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# Trading efficiency of fund families: Impact on fund performance and investment behavior

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# Impact on Fund Performance and Investment Behavior


## ABSTRACT

This study examines how the efficiency of trading desks operated by mutual fund families affects portfolio performance and investment behavior of affiliated funds. We estimate the trading efficiency of a fund family's trading desk as the difference between the gross return of the family's index fund, which incorporates trading costs, and the return of the underlying index, which does not incorporate trading costs, around index adjustment dates. By operating more efficient trading desks that help reduce trading costs, fund families improve the performance of their funds significantly and also enable their funds to trade more and hold less liquid portfolios.



JEL *classification:* D23; G23; G24

*Keywords*: Mutual funds; fund families; trading efficiency; fund performance; investment behavior

## 1. Introduction

Most mutual funds operate as part of fund families. Fund families make strategic decisions with far-reaching consequences for the operations and performance of their member funds. Academic research has documented some of these decisions and their impact on a fund's investment behavior and performance.[1] However, one of the most direct ways in which fund families can affect the investment behavior and performance of their member funds, which is through the operation of a trading desk, has received little attention.

The importance of a trading desk is highlighted by the fact that it is the conduit through which trading strategies formulated by the fund's research process get implemented. For example, it determines when to trade, which trading venues and/or brokers to use and to what extent, and what type of orders to use and how to split them.[2] Consequently, the trading desk determines how close the real return of a fund's trading strategy is to the paper return of that same strategy that would be achieved only if the fund could transact at all times (at observed prices) in unlimited quantities with no price impact and free of all commissions. This difference reflects trading costs in the form of execution costs such as commissions, bid-ask spreads, and price impact but also in the form of opportunity costs from not trading when requested by the fund's research process because the execution costs of doing so are prohibitive.[3] Thus, a more efficient trading desk is expected to generate lower trading costs for its affiliated mutual funds than a less efficient one.

Addressing the impact of trading desks on their affiliated mutual funds, we test two hypotheses. Our first hypothesis postulates that funds from families with more efficient trading desks

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[1] See, e.g., Gaspar et al. (2006), Kacperczyk and Seru (2012), and Chen et al. (2013).

[2] See Anand et al. (2012) for an excellent discussion of how trading desks support their portfolio managers.

[3] Evidence from previous research shows that these costs are an important determinant of performance. For example Edelen et al. (2013) and Busse et al. (2016) both show that trading costs of mutual funds are typically comparable in magnitude to the funds' expense ratios.

outperform funds from families with less efficient trading desks simply because a more efficient trading desk allows a fund manager to trade at lower costs., i.e. she benefits from lower execution costs and fewer missed opportunities to implement research ideas. Our second hypothesis postulates that funds exploit the advantage of being affiliated with a more efficient trading desk in their trading strategy in at least one of the following ways: they (1) trade more, (2) hold less cash, and (3) hold less liquid stocks. The first aspect derives directly from the economic insight that investors respond to higher trading costs by reducing the frequency and volume of their trades (see, e.g., Constantinides 1986). The rationale underlying the cash hypothesis is that cash is used (among other reasons) as a buffer to minimize transaction costs when investors withdraw money from the fund. Since efficient trading desks allow funds to sell stocks in a less costly way when they need to cover unexpected liquidity needs, we expect funds affiliated with more efficient trading desks to hold less cash. Efficient trading desks provide yet another benefit. At the heart of our first hypothesis described above is the argument that efficient trading desks help fund managers lower their general trading costs. However, we expect this advantage to amplify when managers trade illiquid—and, therefore, costlier-to-trade—stocks, in which case the higher trading efficiency pays off more. This allows affiliated fund managers to earn the illiquidity premium (see, e.g., Amihud and Mendelson 1986). Therefore, we expect funds to hold more illiquid stock portfolios when affiliated with more efficient trading desks, everything else constant.

We test these hypotheses using a novel trading cost measure. Our measure exploits instances when funds from different families are known to trade the same stocks at the same time. More specifically, we analyze cases when index funds from different families trade due to index adjustments. Focusing on S&P 500 index funds, which represent the most widespread type of index funds,[4] we estimate the efficiency of the trading desk of a given fund family as the difference between the return of its index fund gross of expenses and the return of the S&P 500 index (henceforth, return difference) around index adjustment dates.[5] Trading costs are reflected in the gross return of an index fund but not in the return of the underlying index, making the return difference a reasonable measure of the costs associated with trades of index funds in response to changes in the composition of the underlying index. Since the number of index adjustment and the associated trading costs vary from year to year, we calculate the return difference measure for each index fund and year separately and then use it to compare index funds in the cross-section every year. We interpret cross-sectional variation in the return differences of S&P 500 index funds as indication of cross-sectional differences in the quality of the families' trading desks in a specific year.

Using a broad sample of US equity funds for the period 2000 to 2013, we find strong support for our first main hypothesis that trading efficiency of mutual fund families has a positive impact on the performance of their member mutual funds. In a matched sample approach, we find that actively managed funds belonging to families with the most efficient trading desks deliver a significantly higher performance than their counterparts from families with the least efficient trading desks. This result is also economically significant, with the performance differences between these two fund groups being more than 120 basis points per year and is further supported by additional multivariate regression tests.

We take multiple steps to rule out alternative explanations or alleviate endogeneity concerns. First, in all our regression specifications we include multiple fund and family characteristics as

[4] In our sample period, 83 fund families offered index funds tracking the S&P 500, but only 11 families offered index funds tracking the Russell 2000, which is the second most popular index among fund families.

[5] Blume and Edelen (2004) study the performance and tracking errors of index funds that track the S&P 500 index and document large differences in these variables across these funds.

well as style-by-year and family fixed effects to control for style characteristics and unobservable family characteristics. Second, we employ two placebo tests. The first one is based on a bootstrap procedure, which randomly assigns the efficiency measure of a family's trading desk to fund-year observations and estimates the relation between fund performance and trading efficiency. We repeat this procedure 10,000 times and the results rule out that the effect of trading efficiency on performance is spurious. The second placebo test constructs an alternative measure of trading efficiency based on index funds that are outsourced by the fund family. This efficiency measure should not be related to the trading efficiency of the outsourcing family and the performance of its in-house funds because the trading desk of the outsourcing family is not responsible for the implementation of trades of the outsourced index funds. This responsibility lies with the external advisors who manage the outsourced index funds. Supporting our argument, we find no positive and significant relation of this alternative trading efficiency measure with the performance of funds managed in-house.

We also find strong support for our second hypothesis. We document that funds belonging to families with more efficient trading desks trade more. The average portfolio turnover of funds from families with the most efficient trading desks is up to about 14 percentage points higher than that of funds from families with the least efficient trading desks. Furthermore, funds from families with the most efficient trading desks hold cash positions that are one third smaller and hold stocks that are less liquid (as indicated by an average relative bid-ask spread that is up to one quarter bigger).

Our paper is related to the literature that studies the importance of trading costs as a determinant of investment decisions (see, e.g., Demsetz 1968). In particular, two major mechanisms are established for the relationship between trading costs and investment behavior. First, trading stocks entails costs and investors accommodate trading costs by reducing the frequency and volume of their trades (see, e.g., Constantinides 1986). Second, since less liquid stocks are associated with higher average returns (see, e.g., Amihud and Mendelson 1986, Brennan et al. 1998, Brennan and Subrahmanyam 1996, and Amihud 2002) investors with lower trading costs hold less liquid assets (see, e.g., Amihud and Mendelson 1986). We contribute to this literature by showing that mutual funds do indeed respond to lower trading costs resulting from affiliation with more efficient trading desks in a way that is consistent with the theoretical predictions of this literature.

Our paper also makes a contribution to a growing literature that looks at how decisions of mutual fund families affect the performance outcomes and investment behavior of its member funds. For instance, Guedj and Papastaikoudi (2004) and Gaspar et al. (2006) show fund families subsidize the performance of their top-performing funds. Kacperczyk and Seru (2012) analyze whether a family strategy to centralize decision making affects fund performance. Chen et al. (2013), Kostovetsky and Warner (2015), Moreno et al. (2016), Debaere and Evans (2015), and Sorhage (2015) analyze the decision of mutual fund families to outsource part of their duties and how this decision affects fund performance. Finally, Kempf and Ruenzi (2008) and Simutin (2013) show that intra-family competitive dynamics can affect certain investment decisions of the member funds. Our paper contributes to this literature by documenting that setting up an efficient trading desk is another important way through which mutual fund families can improve the performance of their member funds.

The remainder of this paper is organized as follows. In section 2, we discuss our data and the methodology we employ to measure trading desk efficiency and then present sample summary statistics on our efficiency measure. Section 3 examines the impact of trading desk efficiency on mutual fund performance and rules out alternative explanations for our findings. We analyze how the efficiency of the trading desk affects the trading behavior of mutual funds in Section 4. Section 5 concludes.

## 2. Data and methodology

### 2.1. Data sources

We obtain data from multiple sources: (1) CRSP Survivor-Bias-Free US Mutual Fund (CRSP MF) database, (2) Thomson-Reuters Mutual Fund Holdings database, (3) CRSP US Stock database, (4) Morningstar Direct database, (5) Active Share database of Cremers and Petajisto (2009) and Petajisto (2013), (6) N-CSR SEC Filings, and (7) CRSP Indices database.

The CRSP MF database provides information about fund characteristics such as fund returns, total net assets under management (TNA), expenses, age, and investment objective.[6] Furthermore, the database includes an identifier that allows us to assign each fund to a specific fund family. We focus on US equity funds and eliminate global, international, balanced, and fixed-income funds. We aggregate data reported at the share class level using MFLINKS to group together share classes that belong to the same fund and weight the variables of interest by the assets of the share classes.

From the Thomson Mutual Fund Holdings database we obtain the portfolio holdings of each fund as well as the names of the fund`s investment advisors and match this information via MFLINKS to our CRSP sample. We supplement the holdings information with daily stock data from the CRSP US Stock database.

We use the Morningstar Direct database, the Active Share database, the N-CSR SEC Filings, and the CRSP Indices database to identify S&P 500 index funds. From the CRSP Indices database we also obtain information on the S&P 500 returns and the index constituents at each point of time.

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6 We determine a fund’s investment objective like in Pástor and Stambaugh (2002) based on the CRSP fund objective codes.

## 2.2. Measuring trading desk efficiency

### 2.2.1. Methodological steps

Our measure of the trading efficiency of a fund family's trading desk is based on the premise that more efficient trading desks would make it possible for a family's index fund to adjust its portfolio at lower trading costs in response to index reconstitutions. This would then lead to a higher return difference between the index fund and the index around index adjustment dates. Thus, in essence we exploit instances when trading desks of different fund families trade the same securities over the same period to accomplish the similar task of tracking the same index.

To estimate the efficiency of a fund family`s trading desk, we first identify S&P 500 index funds following a similar approach as in Berk and van Binsbergen (2015). We focus on S&P 500 index funds because index funds that track the S&P 500 represent the largest category of index funds offered across a larger number of families as compared to other types of index funds that track different indices.[7] We first identify all index funds that are classified as such in the CRSP MF database. We then use information about the benchmarks of these funds from Morningstar Direct and from the Active Share database to extract index funds that follow the S&P 500.[8] From these funds, we eliminate all funds that replicate the index synthetically using derivatives, so that we are left with funds that replicate the index physically by holding an appropriate stock portfolio. To further ensure exclusion of such funds and funds that follow the index loosely, we follow Boldin and Cici (2010) and impose additional criteria that have been used in previous research:

[7] We explored the possibility of constructing alternative trading efficiency measures based on index funds that follow other indices, such as Russell 1000 Value, Russell 1000 Growth, Russell 2000, Russell 3000, and NASDAQ 100. However, the number of families that offer index funds that track these indices is rather small. In fact, Russell 2000, which is the second most popular index among fund families, is tracked by index funds offered by only 11 sample families. Nonetheless, it was reassuring to observe that the efficiency measures constructed from S&P 500 funds and Russell 2000 funds were highly correlated, with a correlation coefficient of 0.71 (p-value=0.0142).

[8] Details on the construction of the Active Share data are provided in Cremers and Petajisto (2009) and Petajisto (2013). The Active Share database was downloaded from Antti Petajisto's website: http://www.petajisto.net/data.html.

The number of portfolio stock positions is between 400 and 520; the fund beta with respect to the S&P 500 index is between 0.98 and 1.02; and the $R^2$ of the corresponding regression is higher than 0.98.

For this sample of S&P 500 index funds, we then calculate the return difference between each index fund and the S&P 500 index over all trading days that are within a week before and after an index reconstitution.[9] Our choice of this particular window was shaped by evidence from Green and Jame (2011), who show that index funds do not restrict their portfolio rebalancing to the effective index reconstitution date but trade around that date in an attempt to mitigate transaction costs. In particular, they find that the lion`s share of index funds trade within a one week window around index adjustment days. Thus, the return difference reflects the various decisions made by the trading desk: when to trade, which trading venues and/or brokers to use and to what extent, and what type of orders to use and how to split them. In light of this, we would expect a more efficient trading desk to manage such activities better, which would result in higher return differences for its affiliated index fund. The return difference is then averaged for each index fund across all non-overlapping index adjustment periods in a specific year to come up with an annual measure of the trading efficiency of each index fund.

We employ this measure of the trading efficiency of an index fund as our proxy for the efficiency of the trading desk of the corresponding fund family if the index fund is in-house managed. Thus, we exclude all outsourced index funds for which a sub-advisor is responsible since

[9] To calculate the return difference, we use the gross-of-expenses return of the index fund. This ensures that the return difference is not influenced by the total expense ratio of the index fund.

only the sub-advising company and its trading desk are responsible for their trade execution.[10] This leaves us with 83 fund families, for which we can measure the efficiency of their trading desk.[11]

Finally, we assign the trading desk`s efficiency measure of a specific fund family to all actively managed US domestic equity funds that belong to that family. We focus only on actively managed funds that are in-house managed. The reason is that the trading desk of a given fund family is responsible for the execution of trades of in-house funds but not for the execution of trades of outsourced funds, which are managed by an external advisor. Our sample of actively managed funds consists of 1,106 US actively managed equity funds and 7,053 fund-year observations over the 2000 to 2013 period.[12] These actively in-house managed equity funds are the subjects of our analysis in this paper.

### 2.2.2. Our measure and approaches from previous research

Previous research has put forth several approaches for estimating the trading costs of financial institutions. In their pioneering study, Keim and Madhavan (1997) develop an algorithm for estimating transaction costs, which they apply to the transactions of 21 financial institutions for the 1991–1993 period. The applicability of this algorithm to more recent periods is called into question by Busse et al. (2016), who show that the algorithm provides negative transactions costs estimates in their sample. In an alternative approach, Edelen et al. (2013) estimate fund transaction costs incorporating only bid-ask spreads and commission expenses, which provides a partial picture of a fund's total trading costs. As a third approach, Anand et al. (2012) and Busse et al.

[10] To identify sub-advised index funds, we follow Chen et al. (2013) and compare the name of the fund family provided by CRSP to the name of the investment advisory firm provided by Thomson. If their names differ and they do not belong to the same ownership structure, we classify the index fund as sub-advised.

[11] In the very rare cases that a fund family has two S&P index funds, we calculate the trading desk efficiency of the family based on the index fund with longer history.

[12] The starting date is determined by the availability of the CRSP fund family identifier.

(2016) estimate trading costs using the proprietary Ancerno database. However, Ancerno stopped providing information on fund names and identifiers in September of 2011, which makes it impossible to use the Ancerno Database for comparisons across funds and families in more recent periods. Finally, using an approach, which is closest to ours, Bollen and Busse (2006) estimate trading costs by comparing a mutual fund's daily returns with the daily returns of a synthetic benchmark portfolio that matches the fund's holdings but has zero trading costs by construction.

Our paper and the study by Bollen and Busse (2006) differ in two main respects. First, their approach for measuring fund trading costs hinges on the synthetic benchmark portfolio perfectly mimicking the actual daily holdings of a mutual fund, which is impossible given that daily fund holdings are unobservable. Thus, their measure of trading costs also reflects misalignment of unobservable daily fund holdings and the interpolated holdings of the benchmark portfolio. This limitation is not present in our approach because rather than using a synthetic benchmark we use the actual index followed by an index fund as the actual benchmark portfolio. Second, the focus of our study is different in that we assess the efficiency of the trading desk and then relate it to the performance of the affiliated funds. In other words, we want to know how this particular feature of the fund family—the efficiency of its trading desk—affects affiliated funds. Bollen and Busse (2006), on the other hand, focus on how reductions in the tick size of U.S. equity markets affect the trading costs of mutual funds as a group.

Despite its many attractive features, we acknowledge that our measure is possibly subject to two limitations. First, our efficiency measure might reflect not only trading costs but also security lending revenues of index funds to some extent. However, as shown by Adams, Mansi, and Nishikawa (2014), the securities lending income of S&P 500 index funds is very small. For the median S&P 500 index fund it makes up only about 1.1 basis point of the net asset value.[13] Second, our efficiency measure is based on S&P 500 index funds. The S&P 500 index consists of large cap stocks, raising the concern that the return difference of S&P 500 index funds reflects only trading quality in large cap stock, which might differ from trading quality in small cap stocks. Our empirical results moderate this concern as our efficiency measure based on S&P 500 index funds is highly correlated (correlation coefficient = 0.71, p-value = 0.01) with an alternative efficiency measure based on Russell 2000 index funds, which reflects the quality of the families' trading desk with respect to small cap stocks.

### 2.3. Sample characteristics

Table 1 presents summary statistics on family and fund characteristics, respectively in Panels A and B, for our sample and the remaining actively managed US equity funds in CRSP.

- Insert Table 1 approximately here -

Panel A of Table 1 suggests that funds in our sample come from larger, older, and more diversified families than the remaining funds. The sample families cover about 30% of the funds and about 47% of the assets controlled by all actively managed US equity funds. Panel B shows that the average fund in our sample is more than twice as large as the average fund in the peer group, holds less cash, and differs to varying degrees with respect to age, turnover, flow, flow volatility, and expense ratio.

[13] Among all index funds, the revenues are the smallest for S&P 500 index funds. For small cap index funds, they are particularly high (7.6 index points). This provides further support for our choice to calculate the efficiency measure using S&P 500 index funds.

## 2.4. Characteristics of the efficiency measure

In Table 2 we report information on the characteristics of our efficiency measure.[14] Panel A reports summary statistics on the distribution. The mean and median value of our efficiency measure is negative, which is consistent with the typical index fund generating trading costs that cause them to underperform the index. The underperformance for the average index fund in our sample is 49 basis points. However, there is a clear time trend, with the underperformance being much higher in the earlier years of our sample than in the later ones. This is most likely due to technological and efficiency improvements in the later years, which have resulted in systematic lower trading costs. For example, there has been a downward trend in commission expenses and tremendous advances in computing power and trading software. We control for these time effects by employing style-by-time fixed effects in our later analyses. This allows us to focus on differences in trading efficiency across fund families in each year

- Insert Table 2 approximately here -

Panel B reports serial correlations for our measure over different lags. The serial correlation coefficients suggest that our efficiency measure exhibits persistence over several years. This result is consistent with Anand et al. (2012) who find that institutional trading desks exhibit persistent skills with respect to quality of trade execution.

[14] In unreported results we examined whether our trading efficiency measure is related to brokerage commissions. Like Edelen et al. (2013), we collected commission data for our index funds from N-SAR reports. One limiting factor is that fund commission amounts are not reported at the fund level but aggregated at the series level, which is a group of funds (some of which are actively-managed) that file under the same N-SAR report. The correlation between our trading efficiency measure and commissions normalized by fund assets is 0.22 but statistically insignificant. The lack of significance is perhaps explained by the fact that the aggregation in N-SAR reports introduces measurement error in the commission measure of index funds.

### 2.5. Efficiency measure and family and fund characteristics

To understand the characteristics of families and funds that are associated with more efficient trading desks, in Table 3 we examine the characteristics of family or fund groupings that are stratified by the level of the efficiency measure. Specifically, we rank and sort families or funds into quintiles based on the efficiency measure in year *t-1* and compute average characteristics measured in year *t* for the different efficiency groups. In addition, we report simple correlations between our efficiency measure in year *t-1* and each of the family or fund characteristics in *t*.

Panel A focuses on family characteristics. Comparisons of the different efficiency groups reveal no clear relation between most of the family characteristics and our efficiency measure. There appears to be no monotonic relation between the efficiency measure and these characteristics as documented by their insignificant correlations. The only exception to this is the relation between the efficiency measure and its lagged value, which is consistent with Panel B of Table 2. However, the cross-sectional relation between past and current efficiency measures is not uniformly strong across the various groups. Whereas trading desks that are classified as least efficient in *t-1* (Q5) are by far the least efficient in *t* as well, as documented by the worst return difference of -0.63, the pattern is less pronounced for the remaining groups. The trading desks that are classified as most efficient in *t-1* (Q1) are the most efficient ones in *t* as well (return difference = 0.21) and the difference in *t* (Q1 – Q5) is highly significant. However, the difference between Q1 and the middle group (Q2/Q3/Q4) is fairly small, suggesting a non-linear cross-sectional relation between past and current efficiency measures. In addition, we find significant differences between the top and bottom efficiency groups for family size and family focus. Families in the top group seem to be larger and less focused than families in the bottom group. Since larger families are likely to get better trade execution terms due to their higher trading volume, in our hypotheses tests, we will explicitly control for family size either in a matched sample or multivariate analysis in order to rule out attribution of our results to a family size effect.[15]

- Insert Table 3 approximately here -

In Panel B, we perform similar comparisons but with the focus on fund characteristics. Actively managed US domestic equity funds from families with the most efficient trading desks appear to be larger, experience higher and less volatile flows, have lower expense ratios, hold smaller cash balances, and generate higher net-of-fee annual returns than funds from families with the least efficient trading desks. This is also supported by significant correlations between the efficiency measure and these characteristic. The higher fund returns and smaller cash balances provide first support for our hypotheses, that funds affiliated with more efficient trading desks generate better performance and hold less cash. We provide a more detailed analysis of these hypotheses in Sections 3 and 4, respectively.

In Panel C we report characteristics related to the liquidity of the fund's stockholdings. The liquidity-related characteristics are stock characteristics that are value-weighted at the portfolio level, with weights determined by the market value of each stock position. They include: market capitalization, dollar volume of shares traded, relative spread, measured as the difference between the logarithm of the best offer price and the logarithm of the best bid price, Amihud (2002) illiquidity measure, measured as the stock`s absolute return divided by its dollar volume, and liquidity beta, measured as the sensitivity (beta loading) on the liquidity factor as in Pástor and Stambaugh (2003). Funds from families with the most efficient trading desks appear to hold less

[15] Family size could more generally capture differences in economies of scale achieved by larger families in terms of information production, trading, and other operations, all likely to affect fund performance as documented in Chen et al. 2004.

liquid stocks. Specifically, funds in the top efficiency group tend to hold stocks that have a lower market cap, lower dollar trading volume, higher relative spread, and higher Amihud illiquidity measure. These are important distinctions that provide first support for our hypothesis that being affiliated with a more efficient trading desk allows the fund manager to invest in less liquid stocks. We will address this hypothesis in greater detail in Section 4.

## 3. Trading efficiency and performance

In this section we explore the relation between our efficiency measure of a fund family's trading desk and the performance of the funds belonging to that same family. In Section 3.1 we test our first hypothesis that funds belonging to families with more efficient trading desks generate better performance than funds from families with less efficient trading desks. In Section 3.2 we provide evidence supporting the validity of our measure of the efficiency of a family's trading desk.

### 3.1. Does trading desk efficiency have an impact on fund performance?

We test our performance hypothesis using two approaches. Our first approach employs a matched sample analysis whereby we perform performance comparisons of funds from families with high trading efficiency with funds from families with low trading efficiency that share similar characteristics. An attractive feature of this approach is that it can control for fund or family characteristics that might affect performance in a non-linear fashion. Each year we sort our sample funds into quintiles based on the trading desk`s efficiency of the corresponding fund family in the previous year *t-1*. Performance is measured in the subsequent year *t*. We sort based on the lagged value of the efficiency measure to avoid spurious correlation between trading efficiency and fund performance. The top group consists of all funds belonging to families that are in the top quintile with respect to their trading desk efficiency, while the bottom group consists of funds belonging to families in the quintile with the lowest trading efficiency. After we stratify funds by their trading efficiency, we match each fund from the top group with an equally weighted portfolio of all funds from the bottom group that share the same investment style and belong to fund families of similar size (meaning that they belong to the same quintile with respect to family size in the respective year).

In addition to investment style and family size, we match on some other fund characteristics by identifying funds that belong to the same quintile with respect to a given characteristic. Our choice of these other characteristics is motivated by previous research that has studied the relation between fund performance and fund characteristics. These additional characteristics include fund size, fund age, fund turnover, past fund performance, and fund flow volatility, respectively.[16] For each fund in the top group we calculate the difference between its performance and that of the matching portfolio consisting of funds from the bottom efficiency group.

We use three different measures of performance: (1) Jensen (1968) alpha, (2) Fama and French (1993) 3-factor alpha, and (3) Carhart (1997) 4-factor alpha. We estimate these measures based on net-of-fee returns. Annual fund alphas are constructed as the difference of the realized and expected excess fund returns in a given year (each compounded over the 12 monthly observations). We compute a fund's expected net return in a given month using factor loadings estimated over the previous 12 months and factor returns in that month.[17] The performance differences for the various matching criteria and performance measures are provided in Table 4.

[16] Previous research has analyzed the relation between fund performance and fund size (see, e.g., Berk and Green 2004), fund age (see, e.g., Ferreira et al. 2013), portfolio turnover (see, e.g. Carhart 1997), past performance (see, e.g., Hendricks et al. 1993), and fund flow volatility (see, e.g., Rakowski 2010).

[17] Results remain qualitatively similar when we estimate factor loadings over the previous 24 or 36 months or when we use returns of the contemporaneous year to estimate the factor loadings in-sample. The results also hold when we estimate factor loadings over the previous 12 months based on returns of daily frequency.

- Insert Table 4 approximately here -

Table 4 clearly shows that funds belonging to families with most efficient trading desks deliver a significantly higher performance than funds from families with the least efficient trading desks that share similar characteristics. The estimated outperformance of the most efficient funds relative to the matched least efficient funds is statistically significant in 14 out of 15 cases. This outperformance is also economically significant, ranging from 1.2 to 2.4 percentage points per year.[18]

Our second approach for assessing the impact of trading efficiency on performance employs multivariate regressions. This approach allows us to control for a broad variety of family and fund characteristics simultaneously. Our pooled regression model is specified as follows:

$$\begin{aligned} Perf_{i,t} &= \alpha + \beta Efficiency_{i,t-1} + \gamma_1 FamSize_{i,t-1} + \gamma_2 FamFocus_{i,t-1} \\ &+ \gamma_3 FundSize_{i,t-1} + \gamma_4 FundAge_{i,t-1} + \gamma_5 FundTO_{i,t-1} + \gamma_6 Perf_{i,t-1} \\ &+ \gamma_7 FundFlow_{i,t-1} + \gamma_8 FundFlowVola_{i,t-1} + \gamma_9 FundTER_{i,t-1} + \varepsilon_{i,t} \end{aligned} \quad (1)$$

In this regression, the independent variable is fund performance which is measured as described in Table 4. The key independent variable is the measure of trading desk efficiency (*Efficiency*) as defined in Section 2.2. To control for possible effects of fund and family characteristics on performance, we include the logarithm of the fund family's net assets under management reported in millions (*FamSize*), the investment concentration of the fund family across investment styles (*FamFocus*) as in Siggelkow (2003), the logarithm of the fund's total net assets under management reported in millions (*FundSize*), the logarithm of the fund's age in years (*FundAge*), the fund's

[18] In unreported results, we used the information ratio as an alternative measure of trading efficiency. The information ratio was computed as the average signed return difference between the index fund and the index divided by the standard deviation of the same return difference. The results are qualitatively similar but weaker in comparison to the results we get based on our efficiency measure. This is consistent with the view that index funds are able to achieve a higher return differential only at the costs of a higher tracking error.

yearly turnover ratio (*FundTO*), the lagged fund performance (*Perf*), the fund flows (*FundFlow*) as defined in Sirri and Tufano (1998), the fund flow volatility (*FundFlowVola*), measured as the standard deviation of the fund`s monthly net-flows during the year, and the fund's total expense ratio (*FundTER*). To control for unobserved family characteristics and to rule out the impact of investment style on performance in each year, we include family and style-by-year fixed effects in the regression. We cluster standard errors at the family level.

- Insert Table 5 approximately here -

Table 5 again provides evidence that the trading desk efficiency of a fund family is positively related to the performance of the families' actively managed funds. This holds for all performance measures, suggesting that a higher trading efficiency measure is associated with better performance relative to other funds with lower trading efficiency. The economic effect is again significant. A one-standard-deviation increase of the efficiency measure leads to an increase in performance of up to 60 basis points.[19]

Overall, the results from Tables 4 and 5 strongly support our first main hypothesis that actively managed equity funds belonging to families with more efficient trading desks outperform comparable funds from families with less efficient trading desks. This is consistent with the view that fund families can provide a performance-enhancing service to their funds by reducing their trading costs through the operation of an efficient trading desk.

[19] One could argue that since our trading efficiency measure is constructed from S&P 500 index funds, it captures only trading efficiency with respect to trading of large stocks. This is not corroborated by unreported tests that compare the impact of trading efficiency on performance for funds that invest in large stocks versus funds that invest in small stocks. This additional evidence is consistent with the view that our efficiency measure based on S&P 500 index funds is a good proxy of the trading efficiency of a family's trading desk across all different types of stocks.

### 3.2. Relevance of our measure

In this section we conduct two placebo tests to check the validity of our measure.

#### 3.2.1 Placebo test: Bootstrap

Our first robustness test employs a bootstrap procedure that imposes the null of the efficiency of the trading desk having no effect on fund performance. Every year of the sample period we randomly assign the efficiency measure of fund families' trading desks to each sample fund, creating in effect counterfactuals where we expect efficiency to have no effect on performance. This randomization of fund-years with respect to their trading desk efficiency measures keeps all other fund or family characteristics unchanged as well as the original data structure of our sample. For each random assignment, we estimate regression model (1), and we repeat this procedure 10,000 times.

- Insert Figure 1 approximately here -

In Figure 1 we show the distribution of the coefficients estimated for all the iterations of the bootstrap. We report results only when performance is measured as the Carhart alpha, but results are similar for all the other performance measures and are therefore not reported here in the interest of brevity. In Figure 1 we observe that the actual estimate from Table 5 is positioned at the outermost right-hand tail of the bootstrap distribution. The actual estimate is significantly different from the mean of the empirical distribution resulting under the null of no performance effect due to trading desk efficiency. Thus, the evidence from the bootstrap strongly rejects the null in favor of our hypothesis that the efficiency of the trading desk positively affects fund performance.

### 3.2.2 Placebo test: Efficiency measure based on outsourced index funds

The presence of both outsourced and in-house managed index funds provides us with an opportunity to run another placebo test. If our efficiency measure indeed captures the efficiency of the family's trading desk, then we should observe a performance effect only when the efficiency measure is constructed based on index funds that are in-house managed. The rationale is that the trading desk of a given fund family is responsible for the execution of trades of in-house index funds but not for the execution of trades of outsourced index funds, which are managed by an external advisor. Thus, a version of the efficiency measure based on outsourced index funds represents an attractive placebo treatment that is expected to have no effect on the performance of the active funds that are in-house managed.

The results presented so far are all based on the efficiency measure calculated from in-house managed index funds. To test whether the placebo efficiency measure based on outsourced index funds has an impact on the performance of the actively managed funds of the outsourcing family, we repeat the analysis of Table 5 but now calculate the efficiency measure based on outsourced index funds only.[20]

- Insert Table 6 approximately here -

Table 6 shows that that the placebo efficiency treatment, as expected, has no positive performance impact on the performance of actively managed funds of the outsourcing family. This second falsification exercise further supports the notion that the efficiency measure based on in-house index funds captures the quality of a family's trading desk.

[20] We cannot repeat the matched sample due to the low number of observations, which does not allow us to form appropriate matching groups.

## 4. Trading efficiency and trading strategy

In this section we test our second hypothesis that more efficient trading desks affect funds' trading strategy in at least one of the following ways: they (1) trade more (Section 4.1), (2) hold less cash (Section 4.2), and (3) hold less liquid stock portfolios (Section 4.3).

### 4.1. Trading efficiency and turnover

In this section we test the hypothesis that funds belonging to families with more efficient trading desks exhibit a higher turnover. The underlying rationale is that investors respond to higher trading costs by reducing the frequency and volume of their trades (see, e.g., Constantinides 1986). As in Section 3.1, we use two testing approaches, which we report in Table 7: the matched sample approach (Panel A) and the multivariate regression approach (Panel B).

We utilize various turnover measures. The first measure, *FundTO*, is the fund's yearly turnover ratio, defined as the minimum of security purchases and sales divided by the average total net assets under management during the calendar year. The second group of measures, *BuyTO* and *SellTO*, are two variables derived from fund turnover that represent the separate effects of buy and sell trading by adding (subtracting) the percentage change in fund`s total net assets under management, as in Carhart (1997). The final measure, *PositionTO,* represents the position-adjusted turnover ratio as suggested by Edelen et al. (2013). To come up with this measure, we first estimate the average position size for a fund by dividing the fund`s total net assets under management by its total number of holdings. Then, we calculate the percentile rank of this position size relative to all other funds of the same investment objective in a given year. Finally, we multiply *FundTO* with this percentile to obtain the position-adjusted turnover ratio.

- Insert Table 7 approximately here -

Results from the matched approach reported in Panel A of Table 7 provide strong evidence that the trading desk efficiency of a fund family is positively related to the turnover of the families' funds. Funds belonging to families with the most efficient trading desks exhibit significantly higher turnover than funds in the base group. In particular, the observed difference in turnover amounts to up to 14 percentage points.

Results from the multivariate regressions, reported in Panel B, tell a similar story. Funds from families with more efficient trading desks exhibit higher turnover, as evidenced by the significance of the coefficients of the *Efficiency* variables. Thus, our findings are consistent with the view that funds from families with more efficient trading desks exploit this advantage to pursue more investment opportunities than funds from families with less efficient trading desks.

### 4.2. Trading efficiency and cash position

In this section we examine whether funds affiliated with more efficient trading desks hold less cash. The basic idea is that these funds can sell stocks in a less costly way than funds affiliated with less efficient trading desks when they need to cover unexpected liquidity needs, which makes them need to hold less cash.

To examine whether cash holdings of mutual funds are affected by the trading efficiency of their respective families, again we employ the matched sample approach (Panel A) and the multivariate regression approach (Panel B) used in the previous section. Our measure of a fund`s *Cash holding* position is the reported portfolio weight in cash in the CRSP MF database.

- Insert Table 8 approximately here -

The results of Table 8 show that for both approaches, trading desk efficiency relates negatively to the fraction of assets held in cash. The cash holding of funds from families with the most efficient trading desks is up to one percentage point smaller than the cash holding of funds from the families with the least efficient trading desks as shown in the matched sample results of Panel A. This is an economically significant difference given that funds from the most efficient group hold on average less than three percent of their assets in cash during our sample period.

### 4.3. Trading efficiency and liquidity of held stocks

In this section we test the hypothesis that funds from families with more efficient trading desks hold stock portfolios with less liquid stocks. The underlying rationale is that more efficient trading desks provide their affiliated funds with an even larger transaction cost advantage when trading illiquid stocks,  allowing them to earn an illiquidity premium.

We estimate the liquidity of a fund’s stock portfolio following Massa and Phalippou (2005) as the value-weighted average of the liquidity measure of all stocks held by the fund. We use various proxies for stock liquidity that are documented in the literature. *MarketCap* captures the stock`s market capitalization and *DollarVol* is the stock turnover times the stock price (see, e.g., Brennan et al. 1998). The higher each measure, the more liquid is a stock or portfolio. In contrast, *Relative Spread* (see, e.g., Holden et al. 2014), the difference between the logarithm of the best offer price and the logarithm of the best bid price, *Amihud* (see Amihud 2002), the stock`s absolute return divided by its dollar volume, and *LiqBeta*, the sensitivity (beta loading) to the liquidity factor as in the Pástor and Stambaugh (2003) 5-factor model, define the level of a stock`s illiquidity.

- Insert Table 9 approximately here -

To examine whether the stock portfolio liquidity of mutual funds is affected by the trading efficiency of their respective families, again we use the matched sample approach and the multivariate regression approach. Results from the matched sample approach, reported in Panel A of Table 9, suggest that efficient funds hold less liquid stocks. For *MarketCap* and *DollarVol* we find a negative and highly significant difference between funds in the top and the bottom efficiency group, i.e. funds in the top group holds smaller and less traded stocks. Not surprisingly, these stocks are characterized by a higher relative bid-ask spread and a higher price impact of a trade as documented by the positive and highly significant values of *Relative spread* and *Amihud*. They also carry a higher liquidity risk as suggested by the positive *LiqBeta* (significant in 4 out of 5 cases). These differences are also highly economically significant. For example, the market cap difference between the two groups is 6.4 billion dollars, which is economically significant given an average market cap of 25.7 billion dollars in our sample. Similarly, the relative spread difference is in the range of 0.03 to 0.06 basis points, whereas the average relative spread is 0.26 basis points.[21] These findings are consistent with the view that the trading cost reduction benefit provided by more efficient trading desks allows mutual funds to exploit more opportunities among illiquid stocks, trading of which incurs higher trading costs but also potentially higher returns.

As an alternative way of assessing the economic significance of these results, in unreported tests we compared the impact of trading efficiency on the Carhart alpha versus its impact on the five factor alpha estimated by augmenting the Carhart model to include the Pastor-Stambaugh liquidity factor. We find that the five factor alpha difference between high and low efficiency groups remains economically significant at an average of 122 basis points and is statistically significant in three of out five cases. This suggests that an efficient trading desk provides its affiliated funds benefits that go beyond earning the illiquidity premium. Specifically, the decline in performance difference between high and low efficiency fund groups by 54 basis points (from

[21] For the remaining liquidity variables, the averages are as follows: For dollar volume, the average is 32.8 million dollars, for the Amihud measure the average is 0.4209, and for the liquidity beta the average is -0.0007.

176 to 122 basis points) on average when we move from the Carhart alpha to the five factor alpha means that only about one third of the economic benefit of an efficient trading desk comes from allowing affiliated funds to invest in illiquid stocks and earn the illiquidity premium.

In Panel B, we provide results from the same linear regression equation (Model 1) where we replace the dependent variable iteratively with each one of the five variables used to measure liquidity. Interestingly, the linear regression approach does not allow us to draw the same conclusion as the matched-sample approach employed in Panel A because the coefficients of the *Efficiency* variable are not statistically significant. Two effects might cause this lack of significance. First, linear regression models have limited power to discern an effect due to trading desk efficiency if non-linear effects are at work (like the non-linear pattern in the cross-sectional relation between current and past efficiency measures documented in Panel A of Table 2). While this limitation is present throughout all our analyses, there is also a second effect which is particularly severe for this liquidity analysis. Table 3 suggests that the various efficiency groups are unbalanced by certain family and fund characteristics. For example, there is an overrepresentation of larger funds in the highest trading efficiency group relative to the lowest efficiency group. Larger funds are known to hold more liquid portfolios simply because of their size as documented by Busse et al. (2016). This would make it harder to find a difference in portfolio liquidity in the direction suggested by our hypothesis. A matched sample approach is better suited to deal with non-linear effects and can help balance our data to allow for meaningful comparisons that can better mitigate the confounding effect of other fund characteristics.

## 5. Conclusion

In this paper we study an important but overlooked mechanism through which mutual fund families can affect the performance of their mutual funds. Mutual fund families decide the type and amount of resources that they devote to the operations of their trading desks. This decision dictates the efficiency of the trading desk, which in turn can have a direct impact on the trading costs and performance of a family's member funds.

Introducing a measure of trading efficiency that allows for meaningful comparisons across fund families with different investable universes, we document that operating an efficient trading desk is important. Funds from families with the most efficient trading desks outperform those from families with the least efficient ones by more than 120 basis points per year. This supports the idea that a more efficient trading desk allows a fund manager to trade at lower costs and to profitably implement research ideas more often. Jointly, these effects boost performance. This finding is robust and is further corroborated by additional tests that rule out alternative explanations and alleviate endogeneity concerns.

Besides a performance impact, the level of trading efficiency of a trading desk also appears to affect the trading strategies of the affiliated mutual funds. In particular, the presence of a more efficient trading desk within a mutual fund family is associated with the member funds trading more and holding less cash. They also seem to hold more illiquid stocks. Altogether, this suggests that funds belonging to families with more efficient trading desks internalize the trading efficiency of trading desks in their decision-making in a way that is consistent with economic theory.

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**Table 1 – Sample characteristics**

This table reports descriptive statistics for the fund families (Panel A) and funds (Panel B) of our sample compared to non-sample funds in the CRSP universe. Our sample consists of actively managed equity funds that belong to the 83 fund families, for which we can measure the efficiency of their trading desk. The non-sample consists of the remaining actively managed US equity funds in CRSP. The sample period is 2000 – 2013. Family size is the average total net assets under management of a fund family in millions of dollars. Number of funds in family is the average number of different funds that belong to the same fund family. Family focus represents the average concentration of a fund family across investment objectives. A family's concentration is the Herfindahl index computed as the sum of the squared asset weights that a family has in various investment objectives, defined as in Siggelkow (2003). Family age represents the average fund age in years of the oldest fund in a family. Fund size represents the average total net assets under management of the fund in millions of dollars. Fund age represents the average fund age in years. Fund turnover is defined as the average of the minimum of security purchases and sales divided by the average total net assets under management during the calendar year. Fund flow represents the average of a fund`s percentage growth rate adjusted for internal growth of the fund, as defined in Sirri and Tufano (1998). Fund flow volatility is the average standard deviation of a fund`s monthly net-inflows during the year. Fund expense ratio represents average funds' fees charged for total services. Fund cash holdings is the average cash position reported by a mutual fund to CRSP in its quarterly statements, relative to the size of the fund. Fund return is the average fund's net-of-fee annual return. The last column of the table reports the difference in fund family and fund statistics between our sample and the non-sample CRSP universe. ***, **, * denote statistical significance for the difference in means between both groups at the 1%, 5%, and 10% significance level, respectively.

**Panel A: Family characteristics**

| | Sample | Non-sample CRSP universe | Difference | |
|---|---|---|---|---|
| Family size(in million USD) | 24,884.77 | 2,954.09 | 21,930.68 | *** |
| Number of funds in family | 13.16 | 3.17 | 9.99 | *** |
| Family focus (in %) | 49.36 | 78.32 | -28.96 | *** |
| Family age (in years) | 20.88 | 12.03 | 8.85 | *** |
| Number of families | 83 | 792 | | |

**Panel B: Fund characteristics**

| | Sample | Non-sample CRSP universe | Difference | |
|---|---|---|---|---|
| Fund size (in million USD) | 1,642.64 | 712.78 | 929.86 | *** |
| Fund age (in years) | 11.10 | 9.49 | 1.61 | *** |
| Fund turnover (in %) | 92.18 | 86.57 | 5.61 | *** |
| Fund flow (in %) | 11.14 | 13.96 | -2.82 | ** |
| Fund flow volatility (in %) | 15.44 | 16.83 | -1.40 | *** |
| Fund expense ratio (in %) | 1.11 | 1.35 | -0.24 | *** |
| Fund cash holdings (in %) | 2.33 | 3.71 | -1.39 | *** |
| Fund return (in %) | 7.74 | 7.25 | 0.49 | |
| Number of funds | 1,106 | 3,149 | | |

**Table 2 – Characteristics of the efficiency measure**

This table reports summary statistics of the trading desk efficiency measure over the period 2000 to 2013. The efficiency measure is estimated as the annualized average return difference between a family`s S&P500 index fund and the index around index adjustment dates within a year. In Panel A, we report summary statistics on the distribution of the trading desk efficiency measure for different sub-periods and the total sample. We report the average efficiency measure, its standard deviation and the 5th, 25th, 50th, 75th, and 95th percentile, respectively. Panel B shows serial correlations of the efficiency measure at various lags.

**Panel A: Efficiency measure (in %) per sub-period**

| Year | Mean | Std. | Percentiles | | | | | N |
|---|---|---|---|---|---|---|---|---|
| | | | 5% | 25% | 50% | 75% | 95% | |
| 2000-2004 | -0.91 | 0.95 | -2.77 | -1.41 | -0.71 | -0.34 | 0.21 | 215 |
| 2005-2009 | -0.18 | 0.78 | -1.24 | -0.64 | -0.22 | 0.20 | 1.18 | 181 |
| 2010-2013 | -0.19 | 0.70 | -1.85 | -0.41 | -0.05 | 0.21 | 0.63 | 118 |
| 2000-2013 | -0.49 | 0.91 | -2.07 | -0.79 | -0.39 | 0.01 | 0.87 | 514 |

**Panel B: Serial correlation**

| Efficiency measure in | t | t-1 | t-2 | t-3 | t-4 | t-5 | t-6 |
|---|---|---|---|---|---|---|---|
| t | 1 | | | | | | |
| t-1 | 0.1511 *** | 1 | | | | | |
| t-2 | 0.2313 *** | 0.1647 *** | 1 | | | | |
| t-3 | 0.1412 *** | 0.2115 *** | 0.1289 *** | 1 | | | |
| t-4 | 0.1183 *** | 0.1261 *** | 0.1973 *** | 0.1237 *** | 1 | | |
| t-5 | 0.0810 *** | 0.1323 *** | 0.1056 *** | 0.1867 *** | 0.1441 *** | 1 | |
| t-6 | 0.1043 *** | 0.1200 *** | 0.1047 *** | 0.1312 *** | 0.1611 *** | 0.1090 *** | 1 |

**Table 3 – Efficiency measure and fund, fund family, and fund portfolio characteristics**

This table reports information on family characteristics (Panel A), fund characteristics (Panel B), and the liquidity of portfolio stockholdings (Panel C) stratified by the efficiency of their corresponding trading desks. In year *t-1*, fund families are sorted into quintiles according to their efficiency measure, which is described in Table 2. *Q1* (*Q5*) includes families or funds affiliated with trading desks with the lowest (highest) efficiency measures. In each panel, we report the average values for year *t* together with the difference between *Q5* and *Q1*. In the last column, we estimate the correlation coefficient between the efficiency measure in year *t-1* and the respective variable in year *t*. In Panel A, we report family characteristics. Family size, number of funds in family, family focus, and family age are defined as in Table 1. Efficiency measure is defined as in Table 2. In Panel B, we report fund characteristics. Fund size represents the average total net assets under management of the fund in millions of dollars. Fund age represents the average fund age in years. Fund turnover is defined as the average of the minimum of security purchases and sales divided by the average total net assets under management during the calendar year. Fund flow represents the average of a fund`s percentage growth rate adjusted for internal growth of the fund, as defined in Sirri and Tufano (1998). Fund flow volatility is the average standard deviation of a fund`s monthly net-inflows during the year. Fund expense ratio represents average funds' fees charged for total services. Fund cash holdings is the average cash position reported by a mutual fund to CRSP in its quarterly statements, relative to the size of the fund. Fund return is the average fund's net-of-fee annual return. In Panel C, we report fund portfolio characteristics that capture the (il)liquidity of the stockholdings. Market capitalization is the value-weighted average of the market capitalization of all stocks held by a fund. Dollar volume measures the value-weighted average of the dollar volume of shares traded of all stocks held by a fund. Relative spread is the value-weighted relative spread of the individual stocks held, which is measured for each stock held as the difference between the logarithm of the best offer price and the logarithm of the best bid price. Amihud measure is the value-weighted average of the Amihud measures of individual stocks held, which is based on the illiquidity measure of Amihud (2002). Liquidity beta is the sensitivity (beta loading) to the liquidity factor as in the Pástor and Stambaugh (2003) 5-factor model. ***, **, * denote statistical significance at the 1%, 5%, and 10% significance level, respectively.

**Panel A: Family characteristics**

| | *Q1* *(Bottom)* | *Q2/Q3/Q4* *(Medium)* | *Q5* *(Top)* | *Q5-Q1* | *Correlation* |
|---|---|---|---|---|---|
| Family size (in million USD) | 10,056.77 | 35,492.22 | 21,299.30 | 11,242.53 * | 0.0499 |
| Number of funds in family | 9.54 | 16.04 | 11.46 | 1.91 | 0.0319 |
| Family focus (in %) | 56.30 | 44.31 | 49.15 | -7.14 * | -0.0002 |
| Family age (in years) | 19.22 | 23.68 | 22.35 | 3.13 | -0.0393 |
| Efficiency measure (in %) | -0.63 | -0.23 | -0.21 | 0.42 *** | 0.1511 *** |

**Table 3 – Efficiency measure and fund, fund family, and fund portfolio characteristics (continued)**

**Panel B: Fund characteristics**

| | *Q1 (Bottom)* | *Q2/Q3/Q4 (Medium)* | *Q5 (Top)* | *Q5-Q1* | | *Correlation* | |
|---|---|---|---|---|---|---|---|
| Fund size (in million USD) | 1,057.39 | 2,007.54 | 1,794.97 | 737.58 | *** | 0.0736 | *** |
| Fund age (in years) | 10.77 | 11.40 | 10.60 | -0.17 | | 0.0666 | *** |
| Fund turnover (in %) | 93.96 | 84.49 | 89.63 | -4.33 | | -0.0347 | |
| Fund flow (in %) | 3.94 | 10.01 | 12.49 | 8.55 | *** | 0.0507 | ** |
| Fund flow volatility (in %) | 20.42 | 13.83 | 15.54 | -4.88 | *** | -0.0855 | *** |
| Fund expense ratio (in %) | 1.23 | 1.09 | 1.00 | -0.23 | *** | -0.2157 | *** |
| Fund cash holdings (in %) | 2.73 | 2.32 | 2.07 | -0.66 | *** | -0.0975 | *** |
| Fund return (in %) | 6.44 | 7.77 | 9.51 | 3.07 | *** | 0.2327 | *** |

**Panel C: (Il)liquidity measures of funds` stockholdings**

| | *Q1 (Bottom)* | *Q2/Q3/Q4 (Medium)* | *Q5 (Top)* | *Q5-Q1* | | *Correlation* | |
|---|---|---|---|---|---|---|---|
| Market capitalization (in million USD) | 27,200 | 25,800 | 24,000 | -3,200 | *** | -0.0445 | * |
| Dollar volume (in million USD) | 34.60 | 32.70 | 31.60 | -3.00 | ** | 0.0547 | ** |
| Relative spread | 0.0023 | 0.0027 | 0.0027 | 0.0004 | ** | -0.1062 | *** |
| Amihud measure | 0.1808 | 0.4120 | 0.6534 | 0.4726 | *** | 0.1121 | *** |
| Liquidity beta | -0.0006 | -0.0014 | 0.0022 | 0.0028 | | -0.0014 | |

**Table 4 – Mutual fund performance – Matched sample analysis**

This table reports results from a matched sample analysis where each fund from families with the most efficient trading desks (Top Efficiency) is matched with an equally weighted portfolio of funds affiliated with families with the least efficient trading desks (Bottom Efficiency) using the following matching criteria: Year, Style, Family size, Fund size, Fund age, Fund turnover, Fund performance, and Fund flow volatility. Fund performance represents the fund`s net-of-fee performance measure of the previous year and the remaining variables are defined as in Table 1. One-year-lagged values of these attributes are used to rank funds into quintiles independent of the categorization of funds into top efficient and bottom efficient groups. To categorize funds by their trading efficiency, in year *t-1* fund families are sorted into quintiles according to their efficiency measure. Top Efficiency (Bottom Efficiency) group includes funds from families with the highest (lowest) efficiency measures. Funds from the Top Efficiency group are matched to funds from the Bottom Efficiency group that belong to the same investment style and the same Family size quintile in a certain year. In rows one through five we use the quintile ranking based on Fund size, Fund age, Fund turnover, Fund performance, and Fund flow volatility as an additional matching criterion, respectively. Performance differences between top efficient funds and the corresponding bottom efficient matched portfolio are computed for the following performance measures based on net-of-fee returns: Jensen (1968) alpha (Jensen), Fama and French (1993) 3-Factor alpha (Fama French) and Carhart (1997) 4-Factor alpha (Carhart). P-values reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% significance level, respectively.

| Matching characteristics | Observations | Jensen | Fama French | Carhart |
|---|---|---|---|---|
| Year, Style, Family size, and Fund size | 438 | 0.0177 *** | 0.0207 *** | 0.0179 ** |
| | | (0.0002) | (<.0001) | (0.0133) |
| Year, Style, Family size, and Fund age | 406 | 0.0121 *** | 0.0166 *** | 0.0120 |
| | | (0.0074) | (0.0003) | (0.1067) |
| Year, Style, Family size, and Fund turnover | 369 | 0.0219 *** | 0.0172 *** | 0.0205 ** |
| | | (<.0001) | (0.0024) | (0.0146) |
| Year, Style, Family size, and Fund performance | 419 | 0.0125 *** | 0.0170 *** | 0.0142 * |
| | | (0.0054) | (0.0007) | (0.0673) |
| Year, Style, Family size, and Fund flow volatility | 383 | 0.0184 *** | 0.0224 *** | 0.0235 *** |
| | | (0.0001) | (<.0001) | (0.0004) |

**Table 5 – Mutual fund performance – Regression analysis**

This table presents results from pooled OLS regressions that analyze the impact of trading desk efficiency on mutual fund performance using three different net-of-fee performance measures: Jensen (1968) alpha (Jensen), Fama and French (1993) 3-Factor alpha (Fama French) and Carhart (1997) 4-Factor alpha (Carhart). The main independent variable is *Efficiency*, estimated as the annualized average return difference between a family`s S&P500 index fund and the index around index adjustment dates within a year. All independent variables are lagged by one year and additional independent controls include family size, family focus, fund size, fund age, fund turnover, fund performance, fund flow, fund flow volatility and fund expense ratio. Family size (*FamSize*) is the logarithm of the fund family's assets under management. Family focus (*FamFocus*) represents the concentration of a fund family across investment objectives, defined as in Siggelkow (2003). Fund size (*Fund Size*) represents the logarithm of the fund's total net assets under management. Fund age (*FundAge*) is the logarithm of the fund's age in years. Fund turnover (*FundTO*) is the fund's yearly turnover ratio, defined as the minimum of security purchases and sales divided by the average total net assets under management during the calendar year. Fund performance (*Perf*) represents the fund`s respective net-of-fee performance measure of the previous year. Fund flow (*FundFlow*) represents the fund`s percentage growth rate adjusted for internal growth of the fund, as defined in Sirri and Tufano (1998). Fund flow volatility (*FundFlowVola*) is the standard deviation of the fund`s monthly net-inflows during the year. Fund expense ratio (*FundTER*) represents funds' fees charged for total services. All regressions are estimated with style-by-year and family fixed effects. P-values reported in parentheses are based on robust standard errors clustered at the family level. ***, **, * denote statistical significance at the 1%, 5%, and 10% significance level, respectively.

| | Jensen | | Fama French | | Carhart | |
|---|---|---|---|---|---|---|
| *Efficiency* | 105.0100 | ** | 173.9035 | *** | 189.5582 | ** |
| | (0.0213) | | (0.0015) | | (0.0239) | |
| *FamSize* | -0.0098 | *** | -0.0051 | | -0.0051 | |
| | (0.0039) | | (0.1198) | | (0.1306) | |
| *FamFocus* | -0.0098 | | -0.0028 | | -0.0136 | |
| | (0.5428) | | (0.8903) | | (0.4629) | |
| *FundSize* | -0.0053 | *** | -0.0031 | *** | -0.0034 | *** |
| | (0.0000) | | (0.0056) | | (0.0021) | |
| *FundAge* | 0.0095 | *** | 0.0065 | *** | 0.0064 | ** |
| | (0.0000) | | (0.0024) | | (0.0100) | |
| *FundTO* | -0.0019 | | -0.0017 | | -0.0024 | |
| | (0.3077) | | (0.5179) | | (0.4782) | |
| *Perf* | 0.0363 | *** | -0.0317 | | -0.0003 | |
| | (0.0066) | | (0.1965) | | (0.9865) | |
| *FundFlow* | -0.0001 | | -0.0001 | | -0.0006 | |
| | (0.6062) | | (0.9184) | | (0.2071) | |
| *FundFlowVola* | 0.0000 | | -0.0003 | ** | -0.0002 | |
| | (0.8268) | | (0.0124) | | (0.2322) | |
| *FundTER* | -1.1354 | *** | -0.472 | | 0.0852 | |
| | (0.0001) | | (0.1228) | | (0.8268) | |
| Observations | 5,792 | | 5,792 | | 5,792 | |
| Adj. $R^2$ | 0.2662 | | 0.1729 | | 0.1942 | |

**Table 6 – Placebo test: Efficiency measure based on outsourced index funds**

This table presents results from pooled OLS regressions that analyze the impact of trading desk efficiency on mutual fund performance accounting for the effects of managerial outsourcing. We use three different net-of-fee performance measures: Jensen (1968) alpha (Jensen), Fama and French (1993) 3-Factor alpha (Fama French) and Carhart (1997) 4-Factor alpha (Carhart). The main independent variable is *Efficiency_Out*, estimated as the annualized average return difference between a family`s outsourced S&P500 index fund and the index around index adjustment dates within a year. As in Table 5, we relate fund performance with this efficiency measure. Other independent variables and fixed effects are defined as in Table 5 and all independent variables are lagged by one year. P-values reported in parentheses are based on robust standard errors clustered at the family level. ***, **, * denote statistical significance at the 1%, 5%, and 10% significance level, respectively.

| | Jensen | | Fama French | | Carhart | |
|---|---|---|---|---|---|---|
| *Efficiency_Out* | -747.7957 | * | -839.1581 | | -501.7972 | |
| | (0.0834) | | (0.1219) | | (0.1132) | |
| *FamSize* | 0.0064 | | 0.0053 | | 0.0038 | |
| | (0.1046) | | (0.2158) | | (0.3671) | |
| *FamFocus* | -0.0151 | | -0.0199 | | -0.0305 | |
| | (0.7193) | | (0.5802) | | (0.6022) | |
| *FundSize* | 0.0008 | | 0.0011 | | -0.0013 | |
| | (0.8761) | | (0.7201) | | (0.5689) | |
| *FundAge* | -0.0003 | | -0.0023 | | -0.0001 | |
| | (0.9611) | | (0.5268) | | (0.9934) | |
| *FundTO* | 0.0046 | | 0.0008 | | 0.0057 | |
| | (0.4608) | | (0.9229) | | (0.3499) | |
| *Perf* | -0.0299 | | -0.0665 | *** | -0.0042 | |
| | (0.6130) | | (0.0009) | | (0.8589) | |
| *FundFlow* | 0.0076 | ** | 0.0063 | ** | 0.0027 | |
| | (0.0500) | | (0.0330) | | (0.6516) | |
| *FundFlowVola* | -0.0038 | | -0.0043 | | -0.0029 | |
| | (0.1543) | | (0.1315) | | (0.5258) | |
| *FundTER* | -2.1425 | * | -0.9613 | | -1.0000 | |
| | (0.0656) | | (0.5241) | | (0.5609) | |
| Observations | 413 | | 413 | | 413 | |
| Adj. $R^2$ | 0.2965 | | 0.3802 | | 0.2657 | |

**Table 7 – Trading efficiency and turnover**

This table shows results from a matched sample analysis (Panel A) and pooled OLS regressions (Panel B) that analyze the impact of trading desk efficiency on mutual funds` trading activity. We employ four measures of trading activity. The first one is fund turnover (*FundTO*), computed as the minimum of security purchases and sales divided by the average total net assets under management during the calendar year. The second and third measures are buy turnover (*BuyTO*) and sell turnover (*SellTO*), which are intended to separate buy and sell trading, as defined in Carhart (1997). The fourth measure is a position-adjusted turnover (*PositionTO*) as suggested in Edelen et al. (2013). For this measure, fund turnover is multiplied with the percentile rank of the fund`s position size, estimated by dividing its total net assets by the number of stocks in the portfolio. In Panel A each fund from families in the Top Efficiency group is matched with an equally weighted portfolio of funds from families in the Bottom Efficiency group using the following matching criteria: Year, Style, Family size, Fund size, Fund age, Fund turnover, Fund performance and Fund flow volatility, as described in Table 4. Turnover differences between Top Efficiency funds and the corresponding Bottom Efficiency matched portfolio are reported. The main independent variables in the pooled regressions of Panel B is *Efficiency*, which is described in Table 5. Fund performance (Perf) represents the fund`s net-of-fee Carhart (1997) 4-Factor alpha of the previous year. Other independent variables and fixed effects in Panel B are defined as in Table 5. All independent variables are lagged by one year. P-values reported in parentheses are based on robust standard errors clustered at the family level. ***, **, * denote statistical significance at the 1%, 5%, and 10% significance level, respectively.

**Panel A: Matched sample analysis**

| Matching characteristics: | Obs. | FundTO | | BuyTO | | SellTO | | PositionTO | |
|---|---|---|---|---|---|---|---|---|---|
| Year, Style, Family size, and Fund size | 305 | 0.1020 | *** | 0.0996 | *** | 0.1009 | *** | -0.0082 | |
| | | (0.0052) | | (0.0066) | | (0.0059) | | (0.7744) | |
| Year, Style, Family size, and Fund age | 289 | 0.1133 | *** | 0.1105 | *** | 0.1130 | *** | 0.0600 | ** |
| | | (0.0010) | | (0.0014) | | (0.0011) | | (0.0112) | |
| Year, Style, Family size, and Fund turnover | 246 | 0.0848 | *** | 0.0833 | *** | 0.0838 | *** | 0.0370 | * |
| | | (<.0001) | | (<.0001) | | (<.0001) | | (0.0848) | |
| Year, Style, Family size, and Fund performance | 302 | 0.1145 | *** | 0.1080 | *** | 0.1127 | *** | 0.0711 | *** |
| | | (0.0011) | | (0.0025) | | (0.0014) | | (0.0061) | |
| Year, Style, Family size, and Fund flow volatility | 278 | 0.1372 | ** | 0.1383 | ** | 0.1360 | ** | 0.0508 | * |
| | | (0.0377) | | (0.0362) | | (0.0401) | | (0.0697) | |

**Table 7 – Trading efficiency and turnover (continued)**

**Panel B: Regression analysis**

| | FundTO | BuyTO | SellTO | PositionTO |
|---|---|---|---|---|
| *Efficiency* | 632.920 ** | 619.519 ** | 598.581 ** | 1106.188 *** |
| | (0.0132) | (0.0171) | (0.0204) | (0.0009) |
| *FamSize* | 0.0392 ** | 0.0324 * | 0.0381 ** | 0.0292 * |
| | (0.0128) | (0.0570) | (0.0159) | (0.0590) |
| *FamFocus* | 0.1399 | 0.1226 | 0.1413 | 0.1169 |
| | (0.1055) | (0.1677) | (0.1034) | (0.1444) |
| *FundSize* | -0.0280 *** | -0.0386 *** | -0.0283 *** | 0.1154 *** |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| *FundAge* | 0.0162 * | 0.0150 | 0.0165 * | -0.0035 |
| | (0.0824) | (0.1337) | (0.0791) | (0.7902) |
| *FundTO* | 0.7404 *** | 0.7391 *** | 0.7414 *** | 0.4129 *** |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| *Perf* | -0.0875 | -0.0606 | -0.0962 | 0.0457 |
| | (0.1447) | (0.3120) | (0.1112) | (0.3811) |
| *FundFlow* | -0.0017 | -0.0012 | -0.0020 | 0.0016 |
| | (0.3334) | (0.4318) | (0.2994) | (0.3209) |
| *FundFlowVola* | -0.0001 | 0.0002 | -0.0002 | -0.0005 |
| | (0.7780) | (0.7803) | (0.7231) | (0.3952) |
| *FundTER* | -1.9523 | -3.0033 | -2.2647 | -4.4707 * |
| | (0.3698) | (0.1804) | (0.2995) | (0.0939) |
| Observations | 4,529 | 4,529 | 4,529 | 4,529 |
| Adj. $R^2$ | 0.7905 | 0.7745 | 0.7904 | 0.5934 |

**Table 8 – Trading efficiency and cash holdings**

This table shows results from a matched sample analysis (Panel A) and pooled OLS regression (Panel B) that analyzes the impact of trading desk efficiency on mutual funds` cash holdings position. *Cash holdings* is the cash position reported by mutual funds to CRSP in their quarterly statements, relative to the size of the fund. In Panel A each fund from families in the Top Efficiency group is matched with an equally weighted portfolio of funds from families in the Bottom Efficiency group using the following matching criteria: Year, Style, Family size, Fund size, Fund age, Fund turnover, Fund performance and Fund flow volatility, as described in Table 4. Differences in the cash holdings between Top Efficiency funds and the corresponding Bottom Efficiency matched portfolio are reported. In the pooled regressions of Panel B, the main independent variable is *Efficiency*, which is described in Table 5. Fund performance (*Perf*) represents the fund`s net-of-fee Carhart (1997) 4-Factor alpha of the previous year. The other control variables of the standard regression model in the first column of Panel B are described in Table 5. Additional independent controls include Front load and Deferred load. Front load (*FrontLoad),* is the fund`s front-end load. Deferred load (*DeferredLoad),* represents the fund`s back-end load. All independent variables are lagged by one year and fixed effects in Panel B are defined as in Table 5. P-values reported in parentheses are based on robust standard errors clustered at the family level. ***, **, * denote statistical significance at the 1%, 5%, and 10% significance level, respectively.

**Panel A: Matched sample analysis**

| Matching characteristics: | Observations | Cash holdings | |
|---|---|---|---|
| Year, Style, Family size, and Fund size | 400 | -0.0049 | *** |
| | | (0.0032) | |
| Year, Style, Family size, and Fund age | 375 | -0.0077 | *** |
| | | (<.0001) | |
| Year, Style, Family size, and Fund turnover | 343 | -0.0102 | *** |
| | | (<.0001) | |
| Year, Style, Family size, and Fund performance | 369 | -0.0069 | *** |
| | | (0.0002) | |
| Year, Style, Family size, and Fund flow volatility | 349 | -0.0050 | *** |
| | | (0.0018) | |

**Table 8 – Trading efficiency and cash holdings (continued)**

**Panel B: Regression analysis**

| | Cash holdings | | | |
|---|---|---|---|---|
| *Efficiency* | -85.1253 | *** | -85.7618 | *** |
| | (0.0003) | | (0.0002) | |
| *FamSize* | -0.0031 | ** | -0.0032 | ** |
| | (0.0208) | | (0.0213) | |
| *FamFocus* | -0.0204 | * | -0.0205 | * |
| | (0.0594) | | (0.0580) | |
| *FundSize* | 0.0017 | *** | 0.0017 | *** |
| | (0.0012) | | (0.0011) | |
| *FundAge* | -0.0049 | *** | -0.0048 | *** |
| | (0.0000) | | (0.0000) | |
| *FundTO* | -0.0013 | | -0.0013 | |
| | (0.1532) | | (0.1604) | |
| *Perf* | 0.0053 | | 0.0053 | |
| | (0.2526) | | (0.2487) | |
| *FundFlow* | 0.0000 | | 0.0000 | |
| | (0.5367) | | (0.5311) | |
| *FundFlowVola* | -0.0002 | *** | -0.0002 | *** |
| | (0.0000) | | (0.0000) | |
| *FundTER* | 0.5787 | *** | 0.5724 | *** |
| | (0.0058) | | (0.0095) | |
| *FrontLoad* | | | 0.0165 | |
| | | | (0.5198) | |
| *DeferredLoad* | | | -0.0104 | |
| | | | (0.8693) | |
| Observations | 4,022 | | 4,022 | |
| Adj. $R^2$ | 0.0615 | | 0.2082 | |

**Table 9 – Trading efficiency and portfolio liquidity**

This table shows results from a matched sample analysis (Panel A) and pooled OLS regressions (Panel B) that analyze the impact of trading desk efficiency on mutual funds` portfolio liquidity. We use five measures of portfolio liquidity: Market capitalization (*MarketCap*) is the value-weighted average of the market capitalization of all stocks held by a fund. Stock dollar volume (*DollarVol*) is the value-weighted average of the dollar volume of shares traded of all stocks held by a fund. The higher the value of these first two measures, the higher is the fund`s portfolio liquidity. In contrast, the following proxies measure a portfolio`s illiquidity level. Relative spread (*Relative Spread*) is the value-weighted relative spread of the individual stocks held, which is measured for each stock held as the difference between the logarithm of the best offer price and the logarithm of the best bid price. Amihud measure is the value-weighted average Amihud measure of individual stocks held, which is based on the illiquidity measure of Amihud (2002). Liquidity beta is the sensitivity (beta loading) to the liquidity factor as in the Pástor and Stambaugh (2003) 5-factor model. In Panel A each fund from families in the Top Efficiency group is matched with an equally weighted portfolio of funds from families in the Bottom Efficiency group using the following matching criteria: Year, Style, Family size, Fund size, Fund age, Fund turnover, Fund performance and Fund flow volatility, as described in Table 4. Differences in the portfolio liquidity measures between Top Efficiency funds and the corresponding Bottom Efficiency matched portfolio are reported. In the pooled regressions of Panel B, the main independent variable is *Efficiency*, which is described in Table 5. Fund performance (*Perf*) represents the fund`s net-of-fee Carhart (1997) 4-Factor alpha of the previous year. Other independent variables and fixed effects in Panel B are defined as in Table 5. All independent variables are lagged by one year. P-values reported in parentheses are based on robust standard errors clustered at the family level. ***, **, * denote statistical significance at the 1%, 5%, and 10% significance level, respectively.

**Panel A: Matched sample analysis**

| Matching characteristics: | Obs. | MarketCap | DollarVol | Relative spread | Amihud | LiqBeta |
|---|---|---|---|---|---|---|
| Year, Style, Family size, and Fund size | 316 | -4,120.2 *** | -6.1483 *** | 0.0005 *** | 0.4536 *** | 0.0205 *** |
| | | (0.0004) | (<.0001) | (<.0001) | (<.0001) | (0.0016) |
| Year, Style, Family size, and Fund age | 313 | -5,870.5 *** | -7.3934 *** | 0.0006 *** | 0.4454 *** | 0.0172 *** |
| | | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.0017) |
| Year, Style, Family size, and Fund turnover | 251 | -6,434.1 *** | -7.7943 *** | 0.0003 *** | 0.3149 *** | 0.0063 |
| | | (<.0001) | (0.0002) | (0.0013) | (0.0083) | (0.3015) |
| Year, Style, Family size, and Fund performance | 317 | -3,982.3 *** | -6.3384 *** | 0.0004 *** | 0.4249 *** | 0.0118 ** |
| | | (0.0011) | (0.0003) | (0.0001) | (0.0002) | (0.0178) |
| Year, Style, Family size, and Fund flow volatility | 287 | -4,488.9 *** | -6.2973 *** | 0.0004 *** | 0.3940 *** | 0.0121 ** |
| | | (0.0006) | (0.0004) | (0.0011) | (0.0024) | (0.0482) |

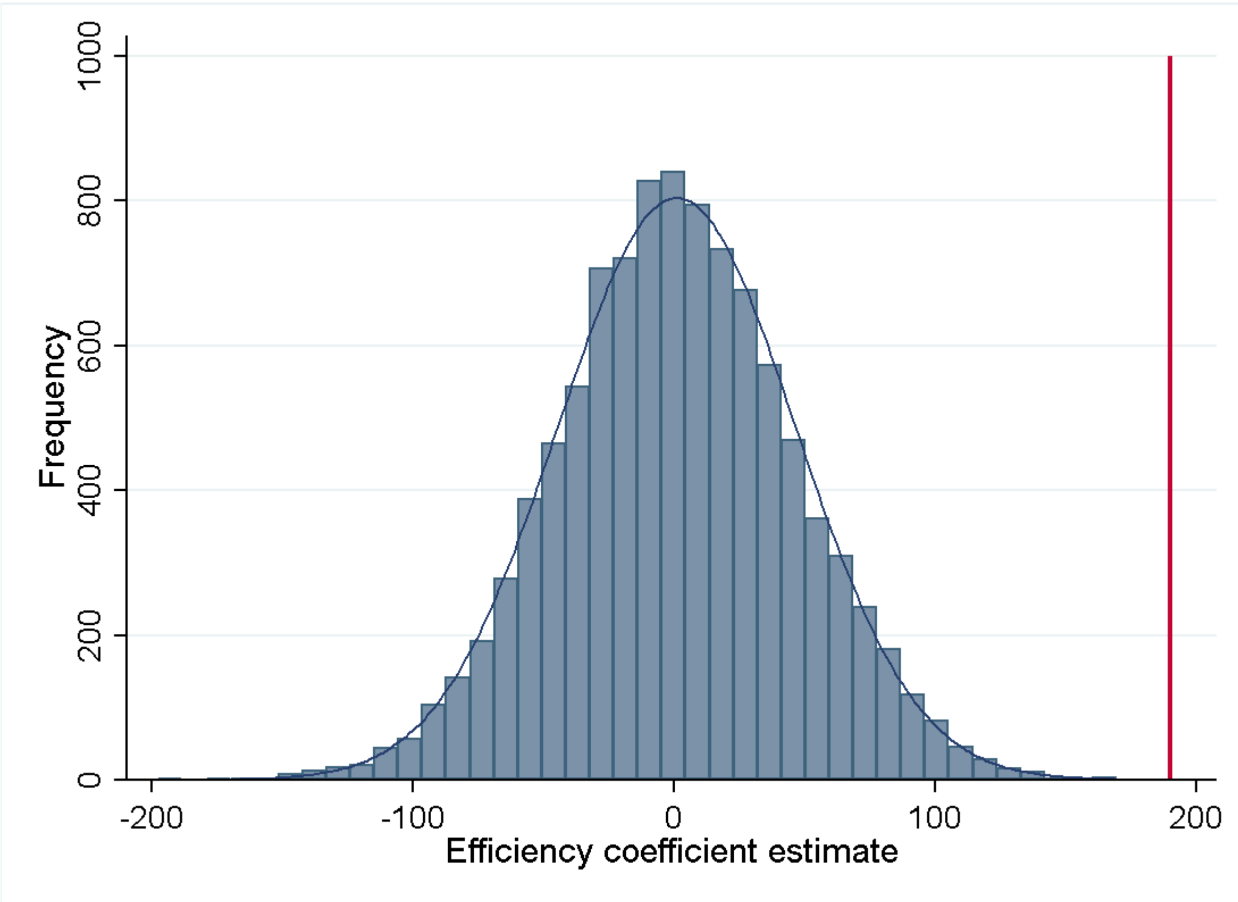
**Table 9 – Trading efficiency and portfolio liquidity (continued)**

**Panel B: Regression analysis**

| | MarketCap | DollarVol | Relative spread | Amihud | LiqBeta |
|---|---|---|---|---|---|
| *Efficiency* | -479.7777 | 87.9270 | -1.0001 | 37.8861 | 51.5690 |
| | (0.6967) | (0.9152) | (0.3199) | (0.8048) | (0.3971) |
| *FamSize* | -0.0526 | -0.0454 | -0.0001 | -0.0102 | -0.0002 |
| | (0.3623) | (0.1996) | (0.4742) | (0.6862) | (0.9698) |
| *FamFocus* | -0.1672 | -0.1006 | -0.0002 | -0.0415 | 0.0192 |
| | (0.5396) | (0.6109) | (0.6813) | (0.5590) | (0.3904) |
| *FundSize* | 0.0324 ** | 0.0122 | 0.0000 ** | -0.0024 | -0.0038 *** |
| | (0.0215) | (0.2627) | (0.0174) | (0.5243) | (0.0056) |
| *FundAge* | -0.0621 | -0.0008 | 0.0001 * | 0.0135 | 0.0114 *** |
| | (0.3158) | (0.9881) | (0.0648) | (0.1689) | (0.0001) |
| *FundTO* | -0.0518 | 0.0172 | -0.0001 *** | -0.0216 *** | -0.0040 * |
| | (0.4069) | (0.7154) | (0.0042) | (0.0062) | (0.0748) |
| *Perf* | -0.5567 *** | -0.4497 *** | 0.0001 | 0.0350 | -0.0097 |
| | (0.0001) | (0.0000) | (0.5828) | (0.3101) | (0.7264) |
| *FundFlow* | 0.0029 | 0.0058 ** | 0.0000 | -0.0007 ** | 0.0004 |
| | (0.2260) | (0.0139) | (0.1909) | (0.0213) | (0.3231) |
| *FundFlowVola* | -0.0009 ** | 0.0000 | 0.0000 | 0.0001 | -0.0002 *** |
| | (0.0325) | (0.9448) | (0.5222) | (0.1417) | (0.0011) |
| *FundTER* | -41.2884 *** | -22.6408 ** | 0.0147 * | 4.9150 * | -0.5054 |
| | (0.0035) | (0.0475) | (0.0502) | (0.0525) | (0.2484) |
| Observations | 4,551 | 4,551 | 4,551 | 4,551 | 5,792 |
| Adj. $R^2$ | 0.8044 | 0.8141 | 0.8900 | 0.5323 | 0.0982 |

**Figure 1 – Placebo test: Bootstrap**

This figure shows the distribution of coefficient estimates on the key efficiency variables from 10,000 bootstrap simulations of the regression model (1). In each simulation, the efficiency measure of a fund family`s trading desk is randomly assigned to fund-year observations and then model (1) is estimated. The mutual fund performance measure used is the net-of-fee Carhart (1997) 4-Factor alpha.



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