The Role of Liquidity and the Relation between Fund Size and Fund Performance

Anon Phongpetra (386496)

Bachelor Thesis: Financial Economics

Supervisor: Dr. Maurizio Montone

Second Assessor: Antti Yang

August 1, 2018

Abstract

I investigate the relationship between fund size and fund performance and the role of liquidity in equity mutual fund. Using a comprehensive sample of U.S. equity mutual funds from 2003 to 2017, I find that fund returns, before and after expenses, decline with lagged fund size and the magnitude of this negative relation is stronger during economic contraction. Consistent with Chen, Hong, Huang, and Kubik (2004), I discover that this inverse relationship is most pronounced among funds that primarily invest in small-cap and illiquid stocks, suggesting that liquidity is an important reason why fund size erodes fund performance. However, I find evidence that indicates an increase in the size of the family fund negatively affect the fund performance, which contradicts the previous studies. Overall, this paper's findings conclude that the effect of size on fund performance still exist in today's mutual fund industry and that liquidity is responsible for this adverse scale effect.

Table of Contents

Introduction

The mutual fund industry across the world has seen robust growth in assets in the past two decades. The total net assets in US equity mutual funds exceeds $18.7 trillion at the end of 2017, which is almost more than double their level before the 2007-2009 financial crisis. (Investment Company Institutes, 2018) In 2017 alone, the total net assets in these funds increased nearly $1.5 trillion, corresponding to the stronger demands for mutual funds as measured by net new cash inflow and the vigorous gains in stock markets around the world- US stocks returns approximately 19 percent.[1] However, numerous studies show that the average equity mutual fund underperforms the stock market and relatively few actively managed equity funds can persistently outperform the passive investment strategies.[2] Therefore, it is essential to investigate the nature of economies of scale in this fast-growing mutual fund industry and explore the value of active fund management.

The purpose of this paper is to examine one of the fundamental role of mutual funds in the economy- the economies of scale in active money management. To precisely stated, *does equity fund size have any significant influence on the fund performance?* Many academics have tried to determine this relation, but the empirical literature is limited. Using a small sample of funds from 1974 to 1984, Grinblatt and Titman (1989) find mixed evidence that gross fund returns decline with fund size, but there is no effect on net returns. Indro, Jiang, Hu, and Lee (1999) conclude that there is a non-linear relationship between fund size and performance; performance initially increases and then decreases as fund size reaches its optimal size. Moreover, Becker and Vaughan (2001) argue that as fund size increases, the fund manager loses flexibility in executing a desirable trade, which might cause a negative market impact prices to move and eventually impair fund performance. The most significant and the principle studies that this paper is centered on is written by Chen, Hong, Huang, and Kubik (2004), who present evidence that fund size erodes fund performance. They find that there is a stronger adverse effect of size on performance in the small-cap fund and they conclude that fund size erodes performance because of liquidity.

While the effect of scale on performance is an important question, there has not been researched conducted lately that use the most recent data. Most of the prior studies either use a

[1] The statistics are documented by Investment Company Institute's, through its 2018 Investment Company Factbook

[2] The findings are supported by numerous studies, including Carhart (1997), Jensen (1968) and Berk and Green (2004)

small sample sizes period or the old data of mutual fund before the 21st century when the fund market was still relatively small. This paper aims to investigate whether fund size still negatively impact fund performance in today's economic condition by using the most recent data of US equity mutual funds. Since there have been many changes to the regulatory landscape of the mutual fund industry, I also examine the effect of family fund size on fund performance to explore the value and benefit of fund organization. Lastly, I analyze the effect of liquidity on the relation between fund size and fund performance to improve one's understanding of why diseconomies of scale might exist in active fund management.

Using mutual fund data from 2003 to 2017, I begin my investigation by performing cross-sectional variation to see if performance depends on lagged fund size. Since there may be heterogeneity between fund of different sizes and fund of different styles, I evaluate the performance of mutual fund by using CAPM, Fama-French three-factor model, and Carhart four-factor model. Moreover, I regress the various adjusted returns on lagged fund size and other observable fund characteristics with monthly and fixed firm effect. To test for liquidity hypothesis, I include in the regression an additional dummy variable that differentiates fund-specific investment styles and an interaction term.

The results of this study indicate that there is an inverse relationship between fund size and its performance. After controlling for various fund characteristics and survivorship bias, there is evidence to support that fund size erodes fund performance. The negative relationship between fund size and its performance is non-linear, as the magnitude of this relation increases as fund size grows. Moreover, I argue that the implementation of new regulations in the mutual fund industry will trigger a negative relationship between the size of the family fund and its performance. Consistent with this prediction, I find evidence that indicates an increase in the size of the family fund will negatively affect the fund performance. Even though the effect is statistically significant, it is not economically significant enough to create a major impact on fund performance. The test on the liquidity hypothesis suggests that fund size erodes fund performance because of the trading costs associated with liquidity and price impact. The size effect on performance is more pronounced in funds that have to invest in small stocks, which tend to be more illiquid, than those funds that invest in large stocks. This finding strongly indicates that liquidity is an important factor to why fund size erodes fund performance.

To ensure robustness of the result, I test whether fund size erodes fund performance during the 2007-2009 financial crisis. The result of this test shows that there is a stronger

negative relationship between fund size and its performance during economic contraction. The relation supports the view that during the recession, there is a shortage of liquidity and large funds have a higher exposure to the liquidity risk, which reduces its performance.

This paper provides several contributions to the mutual fund literature. First, this paper updated the prior study of Chen et al. (2004) by using the most recent data of mutual funds to investigate the relationship between fund size and fund performance. This will be useful for investors in understanding the role of mutual fund in today's economic conditions, especially in light of the substantial inflows that have increased the size of funds in the past decade, and caution them of the potential diseconomies of scale in active fund management. In addition, by providing an analysis of liquidity hypothesis, I can confirm the findings of Chen et al. (2004) and Yan (2008) that conclude liquidity is an important reason why fund size erodes fund performance.

This paper is structured as follow. In section 1, I present a literature review of the relevant academic studies on mutual fund and in section 2, I outline the hypothesis behind this research paper. Section 3 discusses the sample used in this study and section 4 provides a comprehensive research methodology. In section 5, I present my empirical findings and their implications, before addressing the study's conclusion and limitation in section 6.

1. Literature Review

This section provides the discussion of relevant academic literature on the mutual fund to enhance the readers understanding of the primary research of this paper. The paper focuses on the relationship between funds size and its performance, which will be useful to investors in understanding the role of mutual funds in today's economy- is there an economy of scale in active investment management? The main topics that are fundamental to the study of mutual funds are the following.

1.1: Mutual Fund Performance

The mutual fund industry has been growing tremendously in the last two decades, and its performance can be attributed to several factors, including portfolio manager luck and skill. Although investors appear to trust the expertise of mutual fund managers to invest their money, academics have questioned the ability of funds to outperform the market benchmarks.

One of the earliest studies on mutual fund performance is conducted by Jensen (1968), where he concludes that the average return of actively managed mutual funds underperforms passive benchmarks and the ability of fund manager to pick out stock is no better than randomly selecting the stock. However, it is possible that the test conducted, based on aggregate mutual fund holdings, is not powerful enough to detect the manager's ability and thus, the recent results are far more encouraging for active fund managers.

Wermers (2000) performs a comprehensive analysis on the performance of the mutual fund industry at the stock holdings level, and net returns to level, using data from 1975 to 1994. His empirical research shows that mutual fund with stock-based portfolios outperform a board market index by 1.3 percent per year, where 70 basis points is gain from the talents in selecting the stocks that outperform their characteristic benchmark portfolio and the remaining 60 basis points are from the higher average returns related to the characteristics of stock owned by the funds. Moreover, the high-turnover funds hold stocks with significantly higher average returns than low-turnover funds, which suggests that the managers of high-turnover funds have some stock-picking skills rather than just pure luck. Thus, the study strongly supports the value of active mutual fund management.

To further emphasize this importance, Baker, Litov, Wachter, and Wurgler (2010) uses the subsequent earnings announcement returns of stocks that funds hold and trade to analyze

fund manager's skill and fund performance. They find that average U.S. equity fund's recent buys comprehensively outperform its recent sell around the next earnings announcement, which indicates the fund manager's trading skill and their ability to forecast earning-related fundamentals. The result also matches with other long-horizon studies on fund performance that funds with growth-oriented style tend to perform better than those value-oriented styles. Lastly, they discover that the earnings announcement returns represent between 18% to 51% of the total abnormal returns earned by stocks that fund trade, which reinforce the previous findings documented by Chen et al. (2000). These recent studies indicate that by using a more powerful test, they can detect the fund manager's ability in choosing the stock, which is responsible for the mutual fund performance.

1.2: Fund Flows and Momentum

One of the fundamental anomalies in financial economics is why financial institution, such as mutual fund, appears to be so highly compensated, despite the uncertainty in the added value of their activities. Researches on the relationship between the performance of mutual fund managers and past performance provide no unanimous conclusions, but manager appears to earn rich rewards from superior past performance through the additional inflow of investment.

Carhart (1997) studies the persistence in mutual fund performance by extending Fama and French three-factor model with a fourth factor, momentum. He finds mutual funds that earn a higher one-year return is because they coincidently hold a relatively larger position in the last year's winning stocks and those mutual funds that follow one-year momentum strategy earn significantly lower abnormal returns due to transaction costs. This suggests that there is a short-term persistence in mutual fund returns and that wealth maximizing investor should invest in funds with high returns last year as they are more likely to generate higher than average expected returns in the next year, but not in years afterward. Also, the investor should avoid funds with persistently poor performance because even though these funds might outperform in the incoming year, they would not be able to cover their investment and transaction costs. Based on this findings, we should expect to see a higher level of cash inflow for the better performing mutual funds.

Sirri and Tufano (1998) investigate the determinant of fund flows into US equity mutual funds, and they conclude that investors fixate their fund purchase decisions on the prior performance information, which they tend to invest excessively more in funds that performed

well in the prior period. Their finding is in line with Gruber (1996), who find evidence that the aggregate pattern of investor spending is rational and that investors believe if they were to invest in funds which are receiving more inflow, they would earn a risk-adjusted return that outperforms the passive index funds. Sirri and Tufano (1998) also discover that search costs are an important determinant of fund flows and funds that receive greater media coverage (higher marketing fee) grow rapidly faster than others because of the lower consumers' search cost. Therefore, it can be concluded that high-fee funds (spend more on marketing) have a stronger performance-flow relationship than those of low-fee funds. This helps justify why well-performed funds will receive more media coverage and thus, more fund inflow.

Furthermore, the Berk and Green (2004) analyze the mutual fund flow and performance in rational markets where they find evidence that fund flow rationally reacts to past performance, even though fund performance shows no persistent and active managed funds underperform the passive benchmarks. Investors are rational and interpret the past superior performance of the fund as evidence of manager's skill, but due to the increasing inflow of money, there are decreasing returns for managers in utilizing their superior ability. The size of the fund and manager's compensation increased to the point where expected excess returns to investors are competitive in going forward and result in the fund to underperform the passive benchmark. This finding provides additional evidence as to why fund flow is positively related to the past performance of the fund, even though there appears to be no persistence in fund performance.

1.3: Fund Size

For many years, the relationship between fund size and fund performance has been one of the most studied topics in mutual fund research, but until today, the findings do not provide a clear-cut result. Although most of the research finds a negative relationship, some studies still confirm that growth in fund size is desirable.

Indro, Jiang, Hu, and Lee (1993) investigate the relationship between fund size and its performance as they believe that the inconsistent conclusions of prior studies result from the failure to identify the diminishing returns to scale in active management. They discover that the marginal returns become negative and there are diminishing marginal returns to information acquisition/trading when mutual funds exceed its optimal size. These diseconomies of scale occur because as fund becomes larger, the active managers are incapable of successfully

exploiting the information in a timely manner and become less consistent in implementing the investment process and valuation criteria set by the firm philosophy. Therefore, they encourage the fund to maintain its optimal size that is sufficient to cover the information costs and achieve the maximum efficiencies in returns.

Beckers and Vaughan (2001) study the impact of scale on mutual fund performance by performing laboratory experience, which they imitate the effect of size on returns for possible investment strategies and control for all confounding influences. They find larger fund managers have difficulty in efficiently choosing the desired portfolio that matches with the fund style-profile than the smaller fund manager. Therefore, the increases in fund size and growth could potentially lead to an increase in tracking error of the investment strategy, reduction in fund's information ratio and less value-added contribution to the fund. Most importantly, they discover no monotonic pattern in the implicit transaction costs as fund size increases. This suggests that fund performance does not erode entirely due to the implicit transaction costs as fund size increases, but also because of the loss in efficiency and less flexibility in execution by the managers.

Furthermore, Chen, Hong, Huang and Kubik (2004) presents evidence that both gross and net fund returns declines as fund size grow for the actively managed funds in the period of 1962 to 1999. They discover that the effect of fund size on fund returns is most pronounced among funds that hold an illiquid portfolio with high growth and turnover, which tend to have a high demand for immediacy. This suggests that liquidity is an influential factor of why fund size erodes fund performance and that the relationship is not driven by heterogeneity in fund style or other fund characteristics that are correlated with fund size. Moreover, they find that the organizational diseconomies related to hierarchy costs are responsible for the large fund to underperform the smaller fund. Large organizations with hierarchies exacerbate the process of idea implantation and the efforts to discover specific investment ideas are diminished relative to those in the smaller organization. Therefore, there is an inverse relation between fund size and fund performance.

Contrary to most studies, Zera and Madura (2001) emphasize the negative relationship between expense percentage and the individual funds and fund family size. Interestingly, the research shows that the elasticity of fund expenses with respect to fund size does not change across individual fund size categories and there exists a significantly negative relationship

between expense percentage and the individual funds and fund family size. This indicates that the growth in fund size is cost-efficient as it is associated with smaller expense percentages.

1.4: Transaction Costs

The evaluation of trading costs associated with financial trades has been an important research topic in securities markets. Transaction costs researches provide significant insight into the mutual fund performance as they show valuable information about the magnitude of leakage in performance from active trading. The costs can be categorized into two factors- the implicit costs (market impact costs and bid-ask spreads, e.g.) and the explicit costs. (taxes and brokerage, e.g.) The explicit costs of trading are detailed and measurable, but the implicit costs are difficult to accurately quantify as there are various calculation techniques to estimate them. Therefore, the studies of transaction costs on mutual funds have led to various conclusions.

Keim and Madhavan (1997) analyze the relationship between transaction costs and the investment styles of portfolio managers, using the sample of institutional equity trades. They find that active management results in a significantly higher trading activity than the passive buy-and-hold method, so naturally, the active management incurs substantially higher transaction costs. Also, their result shows that the implicit transaction costs are significantly higher for "growth" investment style, which require more demand for trade immediacy, than the "value" investment style. Evidently, transaction costs increased with the growth of trade size, and when active funds become larger, they must inevitably execute in more trading. The cost disadvantage occurs when the purchase and sale of large blocks of stock aggravate the informational asymmetry and liquidity problem for market makers and increase in bid-ask spread. Therefore, the fund performances could be negatively affected by the efficient execution of actively trading strategies due to higher transaction costs.

Perold and Salomon (1991) investigate the important impediment to good investment performance- diseconomies of scale in the transaction. They explain that the diseconomies of scale occur when asset under management increases because the larger size of the asset leads to an increase in position size and declines in the portfolio return as a percentage of assets. The wealth created (in dollars) will naturally increase, and the wealth-optimal point will be reached when the cost of additional trading exceeds the opportunity cost of not trading. Therefore, the further growth in assets will result in an increased non-executed trade and more substantial

opportunity costs. This indicates that increasing the fund size will trigger more opportunity costs and lower percentage returns.

The most recent studies on the impact of transaction cost on the mutual fund are conducted by Chan, Faff, Gallagher, and Looi (2008), where they examine the extent to which fund size and trading activity erode the fund performance. To their surprises, they find no relationship between fund size and market impact costs, but upon closer examination of portfolio configuration of managers, they discover that large fund reduces the market impact costs by holding more stocks in their portfolio and investing significantly in large liquid stock. Due to the transaction costs that are positively correlated with stock illiquidity and trade size, large funds need to maintain the costs by investing in more liquidity securities and as a result, realize a relatively lower return than smaller funds. This indicates that transaction costs significantly influence the portfolio configuration preference and negatively impact the fund performance because large funds incur opportunity cost for not investing in illiquid securities and thus, experience a low return.

1.5: Mutual Fund Family

A mutual fund family is a group of mutual funds that are managed by one investment group, and each of the mutual funds is unique with its investment portfolio. In this sense, mutual funds belong to a boarder organizational structure, which the family might have a significant influence on the fund performance or there might exist a cross-sectional dependence of fund flow across funds of the same family.

Khorana and Servaes (2011) examine investor behavior and the determinants that drive market share in the mutual fund industry. They find that the families that charge a lower fee and offer a broader range of funds relative to the competitor tend to have a larger market share. Moreover, Nanda, Wang, and Zheng (2000) conclude that there is a positive spillover effect from a superior performer to other funds within the family, which results in greater inflows to the other funds in the family. This indicates that the correlation between fund flows can increase the cumulative inflows in a non-linear way and it is sufficient for the family to focus on a few outperforming funds that would eventually lead to an increased inflow to the entire family. This strategy allows the firm to have flexibility in allocating its resources to promote the well-performing funds or expand its research department. Evidently, larger families offer a more

substantial number of funds, which provides them with more resources to adopt a fund promoting strategy, gain larger market share and exhibits a greater aggregated inflow.

Chen et al. (2004) also find that the fund performance increases with the size of the other funds in the family because the large family fund can capture the economies of scale associated with marketing, trading commissions, and lending fees. These costs are substantial, and the spread in performance between large and small family fund can easily be accounted for. Therefore, as many studies suggested, there are many advantages of large mutual fund family and the size has a positive effect on its performance.

1.6: Effect of changes in regulations

In the last decade, there have been many changes to the regulatory landscape that has significantly impacted the mutual fund industry. Many of the previous studies have examined the sample periods ending in 2000 and concluded that the performance of a mutual fund is positively related to the size of the family to which it belongs. (Chen et al., 2004; Guedj and Papastaikoudi, 2004) However, since then, there have been many significant regulatory changes, such as Regulatory Fair Disclosure (Reg FD), Global Settlement (GS) and the increase in regulatory inspection caused by late trading and market timing scandals, which may have affected the ability of large families' fund to outperform their smaller peers.

The study by Bhojra, Cho, and Yehuda (2012) examines the effect of these regulatory changes to test if the size of the family fund is still positively related to its performance, and they conclude that the beneficial effects of fund family size (superior stock picking ability and information advantage) on fund performance has significantly weakened subsequently to the regulatory changes. The stricter regulations lead to limiting the selective disclosure of information by firms to analysts, lowering the quality of sell-side research due to the changes of the cost-benefit tradeoff of research to large investment banks and increasing the administration costs to limit the late trading and marketing timing opportunities. These factors have significantly reduced the large fund family's performance, and the positive association between the size of the family fund and its performance has gradually decreased.

2. Hypothesis

The central research question of this thesis is: *does equity fund size have any significant influence on the fund performance?*

The core research and hypothesis of this paper examines the relationship between mutual fund size and its performance, using data sample from 2003 to 2017. Previous studies done by Chen et al. (2004) and Yan (2008) have concluded on a consensus that fund size erodes fund performance. They suggest that liquidity is an influential factor and that the relationship is not driven by heterogeneity in fund style or other fund characteristics that are correlated with fund size. The prior studies used the sample data range from 1962 to 2002, so it is interesting and beneficial to test whether the same conclusion still holds when using a more updated data that can better represent the role of mutual fund in today's economic condition. Thus, my hypothesis is as follow:

First Hypothesis*: Fund size negatively affects fund performance*

Since many funds belong to fund families (e.g., BlackRock Family offers as many as 864 funds), I delve deeper into the effect of the size of fund family on fund performance. Guedj and Papastaikoudi (2004) find that there is a stronger persistence of performance in larger families due to their flexibility in allocating resources to promote the well-performing funds or hire more fund managers. Chen et al. (2004) also provide evidence to support that the fund performance increases with the size of the other funds in the family because the large family fund can capture the economies of scale associated with expenses. However, since 2000, there have been many changes to the regulatory landscape that has significantly impacted the mutual fund industry. The study by Bhojra, Cho, and Yehuda (2012) conclude that the beneficial effects of fund family size performance have significantly weakened after the stricter regulatory changes. Therefore, I investigate the relationship between the size of the family fund and its performance using the data from after the regulatory changes, as I believe the stricter regulation has caused the positive relationship to disappear. My hypothesis is as follow:

Second Hypothesis: *There is a negative relationship between the size of the fund within the family and its performance*

To find a potential explanation to support my first hypothesis, I test the liquidity hypothesis designed by Chen et al. (2004). The hypothesis stated that fund size erodes fund performance because of the trading costs associated with liquidity and price impact. The effect of fund size will erode performance much more among funds that have to invest in small stocks (small market capitalization) than funds that invest in large stocks because funds that hold primarily small-cap stocks are more illiquid in the sense that the stocks in the portfolio tend to have large Kyle lambdas and big bid-ask spread. As a result, they need to find new stock ideas with asset base growth while the large funds can increase their current stock positions without being affected too much by price impact. The finding of this hypothesis will help determine the factor that erodes fund performance, so my hypothesis is stated as follow:

Hypothesis 3*: There is a smaller effect of fund size on fund performance for funds that invest primarily in Large Cap Stocks*

3. Data

My data on mutual funds are obtained from the Center for Research in Security Prices (CRSP)-Survivor-Bias free US Mutual Fund Database, which spans from the beginning of 2003 to the end of 2017. Following Chen et al. (2004) and many prior studies, I restrict my analysis to only diversified U.S. equity mutual funds, by removing fixed income, international, hybrid and specialized sectors funds. Also, the fund must invest in more than 70% of common stocks and must have at least one year of reported return because the benchmark portfolio used in my calculation is formed based on fund past performance. To eliminate redundant observations of mutual funds that have different share classes and report their returns multiple times in the same month, I aggregate the subclass of each fund into a single mutual fund.

According to Elton, Gruber, and Blake (2001), there is a systematic upward bias in the reported return of funds that have less than $15 million in total net assets under management. Therefore, I exclude fund with less than $15 million in total net asset and sort all the samples into ten deciles based on their last month total net assets. (the first decile represents the smallest funds and tenth deciles represents the largest funds) This allows me to better analyze and observe for any relationship between scale and performance. The number of mutual funds that pass my selection criteria and includes in my sample is 8,882 mutual funds.

Table 1 reports the summary statistic of all my sample. The total data have average total net assets (*TNA*) of $842 million with a standard deviation of $3968.21 million. It is important to note that the standard deviation is large due to the substantially large spread of the *TNA*. Also the proxy of fund size that I will use in the analysis is the log of a fund's *TNA* (*LOGTNA*) and for family fund size, I will use *LOGFAMSIZE*, which is the log of one plus the cumulative *TNA* of the other funds in the family's fund that the fund belongs to, excluding its own *TNA*. The average fund turnover (*TURNOVER*) is 67.92 percent per year, and it is defined as the minimum of purchases and sales of securities divide by the average *TNA* for one year. The average age (*AGE*) is 18.57 years and the average expense ratios (*EXPRATIO*), defined as total annual expense divide by year-end *TNA*, is approximately 96 basis points per year. Lastly, the variable *FLOW* in month *t* is defined by Chen et al. (2004) as the fund's *TNA* in month *t* minus with the product of the fund's *TNA* at month *t*-12 with the net fund return between months *t*-12 and *t*, all divided by fund's *TNA* at month *t*-12. The average fund flow in my sample is 19.8 percent per year.

Table 1: Summary Statistics			
Number of funds: 8,882			
Variables	Mean	Std. Dev	Observations
TNA ($ million)	842.0	3968.21	746,043
LOGTNA ($ million)	5.71	1.65	746,043
LOGFAMSIZE ($ million)	13.99	2.86	735,553
TURNOVER (% per year)	67.92	126	746,043
AGE (years)	18.57	11.33	746,043
EXPRATIO (% per year)	0.96	0.6	746,043
MGMTFEE (% per year)	4.83	3.23	746,043
FLOW (% per year)	19.8	91.5	714,217

Notes: This table reports the summary statistic for 8,882 mutual funds that meet my selection criteria. TNA is the total net assets under management in millions of dollars. LOGTNA is the logarithm of TNA. LOGFAMSIZE is the logarithm of one plus the cumulative TNA of the other funds in the family's fund that the fund belongs to, excluding its own TNA. TURNOVER is the fund turnover, which is defined as the minimum purchase and sales of securities divide by the average TNA for one year. AGE is the number of years since the fund started. EXPRATIO is the total annual expense divided by year-end TNA. MGMTFEE is the total management fee. FLOW is the percentage of new fund flow into the mutual fund over the past year.

Table 2 reports the time-series average of the cross-sectional correlations between various variables of fund characteristics, using all the sample. *LOGTNA* shows a positive correlation with *LOGFAMSIZE* (0.08) and *AGE* (0.36) while varies inversely with *TURNOVER* (-0.14), *EXPRATIO* (-0.17) and *MGMTFEE* (-0.08).

Table 2: Time-series average of correlation between fund characteristic (all funds)

	TNA	*LOGTNA*	*LOGFAMSIZE*	*TURNOVER*	*AGE*	*EXPRATIO*	*MGMTFEE*	*FLOW*
TNA	1	0.39	0.04	-0.06	0.11	-0.11	-0.08	0.00
LOGTNA		1	0.08	-0.14	0.36	-0.17	-0.08	0.01
LOGFAMSIZE			1	-0.03	-0.01	-0.16	-0.14	0.01
TURNOVER				1	-0.01	0.35	0.31	0.00
AGE					1	0.08	0.06	-0.01
EXPRATIO						1	0.84	-0.01
MGMTFEE							1	-0.01
FLOW								1

Notes: This table reports the time-series average of correlation between fund characteristics, using all samples

Table 3 reports the time-series average of the cross-sectional correlations between various variables of fund characteristics, excluding the two smallest deciles. The results show a similar correlation between variables to those in table 2. However, due to the existing correlation between variables, it is important that I control for these fund characteristics before estimating the cross-sectional relationship between fund size and its performance.

Table 3: Time-series average of correlation between fund characteristic (exclude two smallest deciles)

	TNA	*LOGTNA*	*LOGFAMSIZE*	*TURNOVER*	*AGE*	*EXPRATIO*	*MGMTFEE*	*FLOW*
TNA	1	0.56	0.07	-0.12	0.00	-0.23	-0.17	0.00
LOGTNA		1	0.08	-0.15	0.20	-0.18	-0.19	0.00
LOGFAMSIZE			1	-0.02	-0.05	-0.16	-0.15	0.00
TURNOVER				1	0.10	0.39	0.36	-0.01
AGE					1	0.19	0.07	0.00
EXPRATIO						1	0.89	0.00
MGMTFEE							1	0.00
FLOW								1

Notes: This table reports the time-series average of correlation between fund characteristics, excluding the two smallest deciles

Table 4 reports the mean and standard deviations for the monthly fund returns, *FUNDRET*. The monthly gross fund return, adjusted by the return of the market portfolio, is calculated by taking the year-end expense ratio and dividing it by 12. Then, add it to the monthly returns during the year. For all the sample of mutual funds, the average monthly performance is 91 basis point with a standard deviation of 5.01 percent. The net fund returns show that the fund in the sample outperforms the market by 85 basis points per month. The results show that the fund managers can beat the market even after deducting for the management fee and perform quite consistently well. Therefore, this indicates why investors are willing to pay a lot in fees for the manager's stock-picking ability. However, these figures are opposite to those

documented by Chen et al., (2004). The results imply that the largest fund outperform the smallest fund and this does not support any diseconomies of scale in fund performance. Instead, the increase in fund size generates a higher return. It will be interesting to see if there is a positive relationship between fund size and fund performance when I run the regressions.

Table 4: Time-series average of cross-sectional averages of market-adjusted fund returns

	Mutual fund size deciles										
	1	2	3	4	5	6	7	8	9	10	All funds
Gross Fund Return	0.89%	0.99%	0.98%	0.99%	0.93%	1.00%	0.96%	0.94%	1.01%	0.98%	0.91%
(S.D.)	[5.15%]	[4.70%]	[4.50%]	[4.35%]	[4.44%]	[4.39%]	[4.24%]	[4.14%]	[4.26%]	[3.99%]	[5.01%]
Net Fund Return	0.83%	0.92%	0.91%	0.92%	0.86%	0.92%	0.89%	0.87%	0.96%	0.93%	0.85%
(S.D.)	[5.47%]	[4.69%]	[4.49%]	[4.33%]	[4.42%]	[4.39%]	[4.23%]	[4.14%]	[4.23%]	[3.98%]	[5.26%]

Notes: This table reports the time-series average of cross-sectional average of market-adjusted fund returns for each decile and all the sample of mutual funds

4. Methodology

Based on the pioneer studies of Chan et al. (2004), this research paper utilizes cross-sectional variation to examine the relationship between fund size and fund performance as it is less likely to be subjected toward regression-to-mean bias. However, there are two problematic concerns when using this method. The first problem is the fact that there could be heterogeneity between fund of different sizes and fund of different styles, or in another word, the investing styles of the fund might be the significant driving force behind fund performance. Grinblatt and Titman (1989) report that smaller funds outperform larger funds with the abnormal return due to its aggressive growth investment objective and investment style rather than by fund size. Therefore, I adjust for fund performance by using various benchmarks.

4.1 Fund Performance Benchmarks

I employ the simple market-adjusted returns and the returns adjusted by the Capital Asset Pricing Model (CAPM) of Sharpe (1964). For additional explanatory power to observe the cross-sectional variation in fund performance, I consider the returns adjusted using Fama and French (1993) three-factor model and this model augmented with the momentum factor of Jegadeesh and Titman (1993).

Table 5: Summary statistics of the factors

	Mean	SD of	Cross-correlations			
Factor	return	return	VWRF	SMB	HML	MOM12
VWRF	0.82%	4.04%	1	0.37	0.29	-0.35
SMB	0.15%	2.29%		1	0.16	-0.10
HML	0.01%	2.54%			1	-0.40
MOM12	-0.06%	4.55%				1

Notes: This table reports the summary statistics of the factors. VWRF is the return of the CRSP value-weighted stock index in excess of one-month Treasury rate. SMB is the return on a portfolio of small stocks minus large stocks. HML is the return on a portfolio long on high book-to-market stocks and short on low book-to-market stocks. MOM12 is the return on a portfolio of long stock that is the past 12-month winners and short those that are the past 12-month losers.

Table 5 reports the summary statistic for several variables used to produce the fund performance benchmarks. The variables include the returns on CRSP value-weighted stock index of one-month Treasury rate (VWRF), the returns to Fama and French (1993) small stocks minus large stocks (SMB) and high book-to-market stocks minus low book-to-market stocks (HTML) portfolios and the returns-to-price momentum portfolio (MOM12). This last variable

consists of a portfolio that long stocks in the past-12-month winners and short stocks in the past-12-months loser, which are held for one month. The result indicates that the four-factor model can explain considerable time-series variation in the returns because of the relatively high variance of SMB, HML, and MOM12 and of their low correlations with each other. The low cross-correlation also implies that multicollinearity does not significantly affect the estimated four-factor model loadings. (Carhart 1997)

In order to find the relationship between fund size and its performance, I sort the mutual funds at the beginning of each month based on their previous month TNA into ten decile portfolios with an incremental of one billion US dollar. Then, I track these ten portfolios for one month and use the entire time series of their monthly net returns to calculate the loadings to four factors (VWRF, SMB, HML, MOM12) for each of these ten portfolios. The entire process repeats itself each month where each mutual fund will be assigned to the loadings of one of these ten portfolios, but if a mutual fund's monthly net returns exceed its size decile, it will be assigned to a new set of loading with a next month's performance adjusted.

Table 6: Loadings calculated using the CAPM

	CAPM	
Portfolio	Alpha	VWRF
1 (small)	-0.093%	1.05
2	-0.067%	1.03
3	-0.081%	1.02
4	-0.080%	1.00
5	-0.129%	1.02
6	-0.080%	1.02
7	-0.116%	1.01
8	-0.060%	1.01
9	-0.038%	1.01
10 (large)	-0.074%	0.99

Notes: This table reports the loading of the ten (equal-weighted) *TNA*-sorted fund portfolios using CAPM

Table 6 reports the loadings of the ten fund-size (TNA) sorted mutual fund portfolios using CAPM with the first decile classifies as the smallest size and the tenth decile as the largest size.

$$(1) \qquad \mathrm{R}_{i,t} = \alpha_i + \beta_i \mathrm{VWRF}_t + \varepsilon_{i,t} \qquad t = 1, \ldots, T$$

In CAPM model, $\mathrm{R}_{i,t}$ indicates the return (net fund) on one of the ten fund-size-sorted mutual fund portfolio in month t in excess of one-month T-bill return, α_i is the excess return of that

portfolio, β_i is the loading on the market portfolio and $\varepsilon_{i,t}$ denotes a generic error term, which is uncorrelated with all other independent variables. The result shows that the average mutual fund has a beta of 1.02, which indicates that mutual fund security's price moves with the market and that they do not hold a lot of risky securities. Also, the alpha for the smallest portfolio is more negative than that of the largest portfolio, which indicates the smallest portfolio underperform the largest portfolio. This might be due to returns during the financial crisis. The smallest portfolio has the largest beta in all of the portfolio (1.05), and this suggests that the smaller fund invests more in small cap companies than the large funds, which generates higher returns and have more growth potential but are also more volatile. During a period of economic contraction, small-cap companies do not have the resources of large-cap companies, which make them more vulnerable and underperform. On the other hand, the largest portfolio has the smallest beta of 0.99, which indicates that they invest more in mid to large cap companies and are more likely to generate less loss during the financial crisis.

Table 7: Loadings calculated using the 3-Factor model and the 4-Factor model

	3-Factor model				4- Factor model				
Portfolio	Alpha	VWRF	SMB	HML	Alpha	VWRF	SMB	HML	MOM12
1 (small)	-0.09%	1.03	0.13	-0.02	-0.09%	1.01	0.14	-0.04	-0.04
2	-0.07%	1.03	0.08	-0.06	-0.06%	1.02	0.09	-0.07	-0.03
3	-0.08%	1.01	0.05	-0.06	-0.07%	1.00	0.06	-0.08	-0.03
4	-0.09%	1.01	0.01	-0.06	-0.08%	1.00	0.02	-0.08	-0.02
5	-0.13%	1.03	0.03	-0.06	-0.12%	1.02	0.04	-0.08	-0.03
6	-0.08%	1.02	0.01	-0.07	-0.06%	1.01	0.02	-0.10	-0.05
7	-0.12%	1.02	0.00	-0.07	-0.11%	1.01	0.00	-0.08	-0.03
8	-0.06%	1.01	0.02	-0.06	-0.06%	1.01	0.02	-0.07	0.00
9	-0.04%	1.00	0.05	-0.05	-0.03%	1.00	0.05	-0.06	-0.02
10 (large)	-0.08%	1.01	-0.02	-0.08	-0.07%	1.00	-0.01	-0.10	-0.03

Notes: This table reports the loadings using Fama-French (1993) 3-Factor model and this model augmented with momentum factor (4-factor model)

Table 7 reports the loadings of the Fama-French three-factor model and this three-factor model augmented with a momentum factor. The four-factor model can be interpreted as a performance attribution model because the coefficients on the factor-mimicking portfolios indicate the proportion of mean return attributable to four fundament strategies in the stock market: stock return versus treasury rate, large versus small market capitalization stocks, growth versus value stocks and momentum versus contrarian investing strategies. (Carhart

1997) This shows that the four-factor model has significant explanatory power for observing the cross-sectional variation in fund performance.

(2) $$R_{i,t} = \alpha_i + \beta_{i,1}\text{VWRF}_t + \beta_{i,2}\text{SMB}_t + \beta_{i,3}\text{HML}_t + \varepsilon_{i,t} \qquad t = 1, \ldots, T$$

(3) $$R_{i,t} = \alpha_i + \beta_{i,1}\text{VWRF}_t + \beta_{i,2}\text{SMB}_t + \beta_{i,3}\text{HML}_t + \beta_{i,4}\text{MOM12}_t + \varepsilon_{i,t} \qquad t = 1, \ldots, T$$

In these two models, $R_{i,t}$ indicates the return (net fund) on one of the ten fund-size-sorted mutual fund portfolio in month *t* in excess of one-month T-bill return, α_i is the excess return of that portfolio and $\varepsilon_{i,t}$ denotes for a generic error term, which is uncorrelated with all other independent variables. Lastly, β_i's are the loading on various portfolios that represent SMB, HML and MOM12 return on factor-mimicking portfolios for size, book to market equity and on year momentum in stock returns. The result shows that the alpha for the smallest fund is still more negative than that of the largest fund, but the differences are smaller than the previous findings from CAPM. Moreover, the small portfolio tends to have higher loading on SMB and HML than the large portfolio. On Three-Factor model, the first decile has SML and HML of 0.13 and -0.02 while the corresponding loadings for funds in the tenth decile is -0.02 and -0.08. This provides evidence that the larger funds tend to hold large and glamour stocks whereas the small funds tend to play small and value stocks. The result from the Four-Factor model also indicates the same trend for both large and small funds found in the Three-Factor model. However, the loading of momentum on large funds is less negative than those on small funds.

4.2 Regression Specifications

As mention earlier, another problematic concern of using cross-sectional variation is the possible correlation between fund size and other fund characteristics, such as fund age or turnover, which may be the influencing factors in driving the performance of the fund. Therefore, I examine the effect of past fund size on its performance in the regression framework, using the loadings for each benchmark calculated earlier to adjust for the return of each fund. By performing this regression, I can control for the effects of other fund characteristics on performance and isolate the specific relationship between fund size and fund performance. Thus, preventing any spurious effects that might arise. The regression specification that I apply is the following.

(4) $$FUNDRET_{i,t} = \mu + \phi LOGTNA_{i,t-1} + \gamma \text{X}_{i,t-1} + \varepsilon_{i,t} \qquad i = 1, \ldots, N$$

In this model, $FUNDRET_{i,t}$ represents the return (either gross or net) of fund *i* in month *t* adjusted by the various performance benchmark calculated above, μ is a constant, $LOGTNA_{i,t-1}$ is the measure of fund size and $X_{i,t-1}$ is a set of control variables that includes $TURNOVER_{i,t-1}$, $FLOW_{i,t-1}$, $LOGFAMSIZE_{i,t-1}$, $AGE_{i,t-1}$, $MGMTFEE_{i,t-1}$ and $EXPRATIO_{i,t-1}$ and $LAGFUNDRET_{i,t-1}$, which is the previous year return of the fund. In addition, $\varepsilon_{i,t}$ is a standard error term that is uncorrelated with other independent variables. The most important coefficient is ϕ, which explains the relationship between fund performance and fund size while controlling for other fund characteristics, and γ, which is a vector of loadings on the control variables. In order to take into account of the time-series and cross-sectional variations in the panel data sample, I evaluate equation (4) with monthly fixed effect and both monthly and firm fixed effect. After I calculate these monthly regressions, I take time series means and standard deviation of those estimates and investigate if there is an economies of scale in mutual fund.

In order to find the relationship between the size of the family fund and its performance, I sort the data and compile funds into their respective family funds before I apply regression (4) with monthly and firm fixed effect. Lastly, I use the following regression specification to investigate the liquidity hypothesis:

(5) $FUNDRET_{i,t} = \mu + \phi_1 LOGTNA_{i,t-1} + \phi_2 Ind_{[style]} + \phi_2 LOGTNA_{i,t-1} * \phi_3 Ind_{[style]} + \gamma X_{i,t-1} + \varepsilon_{i,t}$ $i=1,\ldots,N$

In this model, $Ind_{[style]}$ is a dummy variable that equals to one if a fund belongs to a specific style category and zero otherwise. $\phi_2 LOGTNA_{i,t-1} * \phi_3 Ind_{[style]}$ is the interaction term, and the remaining variables are the same as in equation (4).

4.3 Robustness Check

For a robustness check, I test whether the relationship between fund size and its performance is different during the 2007-2009 financial crisis. I run the regression using the sample of mutual funds from January 2007 to December 2009.

5. Empirical Results

First Hypothesis*: Fund size negatively affects fund performance*

Table 8 reports the estimation results for the regression specification given in equation (4). In the regression, I use the market and beta-adjusted return with monthly and firm fixed effect to investigate for the relationship between fund size and its performance. The sample consists of funds from fund size deciles two to ten as the first deciles might be subjected to upward biased and lead to inaccurate results. I begin by reporting the results for gross fund returns. The coefficient in front of *LOGTNA* is negative and statistically significant at 1% across the four performance measures. The coefficient of LOGTNA for market-adjusted return with fixed effect is -0.0034, but as I applied the monthly and firm fixed effect to the beta-adjusted return and 4 factor model, the magnitude of the negative relationship increases to about -0.0054. These negative coefficients indicate that an increase in fund size leads to lower fund returns. To illustrate the magnitude of my findings, one standard deviation of *LOGTNA* is 1.65 and two standard deviation shock to fund size means that performance changes by -0.0054 times 3.3, or 1.8 basis points per month (21.6 basis points per year). As a result, an increase in fund size can cause a spread in fund performance of 21.6 basis points year. My findings are consistent with the previous studies of Chen et al. (2004), but in their studies, the magnitude of this negative relationship is stronger; their *LOGTNA* coefficients obtained from using CAPM-adjusted return is -0.028. By comparing the result, it could be concluded that the negative effect of fund size on fund performance has diminished when analyzing with the most recent data of mutual funds.

Another interesting variable for gross fund returns is the *LOGFAMSIZE* and *LOGFUNDRET*, which are both statistically significant across all four performance measures. *LOGFAMSIZE* is a variable that determines whether there is a relationship between the size of the family fund and its performance and its coefficients are negative across all the models, with the range from -0.0002 to -0.0003. I will later investigate and interpret this relationship in hypothesis two. It is important to emphasize the reason to control for family fund size in order to find a significant impact of fund size on its performance because fund size and family size are positively correlated, and that family size has a negative relationship with its performance.

Table 8: Regression of fund performance on lagged fund size, excluding the first decile

	Gross fund returns				Net fund returns			
	No Fixed Beta-Adj	Monthly& Firm Fixed Market-Adj	Monthly & Firm Fixed Beta-Adj	Monthly & Firm Fixed 4 Factor	No Fixed Beta-Adj	Monthly& Firm Fixed Market-Adj	Monthly & Firm Fixed Beta-Adj	Monthly & Firm Fixed 4 Factor
INTERCEPT	0.0098***	0.0352***	0.0263***	0.1012***	0.0096***	0.0349***	0.0262***	0.1005***
	(0.0006)	(0.0018)	(0.0005)	(0.0039)	(0.0007)	(0.0018)	(0.0020)	(0.0038)
$LOGTNA_{i,t-1}$	-0.0008***	-0.0034***	-0.0054***	-0.0053***	-0.0007***	-0.0033***	-0.0044***	-0.0051***
	(0.0001)	(0.0001)	(0.0001)	(0.0003)	(0.0000)	(0.0001)	(0.0001)	(0.0003)
$LOGFAMSIZE_{i,t-1}$	-0.0002***	-0.0003***	-0.0003***	-0.0003***	-0.0002***	-0.0003***	-0.0003***	-0.0003***
	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
$TURNOVER_{i,t-1}$	-0.0044***	0.0047*	0.0001	-0.0010	-0.0048***	0.0045	0.0002	-0.0007
	(0.0015)	(0.0028)	(0.0029)	(0.0029)	(0.0015)	(0.0028)	(0.0029)	(0.0030)
$AGE_{i,t-1}$	0.0000***	0.0001	0.0000	0.0001	0.0000***	0.0001	0.0000	0.0001
	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0001)
$MGMTFEE_{i,t-1}$	-0.0028	-0.0872***	-0.0807***	-0.2766***	-0.0091***	-0.0764*	-0.0689***	-0.2648***
	(0.0026)	(0.0142)	(0.0140)	(0.0320)	(0.0026)	(0.0143)	(0.0140)	(0.0310)
$FLOW_{i,t-1}$	0.0000	0.0001*	0.0000	0.0000	0.0000	0.0001*	0.0000	0.0001
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
$LAGFUNDRET_{i,t-1}$	0.0175***	0.0232***	0.0150***	0.0353***	0.0175***	0.0231***	0.0150***	0.0256***
	(0.0013)	(0.0015)	(0.0013)	(0.0028)	(0.0013)	(0.0015)	(0.0013)	(0.0028)

Notes: This table reports market-return adjusted, 4 factor adjusted and beta-return adjusted model (regression 4) estimates of monthly fund returns regressed on fund characteristics with a one-month lag. The sampl only includes funds that fall within the fund size of decile two to ten to avoid upward bias in decile one. Fund returns are calculated before (gross) and after (net) deducting fees and expenses. The returns are adjuste using the market model and CAPM, with no fixed effect, monthly fixed effects and monthly & firm fixed effect. The dependent variable is *FUNDRET*. The independent variable includes: *LOGTNA*- natural logarithr of TNA, *LOGFAMSIZE*- natural logarithm of plus one the size of family that fund belongs to, *TURNOVER*- the fund turnover, *AGE*- is the number of years since the fund began investing, *MGMTFEE*- the managemer fee charged by the fund, *FLOW*- the percentage of new fund flow into the mutual fund over the past year and *LAGFUNDRET*- the cumulative fund return over the past 12 months. The sample is from January 200 to December 2017. The standard error is reported in the parentheses. Significant level: *** significant at 1%, ** significant at 5% and * significant at 15%.

The coefficient in front of *LAGFUNDRET* is significant and positive, which suggests that the past positive fund return will likely generate positive performance in the future or in another word, there is some persistent in fund returns. This result is consistent with Carhart (1997) who find that there is a short-term persistence in mutual fund returns and that investor should invest in funds with high returns in the prior year as they are more likely to generate higher than expected returns in the next year.

The variable TURNOVER shows mixed results and it is statistically significant in some model. The positive coefficients are not significant at any level, but the negative coefficients are both statistically significant at 1% levels, with the range from -0.0044 to -0.0048. TURNOVER can be interpreted as a proxy for whether a fund is active or passive. Therefore, my result indicates that mutual funds should adopt a value trading strategy, which tends to have a lower turnover rate because a high turnover rate would decrease the fund returns. This is a prudent approach because fewer transactions will help to lower the trading costs and the expense ratio. However, the high turnover funds are only justified when they can generate enough return to counterbalance the trading costs.

The variable MGMTFEE shows a logical result. The variable coefficients are negative across all the performance measures, and they are all statistically significant, except for the beta-adjusted returns with no fixed effect model. The result indicates that the higher management fee charged by the fund would negatively affect the fund returns. Moreover, the last two variables, *AGE*, and *FLOW*, show no relationship with the fund return across all the performance measures.

Next, I report the results of the regression using net fund returns. The coefficient for *LOGTNA* is still negative and statistically significant across all performance benchmarks. The coefficients are almost the same compared to using gross fund returns. Hence, the observations regarding the economic significance and its negative relationship of fund size to its performance mention earlier continue to hold. Moreover, the coefficients of other variables have similar signs to those obtained using gross fund returns.

In table 9, I provide regression of beta-adjusted return with monthly and firm fixed effect model for each decile to better analyze the decreasing return to scale and to confirm the above findings. The result shows a definite pattern of diseconomies of scale in the mutual fund. The coefficient of LOGTNA is negative and statistically significant at one-percent for all the decile. The magnitude of the negative relationship increases as the decile is larger, from -0.0021 in decile one to -0.0360 in decile ten. This suggests that the negative relationship between fund size and its performance is getting stronger when the fund size starts to increase. From decile one to decile five, the inverse relationship increases from -0. 0021 to -0.0603. This indicates that fund size negatively affects fund performance in a non-linear relation and that the size effect increases as the fund size grows. Also, the effect of fund size erosion on its performance is most pronounced when the fund size is between 5 and 6 billion dollars. After that, the size effect starts to weaken as the coefficient becomes more positive; from -0.0601 in decile six to -0.0360 in decile ten. The result concludes that even though an increase in fund size erodes fund performance, there exist some other factors that make the largest-size fund to perform more efficiently than the mid-size fund.

Table 9: Beta-Adjusted with firm and monthly fixed effect per decile

Decile	1	2	3	4	5	6	7	8	9	10
INTERCEPT	0.0086***	0.0991***	0.1778***	0.3409***	0.3770***	0.4276***	0.0303*	0.1127***	0.3881***	0.0329***
	(0.0006)	(0.0000)	(0.0077)	(0.0186)	(0.0590)	(0.0404)	(0.0178)	(0.0179)	(0.0371)	(0.0063)
$LOGTNA_{i,t-1}$	-0.0021***	-0.0143***	-0.0236***	-0.0436***	-0.0603***	-0.0601***	-0.0324***	-0.0164***	-0.0461***	-0.0360***
	(0.0001)	(0.0004)	(0.0009)	(0.0022)	(0.0028)	(0.0034)	(0.0029)	(0.0024)	(0.0043)	(0.0034)
$LOGFAMSIZE_{i,t-1}$	-0.0001***	-0.0003***	-0.0003***	-0.0003***	-0.0001	-0.0006***	-0.0005***	-0.0003**	-0.0005**	-0.0005***
	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
$TURNOVER_{i,t-1}$	0.0037***	0.0035	0.0029	-0.0076	0.0215	-0.0244	0.0183	-0.0037	0.0085	0.0034
	(0.0007)	(0.0041)	(0.0050)	(0.0160)	(0.0185)	(0.0238)	(0.0227)	(0.0238)	(0.0312)	(0.0108)
$AGE_{i,t-1}$	0.0001***	0.0002*	0.0002*	0.0007***	0.0050**	0.0039***	0.0094***	0.0015***	0.0015***	0.0002
	(0.0000)	(0.0001)	(0.0001)	(0.0002)	(0.0020)	(0.0011)	(0.0010)	(0.0004)	(0.0003)	(0.0002)
$MGMTFEE_{i,t-1}$	-0.0258***	-0.0651***	-0.1021***	-0.2021*	-0.0130	-0.0123	-0.0496	-0.0215	-0.0056	-0.0670*
	(0.0037)	(0.0194)	(0.0389)	(0.0833)	(0.0959)	(0.1072)	(0.0880)	(0.1090)	(0.1883)	(0.0403)
$FLOW_{i,t-1}$	0.0001**	0.0001	0.0007***	0.0019***	-0.0041*	0.0005	0.0002***	0.0000	0.0000	0.0002**
	(0.0001)	(0.0001)	(0.0027)	(0.0002)	(0.0028)	(0.0011)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$LAGFUNDRET_{i,t-1}$	0.0145***	0.0111***	0.0130***	0.0014	0.0049	-0.0025	-0.0056	0.0088	-0.0168*	0.0152***
	(0.0006)	(0.0017)	(0.0027)	(0.0046)	(0.0051)	(0.0064)	(0.0074)	(0.0081)	(0.0105)	(0.0030)

Notes: This table reports regression (4) for the beta-return adjusted, regressed on fund characteristics with one-month lag for each decile. Fund returns are calculated before (gross) and after (net) deducting fees and expenses. The returns are adjusted using the CAPM, with monthly & firm fixed effect. The dependent variable is *FUNDRET*. The independent variable includes: *LOGTNA*- natural logarithm of TNA, *LOGFAMSIZE*- natural logarithm of plus one the size of family that fund belongs to, *TURNOVER*- the fund turnover, *AGE*- is the number of years since the fund began, *MGMTFEE*- the management fee charged by the fund, *FLOW*- the percentage of new fund flow into the mutual fund over the past year and *LAGFUNDRET*- the cumulative fund return over the past 12 months. The sample is from January 2003 to December 2017. The standard error is reported in parentheses. Significant level: *** significant at 1%, ** significant at 5% and * significant at 15%

Second Hypothesis: *There is a negative relationship between the size of the fund within the family and its performance*

Table 10 reports the estimation results for the regression specification given in equation (4). The coefficient of *LOGTNA* is negative and statistically significant at one percent for both gross fund return and net fund return across all models. This indicates that there is a negative relationship between a fund size of a fund within a family fund and its performance. The variable of interest in my second hypothesis is the LOGFAMSIZE, which is negative and statistically significant for both gross fund return and net fund return across all models. This suggests that an increase in the size of the family fund will negatively affect the fund performance. The coefficients of LOGFAMSIZE is approximately 0.0002 regardless of the performance benchmark used. To put into perspective, one standard deviation of this variable is 2.86, so a two standard deviation shock in the size of the family that the fund belongs to will lead to 0.1 basis point movement in the fund's performance the subsequent month. (1.2 basis point per year) Even though the effect is statistically significant, it is not economically significant enough to have an impact on the fund performance. This finding is contradicting the result found by Chen et al. (2004), who provides evidence that there is a positive relationship between family fund size and the fund's performance.

Another interesting variable is FUNDRET, which is the fund return from the previous period. The coefficients of the variable are positive and statistically significant across all models. This indicates that there exists some persistence in fund performance as the positive return in the previous month will positively affect fund returns. The result is consistent with Guedj and Papastaikoudi (2003) who find that there is a persistence of performance in family funds due to their effective allocation of resources in proportion to fund performance and not fund needs.

The most surprising result is the variable MGMTFEE. The variable coefficients are positive across all the performance measures, and they are all statistically significant, except for the beta-adjusted returns with no fixed effect model. The result indicates that the higher management fee charged by the fund would positively affect the fund returns. A possible explanation to this results is documented by Elton, Gruber, and Blake (2003), who find that higher management fees are supposed to attract managers that are more skilled and willing to exert more effort in outperforming the market index. Also, funds with high management fees exhibit better stock selection ability, which might positively affect the funds' performance.

Table 10: Regression of fund performance on lagged family fund size

	Gross fund returns				Net fund returns			
	No Fixed Beta-Adj	No Fixed Market-Adj	Monthly Fixed Beta-Adj	Monthly & Firm Fixed Beta-Adj	No Fixed Beta-Adj	No Fixed Market-Adj	Monthly Fixed Beta-Adj	Monthly & Firm Fixed Beta-Adj
INTERCEPT	0.0011***	0.0014***	0.0013***	0.0084***	0.0014***	0.0009***	0.0007**	0.0077***
	(0.0002)	(0.0002)	(0.0003)	(0.0006)	(0.0002)	(0.0002)	(0.0003)	(0.0006)
$LOGTNA_{i,t-1}$	-0.0002***	-0.0004***	-0.0002***	-0.0019***	-0.0001***	-0.0003***	-0.0002***	-0.0018***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$LOGFAMSIZE_{i,t-1}$	-0.0001***	-0.0001***	-0.0001***	-0.0002***	-0.0002***	-0.0001***	0.0000*	-0.0001***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$TURNOVER_{i,t-1}$	-0.0021***	0.0025***	-0.0021***	0.0024***	-0.0022***	0.0021***	-0.0020***	0.0034***
	(0.0004)	(0.0004)	(0.0004)	(0.0007)	(0.0004)	(0.0004)	(0.0004)	(0.0007)
$AGE_{i,t-1}$	0.0000***	0.0001***	0.0000***	0.0001***	0.0000***	0.0001***	0.0000***	0.0001***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$MGMTFEE_{i,t-1}$	0.0120***	0.0209***	0.0125***	0.0342***	-0.0008	0.0099***	0.0007	0.0258***
	(0.0013)	(0.0015)	(0.0013)	(0.0035)	(0.0013)	(0.0015)	(0.0013)	(0.0036)
$FLOW_{i,t-1}$	0.0000	0.0000	0.0001	0.0001*	0.0000	0.0000	0.0000	0.0001**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$LAGFUNDRET_{i,t-1}$	0.0229***	0.0366***	0.0245***	0.0199***	0.0233***	0.0365***	0.0242***	0.0194***
	(0.0007)	(0.0008)	(0.0007)	(0.0006)	(0.0007)	(0.0008)	(0.0007)	(0.0006)

Notes: This table reports market-return adjusted, 4 factor adjusted and beta-return adjusted model (regression 4) estimates of monthly fund returns for family fund regressed on fund characteristics with a one-mont lag. Fund returns are calculated before (gross) and after (net) deducting fees and expenses. The returns are adjusted using the market model and 4 factor model, with no fixed effect, monthly fixed effects and monthl & firm fixed effect. The dependent variable is *FUNDRET*. The independent variable includes: *LOGTNA*- natural logarithm of TNA, *LOGFAMSIZE*- natural logarithm of plus one the size of family that fund belong to, *TURNOVER*- the fund turnover, *AGE*- is the number of years since the fund began, *MGMTFEE*- the management fee charged by the fund, *FLOW*- the percentage of new fund flow into the mutual fund over th past year and *LAGFUNDRET*- the cumulative fund return over the past 12 months. The sample is from January 2003 to December 2017. The standard error is reported in parentheses. Significant level: *** significan at 1%, ** significant at 5% and * significant at 15%

Robustness Check

I find that fund size erodes fund performance during the sample period of 2003 to 2017, so in order to check for the robustness, I investigate whether this finding differs during the period of economic contraction. I run the regression using a sample from the period of January 2007 to December 2009, which is during the global financial crisis. In table 11, I present several variations of regression specification from equation (4). Using gross fund 4 factor-adjusted return with monthly and firm fixed effect (on the right side), the coefficient for *LOGTNA* is -0.0674 at a one-percent statistically significant level, while the regression result using the whole sample period is -0.0053 (from table 8). Using net fund returns, the *LOGTNA* coefficient is -0.0656 at a one-percent statistically significant level, and it is also more negative than the result of table 8. (-0.0051) These results indicate that fund size also erodes fund performance during the financial crisis and the relationship between fund size and its performance is more negative during economic contraction. A possible explanation might be due to the shortage of liquidity and the higher exposure to the liquidity risk that large funds face during the recession. Normally, large funds incur higher market impact cost than smaller funds because of their bigger trading size, but during the crisis, this magnitude becomes larger and more negatively affect its performance.

Moreover, I sort the samples from 2007 to 2009 into five quantiles based on their last month total net assets, and I calculate the regression of net fund beta-adjusted return with monthly and firm fixed effect for each quantile. The result shows a clear pattern of diseconomies of scale in the mutual fund during the recession. The coefficient of LOGTNA is negative and statistically significant at one-percent for all the quantiles. The magnitude of the negative relationship increases as the quantile is larger, from -0.0038 in quantile one to -0.0386 in quantile five. This indicates that fund size negatively affects fund performance in a non-linear relation and that the size effect increases as the fund size grows. The finding of this test is in line with my first hypothesis's result and support the fact that fund size erodes fund performance.

Table 11: Beta-Adjusted with firm and monthly fixed effect, Robustness Check

Quantile	1	2	3	4	5	**Gross Return** 4-Factor M&F Fixed	**Net Return** 4-Factor M&F Fixed
INTERCEPT	0.01541***	0.1016***	0.1686***	-0.0604	-0.0265	0.4272***	0.4198***
	(0.0006)	(0.0221)	(0.0371)	(0.1035)	(0.0231)	(0.0052)	(0.0053)
$LOGTNA_{i,t-1}$	-0.0038***	-0.0136***	-0.0264***	-0.0510***	-0.0386 ***	-0.0674***	-0.0656***
	(0.0002)	(0.0016)	(0.0037)	(0.0063)	(0.0046)	(0.0005)	(0.0005)
$LOGFAMSIZE_{i,t-1}$	-0.0003***	0.0004***	0.0006***	-0.0002	0.0002	-0.0072 ***	-0.0072***
	(0.0000)	(0.0001)	(0.0002)	(0.0003)	(0.0002)	(0.0005)	(0.0001)
$TURNOVER_{i,t-1}$	-0.0076***	-0.0229	-0.0567*	0.0370	0.0017	0.0493 ***	0.0425***
	(0.02829)	(0.0221)	(0.0391)	(0.0498)	(0.0208)	(0.0076)	(0.0076)
$AGE_{i,t-1}$	0.0000	0.0005	0.0016**	0.0172***	0.0016**	0.0017***	0.0017***
	(0.0000)	(0.0007)	(0.0008)	(0.0040)	(0.0007)	(0.0002)	(0.0002)
$MGMTFEE_{i,t-1}$	-0.0326***	-0.1992	-0.0560	-0.1412	-0.1660	-0.5516 ***	-0.5235***
	(0.0114)	(0.1593)	(0.3421)	(0.3548)	(0.1810)	(0.0313)	(0.0317)
$FLOW_{i,t-1}$	-0.0002	0.0005	-0.0087**	0.0008	0.0000	0.0007***	0.0007***
	(0.0001)	(0.0001)	(0.0045)	(0.0043)	(0.0001)	(0.0002)	(0.0002)
$LAGFUNDRET_{i,t-1}$	0.0163***	0.0090**	0.0007	-0.0045	0.0107**	0.2550 ***	0.2557***
	(0.0010)	(0.0043)	(0.0072)	(0.0103)	(0.0054)	(0.0052)	(0.0026)

Notes: This table reports the robustness check of the regression calculated in table 8. The sample is from January 2007 to December 2009. On the left, the 4 factor-adjusted with firm and the monthly fixed effect i calculated for each quantile. On the right, it is calculated for the whole sample. The dependent variable is *FUNDRET*. The independent variable includes: *LOGTNA*- natural logarithm of TNA, *LOGFAMSIZE*- natura logarithm of plus one the size of family that fund belongs to, *TURNOVER*- the fund turnover, *AGE*- is the number of years since the fund began, *MGMTFEE*- the management fee charged by fund, *FLOW*- th percentage of new fund flow into the mutual fund over the past year and *LAGFUNDRET*- the cumulative fund return over the past 12 months. The standard error is reported in parentheses. Significant level: ** significant at 1%, ** significant at 5% and * significant at 1%

Third Hypothesis: *There is a smaller effect of fund size on fund performance for funds that invest in Large Cap Stocks*

Table 11 reports the regression specification (5) with a dummy variable $IND_{[not\ SCG]}$, which equals one if a fund is NOT Small Cap Growth[3] and zero otherwise (invest in small-cap stock), and an additional interaction term of *LOGTNA* and $IND_{[not\ SCG]}$. First I report results for gross fund returns. *LOGTNA* has a negative and statistically significant coefficient with the range of -0.0178 to -0.0263 (across three performance benchmarks) while the interaction term has a positive and statistically significant coefficient with the range of 0.0159 to 0.0234. (across three performance benchmarks) The two variables have a sign that the liquidity hypothesis predicted because, for the "Not Small Cap Growth" fund (IND equals to one), the effect of fund size on performance is smaller than that of the small-cap funds. Also, if I compare these two variables' coefficients for each performance benchmark, I can see that their magnitude is similar. For instance, in the market-adjusted return model, LOGTNA has a coefficient of -0.0260 while the interaction term has a positive coefficient of 0.0234. This indicates that there is a considerable fraction of effect of fund size on performance coming from small-cap funds. The results using net fund returns show a similar pattern, which is also in line with the liquidity hypothesis.

Table 12 reports the regression specification (5) with a dummy variable $IND_{[LC]}$, which equals one if a fund is a Large Cap[4] fund (invest in large-cap stock) and zero otherwise, and an additional interaction term of LOGTNA and $IND_{[LC]}$. First I report results for gross fund returns. LOGTNA has a negative and statistically significant coefficient of approximately -0.003 for the three performance benchmarks. The interaction term has a positive and statistically significant coefficient of approximately 0.0028. (across three performance benchmark) These results are in line with the liquidity hypothesis, which stated that for the Large Cap fund, there would be a smaller effect of fund size on its performance. The results from using net fund returns also support the liquidity hypothesis.

[3] I use the Lipper objective and classification codes to identify fund's investment styles. Funds with zero for the dummy variable means that they invest primarily in companies with market capitalization less than $1 billion at the time of purchase and they have a Lipper objective code of "SG"

[4] Large Cap funds are funds that combine a growth-of-earning orientation and an income requirement for level and/or rising dividends. These funds invest in large-cap stocks and have a Lipper objective code of "GI"

Table 11: Effect of fund size on performance by fund style (Small Cap Growth funds)

	Gross fund returns			Net fund returns		
	Monthly& Firm Fixed Market-Adj	Monthly& Firm Fixed Beta-Adj	Monthly & Firm Fixed 4-factor model	Monthly& Firm Fixed Market-Adj	Monthly& Firm Fixed Beta-Adj	Monthly & Firm Fixed 4 factor model
$INTERCEPT$	0.1991***	0.1328***	0.2531***	0.1988***	0.1350***	0.2535***
	(0.0030)	(0.0026)	(0.0067)	(0.0030)	(0.0026)	(0.0067)
$LOGTNA_{i,t-1}$	-0.0260***	-0.0178***	-0.0263***	-0.0259***	-0.0181***	-0.0265***
	(0.0004)	(0.0003)	(0.0008)	(0.0004)	(0.0003)	(0.0008)
$IND_{[not\ SCG]}$	-0.1886***	-0.124***	-0.1547***	-0.1885***	-0.127***	-0.1561***
	(0.0028)	(0.0024)	(0.0062)	(0.0028)	(0.0024)	(0.0062)
$LOGTNA_{i,t-1}$*	0.0234***	0.0159**	0.0207***	0.0233***	0.0162***	0.0209
$IND_{[not\ SCG]}$	(0.0004)	(0.0003)	(0.0008)	(0.0004)	(0.0003)	(0.0008)
$LOGFAMSIZE_{i,t-1}$	-0.0004***	-0.0003***	-0.0039***	-0.0004***	-0.0003***	-0.0039***
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)
$TURNOVER_{i,t-1}$	-0.0069***	0.0025	0.0010	0.0066***	0.0023***	0.0013
	(0.0027)	(0.0024)	(0.0061)	(0.0028)	(0.0024)	(0.0061)
$AGE_{i,t-1}$	0.0004***	0.0003***	0.0004***	0.0004***	0.0003***	0.0004***
	(0.0001)	(0.0000)	(0.0001)	(0.0001)	(0.0000)	(0.0001)
$MGMTFEE_{i,t-1}$	0.0966***	0.0854***	-0.2659***	0.0858***	0.0737***	-0.2540 ***
	(0.0141)	(0.0122)	(0.0310)	(0.0141)	(0.0122)	(0.0310)
$FLOW_{i,t-1}$	0.0001***	0.0001***	0.0001*	0.0001***	0.0001***	0.0001*
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)
$LAGFUNDRET_{i,t-1}$	0.0197***	0.0129***	0.0322***	0.0196***	0.0119***	0.0325***
	(0.0007)	(0.0010)	(0.0028)	(0.0007)	(0.0001)	(0.0028)

Notes: This table reports the estimates of monthly fund returns regressed on fund characteristic lagged one month. These fund returns are adjusted using the marke model, beta-adjusted, and 4-factor model. The model is based on the regression specification (5) with a dummy variable $IND_{[not\ SCG]}$, which equals one if a fund is no Small Cap Growth and zero otherwise, and an additional interaction term of $LOGTNA$ and $IND_{[not\ SCG]}$. The standard error is reported in the parentheses. Significan level: ***significant at 1%, **significant at 5% and * significant at 15%

Table 12: Effect of fund size on performance by fund style (Large Cap funds)

	Gross fund returns			Net fund returns		
	Monthly& Firm Fixed Market-Adj	Monthly& Firm Fixed Beta-Adj	Monthly & Firm Fixed 4-factor model	Monthly& Firm Fixed Market-Adj	Monthly& Firm Fixed Beta-Adj	Monthly & Firm Fixed 4 factor model
$INTERCEPT$	0.0135***	0.0090***	0.0686***	0.0129***	0.0089***	0.0474***
	(0.0006)	(0.0005)	(0.0012)	(0.0006)	(0.0005)	(0.0005)
$LOGTNA_{i,t-1}$	-0.0029***	-0.0028***	-0.0032***	-0.0028***	-0.0027***	-0.0030***
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)
$IND_{[not\ SCG]}$	-0.0020***	-0.0017***	-0.0023***	-0.0020***	-0.0017***	-0.0024***
	(0.0004)	(0.0003)	(0.0005)	(0.0004)	(0.0003)	(0.0005)
$LOGTNA_{i,t-1}$*	0.0027***	0.0027**	0.0029***	0.0027***	0.0026***	0.0028***
$IND_{[LC]}$	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$LOGFAMSIZE_{i,t-1}$	-0.0001***	-0.0002***	-0.0002***	-0.0001***	-0.0002***	-0.0002***
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)
$TURNOVER_{i,t-1}$	0.0055***	0.0029	0.0077	0.0052***	0.0038***	0.0013
	(0.0008)	(0.0006)	(0.0016)	(0.0001)	(0.0007)	(0.0009)
$AGE_{i,t-1}$	0.0001***	0.0001***	-0.0001	0.0001***	0.0001***	0.0001***
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)
$MGMTFEE_{i,t-1}$	0.0527***	0.0324***	0.0720***	0.0447***	0.0267***	0.0751***
	(0.0039)	(0.0032)	(0.0080)	(0.0038)	(0.0033)	(0.0081)
$FLOW_{i,t-1}$	0.0001**	0.0001***	0.0000	0.0001***	0.0001**	0.0001
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)
$LAGFUNDRET_{i,t-1}$	0.0282***	0.0166***	0.0453***	0.0281***	0.0150***	0.0474***
	(0.0006)	(0.0005)	(0.0013)	(0.0006)	(0.0005)	(0.0005)

Notes: This table reports the estimates of monthly fund returns regressed on fund characteristic lagged one month. These fund returns are adjusted using the marke model, beta-adjusted, and 4-factor model. The model is based on the regression specification (5) with a dummy variable $IND_{[LC]}$, which equals one if a fund is a Larg Cap fund and zero otherwise, and an additional interaction term of LOGTNA and $IND_{[LC]}$. The standard error is reported in parentheses. Significant level: ** significant at 1%, ** significant at 5% and * significant at 1%

6. Conclusion

This paper examines the relationship between fund size and fund performance and the role of liquidity in the active equity mutual fund. Most of the previous researches used a small sample sizes period or the old data of mutual fund before the 21st century when the fund market was still relatively small. Therefore, this paper aims to investigate whether fund size still negatively impact fund performance in today's economic condition by using the most recent data of US equity mutual funds and to analyze the effect of liquidity on the relation between fund size and fund performance.

Using mutual fund data from 2003 to 2017, I begin my investigation by performing cross-sectional variation to see if performance depends on lagged fund size. However, the result does not show any definite pattern, so I evaluate the performance of mutual fund by using CAPM, Fama-French three-factor model and Carhart four-factor model to adjust for any heterogeneity between fund of different sizes and fund of different styles. Moreover, I regress the various adjusted returns on lagged fund size and other observable fund characteristics with monthly and fixed firm effect. To test for liquidity hypothesis, I include in the regression an additional dummy variable that differentiates a fund-specific investment style and an interaction term.

The results of this study provide evidence that fund size erodes fund performance and that the negative relationship between fund size and its performance is non-linear, as the magnitude of this relation increases as fund size grows. My findings are consistent with the previous studies of Chen et al. (2004), but in their studies, they find a stronger negative relationship. By comparing the result, it could be concluded that the negative effect of fund size on fund performance has diminished when analyzing with the most recent data of mutual funds. Also, the result of my robustness indicates that there is a stronger negative relationship between fund size and its performance during economic contraction. The relation supports the view that during the recession, there is a shortage of liquidity and large funds have a higher exposure to the liquidity risk, which reduces its performance.

Moreover, I argue that the implementation of new regulations in the mutual fund industry will trigger a negative relationship between the size of the family fund and its performance. Consistent with this prediction, I find evidence that indicates an increase in the

size of the family fund will negatively affect the fund performance. Even though the effect is statistically significant, it is not economically significant enough to create a major impact on fund performance. This finding is supported by Bhojra, Cho, and Yehuda (2012) who find that the regulatory changes have significantly reduced the large fund family's performance, and the positive association between the size of the family fund and its performance has gradually decreased.

Lastly, I test the liquidity hypothesis and find that the size effect on performance is more pronounced in funds that have to invest in small stocks, which tend to be more illiquid, than those funds that invest in large stocks. This finding strongly indicates that liquidity is an important factor to why fund size erodes fund performance.

There are a few limitations to this research paper. First, the sample data obtained from CRSP database is specifically restricted to US active equity mutual funds. This suggests that my results may not draw the same conclusion when applied to other countries' mutual fund market because of the differences in regulations and investor's behavior. Otten and Bams (2002) discovers a strong contrast between the European and US mutual fund industry in the market importance, total asset size, and the investor's investment preferences. Moreover, this paper uses CAPM, Fama French 3-factor model and Carhart 4-factor model to capture the fund returns regressed on various fund characteristic, including fund size and liquidity. However, these models might not have enough explanatory power to accurately predict the relationship and may cause some bias in the result.

Finally, this paper updated the prior study of Chen et al. (2004) by using the most recent data of mutual funds to investigate the relationship between fund size and fund performance and the role of liquidity. My findings are consistent with Chen et al. (2004) in that mutual fund erodes fund performance and liquidity plays an important role in this diseconomy of scale. However, I find that there is a negative relationship between the size of the mutual fund family and its performance, which is contracting with the previous study. For further research on the topic of mutual funds, it would be interesting to analyze the effect of size on performance in European or Asian mutual fund market. This finding will be useful for investors in identifying the fund markets that has the least effect of size on funds' performance and minimizing their loss on return.

References

2018 Investment Company Fact Book: A review of trends and activities in the investment company industry. (2018). Washington, DC: Investment Company Institute.

Baker, M., Litov, L., Wachter, J. A., & Wurgler, J. (2010). Can Mutual Fund Managers Pick Stocks? Evidence from Their Trades Prior to Earnings Announcements. *Journal of Financial and Quantitative Analysis,45*(5), 1111-1131.

Beckers, S., & Vaughan, G. (2001). Small is Beautiful. *The Journal of Portfolio Management,27*(4), 9-17.

Berk, J., & Green, R. (2004). Mutual Fund Flows and Performance in Rational Markets. *Journal of Political Economy,112*(6), 1269-1295.

Bhojraj, S., Cho, Y. J., & Yehuda, N. (2012). Mutual Fund Family Size and Mutual Fund Performance: The Role of Regulatory Changes. *Journal of Accounting Research,50*(3), 647-684

Carhart, M. M. (1997). On Persistence in Mutual Fund Performance. *The Journal of Finance,52*(1), 57-82.

Chan, H., Faff, R. W., Gallagher, D. R., & Looi, A. (2008). Fund Size, Transaction Costs and Performance: Size Matters! *SSRN Electronic Journal*.

Chen, H., Jegadeesh, N., & Wermers, R. R. (2000). The Value of Active Mutual Fund Management: An Examination of the Stockholdings and Trades of Fund Managers. *SSRN Electronic Journal*.

Chen, J., Hong, H., Huang, M., & Kubik, J. D. (2004). Does Fund Size Erode Mutual Fund Performance? The Role of Liquidity and Organization. *American Economic Review,94*(5), 1276-1302.

Elton, E. J., Gruber, M. J., & Blake, C. R. (2001). A First Look at the Accuracy of the CRSP Mutual Fund Database and a Comparison of the CRSP and Morningstar Mutual Fund Databases. *The Journal of Finance,56*(6), 2415-2430.

Elton, E. J., Gruber, M. J., & Blake, C. R. (2003). Incentive Fees and Mutual Funds. *The Journal of Finance,58*(2), 779-804.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics,33*(1), 3-56.

Grinblatt, M., & Titman, S. (1989). Mutual Fund Performance: An Analysis of Quarterly Portfolio Holdings. *Journal of Business,62*(3), 393-416.

Gruber, M. J. (1996). Another Puzzle: The Growth in Actively Managed Mutual Funds. *The Journal of Finance,51*(3), 783-810.

Guedj, I., & Papastaikoudi, J. (2003). Can Mutual Fund Families Affect the Performance of Their Funds? *SSRN Electronic Journal*.

Indro, D., Jiang, C., Hu, M., & Lee, W. (1999). Mutual Fund Performance: Does Fund Size Matter? *Financial Analysts Journal,55*(3), 74-87.

Jegadeesh, N., & Titman, S. (1993). Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *The Journal of Finance,48*(1), 65-91.

Jensen, M. C. (1967). The Performance of Mutual Funds in The Period 1945-1964. *Journal of Finance,23*(2), 389-416.

Keim, D., & Madhavan, A. (1997). Transactions costs and investment style: An inter-exchange analysis of institutional equity trades. *Journal of Financial Economics,46*(3), 265-292.

Khorana, A., & Servaes, H. (2011). What Drives Market Share in the Mutual Fund Industry? *Review of Finance,16*(1), 81-113.

Nanda, V. K., Wang, Z. J., & Zheng, L. (2000). Family Values and the Star Phenomenon. *SSRN Electronic Journal*.

Otten, R., & Bams, D. (2002). European Mutual Fund Performance. *European Financial Management,8*(1), 75-101.

Perold, A. F., & Salomon, R. S. (1991). The Right Amount of Assets Under Management. *Financial Analysts Journal,47*(3), 31-39.

Sharpe, W. F. (1964). Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk. *The Journal of Finance,19*(3), 425-442.

Sirri, E. R., & Tufano, P. (1998). Costly Search and Mutual Fund Flows. *The Journal of Finance,53*(5), 1589-1622.

Wermers, R. (2000). Mutual Fund Performance: An Empirical Decomposition into Stock-Picking Talent, Style, Transactions Costs, and Expenses. *The Journal of Finance,55*(4), 1655-1695.

Zera, S. P., & Madura, J. (2001). The empirical relationship between mutual fund size and operational efficiency. *Applied Financial Economics,11*(3), 243-251.

Yan, X. (2008). Liquidity, Investment Style, and the Relation between Fund Size and Fund Performance. *Journal of Financial and Quantitative Analysis,43*(03), 741-768.