invest in ETFs.

Furthermore, in terms of the median (mean), the total percentage in all short positions in a given portfolio held by OEFs investing in ETFs is more than five (one and a half) times that of OEFs not investing in ETFs. For example, in the last quarter of 2017, the median overall short position represents 3.67% of TNA among the OEFs investing in ETFs compared to 0.53% of TNA among the OEFs not investing in ETFs. The tendency of OEFs that invest in ETFs to take a short position is very significant and consistent with the *hedging* hypothesis. This tendency,

[9] In each quarter, domestic equity funds are classified into fourteen fund groups according to Lipper classification codes (CRSP variable: *lipper_class*): LCCE (Large-Cap Core), LCGE (Large-Cap Growth), LCVE (Large-Cap Value), MCCE (Mid-Cap Core), MCGE (Mid-Cap Growth), MCVE (Mid-Cap Value), SCCE (Small-Cap Core), SCGE (Small-Cap Growth), SCVE (Small-Cap Value), MLCE (Multi-Cap Core), MLGE (Multi-Cap Growth), MLVE (Multi-Cap Value), MAT+MT (Mixed-Asset Target-Date and Target-Allocation), and others. The percentage of fund observations in each group is of the total number of all funds each quarter. Total fund net asset value is also calculated across all assigned to each group and expressed relative to the total net assets of all funds each quarter.

[10] It is clear that the quality of the data on *short positions* in mutual fund holdings prior to 2010 Q2 is not consistent. I verified this observation with CRSP. The mutual fund holdings database (S12) from Thomson Reuters does not give short portfolio holdings and has a limited set of securities other than US equities. Chen, Desai, and Krishnamurthy (2013) cite the same reason for using the CRSP mutual fund database to examine short positions taken by mutual funds. They study portfolio holdings of mutual that had outstanding short positions in US common stocks from April 2003 through December 2006.

together with the fact that OEFs investing in an ETF and shorting at least one security have less total assets under management seems to indicate that smaller equity funds use the index basket provided by the ETF to engage in tactical investments such as shorting.

OEFs might also likely engage in active management by shorting individual stocks and using ETFs as the main investment base. Table 4 first reports aggregate positions in ETFs by OEFs. Panel A shows that more OEFs take a long but small position in ETFs while fewer OEFs take a short but relatively large position in ETFs. Since 2010, the median aggregate long position in ETFs has ranged from 1.37% to 3.26% of TNA in a given OEF portfolio; the median aggregate short position in ETFs has ranged from 2.49% to 6.39%.

To further investigate individual short positions held by OEFs investing in ETFs, I separate short positions in ETFs from short positions in non-ETF securities held by these OEFs. In a given portfolio, I calculate the average percentage of total net assets (%TNA) in short positions on a per-security basis. The results in Panel B indicate that OEFs investing in ETFs short more in ETFs than other securities when they decide to take a short position. For example, in the fourth quarter of 2017, the median short position in an ETF is 0.99% compared to the median short position on any non-ETF security of 0.23% among OEFs investing in ETFs and shorting a security.

This evidence, although strongly significant only for the median tests, seems to support the assertion that OEFs short ETFs in order to protect their portfolios from negative market shocks. OEFs that invest in ETFs and never short any security, by comparison, have a similar long position in both ETFs and non-ETF securities, Panel C of Table 4 shows.

IV. Tests of Three Competing Hypotheses

Besides using exchange-traded funds (ETFs) to hedge against adverse market movements, open-end equity funds (OEFs) might use them as a liquid financial vehicle for gaining exposures to hard-to-trade assets or for managing hot fund flows. To differentiate the three competing hypotheses, I investigate how OEF holdings deviate from ETF holdings, and examine how the degree of portfolio overlap between the two determines subsequent changes in the ETF positions that OEFs hold.

I follow the construction of "divergence" defined by Cheng, Massa, and Zhang (2013) to quantify the overlap between OEF portfolios and ETF portfolios. Divergence (Div) is defined as

$\sum_{i\in\{f\cup ETF\}}\frac{|w_{i,f,q}-\widehat{w_{i,f,q}}|}{2}$, where $w_{i,f,q}$ is the investment weight of security i in OEF f in quarter q, and $\widehat{w_{i,f,q}}$ is the investment weight of security i in an ETF held by the OEF. Both OEFs and ETFs are required to have detailed holdings data for the divergence calculation. [11]

I calculate divergence for each domestic, active OEF that invests in at least one domestic, passive ETF. If an OEF invests in more than one ETF, I calculate the divergence for each ETF held by the OEF and average the divergences across all ETFs held by the OEF. A numerical illustration of divergence calculation is in the appendix.

If a fund issues multiple holdings disclosures in a quarter, I use its last disclosure for the quarter. Notably, OEFs and ETFs held by the OEFs may not disclose portfolio holdings at the same time, and most of the time they do not. To make divergence calculations as complete as possible, I use the latest disclosed portfolio holdings of ETFs held by OEFs in the six months before the OEFs disclose their ETF investments.

Table 5 presents the quartile distribution and the average and the standard deviations of portfolio divergences every quarter since 2009. The quartile distribution of divergences seems relatively stable over time. The median portfolio divergence between OEFs and ETFs ranges from 67.19% to 86.06%.

To clarify the main motivation of OEF investment in ETFs, Table 6 reports the degree of overlap in portfolio holdings between OEFs and ETFs held by the OEFs, and of subsequent changes in ETF positions by these OEFs. Each quarter, OEFs are sorted into quartiles according to their divergence. For each OEF in each quarter, I aggregate all %TNA allocated to ETFs in long and short positions separately, and calculate changes in ETF positions from the portfolio-formation quarter to the next quarter.

OEFs in the extreme quartiles are the sample funds most involved in differentiating the *hedging* hypothesis from the *substitution* hypothesis. The *hedging* hypothesis clearly predicts that OEFs whose portfolio composition most overlaps with a target ETF will increase short positions and reduce long positions in the target ETF subsequently. Indeed, OEFs in quartile 1 behave as predicted by the *hedging* hypothesis. The *substitution* hypothesis predicts that OEFs in Quartile 4 will increase long positions in ETFs, but the result shows that these OEFs decrease long positions on ETFs significantly. According to the *substitution* hypothesis, concern with

[11] The construction of "divergence" follows that of "active share" defined by Cremers and Petajisto (2009), except that they calculate the difference in portfolio weights between an OEF and its benchmark.

regard to restrictions on illiquid assets would motivate an OEF to invest in a liquid ETF instead of its hard-to-trade underlying assets. In this case, there is very little overlap in portfolio compositions between the OEF and the ETF held by the OEF.

Managers may be reluctant to invest in or actually divest securities immediately if the timing of cash flows does not correspond to managers' view of information about optimal trading. In a model describing mutual fund managers satisfying the liquidity needs of their clients as discretionary liquidity traders, Subrahmanyam (1991) shows that fund managers would trade a basket instead of individual securities in order to minimize adverse selection costs. Edelen (1999) shows that mutual fund trades that are related to cash flows are less profitable than trades that are not so influenced by cash inflows. The opportunity to use ETFs may let a fund manager maintain a desired exposure to the market or to certain sectors while waiting for favorable information to execute individual stock trades; this might allow more efficient management of considerable money to and from the fund. The *flow management* hypothesis predicts that mutual funds tend to increase positions in ETFs right after a surge of fund inflows and to reduce positions after a persistent outflow. I argue, however, that industry leaders, which are typically large firms, may give the fund manager an investment opportunity, without management fees, to obtain a similar exposure.

Table 7 examines changes in ETF positions held by an OEF when the OEF experiences different net fund flows. At the end of each quarter, OEFs are sorted into quartiles by the level of their net fund flows in Panel A, or by the volatility of their net fund flows in Panel B. The level each quarter is the monthly net fund flows cumulated over the quarter. The volatility of net fund flows each quarter is the standard deviation of monthly net fund flows over the prior year. I follow the definition of net fund flows in Sirri and Tufano (1998). For each OEF in each quarter, I aggregate all %TNA allocated to ETFs in long and short positions separately and calculate changes in ETF positions from the portfolio-formation quarter to the next quarter.

In Panel A of Table 7, although OEFs that experience surging fund inflows in the current quarter have overall larger long positions (about 4.82% higher) and smaller short positions (about 1.54% lower) on ETFs than the positions held by OEFs that experience fund outflows, OEFs in Q4 reduce their long positions but increase short ones in ETFs in the next quarter. When quartiles are formed according to the volatility of net fund flows in Panel B of Table 7, OEFs

experiencing volatile fund flows significantly reduce long positions in ETFs much more in the next quarter than OEFs experiencing stable fund flows.

Overall, Table 7 does not support the assertion of the *flow management* hypothesis that OEFs change their ETF holdings in response to fund inflows and outflows. If there is any indication that OEFs use ETFs to manage fund flows, it is that OEFs significantly reduce both long and short positions in ETFs in response to volatile fund flows.

V. Tests on Performance and Risk of ETF investment

To further investigate the motivation for an open-end equity fund (OEF) to invest in exchange-traded funds (ETFs), I examine the performance and risk of OEFs before and after their ETF investment. For each domestic, actively managed OEF, I identify the first month-end (t_0) and the last month-end (t_1) in which the OEF invested in domestic, passively managed equity ETFs. I examine the performance and risk of OEFs over three periods: the pre-holding period (Pre-H) of *[t_0 - 36, t_0]*, the holding period (H) of *[t_0, t_1]*, and the post-holding period (Post-H) of *[t_1, March 2018]*. To exclude temporary holdings in ETFs, I analyze only OEFs that held ETFs in their portfolios for at least a year. I use OEF monthly gross returns to estimate the alpha of Fama-French (1996) three factors plus a momentum factor for each fund portfolio in each period and calculate the fund's information ratio, the alpha divided by the standard deviation of the four-factor residuals. In each period, an OEF must have at least 12 monthly returns in order to estimate its four-factor alpha and to test the null hypothesis that the average of information ratios is equal to zero in a two-tailed test.

Panel A of Table 8 shows that OEFs cannot enhance the four-factor information ratios simply by investing in passive ETFs. For example, the four-factor information ratio of OEFs is -0.077% per month over holding period H in which the OEFs invested in ETFs, which represents a 0.061% decline per month from the pre-holding period to the holding period. The average length of the holding periods across all OEFs investing in ETFs is 56 months; the average length of the pre-holding periods is about 32 months. That the holding period is longer than four years seems to indicate that OEFs use ETFs systematically for portfolio management, instead of just occasional investment.

Although most of the parametric tests on the four-factor information ratios are significantly negative in Panel A, the results may not be robust when the underlying data exhibit

unknown forms of conditional and unconditional heteroscedasticity. For a robustness check, I present statistics based on a bootstrap simulation. The simulation design follows that of Fama and French (2010). A simulation run is a random sample (with replacement) of 111 months, drawn from the 111 calendar months of January 2009 through March 2018. I estimate, fund by fund, the four-factor alpha on the simulation draw of months of fund gross returns, dropping funds that are in the simulation run for less than 12 months. Each run thus produces cross-sections of information ratio estimates using the same random sample of months from populations of OEFs investing in an ETF.

Fama and French (2010) document that such a simulation approach can capture the cross-correlation of fund returns and its effects on the distribution of alpha estimates. Furthermore, it also captures any correlated heteroscedasticity of the explanatory returns and disturbances of a factor model, because the approach jointly samples fund and explanatory returns. I present the percentage of 10,000 simulation runs that produce the average of cross-sectional information ratios below the actual four-factor average in Panel A. For example, the average four-factor information ratio of -0.077% over holding period H in which the OEFs invested in ETFs exceeds the simulated fund return cross-sectional average in 4,693 of 10,000 simulation runs, as indicated by 46.93% in brackets.[12]

As mutual funds can invest in non-equity securities such as bonds, return swaps, or derivatives, I construct two new divergence measures, one for equities only and the other including all holdings.[13] The two parts of Panel B report the statistics for OEFs with high divergence (83% above) and OEFs with low divergence (50% and below), where the divergence is calculated based on equity holdings only. These divergences closely correspond to the 75th and 25th percentiles of divergence distribution in Table 5.

When the divergence is calculated for all holdings, which I do not report to save space, the corresponding 75th and 25th percentiles of divergence distribution are at 95% and 75%, respectively. These results are reported in Panel C. Relative to OEFs exhibiting low divergence

[12] In a robustness check on the simulation, I jointly sample fund and explanatory returns as well as the month when a fund begins and ends a position in an ETF. The results are similar (available upon request).

[13] In the CRSP Mutual Fund Database, I use "*permno*" to identify equities and "*crsp_company_key*" to identify non-equity securities. Foreign stocks or non-security instruments held by mutual funds are also assigned by "*crsp_company_key*." According to the CRSP website, *crsp_company_keys* should match up one to one with portfolio holdings and not be reused.

with ETFs, OEFs exhibiting higher divergence show a better but insignificant information ratio, 0.023% per month over the holding period.

Panel D reports the statistics for OEFs that take at least a short position in ETFs and OEFs that never take a short position in any ETF during the holding period. While Panels B to C show that OEFs engaging in passive ETF investments cannot improve their performance, Panel D shows that OEFs shorting ETFs have significant higher information ratios than OEFs not shorting ETFs in both pre-holding and holding periods. The result holds when the four-factor alphas are estimated based on net-of-expense returns.[14]

One reason OEFs might use ETFs is to hedge against adverse market moves or to participate in the broad movement of the stock market and thus potentially reduce overall portfolio volatility at the expense of poor performance. To meaningfully quantify the reduction in active risk, Table 9 examines the risk of OEFs relative to the market after they invest in ETFs. Panel A shows that overall, 71.3% of OEFs investing in ETFs reduce the volatility of their returns in excess of the market returns from the pre-holding period to the holding period, and 73.9% of OEFs reduce their relative return volatility from the pre-holding to the post-holding period. Both percentages of the variance ratio indicate significant rejection of the null hypothesis (at the 1% level) that the fraction is equal to 0.5 in the binomial distribution in a two-tailed test.

In a robustness check using the bootstrap simulation proposed by Fama and French (2010), in 9,818 of 10,000 simulation runs funds reduced their relative return volatility from the pre-holding period to the holding period less than 0.713. Thus, it is not random that 71.3% of OEFs investing in ETFs reduce the relative return volatility.

Once OEFs implement a risk-reduction strategy using ETFs, they seem to pursue it constantly to manage risk in the post-holding period. It may be due to construction of the holding period, which does not rule out that OEFs might hold ETFs on and off during the holding period, that 44.5% of OEFs investing in ETFs have low relative return volatility in the holding period over the post-holding period. Also, there are many fewer OEFs with at least 12 monthly returns in the post-holding period, which might diminish the reliability of comparisons for the post-holding period.

[14] In a related study, Koski and Pontiff (1999) document that the difference in performance as measured by alpha between funds that use derivatives and those that do not is insignificant, but fund managers might be using derivatives to reduce the impact of prior performance on risk taking. When I extend the analysis using 60 months instead of 36 months as the pre-holding period, I obtain a similar result.

Panels B−D further examine the risk reduction of OEFs relative to high or low divergence with ETFs as well as short or long positions in ETFs. Results in panels support a similar conclusion as in Panel A. Additionally, significantly a higher percentage of OEFs reduce return volatility from the pre-holding to the holding period with regard to low divergence with ETFs than high divergence with ETFs.

There is no way that an equity fund can improve its performance simply by holding ETFs. At the aggregate level, can OEFs investing in ETFs perform better than OEFs not investing in ETFs, given that index-based ETFs provide a convenient and liquid financial instrument for mutual funds? To investigate this issue, each quarter I classify OEFs into two portfolios: one that includes funds that invest in ETFs and one that includes funds that do not invest in any ETF. I calculate the value-weighted gross returns of these two portfolios over three months following the portfolio formation, using as a weight the TNA value of a fund at the beginning of each month. At the end of the sample period, I regress monthly excess returns of each portfolio on Fama-French three factors plus a momentum factor.

Panel A of Table 10 shows that the four-factor alphas of these two portfolios are not differentiable. This finding further confirms that OEFs as a whole cannot perform better by including ETFs in their portfolio strategies.

While OEFs short ETFs for hedging against adverse market movements, they might also take a long position in ETFs to quickly gain market exposure and benefit from the active stock selection. This would require that the OEFs allocate a significant position to stocks outside the ETF basket to gain meaningful performance improvement over the ETF.

Panel B of Table 10 clearly shows that OEFs taking a long position only in ETFs are greatly exposed to the market (RMRF) and the small-minus-big (SMB) factor, but this results in a significantly negative four-factor alpha. OEFs shorting ETFs indeed outperform OEFs taking long positions in ETFs by 18.4 basis points per month, although the difference is insignificant. Given that OEFs shorting ETFs are exposed much less to RMRF and more negatively to momentum (MOM), it indicates that OEFs short ETFs to hedge against adverse movement of the stock market.

VI. Multivariate Analyses

So far, I have explored several variables that might individually explain why active open-end

equity funds (OEFs) take positions in passive exchange-traded funds (ETFs). Yet these variables are not mutually exclusive, and some might be more important than others. The variables might moreover have different explanatory power under different market conditions. Accordingly, I examine the variables simultaneously in a forecasting logistic panel regression.

It is unlikely to know ex-ante what triggers an OEF to invest in an ETF. One observation of perhaps a temporary holding does not provide much information about why an OEF invests in an ETF. Therefore, I next focus on continuous OEF trading activities in ETFs in order to understand how they systematically use ETFs to manage their portfolios. By gaining information on how an OEF changes positions in ETFs in response to changes in fund flows and the degree of composition overlap between the OEF and its ETF holdings, I might be able to differentiate the three hypotheses. Additionally, a logistic panel regression allows investigation of how a fund changes positions on ETFs in response to performance and volatility of the fund itself, the fund's style, and the overall market. The forecasting logistic panel regression is:

$$Y_{i,t+1} = \alpha + \beta_1 DIV_{i,t} + \beta_2 Flow_{i,t} + \beta_3 DIV_{i,t} \times Flow_{i,t} + Controls + \varepsilon_{i,t+1} \qquad (1)$$

where $Y_{i,t+1}$ is a binary variable for Fund i in Quarter t+1.

In Table Panel A, the dependent variable takes a value of one if an OEF increases its long position in ETFs from Quarter t to Quarter t+1; in Panel B the dependent variable takes a value of one if an OEF reduces its short position in ETFs from Quarter t to Quarter t+1. $DIV_{i,t}$ is the lagged portfolio divergence, and $Flow_{i,t}$ is the lagged net fund flow measure for i. The level (volatility) of net fund flows each quarter is the sum (standard deviation) of monthly net fund flows over the quarter. The controls in Quarter t include quarter-end fund total net asset value (TNA), fund age, prior-year fund portfolio turnover rate, a fund's abnormal return, the standard deviation of monthly abnormal returns, a fund's style returns in excess of the market returns (RSRM), the standard deviation of monthly RSRM, cumulative market excess return (RMRF, a Fama-French factor), and the standard deviation of monthly RMRF. All standard errors are adjusted for error correlations clustered by fund and quarter according to Petersen (2009).

A fund's abnormal return is measured by the difference in returns between the fund and its style benchmark. At the beginning of each quarter, OEFs are classified into 14 groups according to a fund's prior-quarter-end Lipper classification code (CRSP variable: *lipper_class*)

defined in Table 2, and the value-weighted Lipper style benchmark returns are calculated each month using a fund's TNA at the beginning of each month as a weight. Quarterly cumulative abnormal returns are monthly OEF gross returns compounded over a quarter minus monthly Lipper style benchmark returns compounded over the quarter. Monthly RSRM are returns on a fund's Lipper style benchmark minus returns on the market, the value-weighted CRSP stock index. Quarterly cumulative RSRM and RMRF are calculated in a way similar to calculation of the fund's cumulative abnormal returns.

If an OEF's ETF investment is a substitute for hard-to-trade assets, the fund takes more long positions in ETFs whose underlying securities overlap less with the fund's holdings. Under the *substitution* hypothesis, β_1 is expected to be positive in Panel A. If an OEF's ETF investment is motivated by flow management, its ETF investments will vary with fund flows, regardless of any overlapping in portfolio composition. Under the *flow management* hypothesis, β_2 is expected to be positive while β_3 is expected to be zero in Panel A. If an OEF's ETF investment is motivated by hedging purpose, the fund takes more short positions in ETFs whose underlying securities overlap more with the fund's holdings. Under the *hedging* hypothesis, β_1 is expected to be positive in Panel B.

The results in Table 11 strongly support the *hedging* hypothesis but not the others. If an OEF experiences one additional percentage point difference in the prior-quarter portfolio divergence, the chance of increasing long positions in ETFs is 0.995 times the chance of not increasing long positions in ETFs (odds ratio: 0.995). Similarly, the chance of reducing short positions in ETFs is about 1.039 times the chance of not reducing short positions in ETFs. Both coefficient estimates are very significant. The coefficient estimates of fund flow by either volatility or level are insignificant.

OEFs with higher TNA are unlikely to increase long positions in ETFs but more likely to reduce short positions in ETFs. A large established equity fund is likely to have enough assets to allow portfolio diversification and implement a dynamic investment strategy on the basis of individual securities, so ETF investment is unnecessary.

On the other hand, an older equity fund might accumulate expertise in using ETFs for tactical asset allocation. We can see that an older OEF is likely to increase long positions in ETFs while unlikely to reduce short positions. An OEF with higher portfolio turnover tends to reduce short positions in ETFs. When OEFs experience less volatile performance than their style

peers, they are likely to increase long positions in ETFs while more unlikely to reduce short ones. OEFs tracking their style benchmark well (i.e., experiencing low volatility of relative performance) are better able to engage in tactical asset allocation using ETFs.

When an OEF investment style experiences more performance volatility than the market, the OEF is unlikely to increase long positions in ETFs while more likely to reduce short positions. When the stock market is very volatile, OEFs aiming to hedge are unlikely to reduce short positions in ETFs. Furthermore, when an OEF's style outperforms the market or the market outperforms the Treasury bill, the OEF aiming to hedge is unlikely to reduce short positions in ETFs.

VII. Conclusion

Given the transparency of the underlying assets in an exchange-traded fund, holding an ETF instead of directly holding the underlying basket of securities is costly to a mutual fund because of fees. Moreover, an ETF investment by a mutual fund is surely open to criticism—why should fund shareholders pay an extra fee to a mutual fund engaging in passive ETF investments? Investors can simply invest in passive ETFs by themselves. Why do mutual funds invest in ETFs?

First, this study shows that open-end equity funds (OEFs) that invest in ETFs tend to take short positions in stock. OEFs that invest in ETFs take more than five times the number of short positions in general than OEFs that do not invest in an ETF. This tendency to take a short position is very significant and consistent with a *hedging* hypothesis. OEFs that invest in ETFs also short more in ETFs than other securities when they decide to take a short position. Furthermore, OEFs with overlapping portfolio positions with a target ETF significantly reduce long positions and increase short positions in the target ETF subsequently. This piece of evidence seems to support an assertion that OEFs short ETFs in order to protect their portfolios against negative market shocks.

This study finds little evidence that OEFs change their ETF holdings in response to fund inflows and outflows. If there is any evidence that OEFs use ETFs to manage fund flows, it is that OEFs significantly reduce long positions in ETFs in response to volatile fund flows. Nor does this study find evidence that liquid ETFs are a preferred venue for equity funds to invest in hard-to-trade stocks that underlie in the ETFs.

Finally, although there is no way for equity funds to enhance the four-factor information ratios simply by holding ETFs, which are typically managed passively, they can reduce overall portfolio volatility significantly according to both parametric tests and bootstrap simulations. My work supports a conclusion that hedging is the primary reason OEFs invest in ETFs. While the funds that invest in ETFs generally do not perform better, there is some evidence that OEFs that take short positions only in ETFs outperform those that take long positions only in ETFs.

Results of a multivariate logistic regression strongly support the *hedging* hypothesis and not the *substitution* or the *flow management* hypothesis. The analysis also shows that an OEF with greater assets under management is unlikely to increase long positions in ETFs while likely to reduce their short positions. A large established equity fund has enough assets implement a dynamic investment strategy using individual securities for maintaining a desired exposure to the market, so ETF investment is unnecessary.

When OEFs experience less volatile performance than their style peers, they are likely to increase long positions in ETFs while more unlikely to reduce short ones. OEFs tracking style benchmarks well also have more capacity to engage in tactical asset allocation using ETFs. In the face of high volatility in style performance, OEFs are unlikely to increase long positions in ETFs and more likely to reduce their short positions. When the market is very volatile, OEFs seeking to hedge are unlikely to reduce short positions in ETFs.

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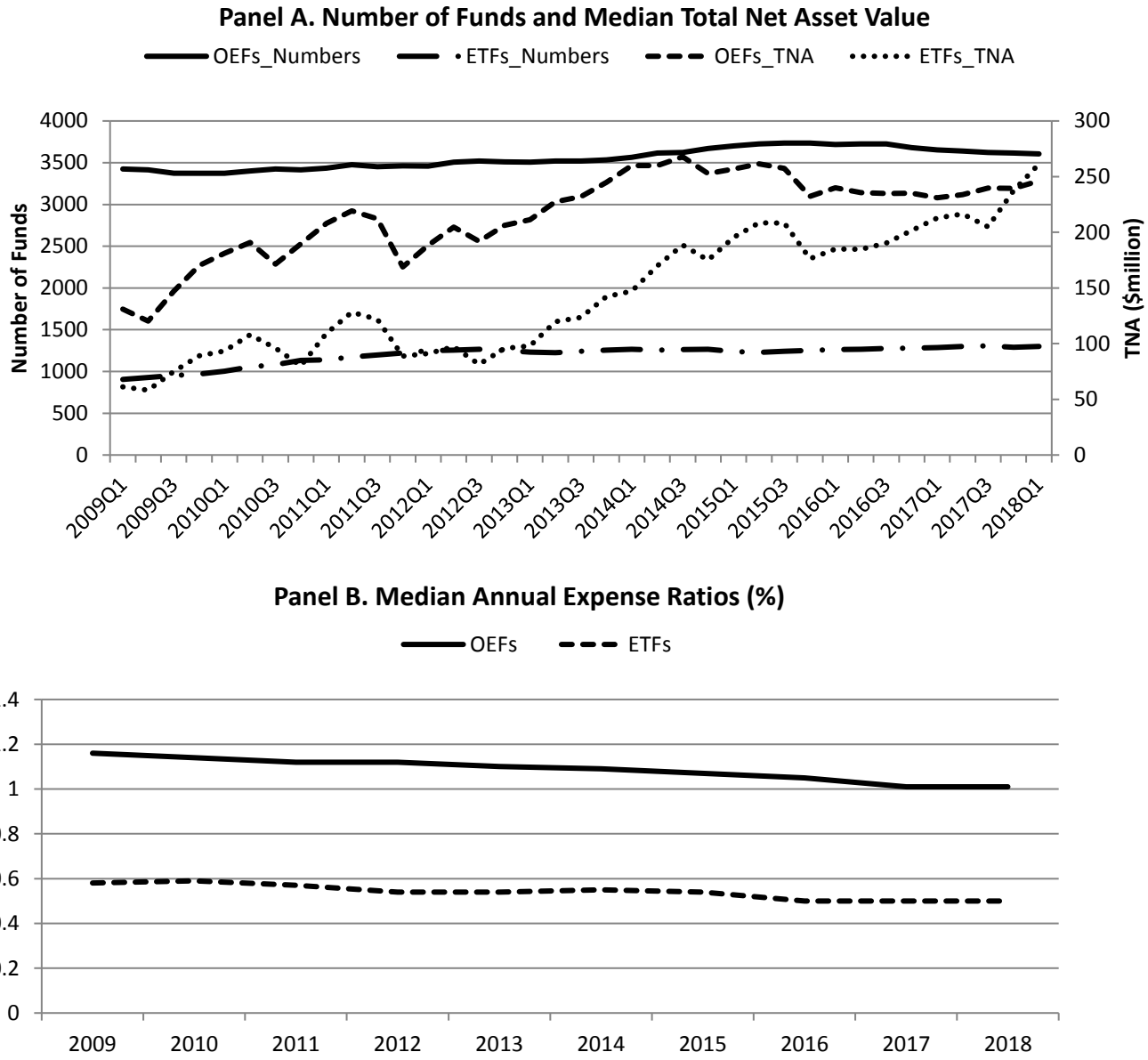
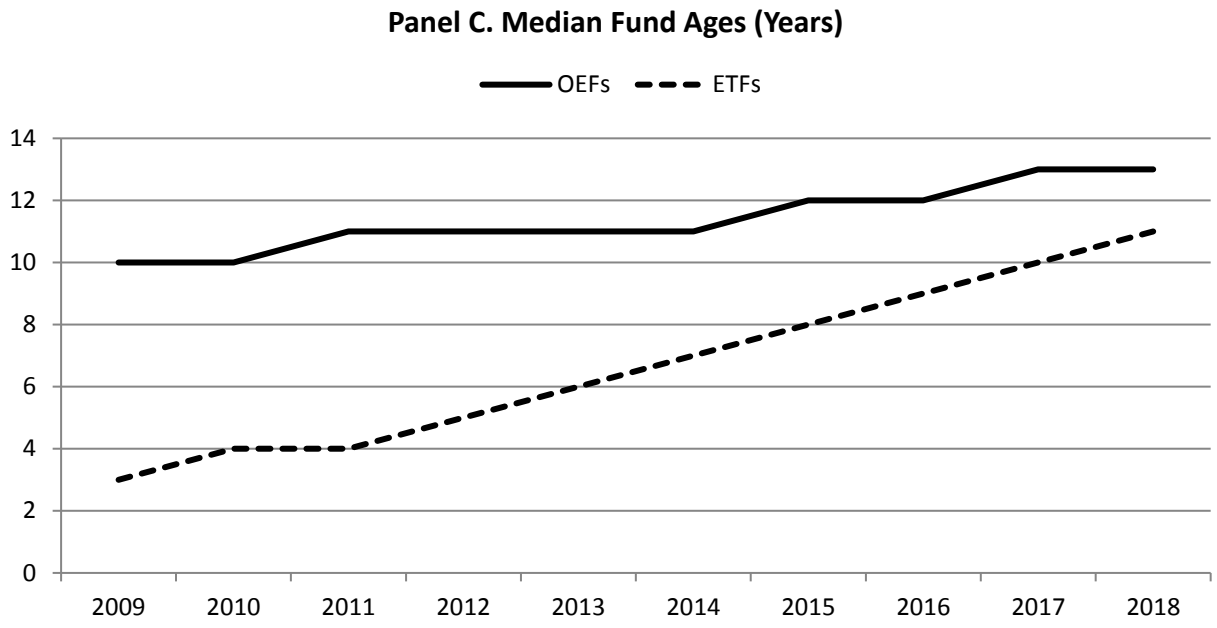
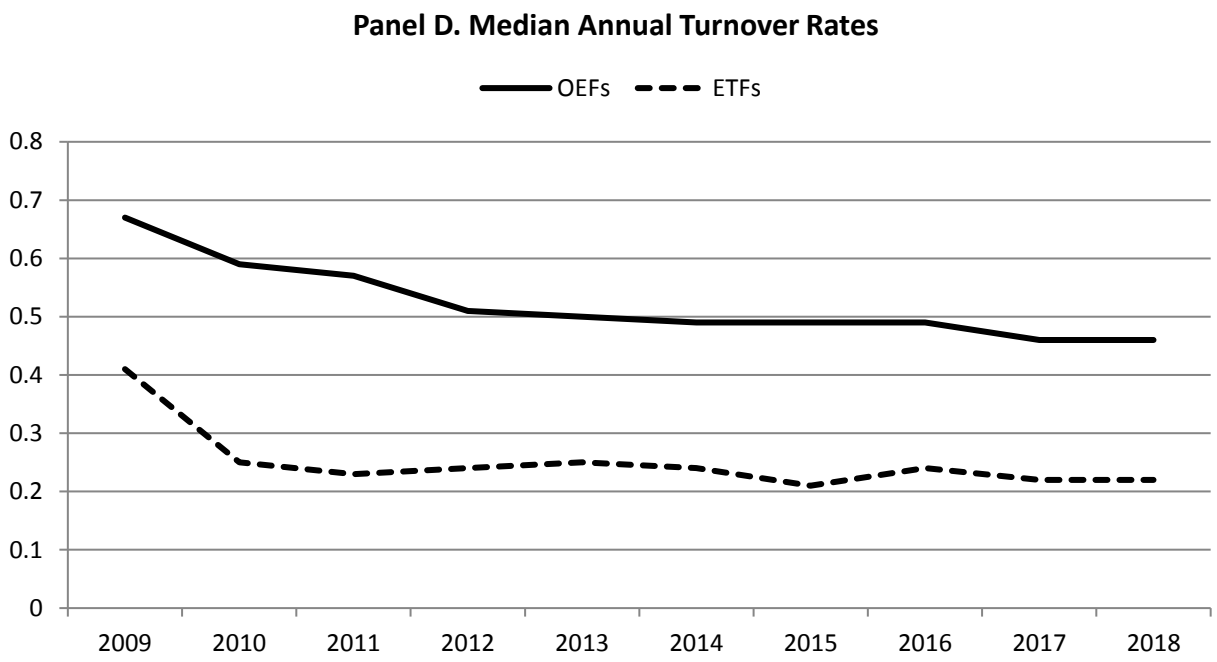


Figure
Active Open-End Equity Funds (OEFs) and Passive Equity Exchanged-Traded Funds (ETFs)
Panel A in this figure shows the number of funds and the median of total net assets (TNA) under management quarterly since 2009. Panels B–D report the median of funds' annual expense ratios, fund ages, and turnover rates. The data are based on the CRSP Mutual Fund Database. Because funds with multiple share classes have the same holdings composition, all the observations pertaining to different share classes are aggregated into one observation. For the TNA under management, the table sums the TNA of the different share classes. For expense ratios, the table takes the weighted average of the expense ratios of the individual share classes, where the weights are the lagged TNA of the individual share classes. For the qualitative attributes of funds (e.g., name, objectives, year of origination), the figure retains the observation of the oldest fund. Newly established funds are included in the calculation only after they first reach at least US$5 million in assets under management. This figure excludes OEFs classified as sector funds at the beginning of a quarter (year) from the quarterly (yearly) calculation. A fund's age is the year difference between the calculation year and the fund's year of establishment.





Figure—*Continued*

Table 1 Attributes of Open-End Equity Funds Investing in ETFs

This table covers portfolios of domestic, actively managed open-end equity funds (OEFs) and domestic, passively managed equity exchanged-traded funds (ETFs) in the CRSP Mutual Fund Database. The four attributes of OEFs are constructed as in the Figure. OEFs are classified quarterly into two groups: one that invests in at least one ETF, and one that does not invest in any ETF during the quarter. In the analysis of annual attributes, the group classification is based on the last quarter of a year with one exception. It is based on the first quarter in 2018. The table reports the median and mean statistics as well as the associated *p*-values for null hypotheses in a two-tailed test. The Fisher test or the x^2 test is conducted according to the procedure described by Siegel (1956, p. 111) to see if the two groups have the same median. The table uses the modified ***t***-test, taking uneven population variances into consideration according to Satterthwaite's procedure described by Anderson and Bancroft (1952, p. 83), to test whether the two groups have the same mean.

	OEFs Investing in ETFs			OEFs Not Investing in ETFs			*p*-value	
	#Funds	Median	Mean	#Funds	Median	Mean	Median	Mean
Panel A. Total Net Asset Value ($million)								
2009	301	107.4	656.9	3074	176.6	989.8	0.001	0.035
2010	510	119.2	593.1	2906	202.0	1119.3	0.000	0.000
2011	519	122.4	642.4	2944	183.7	1056.0	0.000	0.000
2012	554	134.7	699.3	2957	224.9	1258.0	0.000	0.000
2013	446	131.4	837.1	3087	265.0	1459.9	0.000	0.000
2014	529	129.5	942.6	3141	282.8	1586.0	0.000	0.000
2015	526	128.6	843.8	3209	260.4	1481.6	0.000	0.000
2016	563	147.0	944.0	3118	257.6	1544.2	0.000	0.000
2017	581	194.5	1095.1	3036	253.3	1639.0	0.010	0.003
2018	579	180.0	1083.4	3028	261.4	1696.9	0.004	0.001
Panel B. Annual Expense Ratios (%)								
2009	287	1.25	1.30	2202	1.15	1.18	0.000	0.001
2010	384	1.24	1.28	2099	1.12	1.14	0.000	0.000
2011	400	1.20	1.26	2116	1.11	1.13	0.000	0.002
2012	431	1.18	1.23	2121	1.11	1.11	0.035	0.000
2013	345	1.10	1.10	2258	1.10	1.10	0.354	0.895
2014	412	1.06	1.09	2305	1.09	1.08	0.246	0.593
2015	405	1.07	1.11	2381	1.07	1.06	0.196	0.071
2016	431	1.08	1.09	2333	1.04	1.03	0.093	0.049
2017	442	1.04	1.08	2288	1.01	1.00	0.086	0.010
2018	437	1.03	1.02	2276	1.00	1.00	0.686	0.608

Table 1—*Continued*

	OEFs Investing in ETFs			OEFs Not Investing in ETFs			*p*-value	
	#Funds	Median	Mean	#Funds	Median	Mean	Median	Mean
Panel C. Fund Ages (years)								
2009	301	10.0	11.6	3074	10.0	12.5	0.141	0.135
2010	510	9.0	11.3	2906	11.0	13.1	0.060	0.001
2011	519	9.5	11.8	2944	11.0	13.1	0.205	0.015
2012	554	9.0	12.2	2957	11.0	13.4	0.012	0.021
2013	446	9.0	12.1	3087	12.0	13.7	0.009	0.004
2014	529	9.0	11.4	3141	12.0	14.1	0.000	0.000
2015	526	10.0	12.3	3209	12.0	14.4	0.003	0.000
2016	563	10.0	12.6	3118	13.0	15.0	0.000	0.000
2017	581	10.0	13.1	3036	13.0	15.6	0.000	0.000
2018	579	11.0	13.9	3028	14.0	16.4	0.000	0.000
Panel D. Annual Turnover Ratios								
2009	283	0.89	1.45	2169	0.65	0.95	0.000	0.000
2010	384	0.78	1.58	2048	0.56	0.79	0.000	0.000
2011	394	0.75	1.84	2043	0.54	0.75	0.000	0.000
2012	422	0.76	2.11	2044	0.48	0.72	0.000	0.000
2013	335	0.67	1.12	2166	0.48	0.82	0.000	0.012
2014	397	0.64	1.28	2248	0.46	0.80	0.000	0.003
2015	400	0.72	1.58	2281	0.46	1.09	0.000	0.251
2016	413	0.75	1.84	2234	0.45	0.76	0.000	0.001
2017	431	0.70	1.67	2159	0.42	0.65	0.000	0.000
2018	425	0.68	1.60	2182	0.42	0.67	0.000	0.001

Table 2 Investment Styles of Open-End Equity Funds by Lipper Classification Codes

Domestic, actively managed open-end equity funds (OEFs) are classified quarterly into two groups: one that invests in at least one ETF, and one that does not invest in any ETF during the quarter. In each quarter, OEFs in each group are further classified into 14 groups according to a fund's Lipper classification code (CRSP variable: *lipper_class*): LCCE (Large-Cap Core Funds), LCGE (Large-Cap Growth Funds), LCVE (Large-Cap Value Funds), MCCE (Mid-Cap Core Funds), MCGE (Mid-Cap Growth Funds), MCVE (Mid-Cap Value Funds), SCCE (Small-Cap Core Funds), SCGE (Small-Cap Growth Funds), SCVE (Small-Cap Value Funds), MLCE (Multi-Cap Core Funds), MLGE (Multi-Cap Growth Funds), MLVE (Multi-Cap Value Funds), MAT+MT (Mixed-Asset Target-Date and Target-Allocation Funds), and others. Lipper classification codes are described at http://www.crsp.com/products/documentation/lipper-objective-and-classification-codes. The percentage of fund observations in each group is relative to the total number of all funds each quarter. Total fund net asset value is also calculated across all funds assigned to each group and expressed relative to the total net assets of all funds each quarter. The table reports the average of percentages across quarters for each style group; the difference in percentages between two fund groups; and the *p*-value associated with the null hypothesis that the difference is zero. The sample period is from the 1st quarter of 2009 through the 1st quarter of 2018.

Open-End Equity funds	Lipper Classification Codes													
	LCGE	LCCE	LCVE	MCGE	MCCE	MCVE	SCGE	SCCE	SCVE	MLGE	MLCE	MLVE	MAT+MT	Other
Panel A. Style distribution by percentages of fund observations														
OEFs Investing in ETFs	17.59	5.55	9.39	4.11	3.61	3.37	1.89	7.81	10.71	3.96	4.19	8.97	3.52	15.33
OEFs Not Investing in ETFs	12.45	10.02	11.29	5.87	5.82	4.19	2.41	6.46	7.98	3.48	6.59	10.06	3.67	9.74
Difference	5.14	-4.47	-1.90	-1.76	-2.20	-0.82	-0.52	1.35	2.74	0.48	-2.39	-1.09	-0.15	5.59
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.01)	(0.00)	(0.02)	(0.41)	(0.00)
Panel B. Style distribution by percentages of fund net assets														
OEFs Investing in ETFs	9.94	7.02	9.77	15.78	3.23	2.38	1.70	6.78	10.16	2.51	5.11	4.68	6.97	13.95
OEFs Not Investing in ETFs	11.25	16.46	18.64	7.90	4.40	3.03	1.94	2.70	3.72	1.38	8.11	9.42	2.97	8.06
Difference	-1.31	-9.44	-8.88	7.88	-1.17	-0.65	-0.24	4.08	6.44	1.13	-2.99	-4.74	4.00	5.89
p-value	(0.25)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.30)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table 3 Overall Short Positions of Open-End Equity Funds

OEFs are classified quarterly into two groups: one that invests in ETFs and one that does not invest in ETFs during the quarter. The table examines short positions of OEFs that short at least one security. If a fund has multiple portfolio disclosures in a quarter, its latest disclosure is used. In a given portfolio, all percentages of total net assets (%TNA) in short positions are aggregated. The table presents the number of OEFs (#F), the median number of total portfolio securities held in OEFs (#S), the median TNA ($million) of OEFs, and the median and mean %TNA in short positions. The last two columns report the associated *p*-values for null hypotheses in which two groups have the same median or mean of %TNA in a two-tailed test.

Quarter	OEFs Investing in ETFs					OEFs Not Investing in ETFs					*p*-value	
	#F	#S	TNA	%TNA		#F	#S	TNA	%TNA			
				Median	Mean				Median	Mean	Median	Mean
2009Q1	6	63	33.3	-21.00	-19.18	4	55	2.4	-19.36	-17.39	0.952	0.776
2009Q2	7	56	39.8	-21.94	-19.77	8	122	15.9	-28.76	-29.93	0.609	0.218
2009Q3	6	130	68.7	-25.53	-26.31	6	101	14.6	-14.97	-16.91	0.487	0.338
2009Q4	6	39	87.0	-17.03	-21.50	9	83	18.2	-19.57	-18.54	0.816	0.766
2010Q1	6	83	33.3	-22.28	-22.07	3	134	7.2	-17.78	-19.08	0.952	0.787
2010Q2	72	100	78.9	-1.38	-9.28	281	93	186.5	-0.34	-8.37	0.096	0.765
2010Q3	119	126	167.8	-1.48	-11.18	393	89	187.0	-0.43	-9.58	0.005	0.525
2010Q4	136	110	144.0	-2.32	-13.42	385	86	206.7	-0.31	-8.82	0.000	0.042
2011Q1	113	110	145.7	-3.86	-14.66	451	86	214.9	-0.47	-9.11	0.006	0.023
2011Q2	117	137	161.1	-3.31	-18.66	495	77	198.9	-0.32	-6.57	0.000	0.000
2011Q3	152	125	130.4	-3.77	-16.00	487	81	184.7	-0.51	-6.64	0.000	0.000
2011Q4	159	122	140.2	-2.95	-15.31	492	83	181.2	-0.45	-7.41	0.000	0.001
2012Q1	162	105	99.9	-4.02	-15.53	553	83	192.4	-0.49	-7.12	0.000	0.001
2012Q2	184	110	131.4	-4.22	-16.53	605	78	179.6	-0.36	-6.49	0.000	0.000
2012Q3	189	109	146.5	-1.72	-11.22	588	75	222.5	-0.32	-7.10	0.000	0.013
2012Q4	187	123	137.8	-3.49	-14.49	624	78	201.9	-0.29	-5.97	0.000	0.000
2013Q1	183	112	86.6	-5.09	-16.43	626	80	205.9	-0.35	-6.95	0.000	0.000
2013Q2	187	128	77.3	-3.28	-13.58	728	82	212.6	-0.52	-8.22	0.000	0.007
2013Q3	154	109	104.0	-1.39	-12.96	667	82	206.4	-0.44	-6.71	0.019	0.002
2013Q4	136	90	91.6	-2.53	-11.62	620	82	235.4	-0.26	-5.13	0.000	0.002
2014Q1	157	115	133.0	-1.34	-11.38	700	85	284.0	-0.42	-8.05	0.003	0.167
2014Q2	150	102	124.5	-1.56	-10.52	694	88	348.0	-0.25	-6.10	0.000	0.016
2014Q3	148	123	122.9	-1.22	-9.37	676	94	311.6	-0.29	-5.73	0.000	0.043
2014Q4	192	100	103.0	-1.25	-10.62	675	92	329.2	-0.25	-6.39	0.000	0.008
2015Q1	168	112	102.2	-4.01	-15.58	683	94	273.0	-0.35	-6.34	0.000	0.000
2015Q2	168	129	116.0	-4.95	-16.63	746	101	323.4	-0.38	-8.24	0.000	0.001
2015Q3	141	131	134.0	-3.38	-15.85	725	101	359.5	-0.36	-8.92	0.000	0.006
2015Q4	182	111	147.2	-2.66	-17.42	722	89	242.7	-0.43	-9.58	0.000	0.004
2016Q1	177	120	119.1	-3.95	-18.16	689	90	262.8	-0.53	-10.90	0.000	0.002
2016Q2	201	102	113.3	-4.18	-17.85	691	97	284.5	-0.60	-11.44	0.000	0.021
2016Q3	203	100	93.4	-6.21	-26.21	753	96	258.1	-0.45	-11.98	0.000	0.059
2016Q4	184	129	170.3	-3.04	-17.83	741	92	218.2	-0.55	-12.71	0.001	0.063
2017Q1	167	129	157.6	-3.10	-17.98	693	88	261.4	-0.44	-11.91	0.000	0.020
2017Q2	182	114	131.8	-2.71	-17.83	751	98	217.9	-0.59	-12.17	0.000	0.027
2017Q3	205	104	157.9	-2.74	-16.25	753	88	233.5	-0.46	-13.58	0.000	0.276
2017Q4	205	117	192.9	-3.67	-16.96	756	86	244.1	-0.53	-14.13	0.000	0.278
2018Q1	199	114	162.5	-2.46	-13.74	651	90	263.8	-0.43	-14.47	0.000	0.766

Table 4 Positions in ETFs by Open-End Equity Funds Investing in ETFs

This table reports statistics for OEFs that invest in ETFs during a quarter. Each quarter, the table examines (Panel A) aggregate positions in ETFs, (Panel B) short positions of OEFs that short at least a security, and (Panel C) long positions of OEFs that never short any security. In Panels B and C, positions in ETFs are separated from positions in non-ETFs by these OEF portfolios. In a given portfolio, the average percentage of total net assets (%TNA) in positions is calculated on a per-security basis. The table presents the number of OEFs (#F), the median number of total securities held by OEFs (#S), the median TNA ($million) of OEFs, and the median as well as the mean of %TNA per security in the positions across OEF portfolios. The last two columns in Panels B and C report the associated *p*-values for null hypotheses in which two groups have the same median or mean of %TNA in a two-tailed test.

Panel A. Aggregate positions in ETFs held by OEFs

Quarter	Long Positions					Short Positions				
	#F	#S	TNA	%TNA		#F	#S	TNA	%TNA	
				Median	Mean				Median	Mean
2009Q1	341	89	98.6	1.92	5.01	5	58	39.0	-6.96	-6.35
2009Q2	340	91	111.6	1.75	4.72	7	56	39.8	-5.35	-5.73
2009Q3	319	93	119.1	1.47	5.30	6	130	68.7	-1.23	-4.15
2009Q4	286	86	102.7	1.73	5.35	6	39	87.0	-3.15	-5.73
2010Q1	268	89	122.3	1.37	5.76	5	98	91.0	-4.15	-3.87
2010Q2	352	84	116.0	1.65	7.05	20	101	59.5	-2.95	-3.04
2010Q3	354	87	102.0	1.61	6.69	31	85	106.1	-2.74	-4.34
2010Q4	348	78	117.7	1.98	8.32	39	94	116.2	-2.87	-5.96
2011Q1	350	81	142.8	1.79	8.09	34	90	113.4	-3.98	-6.46
2011Q2	334	84	140.8	1.69	7.98	37	130	60.8	-4.16	-7.06
2011Q3	314	80	119.7	1.59	8.25	46	150	52.1	-3.28	-6.16
2011Q4	335	84	127.9	1.65	8.74	41	117	74.5	-3.63	-7.20
2012Q1	352	91	157.9	1.60	8.63	47	108	76.7	-4.88	-7.76
2012Q2	354	91	133.3	1.60	8.06	48	147	73.8	-4.10	-6.99
2012Q3	351	92	140.5	1.56	7.32	45	155	72.4	-3.40	-6.12
2012Q4	324	81	108.4	1.68	7.43	50	122	44.5	-4.87	-6.12
2013Q1	331	98	138.0	1.70	7.41	57	150	50.9	-4.98	-7.64
2013Q2	329	82	153.6	1.69	8.83	50	161	52.5	-5.35	-7.58
2013Q3	282	87	137.0	1.47	7.34	36	153	85.5	-3.61	-6.92
2013Q4	288	99	142.9	1.68	8.58	29	140	62.2	-3.49	-7.18
2014Q1	321	83	128.2	1.81	9.98	28	150	75.9	-6.29	-8.45
2014Q2	310	85	127.8	1.34	9.25	34	108	107.3	-4.72	-8.27
2014Q3	311	91	139.2	1.49	9.76	26	123	103.2	-3.98	-8.01
2014Q4	314	97	142.4	1.83	10.21	39	176	121.1	-3.67	-7.03
2015Q1	336	99	157.0	1.66	9.50	53	142	115.7	-4.61	-7.80
2015Q2	311	92	160.1	1.94	10.76	45	100	90.7	-6.39	-10.44
2015Q3	310	88	131.9	1.75	9.39	37	120	136.5	-5.89	-9.26
2015Q4	316	76	136.5	3.26	12.45	44	137	153.1	-4.10	-8.44
2016Q1	344	73	94.7	2.85	12.23	40	131	95.8	-4.77	-9.01
2016Q2	324	73	114.0	2.23	11.94	46	137	108.9	-6.11	-12.86
2016Q3	330	70	140.0	2.51	12.10	49	102	64.7	-5.16	-15.84
2016Q4	346	68	124.8	2.99	13.48	41	120	156.8	-2.49	-9.69
2017Q1	349	72	134.0	2.42	12.73	40	129	127.5	-3.26	-9.33
2017Q2	230	68	131.6	2.78	13.44	44	135	109.4	-3.29	-7.25
2017Q3	339	79	142.3	2.92	12.60	55	142	130.4	-3.36	-9.00
2017Q4	357	68	200.6	2.80	12.94	49	163	155.9	-3.55	-7.63
2018Q1	357	74	195.2	2.98	13.05	46	161	166.8	-3.43	-6.06

Table 4—*Continued*

Panel B. OEFs that invest in ETFs and short at least one security

Quarter	Short positions in ETFs					Short positions in non-ETFs					*p*-value	
	#F	#S	TNA	%TNA/Security		#F	#S	TNA	%TNA/Security			
				Median	Mean				Median	Mean	Median	Mean
2009Q1	5	58	39.0	-4.19	-3.81	6	63	33.3	-1.35	-1.25	0.866	0.202
2009Q2	7	56	39.8	-3.24	-2.69	6	64	36.5	-1.52	-1.15	0.367	0.032
2009Q3	6	130	68.7	-1.23	-1.45	5	139	68.4	-0.50	-0.59	0.649	0.229
2009Q4	6	39	87.0	-1.58	-1.79	5	56	54.0	-0.52	-0.57	0.649	0.118
2010Q1	5	98	91.0	-1.13	-1.02	6	83	33.3	-0.58	-0.55	0.325	0.130
2010Q2	20	101	59.5	-1.20	-1.48	69	101	83.2	-0.25	-0.77	0.002	0.063
2010Q3	31	85	106.1	-1.25	-1.97	118	128	169.1	-0.26	-0.95	0.000	0.016
2010Q4	39	94	116.2	-1.37	-3.45	134	112	144.0	-0.28	-1.25	0.000	0.143
2011Q1	34	90	113.4	-1.51	-3.18	112	111	148.2	-0.33	-0.96	0.000	0.144
2011Q2	37	130	60.8	-1.16	-3.30	115	140	173.5	-0.38	-0.94	0.001	0.213
2011Q3	46	150	52.1	-1.13	-2.00	151	126	130.0	-0.31	-1.19	0.000	0.045
2011Q4	41	117	74.5	-1.07	-2.38	158	124	139.2	-0.28	-1.33	0.000	0.121
2012Q1	47	108	76.7	-1.64	-3.17	162	105	99.9	-0.34	-1.36	0.002	0.087
2012Q2	48	147	73.8	-1.11	-2.41	183	112	132.7	-0.36	-1.86	0.001	0.395
2012Q3	45	155	72.4	-1.11	-1.88	188	111	147.2	-0.21	-0.93	0.002	0.035
2012Q4	50	122	44.5	-1.04	-1.94	185	123	138.4	-0.27	-1.62	0.000	0.518
2013Q1	57	150	50.9	-1.71	-2.66	183	112	86.6	-0.29	-1.47	0.000	0.039
2013Q2	50	161	52.5	-1.15	-1.84	186	129	78.7	-0.30	-1.47	0.000	0.420
2013Q3	36	153	85.5	-1.24	-2.10	153	109	106.2	-0.21	-1.81	0.000	0.719
2013Q4	29	140	62.2	-1.14	-1.85	136	90	91.6	-0.35	-2.17	0.002	0.528
2014Q1	28	150	75.9	-1.23	-2.19	157	115	133.0	-0.23	-1.18	0.000	0.030
2014Q2	34	108	107.3	-0.97	-2.30	149	103	129.9	-0.29	-1.61	0.001	0.392
2014Q3	26	123	103.2	-0.97	-2.73	147	124	123.1	-0.24	-1.62	0.001	0.469
2014Q4	39	176	121.1	-1.06	-1.91	191	101	101.5	-0.22	-1.26	0.000	0.191
2015Q1	53	142	115.7	-1.01	-2.11	168	112	102.2	-0.25	-0.87	0.000	0.002
2015Q2	45	100	90.7	-1.78	-3.91	167	130	122.5	-0.29	-1.46	0.000	0.053
2015Q3	37	120	136.5	-1.96	-3.22	140	132	134.4	-0.28	-0.85	0.000	0.002
2015Q4	44	137	153.1	-1.96	-2.35	181	112	144.3	-0.32	-1.05	0.000	0.002
2016Q1	40	131	95.8	-1.63	-2.49	177	120	119.1	-0.43	-1.71	0.000	0.122
2016Q2	46	137	108.9	-2.00	-3.90	198	105	115.1	-0.49	-2.00	0.000	0.146
2016Q3	49	102	64.7	-1.50	-4.17	201	101	93.4	-0.48	-1.64	0.008	0.071
2016Q4	41	120	156.8	-1.07	-2.18	183	130	170.1	-0.28	-3.01	0.003	0.563
2017Q1	40	129	127.5	-0.92	-3.26	165	130	157.6	-0.39	-1.25	0.041	0.170
2017Q2	44	135	109.4	-1.57	-3.07	181	116	132.8	-0.31	-1.53	0.000	0.254
2017Q3	55	142	130.4	-0.96	-3.32	203	105	161.3	-0.30	-1.48	0.001	0.136
2017Q4	49	163	155.9	-0.99	-2.98	204	118	195.7	-0.23	-1.20	0.000	0.140
2018Q1	46	161	166.8	-0.83	-2.73	198	114	163.1	-0.17	-1.44	0.000	0.286

Table 4—*Continued*

Panel C. OEFs that invest in ETFs and do not short any security

Quarter	Long positions in ETFs					Long positions in non-ETFs					*p*-value	
	#F	#S	TNA	%TNA/Security		#F	#S	TNA	%TNA/Security			
				Median	Mean				Median	Mean	Median	Mean
2009Q1	341	89	98.6	1.29	2.15	351	89	98.6	1.15	1.36	0.341	0.000
2009Q2	340	91	111.6	1.13	1.91	355	93	114.4	1.09	1.44	0.913	0.003
2009Q3	319	93	119.1	1.05	2.19	338	92	123.4	1.03	1.38	0.181	0.006
2009Q4	286	86	102.7	1.16	2.12	297	89	106.5	1.04	1.45	0.812	0.008
2010Q1	268	89	122.3	1.00	2.09	275	89	123.4	1.05	1.48	0.849	0.030
2010Q2	352	84	116.0	1.21	2.45	378	86	123.6	1.04	2.03	0.160	0.176
2010Q3	354	87	102.0	1.16	2.49	384	86	108.3	1.15	2.10	0.118	0.228
2010Q4	348	78	117.7	1.28	2.63	374	83	130.4	1.16	2.20	0.337	0.189
2011Q1	350	81	142.8	1.26	2.56	391	85	149.8	1.18	2.10	0.542	0.150
2011Q2	334	84	140.8	1.16	2.48	357	86	142.2	1.13	2.08	0.180	0.223
2011Q3	314	80	119.7	1.22	2.70	346	84	126.4	1.17	2.44	0.966	0.567
2011Q4	335	84	127.9	1.35	3.12	360	82	134.0	1.16	2.41	0.807	0.151
2012Q1	352	91	157.9	1.29	2.41	384	93	161.8	1.07	2.02	0.344	0.170
2012Q2	354	91	133.3	1.11	2.74	391	91	134.0	1.07	2.32	0.833	0.282
2012Q3	351	92	140.5	1.20	2.27	382	98	148.8	1.00	1.82	0.831	0.028
2012Q4	324	81	108.4	1.30	2.27	367	86	126.6	1.17	2.06	0.862	0.367
2013Q1	331	98	138.0	1.22	2.49	353	98	143.4	1.03	1.97	0.888	0.147
2013Q2	329	82	153.6	1.18	2.50	355	88	158.8	1.11	2.01	0.421	0.110
2013Q3	282	87	137.0	1.01	2.23	306	86	147.3	1.13	2.17	0.863	0.870
2013Q4	288	99	142.9	1.07	2.65	311	99	154.4	0.99	1.98	0.804	0.044
2014Q1	321	83	128.2	1.26	3.11	334	83	129.4	1.19	2.30	0.309	0.019
2014Q2	310	85	127.8	1.00	2.68	327	85	129.3	1.16	2.39	0.149	0.400
2014Q3	311	91	139.2	1.12	2.71	333	90	133.4	1.10	2.24	0.000	0.147
2014Q4	314	97	142.4	1.28	3.18	337	96	148.5	1.01	2.38	0.083	0.045
2015Q1	336	99	157.0	1.22	2.86	353	98	157.2	1.01	2.37	0.095	0.265
2015Q2	311	92	160.1	1.22	3.30	334	96	170.0	1.03	2.27	0.474	0.012
2015Q3	310	88	131.9	1.24	2.87	331	89	133.5	1.11	2.58	0.334	0.508
2015Q4	316	76	136.5	1.72	4.26	342	77	142.6	1.28	3.03	0.022	0.038
2016Q1	344	73	94.7	1.68	4.02	362	74	101.9	1.31	2.87	0.011	0.015
2016Q2	324	73	114.0	1.55	3.78	344	75	123.2	1.29	2.55	0.490	0.010
2016Q3	330	70	140.0	1.60	3.43	356	75	155.2	1.26	2.49	0.111	0.008
2016Q4	346	68	124.8	1.82	4.20	383	72	134.6	1.35	2.70	0.204	0.001
2017Q1	349	72	134.0	1.80	4.22	375	75	144.3	1.29	3.30	0.023	0.142
2017Q2	230	68	131.6	1.82	4.41	305	76	156.1	1.32	3.61	0.046	0.286
2017Q3	339	79	142.3	1.77	3.88	360	79	146.6	1.27	2.80	0.004	0.016
2017Q4	357	68	200.6	1.82	4.37	385	76	208.1	1.30	3.20	0.304	0.028
2018Q1	357	74	195.2	1.80	4.84	389	78	195.6	1.29	3.31	0.025	0.007

Table 5 Portfolio Divergence between Open-End Equity Funds and their ETF Holdings

This table calculates divergence for each domestic OEF that invests in at least one ETF. Divergence (Div) is defined as $\sum_{i\in\{f\cup ETF\}}\frac{|w_{i,f,q}-\widehat{w_{i,f,q}}|}{2}$, where $w_{i,f,q}$ is the investment weight of stock i in an OEF f in quarter q, and $\widehat{w_{i,f,q}}$ is the investment weight of stock i in an ETF held by the OEF. Both OEFs and ETFs are required to have detailed holdings data for the divergence calculation. If an OEF invests in more than one ETF, the divergences are averaged across all ETFs held by the OEF. If a fund has multiple holdings disclosures in a quarter, its latest disclosure is used. The table presents the quartile distribution as well as the average (AVG) and the standard deviation (SD) of portfolio divergences every quarter since 2009. Divergences are in a percentage format.

Quarter	# of OEFs	Quartile Distribution			AVG	SD
		25%	Median	75%		
2009Q1	331	70.48	86.06	94.64	81.37	18.13
2009Q2	327	69.71	84.52	92.40	79.73	17.25
2009Q3	305	67.50	81.48	90.44	77.72	16.79
2009Q4	257	61.84	77.13	88.34	74.59	17.09
2010Q1	240	58.25	75.18	86.95	71.87	19.80
2010Q2	421	57.86	76.47	86.62	71.63	21.00
2010Q3	483	54.47	76.19	87.55	70.92	22.12
2010Q4	492	55.37	75.63	87.05	70.70	23.30
2011Q1	479	55.46	76.02	87.39	71.01	22.28
2011Q2	447	55.93	73.17	87.30	70.48	23.55
2011Q3	471	52.43	71.89	86.90	69.13	25.05
2011Q4	516	51.96	71.25	85.35	67.95	25.53
2012Q1	543	52.89	73.06	85.36	68.78	23.48
2012Q2	570	52.89	73.24	86.51	69.35	23.14
2012Q3	567	54.69	72.97	87.05	70.01	21.63
2012Q4	553	52.06	72.98	87.09	69.43	22.06
2013Q1	536	55.15	72.33	87.34	70.44	22.23
2013Q2	542	52.73	71.84	86.50	69.82	21.88
2013Q3	460	52.40	73.12	86.40	69.72	21.96
2013Q4	447	51.77	70.54	85.91	68.82	21.04
2014Q1	493	52.32	71.57	85.66	69.18	21.10
2014Q2	478	51.80	68.58	85.42	67.57	21.01
2014Q3	480	54.03	69.39	85.25	68.40	20.68
2014Q4	528	54.93	70.94	85.43	69.47	20.30
2015Q1	513	56.94	73.06	86.42	72.22	19.20
2015Q2	495	56.82	71.68	86.52	71.34	20.03
2015Q3	467	54.58	70.47	86.00	69.03	20.27
2015Q4	526	54.22	70.43	85.87	69.10	21.00
2016Q1	539	52.72	70.98	85.40	69.29	21.60
2016Q2	545	52.49	68.18	84.76	68.12	22.06
2016Q3	557	53.07	70.57	85.61	69.61	30.50
2016Q4	565	56.00	71.08	84.48	69.53	20.08
2017Q1	539	55.69	71.77	85.32	69.50	21.23
2017Q2	484	54.36	71.40	85.11	69.33	21.18
2017Q3	563	50.58	67.56	83.07	66.69	21.74
2017Q4	588	53.12	68.29	83.09	67.27	20.35
2018Q1	586	52.74	67.19	82.75	66.63	19.71

Table 6 Subsequent Changes in ETF Positions of Quartile Portfolios Formed by Divergence

This table examines position changes in ETFs held by an OEF. Each quarter OEFs are sorted by their divergence into quartiles. The divergence calculation is described in Table 5. For each OEF in each quarter, the table aggregates all percentages of total net assets (%TNA) allocated to ETFs in long and short positions separately and calculates changes in ETF positions from the portfolio-formation quarter to the next quarter. Each quarter the table calculates the equally weighted average of percentages of TNA and changes in the percentages across OEFs for each quartile. If a fund has multiple holdings disclosures in quarters, its latest disclosure in the quartile-formation quarter and its first disclosure in the next quarter are used to calculate changes in ETF positions. The table presents the average of changes in ETF positions over quarters since 2009, as well as the associated *p*-values for null hypotheses in which the average of the changes is zero in a two-tailed test. The table also reports the difference statistics between the top and bottom quartiles, as well as the associated *p*-values for null hypotheses in which two quartiles have the same mean in a two-tailed test as in Table 1. Numbers in brackets are the average number of observed OEFs per quarter. The pairs in braces report the average of divergences and the number of OEFs in each quartile. The *p*-value is reported in parentheses.

Quartiles by Divergence in the Portfolio-Formation Quarter Q_0			Changes in ETF Positions (%TNA) from Q_0 to Q_{+1}	
	%TNA of ETF Positions in Q_0			
{Divergence%; #obs}	Long Positions	Short Positions	Long Positions	Short Positions
Q1 (Low)	7.52	-2.68	-0.83	-1.22
p-value			(0.000)	(0.279)
{ 42.70; 122}	[120]	[2]		
Q2	7.60	-3.98	-0.88	0.03
p-value			(0.000)	(0.929)
{ 64.75; 121}	[117]	[7]		
Q3	10.81	-5.47	-1.57	1.33
p-value			(0.000)	(0.004)
{ 79.91; 121}	[115]	[8]		
Q4 (High)	9.32	-9.89	-1.24	2.14
p-value			(0.001)	(0.000)
{ 94.51; 121}	[105]	[20]		
Difference (Q1 - Q4)	-1.80	7.21	0.40	-3.36
p-value	(0.022)	(0.000)	(0.310)	(0.008)

Table 7 Changes in ETF Positions of Portfolios Formed by Net Fund Flows

This table examines changes in ETF positions held by an OEF when the OEF experiences different net fund flows. At the end of each quarter, OEFs are sorted into quartiles in Panel A according to the level of their net fund flows, or into quartiles in Panel B according to the volatility of their net fund flows. The level of net fund flows each quarter is the monthly net fund flows cumulated over the quarter. The volatility of net fund flows each quarter is the standard deviation of monthly net fund flows over a year, ending by the quarter. The table follows the definition of net fund flows by Sirri and Tufano (1998). For each OEF in each quarter, the table aggregates all percentages of total net assets (%TNA) allocated to ETFs in long and short positions separately, and calculates changes in ETF positions from the portfolio-formation quarter to the next quarter. Each quarter the table calculates the equally weighted average of percentages of TNA and changes in the percentages across OEFs for each quartile. If a fund has multiple holdings disclosures in quarters, its latest disclosure in the quartile-formation quarter and its first disclosure in the next quarter are used to calculate of changes in ETF positions. The table presents the average of changes in ETF positions over quarters since 2009, as well as the associated p-values for null hypotheses in which the average of the changes is zero in a two-tailed test. The table also reports the difference statistics between the two referenced groups, as well as the associated *p*-values for null hypotheses in which two groups have the same mean in a two-tailed test as in Table 1. The pairs in braces report the averages of the level or volatility of net fund flows and the number of OEFs in each quartile. Numbers in brackets are the average number of observed OEFs per quarter. The *p*-value is reported in parentheses.

Panel A: Quartiles Sorted by Fund Flows (%)

Quartiles by Fund Flows (%) in the Portfolio-Formation Quarter Q_0			Changes in ETF Positions (%TNA) from Q_0 to Q_{+1}	
	%TNA of ETF Positions in Q_0			
{Fund Flow; #obs}	Long Positions	Short Positions	Long Positions	Short Positions
Q4 (High)	13.50	-6.93	-1.51	-0.06
p-value			(0.000)	(0.944)
{ 49.61;124}	[115]	[13]		
Q3	7.04	-8.50	-0.69	1.56
p-value			(0.000)	(0.002)
{ 0.85;123}	[118]	[6]		
Q2	5.70	-7.06	-0.82	1.63
p-value			(0.000)	(0.017)
{ -2.31;123}	[119]	[4]		
Q1 (Low)	8.67	-8.47	-1.45	1.79
p-value			(0.000)	(0.008)
{-11.33;124}	[115]	[14]		
Difference (Q4 - Q1)	4.82	1.54	-0.07	-1.85
p-value	(0.000)	(0.144)	(0.882)	(0.088)

Table 7—*Continued*

Panel B: Quartiles Sorted by Volatility of Fund Flows (%)

Quartiles by Volatility of Fund Flows (%) in the Portfolio-Formation Quarter Q_0			Changes in ETF Positions (%TNA) from Q_0 to Q_{+1}	
	%TNA of ETF Positions in Q_0			
{Flow Volatility; #obs}	Long Positions	Short Positions	Long Positions	Short Positions
Q4 (High)	13.61	-7.90	-1.83	1.02
p-value			(0.000)	(0.050)
{232.04;124}	[111]	[18]		
Q3	9.95	-7.98	-1.37	1.54
p-value			(0.000)	(0.001)
{ 3.42;123}	[116]	[11]		
Q2	7.35	-6.19	-0.85	0.90
p-value			(0.000)	(0.094)
{ 1.55;123}	[119]	[6]		
Q1 (Low)	4.26	-5.41	-0.46	1.19
p-value			(0.000)	(0.140)
{ 0.59;124}	[121]	[3]		
Difference (Q4 - Q1)	9.36	-2.48	-1.37	-0.18
p-value	(0.000)	(0.020)	(0.000)	(0.852)

Table 8 Performance of Equity Funds after Investing in ETFs

For each domestic, actively managed open-end equity fund (OEF), this table identifies the first month-end (t_0) and the last month-end (t_1) in which the OEF invests in domestic, passively managed ETFs. The performance of OEFs is examined over three periods: the pre-holding period of *[t_0 - 36, t_0]* (Pre-H Period), the holding period of *[t_0, t_1]* (H Period), and the post-holding period of *[t_1, March 2018]* (Post-H Period). Based on OEF monthly gross returns, the table estimates the alpha of Fama-French three factors plus a momentum factor for each portfolio in each period and calculates the fund's information ratio, the alpha divided by the standard deviation of the four-factor residuals. The table analyzes only OEFs that hold ETFs in their portfolios for at least a year. In each period, an OEF must have at least 12 monthly returns in order to estimate its four-factor alpha and test the null hypothesis that the average of cross-sectional information ratios is equal to zero in a two-tailed test. Panel B reports statistics for OEFs with high divergence and OEFs with low divergence, where the divergence is calculated based on equity holdings only. The calculation of divergence is defined in Table 5. Panel C reports statistics for OEFs with high divergence and OEFs with low divergence, where the divergence is calculated based on all holdings. Panel D reports the statistics for OEFs that take at least a short position in ETFs, and OEFs that never take a short position in any ETF during the holding period. The statistics of the difference of performance measures in two groups are reported. Panels B−D use the modified ***t***-test, taking uneven population variances into consideration according to Satterthwaite's procedure described by Anderson and Bancroft (1952, p. 83) to test whether the two groups have the same mean in performance. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The four-factor information ratios are in percent. The sample period is from 200901 through 201803. For a robustness check in 10,000 simulation runs, the table reports the percentage of the actual four-factor information ratio exceeding the simulated one in the brackets.

				Difference over Two Periods		
	Pre-H Period	H Period	Post-H Period	H minus Pre-H	H minus Post-H	Post-H minus Pre-H
Panel A. All OEFs investing in an ETF						
# of OEFs	883	1028	390			
4-factor Information Ratio	-0.016**	-0.077***	-0.076***	-0.061***	0.000	-0.061***
Exceeding Percentage	[74.08]	[46.93]	[60.78]	[25.86]	[31.52]	[47.84]
# of Months	32	56	30			
Panel B1. OEFs having divergence with ETFs greater than or equal to 83% based on equity holdings						
# of OEFs	281	318	139			
4-factor Information Ratio	0.006	-0.057***	-0.086***	-0.063***	0.029	-0.092***
Exceeding Percentage	[62.41]	[37.90]	[46.57]	[26.98]	[43.38]	[40.80]
# of Months	33	57	30			
Panel B2. OEFs having divergence with ETFs less than or equal to 50% based on equity holdings						
# of OEFs	143	174	64			
4-factor Information Ratio	-0.017	-0.055***	-0.065**	-0.038	0.010	-0.048
Exceeding Percentage	[71.10]	[75.35]	[61.20]	[60.48]	[66.59]	[46.21]
# of Months	32	50	32			
Diff (B1 - B2)	0.023	-0.002	-0.021			
	[32.86]	[16.65]	[35.12]			

Table 8—*Continued*

				Difference over Two Periods		
	Pre-H Period	H Period	Post-H Period	H minus Pre-H	H minus Post-H	Post-H minus Pre-H
Panel C1. OEFs having divergence with ETFs greater than or equal to 95% based on all holdings						
# of OEFs	352	433	174			
4-factor Information Ratio	0.01	-0.076***	-0.088***	-0.086***	0.012	-0.098***
Exceeding Percentage	[83.74]	[49.10]	[59.12]	[18.87]	[37.38]	[36.31]
# of Months	32	51	30			
Panel C2. OEFs having divergence with ETFs less than or equal to 75% based on all holdings						
# of OEFs	157	177	64			
4-factor Information Ratio	-0.042**	-0.099***	-0.104***	-0.057**	0.004	-0.062*
Exceeding Percentage	[66.62]	[35.39]	[44.21]	[24.57]	[45.87]	[37.16]
# of Months	32	58	29			
Diff (C1 - C2)	0.052**	0.023	0.015			
	[78.49]	[60.29]	[65.02]			
Panel D1. OEFs taking a short position in ETFs						
# of OEFs	66	118	24			
4-factor Information Ratio	0.069*	-0.041**	-0.012	-0.110***	-0.029	-0.081
Exceeding Percentage	[94.76]	[21.80]	[75.27]	[2.34]	[13.57]	[39.47]
# of Months	30	54	30			
Panel D2. OEFs never taking a short position in ETFs						
# of OEFs	817	910	366			
4-factor Information Ratio	-0.022***	-0.081***	-0.080***	-0.059***	-0.001	-0.058***
Exceeding Percentage	[69.72]	[49.56]	[58.90]	[32.61]	[36.37]	[48.72]
# of Months	32	56	30			
Diff (D1 - D2)	0.092**	0.040*	0.069			
	[91.87]	[20.80]	[69.43]			

Table 9 Risk of Equity Funds after Investing in ETFs

For each of domestic, actively managed OEF, this table identifies the first month-end (t_0) and the last month-end (t_1) in which the OEF invests in domestic, passively managed equity ETF. The risk of OEFs is examined over three periods: the pre-holding period of *[t_0 - 36, t_0]* (Pre-H Period), the holding period of *[t_0, t_1]* (H Period), and the post-holding period of *[t_1, March 2018]* (Post-H Period). Based on OEF monthly gross returns in excess of the market returns, the sample variance is calculated for each of these OEFs in each period. The table analyzes only OEFs that hold ETFs in their portfolios for at least a year. In each period, an OEF must have at least 12 monthly returns in order to calculate its variance. The table calculates the variance ratio over two periods, $\frac{\sigma_N^2}{\sigma_D^2}$, on the basis of individual funds, where σ_N^2 (σ_D^2) is the variance over a period in the numerator (denominator). The table reports the fraction of OEFs whose variance ratio is less than one (%($\frac{\sigma_N^2}{\sigma_D^2} < 1$)), and test the null hypothesis that the fraction is equal to 0.5 in the binomial distribution in a two-tailed test. Panel B reports the statistics for OEFs with high divergence and OEFs with low divergence, where the divergence is calculated based on equity holdings only. The calculation of divergence is defined in Table 5. Panel C reports the statistics for OEFs with high divergence and OEFs with low divergence, where the divergence is calculated based on all holdings. Panel D reports the statistics for OEFs that take at least a short position in ETFs, and OEFs that never take a short position in any ETF during the holding period. Panels B−D use the modified ***t***-test, taking uneven population variances into consideration according to Satterthwaite's procedure described by Anderson and Bancroft (1952, p. 83) to test if the two groups have the same fraction. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The sample period is from 200901 through 201803. For a robustness check in 10,000 simulation runs, the table reports the percentage of the actual % ($\frac{\sigma_N^2}{\sigma_D^2} < 1$) exceeding the simulated one in the brackets.

	Variance Ratios		
	(H Period)/(Pre-H Period)	(H Period)/(Post-H Period)	(Post-H Period)/(Pre-H Period)
Panel A. All OEFs investing in an ETF			
# of OEFs	842	364	352
% ($\frac{\sigma_N^2}{\sigma_D^2} < 1$)	0.713***	0.445**	0.739***
Exceeding Percentage	[98.18]	[31.19]	[94.86]
Panel B1. OEFs having divergence with ETFs greater than or equal to 83% based on equity holdings			
# of OEFs	263	128	127
% ($\frac{\sigma_N^2}{\sigma_D^2} < 1$)	0.662***	0.469	0.677***
Exceeding Percentage	[91.52]	[42.26]	[85.20]
Panel B2. OEFs having divergence with ETFs less than or equal to 50% based on equity holdings			
# of OEFs	135	57	53
% ($\frac{\sigma_N^2}{\sigma_D^2} < 1$)	0.756***	0.491	0.830***
Exceeding Percentage	[93.83]	[47.84]	[95.95]
Diff (B1 - B2)	-0.094***	-0.022**	-0.153***
Exceeding Percentage	[30.28]	[43.18]	[21.70]

Table 9—*Continued*

	Variance Ratios		
	(H Period)/(Pre-H Period)	(H Period)/(Post-H Period)	(Post-H Period)/(Pre-H Period)
Panel C1. OEFs having divergence with ETFs greater than or equal to 95% based on all holdings			
# of OEFs	336	162	154
% ($\frac{\sigma_N^2}{\sigma_D^2} < 1$)	0.735***	0.364***	0.766***
Exceeding Percentage	[96.71]	[10.02]	[94.34]
Panel C2. OEFs having divergence with ETFs less than or equal to 75% based on all holdings			
# of OEFs	151	58	58
% ($\frac{\sigma_N^2}{\sigma_D^2} < 1$)	0.755***	0.569	0.672**
Exceeding Percentage	[99.16]	[73.91]	[83.96]
Diff (C1 - C2)	-0.020***	-0.205***	0.094***
Exceeding Percentage	[30.90]	[2.06]	[64.32]
Panel D1. OEFs taking a short position in ETFs			
# of OEFs	65	24	15
% ($\frac{\sigma_N^2}{\sigma_D^2} < 1$)	0.723***	0.250***	0.733
Exceeding Percentage	[89.12]	[6.88]	[79.80]
Panel D2. OEFs never taking a short position in ETFs			
# of OEFs	777	340	337
% ($\frac{\sigma_N^2}{\sigma_D^2} < 1$)	0.712***	0.459	0.739***
Exceeding Percentage	[98.19]	[36.66]	[94.61]
Diff (D1 - D2)	0.011	-0.209***	-0.006
Exceeding Percentage	[51.94]	[6.55]	[37.21]

Table 10 Performance of Portfolios Formed by Equity Funds Investing in ETFs or Not

As in Table 1, this table classifies OEFs into two portfolios at the end of each calendar quarter starting in 2009: one that includes funds that invested in ETFs and one that includes funds that did not invest in any ETF during the quarter. Equity funds that invested in ETFs are further classified into two portfolios, ones that took a short position only in ETFs during the quarter and ones that took a long position only in ETFs. This table calculates the value-weighted gross monthly returns of these four portfolios over the three months following the portfolio formation, using as a weight the total net asset value of a fund at the beginning of each month. Monthly excess returns of each portfolio are regressed on Fama-French three factors plus a momentum factor over the entire sample period. The table reports the parameter estimates and their *p*-value associated with the null hypothesis that the parameter is equal to zero with an exception: the coefficient of RMRF is equal to one. Return differences of a pair of two portfolios are also regressed on Fama-French three factors plus a momentum factor in each market and the statistics are reported. The number of monthly observations in a regression is reported in brackets, whereas the *p*-value is reported in parentheses. The average of the number of funds in each portfolio is also reported. The four-factor alphas are in percent.

	# Funds	α	β_{RMRF}	β_{SMB}	β_{HML}	β_{MOM}	Adj. R^2
(1) OEFs Investing in ETFs	499	-0.070	0.895	0.101	0.017	-0.037	98.91
		(0.060)	(0.000)	(0.000)	(0.286)	(0.000)	[111]
(2) OEFs not Investing in ETFs	3071	-0.054	0.927	0.020	-0.072	-0.037	98.70
		(0.182)	(0.000)	(0.238)	(0.000)	(0.000)	[111]
(1) – (2)		-0.016	-0.032	0.082	0.090	0.000	53.80
		(0.552)	(0.000)	(0.000)	(0.000)	(0.952)	[111]
(3) OEFs taking a short position only on ETFs	25	0.112	0.384	0.020	0.050	-0.175	68.85
		(0.383)	(0.000)	(0.704)	(0.385)	(0.000)	[111]
(4) OEFs taking a long position only on ETFs	461	-0.071	0.922	0.108	0.015	-0.032	98.88
		(0.065)	(0.000)	(0.000)	(0.364)	(0.000)	[111]
(3) – (4)		0.184	-0.538	-0.087	0.034	-0.143	69.18
		(0.164)	(0.000)	(0.116)	(0.557)	(0.000)	[111]

Table 11 Forecasting Logistic Regression on Position Changes in ETF Investment

Quarterly OEFs' portfolio level data and market condition data are collected. Fund portfolio level data in Quarter t includes: positions in ETFs, divergence measure, fund flow volatility, fund flow level, quarter-end total net asset value (TNA), age, prior-year portfolio turnover rates, and Lipper style-adjusted returns as well as its standard deviation. At the beginning of each quarter, OEFs are classified into fourteen groups according to a fund's prior-quarter-end Lipper classification code. A fund's Lipper style-adjusted returns are monthly OEF's gross returns compounded over a quarter minus monthly Lipper style benchmark returns compounded over the quarter. Market condition data include Lipper style in excess of market returns (RSRM), market excess returns (RMRF, a Fama-French factor), and their standard deviations. In Panel A the dependent variable is one if an OEF increases its long position in ETFs from Quarter *t* to Quarter *t* + 1, while in Panel B it is one if an OEF reduces its short position in ETFs. The table reports coefficients with *p*-value in parentheses, the odds ratio, the number of fund-quarters, and the model deviance statistics G^2. All standard errors are adjusted for error correlations clustered by both fund and quarter according to Petersen (2009). The sample period is from January 2009 through March 2018.

Panel A. Dependent Variable: A dummy variable of one if an OEF increases its long position in ETFs from Quarter *t* to Quarter *t* + 1 and zero otherwise.

Independent Variables in Quarter *t*	Model 1		Model 2	
	Coefficient	Odds Ratio	Coefficient	Odds Ratio
Constant	-0.0587	0.943	-0.0439	0.957
	(0.692)		(0.757)	
Divergence (DIV;%)	-0.0048	0.995	-0.0054	0.995
	(0.001)		(0.000)	
Fund Flow Volatility (FV;%)	0.0060	1.006		
	(0.297)			
FV x DIV	-0.0002	1.000		
	(0.150)			
Fund Flow Level (FL;%)			-0.0003	1.000
			(0.842)	
FL x DIV			0.0000	1.000
			(0.780)	
Ln (TNA;$million)	-0.0355	0.965	-0.0333	0.967
	(0.017)		(0.023)	
Fund Age (years)	0.0038	1.004	0.0038	1.004
	(0.105)		(0.101)	
Prior-year Fund Portfolio Turnover (%)	-0.0065	0.994	-0.0066	0.993
	(0.348)		(0.346)	
Lipper Style-adjusted Gross Returns (%)	0.0066	1.007	0.0069	1.007
	(0.354)		(0.333)	
SD of Lipper Style-adjusted Gross Returns (%)	-0.0515	0.950	-0.0525	0.949
	(0.020)		(0.017)	
Lipper Style minus Market Returns (RSRM;%)	-0.0113	0.989	-0.0115	0.989
	(0.561)		(0.554)	
SD of RSRM (%)	-0.1187	0.888	-0.1189	0.888
	(0.044)		(0.043)	
RMRF Returns (%)	-0.0034	0.997	-0.0034	0.997
	(0.577)		(0.577)	
SD of RMRF Returns (%)	0.0244	1.025	0.0246	1.025
	(0.259)		(0.256)	
Fund-Quarters	13412		13412	
G^2	17200.8		17208.4	

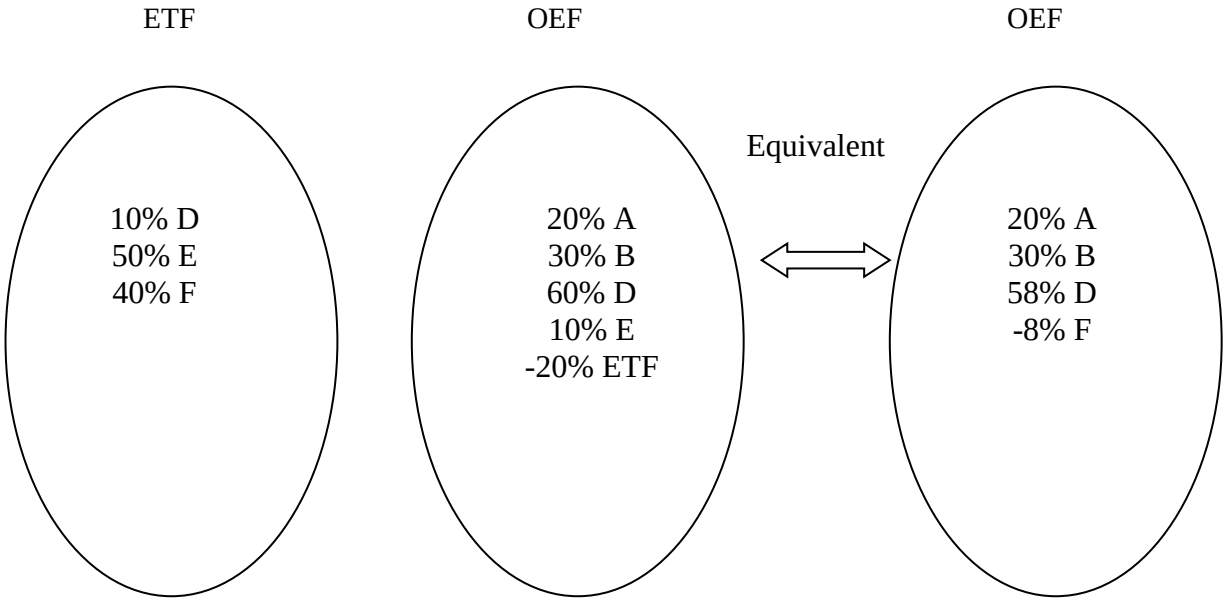
Table 11—*Continued*

Panel B. Dependent Variable: A dummy variable of one if an OEF reduces its short position in ETFs from Quarter *t* to Quarter *t* + 1 and zero otherwise.

Independent Variables in Quarter t	Model 1		Model 2	
	Coefficient	Odds Ratio	Coefficient	Odds Ratio
Constant	-5.9577	0.003	-5.9210	0.003
	(0.000)		(0.000)	
Divergence (DIV;%)	0.0382	1.039	0.0379	1.039
	(0.000)		(0.000)	
Fund Flow Volatility (FV;%)	0.0059	1.006		
	(0.417)			
FV x DIV	-0.0001	1.000		
	(0.443)			
Fund Flow Level (FL;%)			-0.0116	0.989
			(0.435)	
FL x DIV			0.0001	1.000
			(0.433)	
Ln (TNA;$million)	0.1283	1.137	0.1291	1.138
	(0.077)		(0.076)	
Fund Age (years)	-0.0816	0.922	-0.0825	0.921
	(0.004)		(0.004)	
Prior-year Fund Portfolio Turnover (%)	0.0219	1.022	0.0217	1.022
	(0.066)		(0.069)	
Lipper Style-adjusted Gross Returns (%)	-0.0509	0.950	-0.0507	0.951
	(0.144)		(0.145)	
SD of Lipper Style-adjusted Gross Returns (%)	0.3386	1.403	0.3388	1.403
	(0.000)		(0.000)	
Lipper Style minus Market Returns (RSRM;%)	-0.1567	0.855	-0.1563	0.855
	(0.020)		(0.020)	
SD of RSRM (%)	0.4354	1.546	0.4346	1.544
	(0.012)		(0.013)	
RMRF Returns (%)	-0.0283	0.972	-0.0281	0.972
	(0.067)		(0.069)	
SD of RMRF Returns (%)	-0.2142	0.807	-0.2139	0.807
	(0.000)		(0.000)	
Fund-Quarters	13412		13412	
G^2	4640.2		4638.4	

Appendix Numerical Illustration of Divergence Calculation

For a given report date, this figure shows the portfolios of an ETF—a domestic, passive equity exchange-traded fund—and an OEF, a domestic, active open-end equity fund. Securities A to F are individual stocks, and percentage numbers indicate the allocations.



Divergence (Div) is defined as $\sum_{i\in\{f\cup ETF\}}\frac{|w_{i,f,q}-\widehat{w_{i,f,q}}|}{2}$, where $w_{i,f,q}$ is the investment weight of stock i in an OEF f in quarter q, and $\widehat{w_{i,f,q}}$ is the investment weight of stock i in an ETF held by the OEF. In this example, the divergence is $\frac{1}{2}\{|20-0|+|30-0|+|58-10|+|0-50|+|-8-40|\}=88(\%)$. Mathematically, the upper bound of divergence is 1 + |S| when the portfolio compositions between an ETF and an OEF do not overlap, except for a short position of S in the ETF held by the OEF.