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Scale Effects in Mutual Fund Performance: A Study of the Norwegian Market

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ABSTRACT

In this paper, we investigate the effect of scale on performance in the Norwegian mutual fund industry. The study includes a data sample free of survivorship bias containing 70 Norwegian open-end actively managed mutual funds. Overall, we find no statistically significant relationship between the lagged size of Norwegian mutual funds and performance. Also, the study shows that there exist no liquidity effects in the Norwegian mutual fund market of holding small-cap shares. Further, we prove that a funds return does not decline with the lagged size of the family it belongs to, suggesting that scale of mutual funds not necessarily need to be negative depending on how the fund is organized.

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1. INTRODUCTION

Scalability in investments is a well-established concept in academia with references back to Adam Smith's time (1776). There is little which has inspired economics more than the idea of combining and transforming two separate companies with potential for growth into one more efficient company. This thesis aims to identify and examine an issue that is fundamental to understand the role of Norwegian mutual funds in our economy, namely the economies of scale in the active money management industry. More precisely, to examine whether the performance of Norwegian mutual funds depend on their size or asset base. The core research question in this paper is as followed:

"Is there a correlation between size and performance of Norwegian mutual funds?"

Developing a more robust understanding of how the performance of a fund depends on the size or asset base of the fund would naturally be valuable for investors. This, mainly due to the massive inflows which have increased the asset base of Norwegian mutual funds in recent time (see Figure 1). As a mutual fund grows, the fund will have to expand the number of stocks they buy, diluting their best ideas. As the fund grows larger, it looks more like the overall market, and runs into the iron law of costs (Buttonwood/The Economist, 2017). Is this the case in the Norwegian mutual fund market, or can it be proved that the asset base of mutual funds does not have an impact on its performance? Also, this study is valuable for those who are in charge of the decision-making authority in Norwegian funds. Another significant motivational factor is that the issue of persistence of fund performance depending on scale-ability of the fund investments[1].

Further, this research aims to increase common understanding regarding the factors driving fund return and to open the door for further research on an industry of growing importance for Norwegian households and private investors (VFF, 2017). Most research on this topic comes from the US (see Grinblatt & Titman (1989), Indro et al. (1999) and Chen et al. (2004)). They find, almost exclusively, a negative correlation between size and risk-adjusted returns. However, using a worldwide sample of mutual funds from 27 countries, Ferreira et al. (2012) show that the US

[1] See, e.g., Gruber, M. J. (1996); Berk, J. and Green, R.C. (2004)

evidence of diminishing returns to scale is not a universal truth as performance is not negatively affected by scale for funds located outside of the US.

In this paper's analysis of the impact of Norwegian mutual fund size on performance, we expand the search for specific scaling effects which are expected to affect a fund's performance by including two additional research questions, mainly based on the liquidity hypothesis and the role of organizational structure suggested by Chen et al. (2004). The additional research questions are as followed:

"Is fund size a limiting factor for the returns of Norwegian mutual funds investing in small-cap stocks?"

"Is family fund size a limiting factor for the returns of Norwegian mutual funds investing in small-cap stocks?"

In the preliminary assessment of the data, this paper divides the sample covering the period 2009-2017, into three size portfolios. These portfolios are compared by applying well- known performance benchmarks from financial literature. Furthermore, fund size may correlate with other fund characteristics. We therefore analyze the effect of past fund size on performance using panel data regression, where we can control for the correlation effect from other chosen fund characteristics on performance.

Generally, after utilizing various performance benchmarks and controlling for other observable fund characteristics, we find no support indicating that fund performance is correlated with its lagged assets under management for the funds in our sample. Further, we find no support of the liquidity hypothesis, which states that size erodes performance more for funds that must invest in small-cap stocks, which tend to be illiquid. Lastly, we consider the effect that the size of the fund family has on performance, but our study finds no significant results suggesting that scale of mutual funds not necessarily need to be negative depending on how the fund is organized.

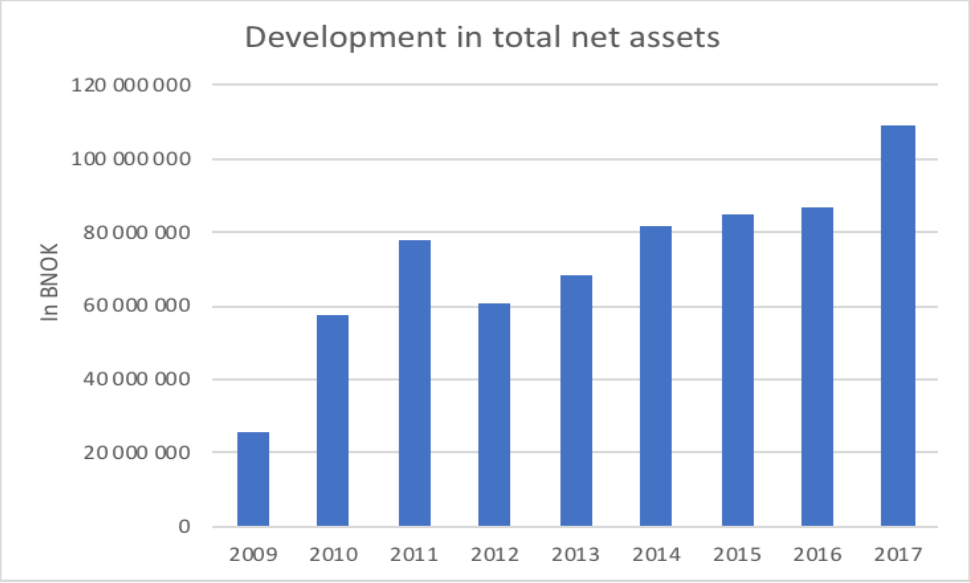
This thesis will proceed as follows. In section 2 we introduce the Norwegian mutual fund market and previous research on the field. Section 3 presents the data, before the methodology in section 4. In section 5 we present our empirical findings before we conclude in section 6.

2. BACKGROUND AND PREVIOUS RESEARCH

2.1 The Norwegian Mutual Fund Market

The capital market in Norway is continuously growing and evolving as time passes, consequentially affecting managers to actively adapt the innovation with the purpose of outperforming the market. The Norwegian population's savings in mutual funds have become more common during the last few years, and by the end of 2017 NOK 151 billion was invested in Norwegian mutual funds[2] which correspond to an increase of 22 percent from the beginning of the same year (market statistics Verdipapirfondenes Forening (VFF), 2017). When expanding time horizon, one can notice an increase of 430% in total net assets in the last ten years (market statistics VFF, 2007 and 2017). This is seen in context to the transition from the traditional pension benefit plans to defined contribution pension plans[3] as well as a commercialization of the securities market. The mutual fund market is central to the Norwegian financial market and will be of increasing importance for both private and institutional investors in the future.

Figure 1 TNA in Norwegian mutual funds (VFF 2018)



[2] Mutual funds where at least 80 percent of the fund's total net assets are invested in the stock market geographically limited to the Norwegian stock market (VFF, https://vff.no/fondshandboken/artikler/aksjefond)

[3] Since 2006 it has been mandatory for employers to give employees an occupational pension scheme plan. For those who have so-called defined-contribution pension plans, the employer sets a certain amount - equivalent to between two and eight percent of your income between 1 and 12 G - into this account every month. The scheme is called obligatory occupational pension (OTP), and the money on the account is paid in addition to the National Insurance Scheme when you reach retirement age. Each employee has to actively decide the percentage level of pension invested in stocks (law February 8th, 2006, regarding obligatory occupational pension [OTP-law]

Developments in the financial market and changes in the state's public pension scheme result in each of us making more financial decisions than before. Also, the fact that Norwegians are living longer (SSB, 2016) will make it necessary to save more on their own to maintain purchasing power when retired. The Norwegian government stated in the pension reform from 2011 that in line with expectations of Norwegian citizens living longer, the pension will be divided on more years (Norwegian Government, 2017). It is therefore essential for the future that savings are well managed to ensure return. What kind of structure of mutual funds should Norwegians choose for their future savings and how should a mutual fund invest new money?

Information technology has led consumers to gain access to more suppliers and a more substantial offer of products, thereby increasing the opportunities in the savings market. Also, the Norwegian government in 2017 released a new financial instrument for private investors, namely "Aksjesparekonto" (ASK). With this product, the market becomes more efficient as one can switch (subscribe) between different mutual funds and withdraw (redeem) the original investment without paying taxes[4]. Taxation is further triggered when securities are sold, and the money is taken out of the ASK account. Such a measure will allow private investors to sell out of a market position depending on the time you think is correct and not due to your tax situation at the same time. ASK gives private investors similar advantages as investment companies, which, according to the exemption method[5], are exempted from tax on dividends and on capital gains. Taxation provides incentive to save in mutual funds. Additionally, the Norwegian government also released Individual Pension Savings (IPS) in 2017, a product including tax benefits[6]. All these products make it easier and more beneficial for individuals and institutional investors to save in stocks and mutual funds.

2.2 The Berk & Green Model

Although scaling effects in the active money management industry is a critical issue to understanding performance in the industry, the issue has received limited

[4] Law on wealth and income tax (tax act) § 10-21. Taxation of share savings account and account holder
[5] Tax act §§ 2-2, 2-5, 2-13, 2-38, 10-13, 10-40, 10-36 fourth paragraph, 10-41
[6] Regulations concerning changes in regulations for completion and implementation, etc. of the Tax Code of March 26, 1999 No. 14

attention in Norway. Thus, this study offers a rare empirical standpoint on the effect of size on performance for Norwegian mutual funds. As the existence of actively managed mutual funds increases rapidly, investors consume considerable resources in identifying those managers with the best ability in picking stock winners. Further, the funds controlled by these managers play a pivotal role in the determination of stock prices. To recognize the role of these mutual funds in the economy, it is crucial to understand the economies of scale in the active money market industry.

Berk & Green (2004) argue that diminishing returns to scale can reconcile the lack of average outperformance and performance persistence with the existence of managerial skill. They define positive scaling effects as average unit cost reduction at increased production volume (fixed labor costs, gathering information, research and administrative expenses) whereas negative scaling effects are working oppositely, namely increasing the cost level.

In competitive markets, corporate finance theory argues that prices of securities will adjust such that its expected return reflects the perceived risk. The crux of the matter in valuation theory is that news will instantly influence the value of any security through the price mechanism. However, this price mechanism does not account for mutual funds. Berk & Green (2004) showed that the value of a fund is mirrored through size measures (quantiles) rather than the price. They showed this by developing a theoretical model for active management of funds, which claims that a funds return decrease with fund size. That is, fund flows harm rather than improve subsequent fund performance. As the funds flow to the managers, they will employ managerial skill to identify positive net present value (NPV) stocks and execute these. The implication of Berk & Green's (2004) findings is that a fund's size is a direct product of its historical performance and its manager's ability to pick stocks.

2.3 Related Empirical Studies on Scale on Performance

Despite Berk & Green's (2004) arguments that the size of a fund reflects the manager's ability to pick stocks, we hypothesize in our thesis that the size of each mutual fund in our sample will have an influence on its achievable returns.

From a historical point of view, mutual funds are expected to display economies of scale like other financial institutions, where it is desirable with growth in the fund's asset base. Carter (1950) argue that large-cap mutual funds should outperform

small-cap due to lower management fees, more significant influence in capital markets and larger assets base for the use of research and development.

Pollet and Wilson (2008) examine whether actively managed funds experience declining returns in line with growth. The results showed that managers scaled up their existing positions when the fund's size increases instead of developing new investment strategies. Large funds and funds investing in low-value limited companies diversify the portfolio better as a response to growth and that this diversification, especially for small-cap funds, can be seen in conjunction with the better performance.

However, there have also been studies showing that the findings in the US turn out not to be the case in all markets. Ferreira, Keswani, Miguel & Ramos (2012) investigated the size effects of US and non-US funds on performance and find that for non-US funds the relationship between fund size and performance is positive and significant[7]. The authors state that a possible explanation for the findings is that US funds are much larger on average than funds elsewhere in the world. More specifically, the average US fund is more than five times larger than the average non-US fund. This, of course, makes our study on the Norwegian mutual fund market even more interesting, as Ferreira et al. (2012) reports that Norwegian mutual funds on average are seven times smaller than those in the US market. Therefore, we do not necessarily expect to find the same scaling effects as in the US.

A negative relation between fund size and performance can imply diseconomies of scale. Some researchers argue that small, actively managed funds will be more fitted to capture investment opportunities. This is due to their size of the management team, low administration cost, low price impact and that their teams often are more focused (Beckers and Vaughan, 2001). In the same year as Berk & Green developed their model, a comprehensive study performed in the US fund market was conducted by Chen, Hong, Huang & Kubxik (2004). In line with Berk & Green's model, they show that the scaling relationship between fund size and return is negative. More specifically, liquidity erodes performance and size matters significantly for small-cap funds but does not influence large-cap funds. Further,

[7] Discussing with Miguel Ferreira (Ferreira et al., 2012), he explained that in their paper they did not analyze for the Norwegian market separately from the other non-US funds. Hence, we cannot expect our findings to reflect the ones reported by Ferreira et al. (2012).

Chen et al. (2004) also argue that large-cap funds achieve economies of scale due to their ability to hire additional managers and in that way covering more investment opportunities by increasing research and development. However, in their study, Chen et al. (2004) underline the importance of the decline in motivation and manager incentives of finding new investment opportunities when control over asset allocation is reduced, thereby tending to organizational diseconomies of scale.

3. DATA

3.1 Sample Description

Monthly data on Norwegian mutual funds come from the Thomson Reuters Lipper database and VFF and spans the period January 2009 to December 2017. We want to examine the effect of size on performance during the recent decade. Therefore, with reference to previous research on this topic[8], chose a time period of 9 years.

We restrict our analysis to open-end actively managed Norwegian mutual funds[9] with at least 80% invested in the Norwegian stock market, according to VFF industry standard (VFF, 2012). By Norwegian law[10], we have that Norwegian mutual funds must invest/hold at least 16 different stocks and that each stock position cannot exceed 10% of total assets in the fund. We exclude funds that primarily invest in foreign markets since they have different exposure to risk, and they would require additional benchmarks. The funds must have data on net asset value (NAV), total net assets (TNA), TNA of the family the fund belongs to, age, flow and total expense ratios. To avoid survivorship bias, we include all funds in the chosen sample period, both active and delisted funds. We treat delisted funds by only including the months with available data, and zero otherwise. As a final restriction, a fund must have reported returns for at least 12 months to be part of our sample. After accounting for these restrictions, we end up with a sample of 70 distinct funds ranging from the beginning of 2009 to the end of 2017. All the funds are listed in Appendix 3 and form the basis of our analysis.

[8] See Ferreira et al (2012), Söderlind et al. (2000), Indro et al. (1999), Grinblatt and Titman (1992)
[9] Section 1-2 of the Securities Funds Act (2011) refers to mutual funds as "an independent capital gain arising from capital contributions from an indefinite circle of persons against the issue of shares in the fund and which consist essentially of financial instruments and / or deposits in credit institutions."
[10] Securities Trading Act, § 6-2: Mutual fund shares

3.2 Benchmark Index

The natural choice for benchmark index is the Oslo Børs Mutual Fund Index (OSEFX), which is in line with Morningstar's performance analyzes of Norwegian mutual funds. OSEFX is a capped version of OSEBX. The capping rules complies with the UCITS[11] directives for regulating investments in mutual funds. The maximum weight of a security is 10% of total market value of index and securities exceeding 5% must not combined exceed 40%. The OSEFX index is adjusted for dividend payments. It is investable and contains a representative sample of all Norwegian shares on Oslo Stock Exchange.

3.3 Risk-Free Rate

In the preliminary assessment of the data, we report excess returns, that is, the fund return less the risk-free rate. In the real world, there are no assets that can realize returns entirely riskless. Therefore, a proxy is needed. Researchers such as Fama and French (1993) and Carhart (1997) used the one-month US Treasury bill as the proxy for the risk-free rate. In our analysis, we use monthly NIBOR (Norwegian Inter Bank Offering Rate) gathered from the OBI database[12].

3.4 Factor Returns

We collected the factor portfolios small-minus-big (SMB), high-minus-low (HML), and prior 1-year momentum (PR1YR) from the OBI database. The source of the data comes from daily observations of stock market data from the Oslo Stock Exchange Data Service. The OBI database consists of many different derived time series, including asset pricing factors for the Oslo Stock Exchange similar to those developed by Fama and French (1993) and Carhart (1997).

3.5 Size Portfolios

The measure for fund size is the fund's total net assets (TNA). From Table 1, we see that average TNA is NOK 1 142 million for the entire sample, with a standard

[11] UCITS is a type of mutual fund that complies with common European rules, which has extensive requirements for risk diversification, what the Fund can invest in and frequent access to shareholders to redeem the shares. UCITS funds are intended to be an investment option for consumers.

[12] The OBI database was made available for BI students by Bernt A. Ødegaard.

deviation of NOK 1 401 million, which tells us there is a substantial spread in TNA, and median of NOK 550 million. There is positive skewness in the data sample given by the distance from the median to the mean, which would imply that there are more small funds than large, indicating some non-normality in the sample. We take the log of TNA (LOGTNA) to get our proxy for fund size, following Chen et al. (2004) and Ferreira et al. (2012).

In our preliminary assessment of the data, we will look at the performance of all the funds in our sample, viewed as size-based portfolios. We split the data sample into three portfolios, namely small, medium and large funds. With a sample of only 70 funds, we did not want to split the dataset further, as this could result in too few observations in each portfolio. Summary statistics for TNA and the breakpoints for the size-based portfolios are presented in Table 1. The asset base of each portfolio is partially based on the mean and median but is somewhat corrected to get an approximately even number of observations in each portfolio.

Table 1 Size Portfolios

This table reports summary statistics for TNA for all funds and the basis of the size portfolios. The sample is from January 2009 to December 2017.

Total Net Assets (TNA)	
Max	15 932 206 100,00
Min	0,00
Mean	1 142 169 265,00
Median	550 084 266,00
Standard Deviation	1 401 250 904,00
Skewness	2,07
Kurtosis	4,87
No. of funds	70

Size Portfolios	MNOK	No. of funds
(1) Small	0 – 360	23
(2) Medium	360 – 1,150	24
(3) Large	1,150 and above	23

Appendix 1 and 2 show the equally-weighted and value-weighted cumulative returns graphically from investing in each of the three size portfolios from January 2009 to December 2017. The equally-weighted strategy does not rely on expected

average returns and is therefore assumed to be more robust compared to other price-weighted or value-weighted strategies (Malladi, R., & Fabozzi, F. J., 2017). Hence, we apply equally-weighted portfolios in our analysis.

3.6 Regression Variables

The first variable of interest is fund family size, defined as the TNA of the other funds in the fund's family (i.e., the TNA of a fund's family excluding its own TNA). Chen et al. (2004) find that fund family size has a positive and statistically significant effect on performance, which can be explained by family size capturing economies of scale from trading commissions and lending fees, economies of scope from using the same data and experts, and a reduction in research and administrative expenses. We take the log of the TNA of a fund's family excluding its own TNA to get the variable for family size (LOGFAMSIZE).

Further, we include other fund characteristics that might have an impact on mutual fund performance, following Chen et al. (2004)[13]. The first is expense ratio (EXPRATIO), defined as total operating expenses divided by year-end TNA[14]. The relation between mutual fund returns and expenses provides a test of the value of active management (Ferreira et al., 2012). Fund age (AGE), defined as the number of years since establishment, provides a measure of a fund's longevity and its manager's ability (Ferreira et al., 2012). Fund flows (FLOW) is a variable that should have a positive correlation with future returns. Gruber (1996) argue that investors can detect skilled managers and direct their money to them, also called the smart money hypothesis. Gruber (1996) and Zheng (1999) show that funds experiencing net inflows perform significantly better than funds that experience outflows.

$$FLOW_{i,t} = \frac{TNA_{i,t} - TNA_{i,t-1}}{TNA_{i,t-1}} \qquad (1)$$

The last fund characteristic we include is past performance (LAGFUNDRET). We include this variable to test for performance persistence. Ferreira et al. (2012) argue

[13] In the Lipper Database and Bloomberg Terminal, there exist limited data on total load and turnover, and we have therefore excluded these variables from our regression.
[14] Ferreira et al., (2012) included Norwegian mutual funds in their study. The coverage of total expense ratio (TER) in LIPPER for Norwegian funds is limited. We had a dialog with Miguel Ferreira, who suggested using management fees when TER not is available.

that the effect of past performance on future performance of US funds is economically meaningful, while outside of the US persistence seems to be weaker. Fund returns (EXRET) are calculated as the percentage change in net asset value (NAV) in excess of the risk-free rate.

$$EXRET_{i,t} = \left(\frac{NAV_{i,t} - NAV_{i,t-1}}{NAV_{i,t-1}}\right) - r_f \qquad (2)$$

Table 2 reports summary statistics for our sample. The average fund age is about 15 years. We see that funds in the smallest quantile have lived the shortest, which makes sense considering funds that have lived longer have had more time to grow. The funds in our sample have expense ratios that average 0,12 percent per month. The middle size quantile has the highest average expense ratio. Average fund flow is 3,75 percent per month, and we can see an increase in fund inflow with an increase in size.

Table 2 Summary Statistics

This table reports equally-weighted time-series averages of monthly cross-sectional averages and monthly cross-sectional standard deviations (shown in brackets) of fund characteristics for the funds in our sample. LOGTNA is the logarithm of total net assets under management. LOGFAMSIZE is the logarithm of total net assets under management of the other funds in the family that the fund belongs to. EXPRATIO is operating expenses divided by year-end TNA. AGE is the number of years since the establishment of the fund. FLOW is the percentage of new fund flow into the mutual fund. All fund characteristics are reported monthly, except age which is reported yearly. EXRET is the monthly fund return in excess of the risk-free rate. Fund portfolio 1 (3) has the smallest (largest) funds. The sample is from January 2009 to December 2017.

	Size Portfolios			
	1	2	3	All funds
LOGTNA	7,90	8,72	9,32	8,72
(NOK)	*(0,09)*	*(0,11)*	*(0,18)*	*(0,11)*
LOGFAMSIZE	10,05	10,40	10,62	10,39
(NOK)	*(0,05)*	*(0,15)*	*(0,15)*	*(0,12)*
EXPRATIO	0,12	0,13	0,11	0,12
(% per month)	*(0,01)*	*(0,01)*	*(0,00)*	*(0,01)*
AGE	11,55	15,91	16,77	15,13
(per year)	*(0,76)*	*(1,13)*	*(1,36)*	*(0,82)*
FLOW	2,34	3,57	4,68	3,75
(% per month)	*(4,90)*	*(18,16)*	*(30,39)*	*(13,97)*
EXRET	1,13	1,29	1,18	1,20
(% per month)	*(4,38)*	*(4,50)*	*(4,35)*	*(4,40)*
No. of funds	23	24	23	70

Lastly, we report means and standard deviations for the monthly fund returns. The average monthly performance is 1,20 percent with a standard deviation of 4,40 percent. The funds in size quantile two do better than both the funds in size quantile one and three, which contrast most findings in the US, where the smallest funds outperform the large funds[15]. However, we do not want to overinterpret these results as we have not controlled for heterogeneity in fund styles nor calculated any statistical significance in this table.

Table 3 reports the time-series averages of correlations between the characteristics which we investigate using all funds. We note that the findings give rise to some patterns. For instance, LOGTNA is strongly correlated with LOGFAMSIZE, which is somewhat similar to the findings of Chen et al. (2004) in the US market, which found a correlation of 0,4 between these variables. A possible explanation of the strong correlation (in contrast to US market) is the size of the asset base in the Norwegian mutual fund market. Further, EXPRATIO and FLOW vary inversely with LOGTNA (-0,56 and -0,09, respectively), while AGE has a strong positive correlation with LOGTNA (0,80).

Table 3 Correlation Matrix

This table reports the correlations of the various fund characteristics using all the funds in our sample.

	LOGTNA	LOGFAMSIZE	EXPRATIO	AGE	FLOW
LOGTNA	1,00	0,83	-0,56	0,80	-0,09
LOGFAMSIZE		1,00	-0,80	0,82	-0,18
EXPRATIO			1,00	-0,50	0,08
AGE				1,00	-0,22
FLOW					1,00

The strong correlations between LOGTNA and LOGFAMSIZE (0,83), LOGTNA and AGE (0,80), LOGFAMSIZE and EXPRATIO (-0,80), and LOGFAMSIZE and AGE (0,82) could indicate multicollinearity among predictor variables. To test whether this is the case, we looked at the variance inflation factor (VIF) for each variable, which can be seen in Table 4.

[15] See Chen et al. (2004), Ferreira et al. (2012).

Table 4 Test for Multicollinearity

This table reports the variance inflation factor, which detect multicollinearity in the regression analysis.

	LOGTNA	LOGFAMSIZE	EXPRATIO	AGE	FLOW
VIF	1,3798	1,5196	1,0779	1,3337	1,0330

The VIF value tells us what percentage the variance is inflated for each coefficient. Some researchers say a VIF above 10 indicates high correlation and cause for concern, while others suggest 2,5 or above. In any case, all the VIFs are fairly low, suggesting that multicollinearity is not a problem within our data sample.

4. METHODOLOGY

This chapter presents the methodological framework used in the thesis analysis. With both cross-sectional data on 70 individual funds and time-series data on monthly observations over the period 2009-2017, we run panel regressions to see how fund performance varies with lagged fund size, motivated by the work of Chen et al. (2004) and Ferreira et al. (2012). Chen et al. point out two major worries when using cross-sectional variation, namely heterogeneity in fund styles and correlation of fund size with other fund characteristics. The first worry can be dealt with by estimating mutual fund performance using benchmark models that account for different loads on small-cap stocks, value stocks, and price momentum strategies. The second worry can be dealt with by regressing the adjusted returns on fund size and other observable fund characteristics, including age, expense ratio, past-year fund inflows, and past-year returns (Chen et al., 2004).

4.1 Research Questions

This thesis focuses on revealing size effects among Norwegian mutual funds. The aim is to estimate a linear relationship between the dependent variable (risk-adjusted return) and the regressor (size). The core research question in this paper is formulated as followed:

"Is the correlation between size and performance of Norwegian mutual funds statistically significantly different from zero at the 5% level?"

With a confidence interval of 5%, an observed t-value of 1,96 or higher would imply significant results, meaning fund size has an effect on fund performance. If the observed t-value is below 1,96 we cannot reject the null hypothesis.

Further, in this paper's analysis of the impact of Norwegian mutual fund size on performance, we expand the search for specific scaling effects which are expected to affect a fund's performance, mainly based on the liquidity hypothesis and the role of organizational structure suggested by Chen et al. (2004).

The liquidity hypothesis states that the size of a mutual fund's asset base is more important for funds that invest in small-cap shares since these shares are less negotiable (Chen et al., 2004). These shares are companies with relatively small market capitalization. Mutual funds have restrictions that limits them from buying large portions of small cap firms and that these stocks are less negotiable. Thus, making it difficult beating institutional investors. A mutual fund's position in such companies cannot be increased nor reduced in line with companies with larger equity holdings. The hypothesis assumes that returns on mutual funds with larger positions in small-cap firms do not grow proportionally with total net assets because these funds are obligated to find new investment objects (increased transaction, research/development, and management costs).

The liquidity hypothesis is also supported by the arguments of Berk & Green (2004), namely that small funds can concentrate on a few investment opportunities. On the other hand, when these funds become larger in size, managers must continue to scope good investment opportunities. Thus, the effect of managerial skill becomes diluted.

We test the liquidity hypothesis by first identifying small-cap and large-cap funds in our data sample. To find an indicator of the funds' share of small-cap, we apply a simple regression between the fund's excess return and the excess return of the Oslo Stock Exchange Small Cap Index. We define a large-cap fund dummy that takes the value of 1 if the fund is below the median small-cap loading and 0 otherwise. Further, we augment the regression specification by including this large-cap dummy and an interaction term (LOGTNA*large-cap dummy). In this way, we

can measure the difference between small-cap and large-cap funds regarding their respective relationship between TNA and performance.

Based on the liquidity hypothesis, this paper investigates the following research question:

"Is the correlation between size and performance of Norwegian mutual funds investing in small-cap stocks statistically significantly different from zero at the 5% level?"

This paper also investigates the role of organizations, namely the effect of family size on performance. Some previous studies argue that the size of the fund family to which a fund belongs, have an impact on the mutual funds' performance. Sirri and Tufano (1988) point out, among other factors, that larger fund families are more publicly visible and tend to offer better service level to their clients. Further, Pozen (1998) suggested that fund performance declines with its size but increases with family size (size of other funds in the family). To see if such effects exist amongst Norwegian mutual funds, we include in the regression an interaction term with family size and the large-cap dummy indicator (LOGFAMSIZE*large-cap dummy).

We state the following research question regarding the investigation of the beneficial degree of belonging to a larger fund family:

"Is the correlation between family fund size and performance of Norwegian mutual funds investing in small-cap stocks statistically significantly different from zero at the 5% level?"

4.2 Measuring Fund Performance

To deal with the first concern regarding heterogeneity as proposed by Chen et al. (2004), we measure fund performance by estimating the alphas of various benchmark models. The returns are risk-adjusted using the single index model of William F. Sharpe (1963), the three-factor model of Eugene F. Fama and Kenneth R. French (1993), and the augmented four-factor model of Mark M. Carhart (1997).

4.2.1 Performance Benchmarks

The single index model is the empirical version of the capital asset pricing model (CAPM) and is expressed in ex-post form rather than in an expectations form. The model shows how returns are influenced by the market (β) and can be expressed as followed:

$$R_{p,t} = \alpha_p + \beta_p MKT_t + \varepsilon_{p,t} \quad (3)$$

where $R_{p,t}$ is the excess return of portfolio *p* in month *t* in excess of the one-month risk-free rate, α_p is the excess return of that portfolio, MKT_t is the return on the Oslo Børs Mutual Fund Index (OSEFX) in excess of the one-month risk-free rate, β_p is the loading on the market portfolio, and $\varepsilon_{p,t}$ is the generic error term. The only difference between the classical CAPM and the single index model is the α_p, which represents the excess return of a portfolio that is not explained by the factor(s) in the model. If the CAPM holds, α_p is zero.

The Fama-French three-factor model improves the single index model by including size and book-to-market factors:

$$R_{p,t} = \alpha_p + \beta_{p,1} MKT_t + \beta_{p,2} SMB_t + \beta_{p,3} HML_t + \varepsilon_{p,t} \quad (4)$$

where SMB_t is the return on a portfolio of small stocks minus large stocks, and HML_t is the return on a portfolio that is long high book-to-market stocks and short low book-to-market stocks. If the factor exposures MKT, SMB, and HML capture all variation in expected returns, the intercept (α_p) is zero for all securities and portfolios *p* (Fama and French, 2014). If there is excess return, i.e., the intercept (α_p) is positive, it could stem from either manager skills or luck.

The Carhart four-factor model is an extension of the Fama and French three-factor model and includes an additional factor that captures the momentum anomaly:

$$R_{p,t} = \alpha_p + \beta_{p,1}MKT_t + \beta_{p,2}SMB_t + \beta_{p,3}HML_t + \beta_{p,4}PR1YR_t + \varepsilon_{p,t} \qquad (5)$$

where $PR1YR_t$ is the return on a portfolio that is long stocks that are past 12-month winners and short stocks that are past 12-month losers.

4.2.2 Performance Evaluation

A single index estimation over the entire sample is performed for all the funds, as shown in Appendix 3. From these results, it is possible to read how each fund performs in the sample period and how much explanatory power the model has. These results also serve as a reference when the same estimate is performed on the size portfolios. The explanatory power of the model, or R^2, is relatively high for all the funds in the sample, which means that the variation in the market index explains most of the variation in the fund's return. The high beta values, which are all statistically significant, also show this. In the following section, we will utilize the three performance models on the equally-weighted size portfolios. Appendix 4 reports the summary statistics for the various factors, including mean, standard deviation and correlations.

Tables 5 report the monthly factor loadings calculated using the single index model, three-factor model and four-factor model, divided into our three fund-size sorted portfolios. A significant positive (negative) alpha indicates that the funds outperform (underperforms) the benchmark. Adjusted R^2 tells us how much of the variation in the fund returns the dependent variable captures.

First looking at the single index model, the average mutual fund has a beta of 0.93, with only a slight variation in the market betas of the size portfolios. We see that all size portfolios have positive alphas, meaning they overperform the benchmark and that the best performers are medium-sized funds. The average R^2 is 96,73%, which means the model explains most of the variation in the size portfolios' average return.

Looking now at the three-factor model, we see that small and medium-sized funds tend to have higher loadings on SMB, while large funds have higher loadings on HML, but there is not much variation. The alpha of the portfolio with the smallest funds has a negative sign, meaning the smallest funds underperform the market

when we include additional factors. Large and medium-sized funds still overperform the benchmark, with the best performers being medium-sized funds.

Table 5 Factor Loadings

This table reports the loadings of the three TNA-sorted fund portfolios calculated using the single index model, the Fama-French 3-factor model, and the Carhart 4-factor model. MKT is the return on the Oslo Børs Mutual Fund Index (OSEFX) in excess of the one-month NIBOR rate. SMB is the return on a portfolio of small stocks minus large stocks. HML is the return on a portfolio long high book-to-market stocks and short low book-to-market stocks. PR1YR is the return on a portfolio long stocks that are past-12-month winners and short those that are past-12-month losers. The t-statistics are in brackets. The sample period is from January 2009 to December 2017.

Portfolio	Alpha	MKT	SMB	HML	PR1YR	Adj. R^2
Single Index Model						
1 (small)	0,01%	0,92				96,32%
	(0,12)	(52,96)				
2 (medium)	0,14%	0,94				96,45%
	(1,62)	(53,96)				
3 (large)	0,06%	0,92				97,42%
	(0,82)	(63,53)				
Three-Factor Model						
1 (small)	-0,06%	0,97	0,11	0,02		96,85%
	(-0,72)	(48,24)	(4,43)	(0,71)		
2 (medium)	0,06%	1,00	0,11	0,00		96,96%
	(0,79)	(49,11)	(4,43)	(0,08)		
3 (large)	0,01%	0,96	0,08	0,03		97,73%
	(0,21)	(56,36)	(3,93)	(1,47)		
Four-Factor Model						
1 (small)	-0,02%	0,97	0,11	0,02	-0,02	96,86%
	(-0,28)	(45,74)	(4,34)	(0,71)	(-1,16)	
2 (medium)	0,08%	1,00	0,11	0,00	-0,01	96,94%
	(0,90)	(46,52)	(4,37)	(0,08)	(-0,47)	
3 (large)	0,06%	0,95	0,08	0,03	-0,03	97,79%
	(0,85)	(53,88)	(3,84)	(1,49)	(-1,94)	

Lastly, the four-factor model shows that all three size portfolios have negative loadings on the momentum factor. The four-factor model achieves the highest average R^2 of 97,20% out of all the benchmark models. Therefore, following

Ferreira et al. (2012), we will use the Carhart alpha as our dependent variable further in the analysis. We notice that the average alpha using the four-factor model is 0,04% per month, which might be evidence of outperformance in the Norwegian mutual fund industry. This is especially interesting considering that Ferreira et al. found Norway to be among the worst performers in their worldwide sample from 2000 to 2007. One possible explanation is that the Norwegian stock market has increased in market capitalization, thus expanding the investment universe in a more liquid market. However, on a worldwide basis, the Norwegian market is still considered to be small scale[16]. Looking at the individual alphas, none of them are statistically significant, and we can therefore not conclude that there is outperformance in the Norwegian mutual fund market.

4.3 Relationship Between Fund Size and Performance

To deal with concerns related to the correlation of fund size with other fund characteristics, we analyze the effect of past fund size on performance and control for other fund characteristics on performance, such as family size, age, expense ratio, past-year inflows, and past-year fund returns. We run panel regressions to test the different research questions. Panel data is a combination of cross-sectional and time-series regression, where all observations are gathered in the same dataset. This amounts to approximately 6000 monthly observations per variable, and 520 yearly observations per variable.

To answer the core research question, the panel regression can be expressed as followed:

$$FUNDRET_{i,t} = \mu + \varphi LOGTNA_{i,t-1} + \gamma X_{i,t-1} + \varepsilon_{i,t} \qquad (6)$$

where $FUNDRET_{i,t}$ is the return of fund i in month t adjusted by the four-factor model. 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 LOGFAMSIZE, EXPRATIO, AGE, FLOW, and LAGFUNDRET. γ is the vector of loadings on the control variables, and $\varepsilon_{i,t}$ is the

[16] World Federation of Exchanges – Annual Statistics Guide 2017

generic error term. The coefficient of interest is φ, which captures the relationship between size and performance.

We will also utilize an additional regression to test the liquidity hypothesis and the role of organizational structure:

$$FUNDRET_{i,t} = \mu + \varphi_1 LOGTNA_{i,t-1} + \varphi_2 I_{(style)} + \varphi_3 LOGTNA_{i,t-1}\, I_{(style)} + \gamma X_{i,t-1} + \varepsilon_{i,t} \quad (7)$$

$$FUNDRET_{i,t} = \mu + \varphi_1 LOGTNA_{i,t-1} + \varphi_2 I_{(style)} + \varphi_3 LOGTNA_{i,t-1}\, I_{(style)} + \varphi_4 LOGFAMSIZE_{i,t-1} I_{(style)} + \gamma X_{i,t-1} + \varepsilon_{i,t} \quad (8)$$

where $I_{(style)}$ is a dummy indicator, which equals one if a fund belongs to a specific style category and zero otherwise. When testing the liquidity hypothesis using Equation (7), the coefficient of interest is φ_3, which measures the differential effect of fund size on returns across different fund styles. When testing the role of organizational structure using Equation (8), the coefficient of interest is φ_4, which measures the differential effect of family fund size on returns across different fund styles.

4.4 Panel Data Models

Panel data models examine cross-sectional (group) or time-series (time) effects, or both to deal with heterogeneity or individual effect that may be unobservable. These effects are either fixed or random. A fixed effect model examines whether intercepts vary across groups or time periods. A random effect model explores differences in error variance components across individual or time periods (Park, 2011).

4.4.1 Pooled OLS

If the individual effect (u_i) does not exist, then ordinary least squares (OLS) produces consistent and efficient parameter estimates. The pooled OLS model specifies constant coefficients, which is the usual assumption for cross-sectional analysis. The model can be expressed as followed:

$$y_{i,t} = \alpha + \beta X_{i,t} + \varepsilon_{i,t} \; (u_i = 0) \qquad (9)$$

OLS consists of five core assumptions about the error term:

1. $E[\varepsilon_t] = 0$ The errors have zero mean
2. $Var[\varepsilon_t] = \sigma^2 < \infty$ The variance of the errors is constant and finite over all values of x_t
3. $Cov(\varepsilon_i, \varepsilon_j) = 0$ The errors are linearly independent of one another
4. $Cov(\varepsilon_t, x_t) = 0$ There is no relationship between the error and corresponding x variate
5. $\varepsilon_t \sim N(0, \sigma^2)$ ε_t is normally distributed

If the individual effect (u_i) is not zero, then heterogeneity may influence the assumptions, and the OLS model is no longer the best linear unbiased estimator (BLUE).

4.4.2 Group- and Time-Fixed Effects

A regular OLS regression does not consider heterogeneity across groups or time. A fixed effects model allows us to identify the "within" variation by using a dummy variable in the regression for each group or time (in our case, for each fund and for each year). Using such dummy variables holds the effects that we cannot directly measure or observe constant or "fixed". Controlling for these differences removes the cross-sectional variation related to unobserved heterogeneity, while the remaining variation can be used to identify the causal relationships we are interested in.

When controlling for fixed effects, there are several specific models: fixed group effect model, fixed time effect model, or fixed group and time effect model. To determine which model we should use, we need to look at the overall goodness-of-fit measures (e.g., F and R^2) (Park, 2011).

5. RESULTS

In this part of the thesis, we will first present the empirical findings from our regression analysis, as well as discussing the result in the final section. In our regression analysis, we operate with three levels of significance, respectively 10%, 5% and 1% level and all the applied models are calculated using clustered standard errors.

5.1 The Effect of Size on Performance

Table 6 reports the estimation results for the baseline regression given in Equation (6) using Carhart four-factor model alphas as a measure of risk-adjusted performance, regressed on lagged fund characteristics. The fund characteristics are the fund's logged total net assets, age, fund flow, logged family size, expense ratio and past fund returns. Column (1) presents estimates using the pooled OLS model, column (2) includes time-fixed effects (year dummies), column (3) includes group-fixed effects (fund dummies), and column (4) includes both time- and group-fixed effects. The variable of interest is the coefficient in front of LOGTNA.

Firstly, looking at the overall goodness-of-fit, we see that including time dummies in column (2) increase both adjusted R^2 (from 3,56% to 10,84%) and the F statistic (from 3,76 to 5,20). Including fund dummies in column (3) does not yield the same effect. In fact, the adjusted R^2 decreases and the F statistic is no longer significant when including only group-fixed effects. Therefore, we conclude that the best model to use is the fixed time effect model.

Looking at the model, we first notice that the coefficient in front of LOGTNA is negative, meaning size has a negative effect on performance. However, the coefficient is not statistically significant, and we can therefore not conclude that size has an effect on performance.

Hence, we have answered the core research question:

There is no statistically significant correlation between size and performance of the Norwegian mutual funds in our sample.

Table 6 Regression of mutual fund performance on lagged fund size

This table reports panel regressions of the performance of open-end actively managed Norwegian mutual funds. The dependent variable is the monthly Carhart model alpha estimated using monthly fund returns. LOGTNA is the natural logarithm of TNA. LOGFAMSIZE is the natural logarithm of the size of the family that the fund belongs to. EXPRATIO is the expense ratio. AGE is the number of years since the establishment of the fund. FLOW is the percentage of new fund flow into the mutual fund. LAGFUNDRET is the fund return lagged one month. Column (2) and (4) include year dummies, while column (3) and (4) include fund dummies. The sample is from January 2009 to December 2017. Robust standard errors corrected for fund-level clustering are in parentheses. The regression equation is formulated as followed:

$$FUNDRET_{i,t} = \mu + \varphi_1 LOGTNA_{i,t-1} + \varphi_2 LOGFAMSIZE_{1,t-1} + \varphi_3 EXPRATIO_{i,t-1} + \varphi_4 AGE_{i,t-1} + \varphi_5 FLOW_{i,t-1} + \varphi_6 LAGFUNDRET_{i,t-1} + \varepsilon_{i,t}$$

Panel Regression				
	Pooled OLS			
	(1)	(2)	(3)	(4)
$LOGTNA_{i, t-1}$	-0,00005	-0,00002	-0,0026	-0,0018
	(0,0006)	(0,0006)	(0,0034)	(0,0032)
$LOGFAMSIZE_{i, t-1}$	-0,0003	-0,0004	0,0105**	0,0080**
	(0,0006)	(0,0006)	(0,0046)	(0,0041)
$EXPRATIO_{i, t-1}$	0,2102	0,1760	-8,0730	-10,9471
	(0,5829)	(0,5751)	(11,5279)	(8,2286)
$AGE_{i, t-1}$	0,00001	0,00002	-0,0007**	-0,0013
	(0,00004)	(0,00004)	(0,0003)	(0,0088)
$FLOW_{i, t-1}$	-0,0011	-0,0009	-0,0019	-0,0015
	(0,0008)	(0,0008)	(0,0014)	(0,0012)
$LAGFUNDRET_{i, t-1}$	0,0921***	0,0626	0,0853***	-0,0179
	(0,0238)	(0,0763)	(0,0255)	(0,0895)
Constant	0,0021	0,0057	-0,0615	-0,0244
	(0,0058)	(0,0064)	(0,0382)	(0,1390)
Year dummies	No	Yes	No	Yes
Fund dummies	No	No	Yes	Yes
Observations	450	450	450	450
R^2	4,85%	13,43%	17,71%	26,43%
Adjusted R^2	3,56%	10,84%	1,21%	9,99%
F statistic	3,7643***	5,2011***	1,0731	1,6075***
Note:	*p<0,1;	**p<0,5;	***p<0,01	

5.2 Liquidity Hypothesis

Insofar as liquidity constraints are the cause of the return differentials of different Norwegian mutual funds, it is expected that fund size is of greater importance if the fund has a more significant share of small-cap. The hypothesis suggests that

liquidity constraints play an important role when measuring scalability of fund investment in mutual fund industry (Chen et al., 2004; Pollet and Wilson 2008). Table 7 presents the results of the regression given in equation (7), which we use to test the liquidity hypothesis. Using the Oslo Stock Exchange Small Cap Index gathered from Lipper, we identify the funds in our sample that invest more in small stocks (small-cap funds) and those that invest more in large stocks (large-cap funds). The dummy indicator $I_{(LG)}$ is a large-cap fund dummy that equals one if the fund is below the median small-cap loading and zero otherwise. The regression specifications in Table 6 is augmented with the large-cap fund dummy, and this indicator dummy interacted with LOGTNA. The variable of interest is the coefficient in front of the interaction term. If the liquidity hypothesis is true, then the coefficient of the interaction term should be positive, since, for large-cap funds, there should be less effect of fund size on performance than for small-cap funds (Ferreira et al., 2012).

First, we notice that the coefficient in front of the interaction term is positive, which means that for large-cap funds, there is a smaller effect of fund size on performance. However, the coefficient is not statistically significant. The coefficient in front of LOGTNA, which shows the effect of size on performance for small-cap funds, is negative and statistically insignificant. Ferreira et al. (2012) also found statistically insignificant results for non-US funds, arguing that this could stem from non-US funds loading less in small stock compared to US funds, and therefore are not as much affected by liquidity constraints when they grow.

Modern IT systems also help to eliminate liquidity effects in the Norwegian market. These are measures which aim to limit the exchange rate effect that may arise from purchase and sales of a significant equity position in individual companies, by hiding the orders until executed. The orders will appear after execution. More precisely, the disclosure of orders that are large in scale (LIS) or above size specific to the instrument (SSTI), registered in an order container and orders in securities defined as illiquid may be waived[17].

Hence, the second research question have been answered:

We find no statistically significant results indicating that fund size is a limiting factor for the funds in our sample that invest in small-cap stocks.

[17] Oslo Børs Member and Trading Rules. Rule 2200

Table 7 Effect of fund size on performance by fund style

This table reports panel regressions of the performance of open-end actively managed Norwegian mutual funds. The dependent variable is the monthly Carhart model alpha estimated using monthly fund returns. The regression includes the same fund characteristics used in Table 6, augmented with $I_{(LC)}$, which is a dummy variable that equals one if the fund style is characterized as "large-cap" and zero otherwise, and this indicator variable interacted with LOGTNA. The sample is from January 2009 to December 2017. Robust standard errors corrected for fund-level clustering are in parentheses. The full table is presented in Appendix 5. The regression equation is formulated as followed:

$$FUNDRET_{i,t} = \mu + \varphi_1 LOGTNA_{i,t-1} + \varphi_2 LOGFAMSIZE_{1,t-1} + \varphi_3 I_{(style)} + \varphi_4 LOGTNA_{i,t-1}\, I_{(style)} + \varphi_5 EXPRATIO_{i,t-1} + \varphi_6 AGE_{i,t-1} + \varphi_7 FLOW_{i,t-1} + \varphi_8 LAGFUNDRET_{i,t-1} + \varepsilon_{i,t}$$

	Dependent Variable
	Y
$LOGTNA_{i,\,t-1}$	-0,0006
	(0,0009)
$LOGFAMSIZE_{i,\,t-1}$	-0,0004
	(0,0006)
$I_{(LC)}$	-0,0104
	(0,0077)
$LOGTNA_{i,\,t-1} * I_{(LC)}$	0,0011
	(0,0009)
Time dummies	Yes
Fund dummies	No
Observations	450
R^2	13,81%
Adjusted R^2	10,83%
F statistic	4,6367***
Note: *p<0,1; **p<0,5; ***p<0,01	

5.3 The Role of Organization: The Effect of Family Size on Performance

In reference to our main regression in Table 6, we included LOGFAMSIZE to investigate the effect of a fund's organization on fund performance. As our coefficient in front of LOGFAMSIZE is -0,0004 in the basis regression, the results suggest that fund performance will decline with the size of other funds in the family. However, these findings are not statistically significant. To extend our analysis of the effect of family size on fund return further, we analyze whether there is an effect when accounting for different fund styles. When taking into account that our data sample is complex and that the funds have different investment style, we want to investigate whether the negative effect of family size on performance gets

reinforced when explicitly analyzing for small-cap funds. We hope that the effect becomes statistically significant when including only small-cap funds, which are most affected by scale.

Table 8 augments the regression specification in Table 7 by adding another interaction term with LOGFAMSIZE and the dummy indicator $I_{(LC)}$ (which equals one if the fund is below the median small-cap loading and zero otherwise). The variable of interest is the coefficient in front of this interaction term.

Table 8 Effect of family size on performance by fund style

This table reports panel regressions of the performance of open-end actively managed Norwegian mutual funds. The dependent variable is the monthly Carhart model alpha estimated using monthly fund returns. The regression includes the same fund characteristics used in Table 7, augmented with the indicator variable $I_{(LC)}$ interacted with LOGFAMSIZE. The sample is from January 2009 to December 2017. Robust standard errors corrected for fund-level clustering are in parentheses. The full table is presented in Appendix 6. The regression equation is formulated as followed:

$$FUNDRET_{i,t} = \mu + \varphi_1 LOGTNA_{i,t-1} + \varphi_2 I_{(style)} + \varphi_3 LOGTNA_{i,t-1}\, I_{(style)} + \varphi_4 LOGFAMSIZE_{1,t-1} + \varphi_5 LOGFAMSIZE_{i,t-1} I_{(style)} + \varphi_6 EXPRATIO_{i,t-1} + \varphi_7 AGE_{i,t-1} + \varphi_8 FLOW_{i,t-1} + \varphi_9 LAGFUNDRET_{i,t-1} + \varepsilon_{i,t}$$

	Dependent Variable
	Y
$LOGTNA_{i,\,t-1}$	-0,0006
	(0,0010)
$I_{(LC)}$	-0,0121
	(0,0106)
$LOGTNA_{i,\,t-1} * I_{(LC)}$	0,0010
	(0,0010)
$LOGFAMSIZE_{i,\,t-1}$	-0,0005
	(0,0010)
$LOGFAMSIZE_{i,\,t-1} * I_{(LC)}$	0,0003
	(0,0012)
Time dummies	Yes
Fund dummies	No
Observations	450
R^2	13,82%
Adjusted R^2	10,63%
F statistic	4,3396***
Note: *p<0,1; **p<0,5; ***p<0,01	

The coefficient in front of LOGFAMSIZE is still negative and statistically insignificant. The coefficient in front of the interaction term is positive, which could suggest that large-cap funds benefit more from being part of a large family. However, the coefficient is not statistically significant. Therefore, we cannot conclude that there are major differences between the effect of family size on performance among small-cap funds and large-cap funds.

Hence, we have answered the last research question:

We find no statistically significant results indicating that family size is a limiting factor for the funds in our sample that invest in small-cap stocks.

5.4 Further Discussion

Our results show no significant relationship between size and performance in the Norwegian mutual fund industry. Also, we have included two additional research questions regarding the impact of liquidity constraint and organizational diseconomies affecting fund performance, suggested by Chen et al. (2004) and Ferreira et al. (2012). In this section, we aim to increase our understanding of why previous research documents scaling effects in non-Norwegian mutual fund industry, while such effects do not appear in the Norwegian market.

5.4.1 Geographical Characteristics

In the thesis literature review, we pointed out that the majority of past research regarding the topic of this paper comes from the US[18]. These find, almost exclusively, a negative correlation between size and risk-adjusted return. An explanation for such geographical differences is the fact that domestic US funds are on average five times larger than elsewhere in the world (Ferreira et al., 2012) and that our sample funds may not be comparable to those in the US given such a substantial spread in between sizes. In the Norwegian Central Bank's report "The Norwegian Financial system 2017" (Norges Bank, 2017, p.40), the market capitalization of Oslo Børs was NOK 2100 billion by the end of 2016. According to the report "World Federation of Exchanges – Annual Statistics Guide 2017", market capitalization of Oslo Børs is still small-scale in an international

[18] See Grinblatt & Titman (1989), Indro et al (1999) and Chen et al. (2004)

understanding. The market structure and conditions of competition can be seen as a limiting factor, with opportunities for market adjustments being narrowed. Hence, scaling effects can be difficult to achieve. Finanstilsynet (2008) pointed out that customer management of many investors in a small-cap market can be seen as the major expense for the mutual funds, due to increased unit costs. More specifically, it was underlined that more administrative costs accrue when the number of small customers increases, hence, working against economies of scale, affirmative in view of our findings of no significant relationship between size and returns.

5.4.2 Organizational Complexity

Expenses and complexity in the administration are expected to increase with the size of the organization the fund is part of. Chen et al. (2004) hypothesize that fund size erodes performance due to organizational diseconomies. Following Stein (2002), they argue that a small fund company with only the fund manager taking decisions, the manager can easily make investment decisions in line with incorporated fund investment strategy. When considering a larger fund, one single manager no longer has the capacity to invest and manage all the money. Further, Stein (2002) argues that due to such asymmetry, there may be costs and inefficiencies in a larger organization and that this further leads to a hierarchical governance set.

A manager placed in a lower quintile in a hierarchy continuously carry the risks that managers higher up in the organization will push through their investment goals and strategies in the department. In this case, the manager's effort of researching and process of collecting information will be wasted and thus puts less effort into his research in hierarchical organizations than in a decentralized organization where the manager has stronger decision-making authority. Connecting this to the size of the organization, we found no significant coefficients testing for the relationship between the size of fund organization (LOGFAMSIZE) and performance. This could indicate that Norwegian mutual funds are primarily decentralized and that the managers have a high degree of decision-making authority. However, we have no further insight into the organizational structure and managerial decisions in the different mutual funds in our sample, and thus no basis for confirming a high degree of accuracy in our assumptions regarding hierarchy costs and management decisions. This is a possible suggestion for an element to include in further research.

5.4.3 Other Factors

Scaling effects in the Norwegian mutual fund market will also depend on factors such as legislation, organizational structure and competitive conditions. Khorana, Servaes & Tufano (2008) compares fees in mutual funds in various markets. Their findings suggest that Norwegian mutual funds have high fees for both management and administration. The presence of scaling effects in the mutual fund industry should be reflected in lower expenses in managing the fund as the capital base grows and the cost of managing each customer declines (Banko et al., 2010). A steep level of costs in combination of a small market capitalization should lead to limited opportunities of scaling effects in Norwegian mutual fund industry. This is in line with this paper finding no significant scaling effect between size and performance.

There exist numerous other factors affecting equity performance and scaling in the mutual fund industry. Ferreira et al. (2012) point out a country's financial development, the structure of the fund industry, and the quality of regulatory and enforcement authorities as central factors. Their research ranks the Norwegian mutual funds amongst the poorest in their sample. As an explanation, they state that the Norwegian mutual fund industry is young in combination with small market capitalization. This will create limitations regarding the efficiency in the administration of the funds.

Even though our analysis does not suggest any significant support for a relationship between the size of the fund's asset base and fund performance, the trend is negative. One possible explanation for this no-significant trend of a negative correlation is the difference in net asset value (NAV) impact when orders are executed. It is likely that larger funds will move the fund's NAV because these funds must buy a more substantial amount of stocks relative to smaller funds to obtain the same portfolio weights as the smaller funds. Further, when trades affect NAV, larger mutual funds are likely to pay a premium. This price mechanism also has an impact when the funds are selling shares. More precisely, to unload their position in a stock, larger funds are likely to sell at a discount as the offer exceeds demand.

6. CONCLUSION

In this paper, we have investigated the relationship between the size of 70 open-end actively managed Norwegian mutual funds and their respective adjusted returns, as well as controlling for scaling effects of other fund characteristics. We used a dataset free of survivorship bias ranging from January 2009 to December 2017. The core research question in this paper was formulated as followed:

"Is the correlation between size and performance of Norwegian mutual funds statistically significantly different from zero at the 5% level?"

There exist both theoretical and empirical research that supports the existence of scaling effects in the active money market, but to our knowledge, we are amongst few that have investigated the Norwegian market. The majority of the existing literature in the field is based on the US market which, almost exclusively, find a negative correlation between size and risk-adjusted return and thus demonstrates how organizational diseconomies would penalize the larger funds. On the other hand, Ferreira et al. (2012) showed that these finding of negative scaling effects in the US market are not a universal truth, by finding a significantly positive relationship between adjusted return and total assets in the non-US market.

With both cross-sectional data and time-series data on monthly observations, we utilized panel data regression to see how fund performance varies with lagged fund size, motivated by the work of Chen et al. (2004) and of Ferreira et al. (2012).

The thesis was expanded further to include two effects based on the liquidity hypothesis and the role of organization. Regarding the liquidity hypothesis, this paper investigated the following research question:

"Is the correlation between size and performance of Norwegian mutual funds investing in small-cap stocks statistically significantly different from zero at the 5% level?"

We stated the following research question regarding the investigation of the beneficial degree of belonging to a larger fund family:

"Is the correlation between family fund size and performance of Norwegian mutual funds investing in small-cap stocks statistically significantly different from zero at the 5% level?"

In our thesis, we document no statistically significant relationship between size and performance of Norwegian mutual funds. We further discuss various explanations for our findings. Firstly, the study shows that there exist no liquidity effects in the Norwegian mutual fund market of holding small-cap shares. Secondly, we prove that a fund's return does not decline with the lagged size of the family it belongs to, suggesting that scale of mutual funds not necessarily need to be negative depending on how the fund is organized.

Our findings considering the liquidity hypothesis are in line with those of Ferreira et al. (2012) and support the hypothesis that liquidity constraints explain why larger funds (in the US) are affected by diminishing return to scale and not in the Norwegian market. We also argue that the lack of scale effects in Norwegian mutual funds is related to the market capitalization of Oslo Børs, long adaptation time to international legislation and high levels of costs.

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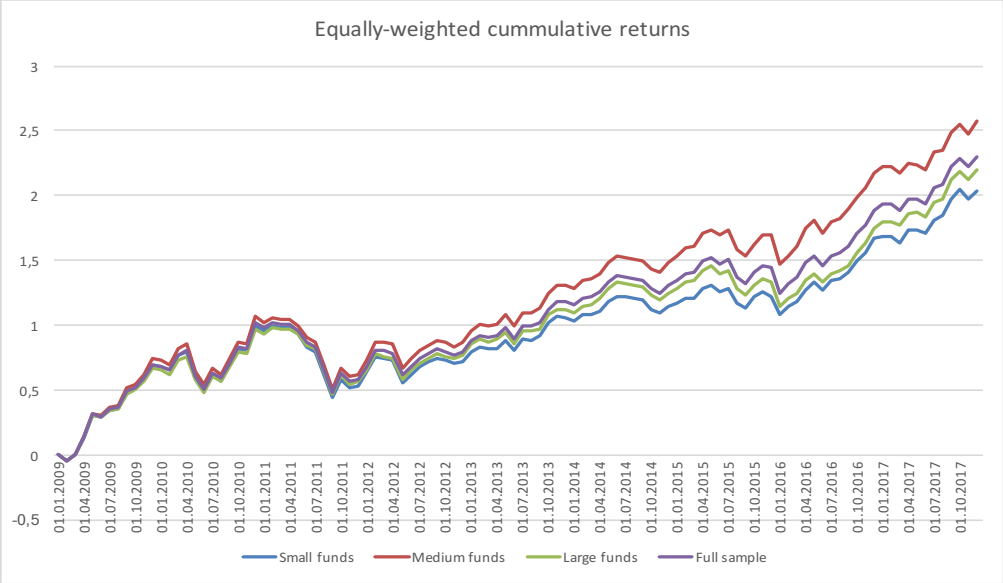
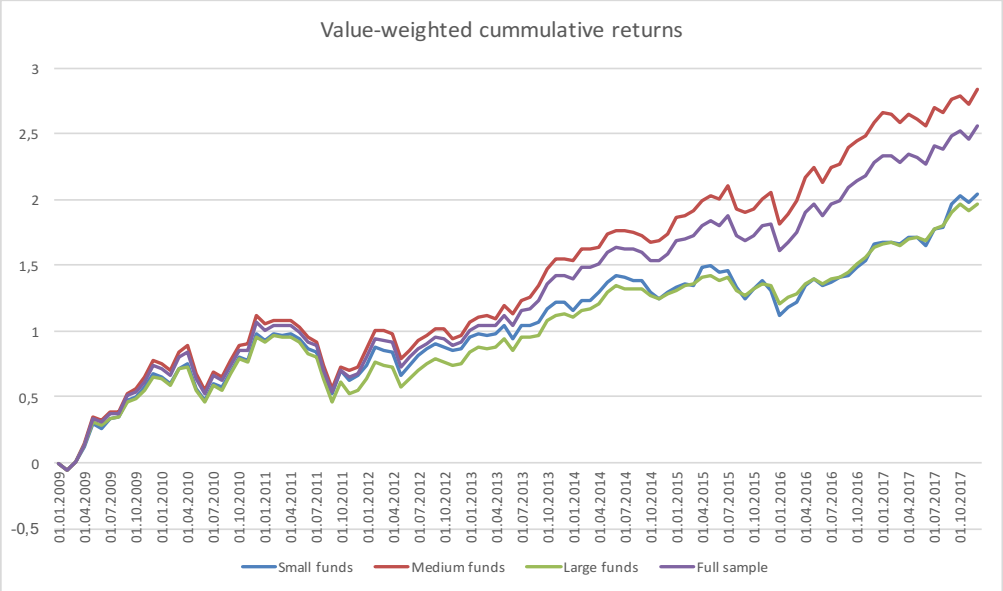
8. Appendix

Appendix 1 – Equally weighted cumulative returns



Appendix 2 – Value weighted cumulative returns



Appendix 3 – Single-index estimation of sample funds

Fund	Average excess return	Alpha	t-stat	Beta	t-stat	Adj. R2	Launch Date	Closed Date
Alfred Berg Aktiv	1,352 %	0,199 %	1,53	0,947	35,02	91,97 %	29.12.1992	
Alfred Berg Aktiv II	1,511 %	-0,116 %	-1,51	0,985	17,71	95,89 %	15.09.1997	01.10.2012
Alfred Berg Gambak	1,457 %	0,424 %	2,35	0,848	22,64	82,70 %	01.11.1990	
Alfred Berg Humanfond	1,112 %	-0,025 %	-0,25	0,934	44,72	94,92 %	23.12.1999	
Alfred Berg Norge +	1,551 %	0,076 %	-0,48	0,961	21,62	97,84 %	03.12.1997	23.04.2014
Alfred Berg Norge (INST)	1,092 %	0,442 %	1,71	0,869	3,68	90,32 %	2014-04-23	31.12.2007
Alfred Berg Norge Etisk	1,429 %	-0,082 %	-0,97	0,985	21,51	97,33 %	14.03.2002	23.04.2014
Alfred Berg Norge (Classic)	1,336 %	0,187 %	2,28	0,943	55,25	96,61 %	01.10.1990	
Arctic Norwegian Equities I	0,859 %	0,213 %	0,61	0,849	8,96	87,12 %	15.11.2010	
Arctic Norwegian Equities II A	1,018 %	0,444 %	1,43	0,819	3,38	79,90 %	22.08.2014	
C WorldWide Aksje Norge III	1,271 %	0,097 %	1,12	0,965	53,64	96,41 %	30.04.2002	
C WorldWide Norge	1,198 %	0,022 %	0,26	0,966	54,65	96,54 %	07.07.1995	
DNB Postbanken Norge	1,064 %	-0,074 %	-0,74	0,935	45,31	95,04 %	27.07.1995	
DNB Avanse Norge I	1,388 %	-0,173 %	-1,25	1,006	21,43	97,03 %	01.10.1966	21.03.2014
DNB Avanse Norge II	1,249 %	-0,188 %	-1,35	1,014	22,45	96,83 %	01.01.1990	24.10.2014
DNB Norge I	1,352 %	-0,068 %	-0,92	0,926	20,96	96,34 %	16.10.1981	21.03.2014
DNB Norge III	1,122 %	-0,016 %	-0,17	0,935	45,28	95,04 %	06.02.1996	
DNB Norge IV	1,147 %	0,005 %	0,05	0,938	45,33	95,05 %	25.11.2002	
DNB Norge Selektiv I	1,079 %	-0,098 %	-0,73	0,967	34,86	91,90 %	19.04.1996	
DNB Norge Selektiv II	1,146 %	-0,030 %	-0,22	0,965	34,77	91,86 %	19.12.2001	
DNB Norge Selektiv III	1,169 %	-0,013 %	-0,09	0,971	34,83	91,89 %	13.06.1994	
DNB SMB	1,112 %	-0,052 %	-0,15	0,956	13,61	63,25 %	16.03.2001	
Danske Invest Norge I	1,235 %	0,056 %	0,62	0,968	51,14	96,07 %	03.01.1994	
Danske Invest Norge II	1,296 %	0,120 %	1,32	0,966	51,30	96,09 %	03.01.1994	
Danske Invest Norge Vekst	1,338 %	0,236 %	1,38	0,906	25,59	85,93 %	03.01.1994	
Danske Invest Norske Aksjer Institusjon I	1,303 %	0,138 %	1,61	0,957	53,76	96,43 %	13.04.2000	
Danske Invest Norske Aksjer Institusjon II	1,319 %	0,144 %	1,57	0,966	50,93	96,04 %	28.11.2006	
Delphi Fondene Norge	1,337 %	0,215 %	1,27	0,922	26,15	86,45 %	03.06.1994	
Delphi Vekst	1,163 %	-0,138 %	-1,06	0,861	14,47	80,93 %	20.10.1997	15.10.2013
Eika Norge	1,066 %	-0,130 %	-0,78	0,983	28,43	88,30 %	08.09.2003	
Eika SMB	1,359 %	-0,003 %	-0,86	0,918	13,40	77,89 %	30.04.1998	
Eika Vekst	1,318 %	0,166 %	-0,17	0,725	14,92	81,63 %	03.04.1998	08.11.2013
FIRST Generator S	1,353 %	0,415 %	0,89	1,166	8,03	73,77 %	03.09.2010	
FORTE Norge	0,723 %	0,083 %	-0,01	0,963	6,86	68,43 %	01.03.2011	
FORTE Tronder	1,339 %	0,734 %	2,20	0,674	2,49	32,14 %	01.01.2013	
Fondsfinans Norge	1,351 %	0,148 %	0,82	0,989	26,55	86,80 %	16.12.2002	
Holberg Norge	0,895 %	-0,204 %	-1,15	0,902	24,58	84,94 %	28.12.2000	
KLP Aksje Norge	1,255 %	0,024 %	0,25	1,011	51,40	96,11 %	12.03.1999	
Landkreditt Norge	0,953 %	-0,203 %	-1,80	0,965	23,26	87,19 %	24.05.2006	23.06.2016
Landkreditt Utbytte	0,892 %	0,321 %	1,58	0,658	3,06	44,86 %	28.02.2013	
NB Aksjefond	1,220 %	-0,284 %	-1,58	0,996	17,62	91,13 %	30.08.1996	17.10.2013
Nordea 1 Norwegian Eq. Fund BP NOK	1,252 %	0,061 %	0,47	0,979	36,52	92,57 %	21.11.1997	
Nordea Avkastning	1,312 %	0,115 %	1,48	0,983	60,86	97,19 %	01.02.1981	
Nordea Kapital	1,341 %	0,152 %	2,11	0,976	65,02	97,53 %	01.01.1995	
Nordea Norge Pluss	0,894 %	0,234 %	0,44	0,977	8,38	90,78 %	27.04.2011	
Nordea Norge Verdi	1,365 %	0,391 %	2,38	0,801	23,46	83,70 %	06.02.1996	
Nordea SMB	0,344 %	-0,854 %	-2,23	0,855	11,93	65,96 %	21.05.1997	31.01.2015
Nordea Vekst	1,355 %	-0,037 %	-0,76	0,994	23,69	98,19 %	02.01.1981	31.01.2015
ODIN Norge C	0,860 %	-0,155 %	-0,82	0,834	21,28	80,85 %	26.06.1992	
PLUSS Aksje	1,196 %	0,091 %	0,99	0,908	47,48	95,47 %	18.10.1996	
PLUSS Markedsverdi	1,234 %	0,070 %	1,06	0,957	70,43	97,89 %	11.01.1995	
Pareto Aksje Norge A	0,947 %	-0,025 %	-0,13	0,799	19,15	77,37 %	09.09.2002	
Pareto Aksje Norge B	0,960 %	-0,047 %	-0,23	0,827	19,25	77,55 %	31.12.2005	
Pareto Aksje Norge C	1,057 %	0,403 %	0,96	0,813	2,85	64,33 %	13.07.2015	
Pareto Aksje Norge D	1,099 %	0,445 %	1,02	0,813	2,84	64,35 %	13.07.2015	
Pareto Aksje Norge I	1,084 %	0,074 %	0,36	0,830	19,29	77,63 %	06.09.2001	
Pareto Investment Fund A	1,425 %	0,251 %	1,48	0,964	27,43	87,53 %	03.01.1985	
Pareto Investment Fund B	1,222 %	0,704 %	2,36	0,685	2,82	56,90 %	29.11.2013	
Pareto Investment Fund C	1,259 %	0,741 %	2,45	0,685	2,80	56,90 %	29.11.2013	
SEB 1 Norway Focus IC (NOK)	1,771 %	0,573 %	2,55	0,790	1,51	58,32 %	02.03.2016	
Sbanken Framgang Sammen	1,476 %	-0,044 %	2,26	1,003	1,91	90,37 %	15.01.2016	
Storebrand Aksje Innland	1,069 %	-0,049 %	-0,59	0,919	52,78	96,30 %	01.07.1996	
Storebrand Norge	1,239 %	0,070 %	0,69	0,961	45,55	95,09 %	14.09.1983	
Storebrand Norge I	1,141 %	0,016 %	0,17	0,925	46,31	95,25 %	03.04.2000	
Storebrand Norge Institusjon	0,349 %	-0,016 %	-1,13	0,918	6,73	96,77 %	10.12.2010	25.02.2014
Storebrand Optima Norge A	1,126 %	-0,001 %	-0,01	0,926	26,76	86,99 %	28.12.2000	
Storebrand Vekst	1,574 %	0,488 %	1,50	0,893	13,19	61,80 %	10.11.1992	
Storebrand Verdi	1,050 %	-0,014 %	-0,12	0,875	36,18	92,44 %	22.12.1997	
Terra Norge	1,474 %	-0,041 %	-1,05	1,003	18,14	92,93 %	03.04.1998	17.10.2013
Verdipapirfondet Vibrand Norden	1,103 %	-0,140 %	-1,92	1,022	67,09	97,68 %	03.06.1997	

Appendix 4 - Summary Statistics for the Factor Returns

This table reports the summary statistics for the factors. MKT is the return on the Oslo Børs Mutual Fund Index (OSEFX) in excess of the one-month NIBOR rate. SMB is the return on a portfolio of small stocks minus large stocks. HML is the return on a portfolio long high book-to-market stocks and short low book-to-market stocks. PR1YR is the return on a portfolio long stocks that are past-12-month winners and short those that are past-12-month losers. The sample period is from January 2009 to December 2017.

				Correlation			
Factor	Mean return	SD of return		MKT	SMB	HML	PR1YR
MKT	1,22%	4,68%	MKT	1,00	-0,61	0,04	-0,32
SMB	0,06%	3,73%	SMB		1,00	-0,08	0,14
HML	0,37%	3,39%	HML			1,00	-0,01
PR1YR	1,08%	4,12%	PR1YR				1,00

Appendix 5 - Effect of fund size on performance by fund style (Full Table)

This table reports panel regressions of the performance of open-end actively managed Norwegian mutual funds. The dependent variable is the monthly Carhart model alpha estimated using monthly fund returns. The regression includes the same fund characteristics used in Table 9, augmented with $I_{(LC)}$, which is a dummy variable that equals one if the fund style is characterized as "large-cap" and zero otherwise, and this indicator variable interacted with LOGTNA. The sample is from January 2009 to December 2017. Robust standard errors corrected for fund-level clustering are in parentheses.

	Dependent Variable
	Y
$LOGTNA_{i, t-1}$	-0,0006
	(0,0009)
$LOGFAMSIZE_{i, t-1}$	-0,0004
	(0,0006)
$I_{(LC)}$	-0,0104
	(0,0077)
$LOGTNA_{i, t-1} * I_{(not SC)}$	0,0011
	(0,0009)
$EXPRATIO_{i, t-1}$	-0,2613
	(0,4770)
$AGE_{i, t-1}$	0,00005
	(0,00004)
$FLOW_{i, t-1}$	-0,0009
	(0,0008)
$LAGFUNDRET_{i, t-1}$	0,0556
	(0,0798)
Constant	0,0116
	(0,0094)
Time dummies	Yes
Fund dummies	No
Observations	450
R^2	13,81%
Adjusted R^2	10,83%
F statistic	4,6367***
Note: *p<0,1; **p<0,5; ***p<0,01	

Appendix 6 – Effect of family size on performance by fund style (Full Table)

This table reports panel regressions of the performance of open-end actively managed Norwegian mutual funds. The dependent variable is the monthly Carhart model alpha estimated using monthly fund returns. The regression includes the same fund characteristics used in Table 11, augmented with the indicator variable $I_{(LC)}$ interacted with LOGFAMSIZE. The sample is from January 2009 to December 2017. Robust standard errors corrected for fund-level clustering are in parentheses.

	Dependent Variable
	Y
$LOGTNA_{i, t-1}$	-0,0006
	(0,0010)
$I_{(LC)}$	-0,0121
	(0,0106)
$LOGTNA_{i, t-1} * I_{(LC)}$	0,0010
	(0,0010)
$LOGFAMSIZE_{i, t-1}$	-0,0005
	(0,0010)
$LOGFAMSIZE_{i, t-1} * I_{(LC)}$	0,0003
	(0,0012)
$EXPRATIO_{i, t-1}$	-0,2914
	(0,5170)
$AGE_{i, t-1}$	0,00005
	(0,00004)
$FLOW_{i, t-1}$	-0,0009
	(0,0008)
$LAGFUNDRET_{i, t-1}$	0,0552
	(0,0790)
Constant	0,0124
	(0,0100)
Time dummies	Yes
Fund dummies	No
Observations	450
R^2	13,82%
Adjusted R^2	10,63%
F statistic	4,3396***
Note: *p<0,1; **p<0,5; ***p<0,01	