BI Norwegian Business School - campus Oslo

GRA 19703

Master Thesis

Thesis Master of Science

Mutual Fund Size and Fund Performance

Navn: Line Urdahl, Sandra Vasset

Start: 15.01.2019 09.00

Finish: 01.07.2019 12.00

Line Urdahl
Sandra Vasset

Master Thesis at BI Norwegian Business School

Master of Science in Business

Major in Finance

- Mutual Fund Size and Fund Performance -

Supervisor:
Costas Xiouros

Date of Submission
01.07.2019

Campus:
BI Oslo, Nydalen

ACKNOWLEDGMENTS

This Master thesis is written as a final assignment to our Master of Science degree in Business with Major in Finance at BI Norwegian Business School. The process has given us valuable insights in applied research methods, as well as a substantial understanding of the mutual fund market. The thesis has been time consuming and challenging, especially the data collection. However, it has been a very educational and exiting process.

We would especially like to thank our supervisor Costas Xiouros for his excellent guidance throughout the semester. He has helped us in the right direction and led us to reflect thoroughly on choices along the way. Additionally, we would like to thank the Norwegian Fund Asset Association for providing us with relevant data. Finally, we would like to thank Bernt Arne Ødegaard for access to Oslo Børs Information.

ABSTRACT

This thesis studies the relationship between size and performance for 67 equity mutual funds in Norway, using a 14 years dataset free of survivorship bias from January 2005 to December 2018. We construct three portfolios based on the funds' size and evaluate their performance by looking at their risk-adjusted return estimated from various factor models. We find no significant evidence that Norwegian mutual funds are able to beat their benchmark, both gross of fees and net of fees. Further, we study the relationship between fund size and performance while controlling for different fund characteristics. We find a statistically significant negative relationship between fund size and performance. Thus, our results indicate that size matters for mutual fund performance in Norway. We suggest that these findings come from price mechanisms, complex decision-making processes, and the fact that the Norwegian mutual fund market has a narrow asset base that could cause investors to dilute their best ideas.

Table of Content

Figures

Tables

1.0 Introduction

1.1 Background

The mutual fund industry plays an increasingly important role in the world's financial markets. The International Investment Fund Association (2018) reported that in the last ten years, net sales of regulated[1] funds had totaled $12.7 trillion, and at the end of 2018, regulated funds had $46.7 trillion in total net assets (TNA) (Investment Company Institute, 2019). Equity funds remained the largest category of regulated funds, accounting for 43 % of net assets worldwide at the end of 2018.

As the mutual fund industry has become an increasingly important role in the economy, the predictability of mutual fund performance has become an essential topic. There are several reasons for measuring performance, and one of the main motives for the investor is which fund to buy or how to choose, or whether it makes sense to invest money in a specific mutual fund. The predictability of future performance has therefore become a critical issue. As the fund industry grows, the more asset base funds hold. The increasing asset base contributes to funds expanding the number of shares they buy, which in turn may dilute their best ideas. Consequently, developing a more robust understanding of how the performance of a fund depends on the size of the fund would be valuable for investors when making investment decisions.

Berk and Green (2004) came up with the theory for why past performance should not predict future performance. They argue that performance persistence should not exist since a fund that performs well will receive new inflow from outside investors. Consequently, the fund will expand its asset base until the fund reaches a point where it will impact the manager's ability to generate abnormal returns, and the investor's expected future return decreases. Hence, the funds are not able

[1]Regulated funds are defined as collective investment pools that are substantively regulated, open-end investment funds. Open-end funds are defined as those that issue new fund shares and redeem existing shares on demand. Typically, mutual funds. In the United States, regulated funds include mutual funds and exchange-traded funds (ETFs). In Europe, regulated funds include Undertakings for Collective Investment in Transferable Securities (UCITS). (Investment Company Institute, 2019).

to generate excess returns at a large scale and fund performance is affected by diseconomies of scale.

If the theory of Berk and Green (2004) is valid, it should be more challenging to generate abnormal returns from a growing fund. It will be reasonable to expect that rational investors will stop investing in the fund when the fund grows big enough, and there are no more abnormal returns. Thus, investors will not benefit from placing their investments in larger funds. According to Berk and Green's theory, there should be equilibrium of mutual fund size in the market. Thus, larger mutual funds will diminish.

The high growth in the mutual fund industry has resulted in substantial growth in the total amount of assets under management, and we find it particularly interesting to investigate this development and see to which extent it has an impact. The purpose of this Master Thesis is to investigate the relationship between mutual fund size and performance for Norwegian equity mutual funds from 2005 to 2018. Specifically, we want to investigate whether a monthly TNA of a domestic mutual fund affects the monthly risk-adjusted performance of the fund. The aim is to answer the following research question:

Does mutual fund size matter for fund performance in Norway?

The literature has been unable to come to a definitive conclusion on both the existence and the cause of diseconomies of scale in the mutual fund industry. We find it therefore interesting to try to understand the role of scale in the Norwegian mutual fund industry. A greater understanding of this relationship will be valuable for Norwegian investors, primarily because of the massive inflows that have increased the average size of Norwegian mutual funds over the last ten years.

1.2 The Norwegian Mutual Fund Market

The world's mutual fund industry is growing tremendously. The mutual fund market in the U.S. has had a leading role worldwide since its establishment, potentially because of its longevity, as it has been available since the 1920s

(Investment Company Institute, 2019). The industry started a lot later in Norway. In 1982, there was only a single mutual fund on the Oslo Stock Exchange, and the market value of Norwegian mutual equity funds was NOK 290 million (Gjerde and Sættem, 1991). Since then, the Norwegian mutual fund market has had a huge growing trend, and over the last decade it has more than tripled in TNA, as illustrated in Figure 1. In February 2019 the Norwegian market reached an all-time high TNA in mutual funds. Large net inflows led to NOK 1 199 billion TNA in the Norwegian mutual fund market. Of this, private customers net invested NOK 1.1 billion, and, 41 % of this went into equity and combination funds (VFF, 2019a). We find investigating the size effect on performance in Norway particularly interesting as the Norwegian mutual fund market is continuously growing.

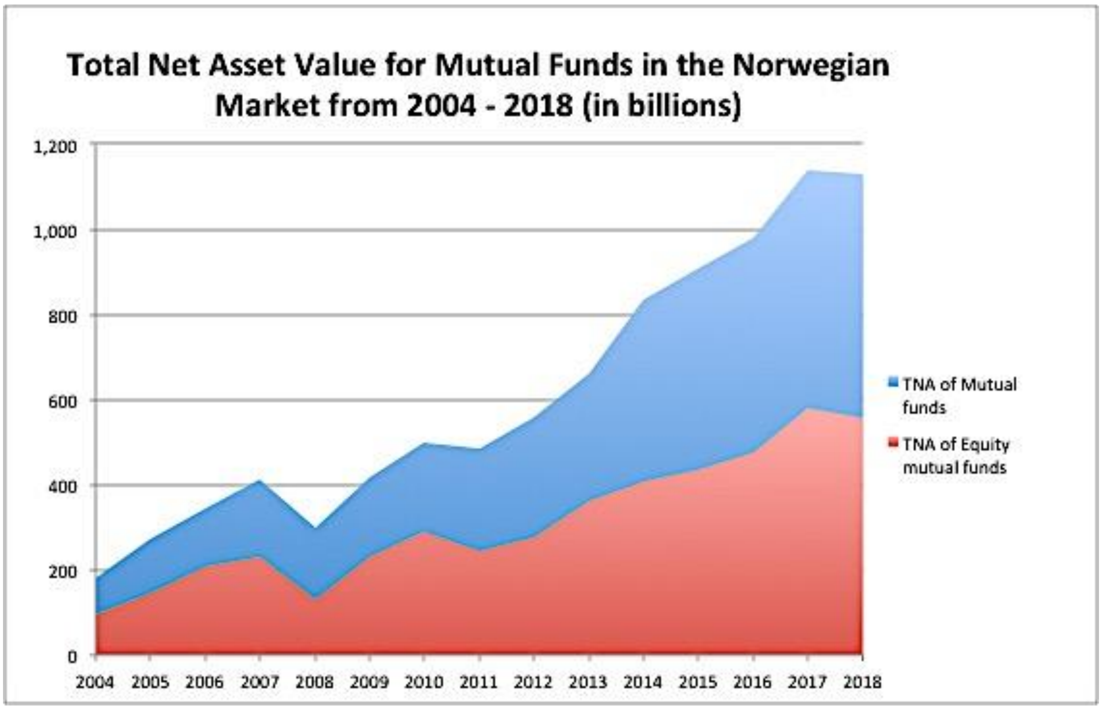


Figure 1: TNA of mutual funds in the Norwegian Market from 2004-2008 (VFF, 2019b).

Mutual funds are divided into several categories such as bond funds, equity funds or money market funds, each representing the different kinds of securities they have targeted for their portfolios and the type of returns they seek. Equity mutual funds account for approximately 50 % of the mutual fund market in Norway (See Figure 1). We therefore find equity mutual funds particularly interesting to focus on, as this type of fund has a considerable portion in the mutual fund industry.

Changes in Norwegian governmental tax regulations may have contributed to the high growth in Norwegian mutual fund TNA the last two years. The law changes have led to, among other things, new financial instruments that will make it easier for individuals to save. The establishments of “Aksjesparekonto” (ASK) and Individual pension savings (IPS) in 2017 are examples of such financial instruments. The authorities established ASK to stimulate increased equity savings among Norwegians. ASK gives the freedom to buy, sell, or swap investments without having to pay taxes on winnings along the way. Profits are only taxed if the securities are sold and withdrawn from the account. The original deposit amount placed on the account can be withdrawn tax-free at any time. This instrument permits private investors to sell out their market position depending on the timing they may find appropriate, rather than sell out based on their tax situation at the time (Regjeringen, 2017) Additionally, an IPS account gives a deduction in ordinary income for deposits up to NOK 40.000 a year in stocks or mutual funds. The tax is only paid when you withdraw the money at retirement age, and taxed as ordinary income (VFF, 2019c). Supplementary, another possible explanation for the growth in TNA is the changes in the Norwegian pension system, such as the law “Obligatorisk tjenestepensjon” (OTP) (OTP-loven, §§1-9, 2005). OTP requires deposits from employers, which saves a minimum of pensions to their employees. Further, the regulation “Innskuddsbasert pensjon” (IBP) (Innskuddspensjonsloven, §1, 2000), allows the employees to select their pensions saved by their employer. Both pension-instruments can be invested in mutual funds. Consequently, the pensions affect private investors interest in mutual funds and in time increases the TNA invested in mutual funds. The purpose of these instruments is to increase the small investors’ ownership in Norwegian companies by making it easier and more favorable for private individuals and institutional investors to save in shares or mutual funds (Skatteetaten, 2019).

1.3 Contribution

This study will contribute to the research on mutual fund performance and fund size in the Norwegian market. There is little consensus among the academics on this issue, and a lot of the findings present contradicting results. There is limited research outside the U.S. on how the size of a fund affects the performance, and to the best of our knowledge, it has not been investigated in the Norwegian market. The Norwegian economy is among one of the highest developed countries in the world (Regjeringen, 2013). We find it motivating to bring new evidence on this topic for Norway. The thesis is complementary to existing research such as Chen, Hong, Huang and Kubix (2004) and Ferreira, Keswani, Miguel and Ramors (2013), as we will measure performance by three different risk-adjusted benchmark models, include different fund characteristics in order to control for fund size, and have a country-specific study outside the U.S.. Our thesis will further contribute to the existing research on mutual fund performance in the Norwegian mutual fund market. There is little research on the Norwegian mutual market, although few researchers such as Sørensen (2009) and Gallefoss, Hansen, Haukaas and Molnár, (2015) have studied the persistence and the performance in the mutual fund market. Lastly, this thesis aims to raise a greater understanding regarding the factors driving fund performance and additionally inspire towards further research on the industry, since this has a growing interest for the Norwegian households and private institutions (VFF, 2018).

1.4 Delimitations

Primarily our data sample contained 71 domestic equity mutual funds in Norway. Since the available databases were not able to provide us data on four of the funds, our sample ended up covering 67 funds. It would have been optimal for our analysis to provide data for all funds. However, as the limitation only applies to four funds, our analysis will still show a reasonable estimate of the domestic mutual fund industry in Norway. Hence, this limitation will not have significant consequences for our results. It should be further noted that since we only study domestic equity mutual funds, we cannot say that our conclusion is valid for all Norwegian mutual funds. Nevertheless, we consider our findings as a good proxy for the domestic mutual funds market in Norway.

Additionally, because of limited available data, we only have the opportunity to do our research based on the last 14 years. Optimally, our research question should have been investigated over a longer period in order to adjust for several economic cycles. Arguably, as our data include the financial crisis in 2008, we cover different cycles, and the analysis will give a perception of the market. It should be noted that all the TNA data provided had to be manually sorted into monthly time series for each fund. When retrieving data manually, there is a chance of making some mistakes. However, by using the MATCH-function in excel, we have to our best ability tried to come around this problem.

When adjusting for fund characteristics, other researchers such as Chen et al. (2004) are also investigating the regression variable Turnover. This characteristic may capture whether a fund is active or an index, and they argue that this variable could be important since it may influence the performance of funds. The available databases were unfortunately not able to provide us with the Turnover for the funds. Nevertheless, we have carefully only picked out active funds, and we do not see this as a major limitation.

Furthermore, for some years we lack total expense ratios for a small number of funds. However, we use the management fees for the missing data. We justify this by the fact that the total expense ratio and the annual management fee are relatively similar in Norway[2]. Thus, we argue that this will not affect our analysis.

1.5 The Main Findings

From our analysis, we find that size has an effect on performance of Norwegian mutual funds. When looking at the risk-adjusted performance of the three equally-weighted portfolios sorted on the funds' TNA, we find a positive alpha for each portfolio when applying three different factor models. Consistent with Sørensen's (2009) findings, we find the alphas to be non-significant and thus little evidence that Norwegian mutual funds are able to outperform their benchmark. The results

[2] We were informed by the Product Manager for DNB Asset Management that the total expense ratio and the management fee are quite similar, as Norwegian mutual funds are not allowed to charge for many other costs in addition to the management fee in Norway.

hold for both gross and net of fees. An interesting finding from the performance estimates is that we can see a tendency that larger funds perform worse on average. Furthermore, the regression results from lagged fund size on performance shows that size has a negative effect on performance. Chen et al.'s (2004) comprehensive study on this topic in the U.S. found strong evidence that fund size erodes performance. Hence, our findings in Norway are consistent with Chen et al.'s (2004) findings.

1.6 Structure

This thesis is organized as follows: First, we will provide a literature review of relevant research on performance persistence and size on performance. Then, the methodology and how we are going forward with the analysis are presented. Section 4 describes our data sample. Our analysis is divided into two sections. We start by investigating if actively managed mutual funds in Norway can achieve abnormal returns measured through three different benchmark models, and to which extent the size, i.e., the mutual fund's TNA, matters in this regard. Further, our analysis focuses on which effect lagged fund size has on performance. This is measured through cross-sectional regressions, where we control for different fund characteristics. Section 5 provides the empirical findings from our analysis and discussions of these findings. Lastly, Section 6 will provide our conclusion and suggestions for future research.

2.0 Literature Review

The considerable increase in the mutual fund industry over the years has resulted in that the awareness for mutual fund selection has widely expanded. Investors demand investment advice, full access to information, and a better selection of mutual funds that outperform the market. Based on this, many researchers have tried to find explanations for performance for mutual funds, which is a crucial aspect when choosing a fund. Consequently, mutual fund persistence has been widely researched (Gruber, 1996). This research has raised issues to understand the role of economies of scale in addition to persistence in the mutual fund industry (Gruber, 1996; Berk and Green, 2002). In subsequent studies, several researchers have studied whether mutual funds can outperform the market and if performance is persistence. Most of the research is done on US mutual funds, and the findings are somewhat mixed, although the vast majority finds no significant persistence, and that mutual funds are not able to outperform the market.

Jensen (1968) was a pioneer in the research of a manager's ability to generate an abnormal return. He found evidence that US Mutual funds from the 1945-1964 period were on average not able to generate excess return net of expenses. These findings were consistent with the efficient market hypothesis (Fama, 1970). The efficient market hypothesis states that stock price reflects all available information and that it is therefore impossible to find mispriced securities. Thus, it is impossible for an active mutual fund to outperform the market. Sørensen (2009) is one of few that have investigated mutual fund performance in Norway. He studied all the mutual funds at the Oslo Stock Exchange from 1982 to 2008, and found the risk-adjusted return to be statistically indistinguishable from zero. Thus, he found little to no evidence of any abnormal return of actively managed funds. On the other hand, researcher such as Wermers (2000) supports the value of active management. He found that mutual funds on average hold stocks that outperform the market. Using a bootstrap methodology, Kosowski, Timmermann, Wermers & White (2006), found that a substantial minority of active fund managers persistently outperform the market by distinguishing skill from luck in mutual fund performance.

Moreover, Fama and French (1993), Elton, Gruber and Blake (1996a), and Carhart (1997) have used different risk adjusted-performance measures where different factors are added to their asset pricing model in order to try to capture the drivers behind the abnormal returns (Bodie, Kane & Marcus, 2014). These studies find no evidence of excess returns for equally weighted portfolios. The findings of whether mutual funds can outperform the market are somewhat mixed and mostly related to the U.S. market. We find it interesting to investigate if the Norwegian mutual fund market can generate abnormal returns adjusted for different risk factors.

Mutual fund characteristics such as, how size and flow may be possible determinants for mutual fund performance is also widely studied. It is both advantages and disadvantages of a large fund. There are disadvantages such as liquidity constraints or price impacts (Perold and Salomon, 1991; Lowenstein, 1997), and larger implications for agency relationships between managers and investors and the optimal contract between them (Brown et al., 1996; Beckers and Vaughan, 2001). However, there might also be certain benefits of scale, such as more resources for research and lower expense ratios. These contradicting effects of mutual fund performance underscore the importance of understanding how different fund characteristics may influence fund return.

Berk and Green (2004) present a theoretical rational expectation model for active portfolio management. They show that the value of the fund is shown through size measures rather than prices. Berk and Green (2004) claim that there are skilled fund managers who can generate abnormal returns. However, the managers are not able to outperform the market in the long run since rational investors are continuously chasing return. The mutual fund investors perceive past excess returns as a sign of skills, and will therefore actively invest their assets to these skilled fund managers. As the fund grows, it becomes increasingly difficult for the manager to sustain the excess returns. The fund's inflow will continue until the fund reaches a point where the manager can no longer generate abnormal returns. When the mutual fund reaches this point, the inflow of funds from investors will stop. Consequently, Berk and Green (2004) argue that diminishing returns to scale in the mutual fund industry can reconcile the lack of persistence in fund performance with the presence of managerial skill at picking stocks. This means that mutual funds will suffer from diminishing decreasing returns to scale and thus, fund flows reduce rather than increase subsequent fund performance. As a result, funds should alter investment behavior as assets under management increase.

There is a lot of research that is consistent with Berk and Green’s findings. Grinblatt and Titman (1989) found mixed evidence that fund returns decline with fund size for US mutual funds from 1974 to 1984. They found that abnormal gross returns exist for growth funds and funds with the smallest total net asset value. However, the smallest fund had the highest expenses and showed results of no abnormal net returns. Their newer published article in 1992 showed contradicting results, where they found positive mutual fund persistence and that that passed performance provides useful information for investors.

Ippolito (1992) studied investor’s reaction to recent fund performance over the period 1965 to 1984. He found a significant positive relationship between fund growth and recent investment performance by using a pooled regression model and a fixed-effects model. He concludes that the relationship is asymmetric and there are underlying movements of investor’s money in the mutual fund industry for recent good performers and away from poor performers.

Using a much larger equity fund sample than Ipploito (1992), Sirri and Tufano (1998) studied inflows and outflows of US equity funds from 1971 to 1990. They rank all funds based on past year performance and sort them into five quintiles. By running a piecewise linear regression, they were capable to separately calculate the sensitivity of fund growth to performance for each performance quintile. They found that fund flows respond to marketing and advertising, and that fund inflows are sensitive to past performance. Investors of equity funds disproportionately flock to high performing funds while failing to flee lower performing funds at the same rate.

The same year as Berk and Green (2004) published their study; Chen et al. (2004) published a comprehensive study on the effect of scale on performance in the active money management industry for US equity funds from 1962 - 1999. Chen et al. (2004) find evidence that fund performance worsens with fund size, which is consistent with Berk and Green’s (2004) research. They investigate the reasons behind the negative relationship between size and performance and hypothesize that other factors also drive performance. Their findings show that the scaling relationship is due to trading costs associated with liquidity and price impact. They claim that funds with lower TNAs can easily invest all their assets in their “best ideas”, whereas a lack of liquidity forces larger funds to invest in their “not so good ideas” and take more significant positions in a share than what is optimal, thereby reducing performance.

Edelen, Evans and Kadlec (2007) argue that trading costs of funds are the main source of diseconomies of scale. They believe that the trading cost reduces the fund performance, as the fund's relative trading costs will increase. Additionally, Pollet and Wilson (2008) researched which further effects may lead to diseconomies of scale and how mutual fund size affects mutual fund behavior. Rather than just linking mutual fund size directly to return, they investigate the effect of growth in TNA combined with fund behavior. They hypothesize that when a fund experiences high capital inflow, management can either put more money on existing shares and thereby incur higher transaction costs, or they can increase the number of shares in the portfolio, having to choose securities with lower expected returns. Pollet and Wilson (2008) find that management tends to choose to scale up their existing investments as the fund grows, rather than increasing the number of investments. Their findings show evidence that one of the causes of diminishing returns to scale for mutual funds is the inability to scale the investment strategy as the fund becomes large. The more the fund grows, the less they diversify and scale. Consequently, this provides a lower return to the mutual fund.

Many academic researchers also find a positive relationship between size and performance. Phillips, Pukthuanthong and Rau (2018) revisited the issue of diseconomies of scale discussed by previous literature. They studied whether the reason for the lack of consensus on the findings between size and return could be due to the endogenous relation between fund size and performance. Phillips, Pukthuanthong & Rau (2016) argue that due to naivety, investors react with equal strength to the new and stale information components of holding period return (HPR) changes when allocating flows. This is because the investors observe HPR, which may indicate that the fund is performing better than its actual returns. This may hide a negative end-return. Although there is no new information regarding expected fund performance or managerial skills, it will increase the fund’s asset allocation from investors chasing stale performance (Philips et al., 2016). They argue that the exogenous increase in fund size is unrelated to expected fund performance. Phillips et al. (2018) identified a set of instrumental variables based on their research from 2016. They then used an instrumental variable approach to control for potential endogeneity in order to examine the relationship between fund size and performance. Using this approach, they find that fund size does not appear to affect fund performance.

Bhojraj, Cho, and Yehuda (2012) examined the relationship between fund family size and performance. They found a positive relationship between performance and fund family size, due to the access of private information within the fund family. They argued that larger fund families received material and non-public information from investment banks, giving them an unfair advantage over smaller fund families. The Securities and Exchange Commission established its fair disclosure regulations in 2000 with the purpose to limit selective disclosure of information by firms to analysts and institutional investors. Bhojrai et al. (2012) found that the positive relationship between fund family size and performance is nonexistent after these regulations were established, and the relationship was positive before these regulations. This advantage was eliminated following the new regulations. We find Bhojraj et al.'s (2012) findings interesting and want to control for fund family size in our analysis to see if this also affects performance in Norway.

Most research focuses on the U.S. market, and little literature has had its focus on other markets in the world. However, Ferreira et al. (2013) study cross-country mutual fund performance. They study how the performance of equity mutual funds relates to fund characteristics for 16.316 open-end actively managed funds in 27 countries around the world. Norway was included in this research. Ferreira et al. (2013) hypothesize that there might be different determinants of mutual fund performance between the U.S. market and around the world, as the U.S. market is much larger and developed than elsewhere. They find evidence that small funds perform better than large funds only in the U.S., and the diseconomies of scale found by Chen et al. (2004) is not a universal truth. Ferreira et al. (2013) find a significant and positive relationship between size and performance for non-US funds, and the possible explanation of this is that the average US fund is more than five times bigger than the average non-US fund. As Ferreira et al. (2013) did not examine the Norwegian market separately from the non-US market, we cannot expect to get the same findings. Therefore, our analysis of the Norwegian mutual funds completely isolated is going to be especially interesting as the US market is enormous compared to the Norwegian market (Ferreira et al., 2013).

We find that our research is both relevant and interesting, as the literature provides contradicting findings and no consensus.

3.0 Methodology

This section will provide the methodological framework that we use to examine whether mutual fund size affects performance. We will follow Chen et al. (2004) and utilize cross-sectional variation to see how fund performance varies with lagged fund size. This is done using the regression framework proposed by Fama and MacBeth (1973), which is one way to deal with panel data samples. We could have used other tradition panel data methods, like a fixed effects approach, looking at whether changes in a fund's performance are related to changes in its size. However, Chen et al. (2004) argue that such an approach is subject to a regression-to-the-mean bias. According to this bias, a fund with some years of lucky performance will experience an increase in fund size, however the performance will regress towards the mean and provide an impression that an increase in fund size is associated with a decrease in fund returns. Since cross-sectional regressions are less subject to such bias, we will utilize this method when measuring the effect of fund size on performance.

Chen et al. (2004) point out two significant concerns that must be dealt with when using only cross-sectional variations. The first concern is heterogeneity in fund styles and will be handled by adjusting for fund performance by various benchmarks models. The second concern is the possibility of a correlation between fund size and other fund characteristics. To deal with this concern, we study the effect of past fund size on performance while also taking other observable fund characteristics into account. Our study is twofold, and we start our research by looking at different multifactor models used to explain mutual fund returns and investigate whether fund managers can deliver abnormal returns measured as the alpha. Since we are interested in the relationship between fund size and performance, we will regress the excess return of three portfolios of funds organized by size on different factors from three performance models. These portfolios are constructed by sorting all funds at the beginning of each month based on their previous month TNA. Further, we will look at each individual fund and evaluate the effect of past fund size on performance.

3.1 Testing of Performance

This section will provide a discussion of the different multifactor models used to estimate mutual fund returns and to determine the fund's ability to evaluate performance. By using factor models in the evaluation of mutual fund performance, we can determine to what extent the exposure of each included risk factor in the model contributes to the performance. The return that is not explained by the respective factors is captured in the alpha intercept (α). The three sub-sections below will explain the different risk-adjusted performance regressions we will run to compute the abnormal returns, compared to the Oslo Stock Exchange Mutual Fund Index (OSEFX) as a market proxy and additional risk factors.

3.1.1 Single Index Model

Alpha is today a commonly used measure of fund performance developed by Jensen (1968). The Jensen's alpha equation from a single-factor model, also known as the capital asset pricing model (CAPM) can be illustrated by:

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_p \left(R_{m,t} - R_{f,t} \right)_t + \varepsilon_{p,t} \qquad (1)$$

Where $R_{p,t}$ is the return on fund's portfolio, $R_{f,t}$ is the risk free rate, $R_{m,t}$ is the return on the reference portfolio, α_p is the excess return on the fund's portfolio and $\varepsilon_{p,t}$ is the generic error term.

A significantly positive alpha from the test implies that a fund generates a superior risk-adjusted return, while a significantly negative alpha implies that a fund performs worse than the market. The alpha generated from the CAPM is exposed to only the market proxy and does not account for other risk factors that may have an impact on explaining fund performance, such as book-to-market and momentum factors. Since Fama and French (1993) three-factor model and Carhart's (1997) four-factor model take various factors into account, we have chosen to emphasize our analysis on these to try to come around the anomaly problem. Chen et al. (2004) also suggest dealing with the heterogeneity issue by testing performance adjusted using the Fama and French's (1993) three-factor model and Charthart's (1997) four-factor model. We find it therefore particularly interesting to use the same methodology combined with additional risk-adjusted performance measures to test our research question for the Norwegian mutual fund market.

3.1.2 The Three-Factor Model

According to the three-factor model by Fama and French (1993), the portfolio's expected return is determined by the portfolio's sensitivity to three factors. The model is an extension of the CAPM and adds two additional variables, the factor of high minus low book-to-market ratio (HML) and small minus big (SMB). The size effect of the SMB factor states that the smaller the company, the greater the return can be expected. The factor of value, HML, states that stocks with a higher book value relative to the market are expected to yield a higher return than stocks with low book value relative to the market (Bodie, Kane & Markes, 2014). A significantly positive alpha from the test implies that a fund generates a superior risk-adjusted return, and this may stem from managerial skill or luck. The three-factor model is illustrated in Equation 2:

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,1}\left(R_{m,t} - R_{f,t}\right)_t + \beta_{p,2}SMB_t + \beta_{p,3}HML_t + \varepsilon_{p,t} \quad (2)$$

3.1.3 The Four-Factor Model

Carhart (1997) developed an extension of the three-factor model by including the momentum effect (PR1YR). PR1YR is the difference between the average of the highest stock returns and the averages of the lowest stock returns over the previous year. What appeared to be the alpha of mutual funds could be explained due to its loadings or sensitivities to market momentum (Bodie, Kane & Marcus, 2014). The momentum factor states that higher historically returns will continue to give a higher expected return in the next year and vice versa. Thus, the momentum factor contributes to explain a considerable part of the return and accordingly attributes to prove less managerial skills. Carthart's (1997) model has shown in various contexts that it has provided explanatory power for the observed cross-sectional variation in fund performance (Jegadeesh & Titman, 1993).

Therefore, we chose to use this model to understand how additional risk factors could influence the performance of mutual funds. The model is illustrated in Equation 3:

$$R_{p,t} = \alpha_p + \beta_{p,1}\left(R_{m,t} - R_{f,t}\right)_t + \beta_{p,2}SMB_t + \beta_{p,3}HML_t + \beta_{p,4}PR1YR_t + \varepsilon_{p,t} \quad (3)$$

3.2 *Testing the Relationship Between Fund Size and Performance*

In order to deal with the concern related to the correlation of fund size with other fund characteristics, we follow Chen et al. (2004) and use the regression framework proposed by Fama and MacBeth (1973). We will estimate the cross-sectional relation each month to see how fund performance changes with lagged fund size while controlling for fund characteristics. Further, to form our overall estimates of the effects of fund characteristics on performance, we take the estimates from the monthly regressions and their time series means and standard deviations in order to calculate their t-statistics.

The regression specification that we will utilize to analyze the effect of past fund size on performance is motivated by Chen et al. (2004):

$$FUNDRET_{i,t} = \mu + \phi LOGTNA_{i,t-1} + \gamma X_{i,t-1} + \varepsilon_{i,t} \quad (4)$$

Where $FUNDRET_{i,t}$ is the return (either gross or net) of fund in month t adjusted by the different performance benchmarks, 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, which includes $LOGFAMSIZE_{i,t-1}$, $AGE_{i,t-1}$, $EXPRATIO_{i,t-1}$, $FLOW_{i,t-1}$, and $LAGFUNDRET_{i,t-1}$. γ is the vector of loadings on the control variables, and ϕ is the coefficient of interest which captures the relationship between size and performance. Additionally, $\varepsilon_{i,t}$ is the generic error term and is uncorrelated with the other independent variables.

The dependent variable $FUNDRET_{i,t}$ will be calculated using the regression framework by Fama and MacBeth, which is a two-step approach. Firstly, each fund's return is regressed against factor time series. We will do this using both the three-factor model and the four-factor model, as well as for both the net and gross return. This is done to determine the factor exposure to each factor, finding the betas. In the second step, we will run the following cross-section equations in order to find the fund return:

$$FUNDRET_{i,t} = R_{i,t} - \beta_1 MKT_t - \beta_2 SMB_t - \beta_3 HML_t - \beta_4 PR1YR_t \quad (5)$$

$$FUNDRET_{i,t} = R_{i,t} - \beta_1 MKT_t - \beta_2 SMB_t - \beta_3 HML_t \quad (6)$$

The βs are the estimated betas from the first step. The one-month FUNDRET on every fund will be used as the dependent variable in the regression specification given in Equation 4. To form our overall estimates of the effects of fund characteristics on performance, we take the estimates from these monthly regressions and follow Fama and MacBeth in taking their time series means and standard deviations in order to calculate the t-statistics.

3.3 Preparation before Empirical Analysis

This section will provide an overview of different statistical tests we have to run in order to check if our empirical analysis is reliable and valid. The most relevant regressions assumptions for our analysis are listed below.

3.3.1 Autocorrelation

Autocorrelation is a common problem in time series regression and occurs when there is a systematic pattern in the order of the error terms, and the error terms will correlate with one another (Brooks, 2014). Autocorrelation affects the precision of the results, and a consequence of the estimated standard errors would be wrong and the OLS estimator is no longer the best linear unbiased estimator (Brooks, 2014). The existence of autocorrelation will increase the likelihood of finding results that size affects performance when it actually does not. We will test for first-order autocorrelation by performing the Durbin-Watson test. Newey West,

(1987) standard error correction will be further used, and this will correct the t-statistics in our analysis.

3.3.2 Multicollinearity

Multicollinearity is a problem that occurs when the explanatory variables are very highly correlated with each other. It is important to investigate whether our regression contains multicollinearity. The consequence of multicollinearity is that it will be difficult to estimate all the coefficients in our model (Brooks, 2014). If our data sample contains multicollinearity, it would be harder to determine whether the coefficient measuring size actually has a significant effect on performance. The variance inflation factor (VIF) is one way to test for multicollinearity, and the test identifies the correlation between independent variables and the strength of that correlation. The value of VIF will tell us what percentage the variance is inflated for each coefficient.

4.0 Data

4.1 Data Description

The Norwegian Fund and Asset Management Association (VFF) and Thompson Reuters Lipper Eikon provide our monthly Norwegian mutual fund data. The data spans over the period from January 2005 to December 2018. Initially, we wanted to study the long-term effects of size and performance in order to adjust for market recessions, but as the available databases have limited access to data, we constrain our analysis to a period of 14 years. Nevertheless, this allows us to study the relationship over the last decade, which also accounts for the financial crisis in 2008 (Norges Bank, 2019). We find it essential to include at least one market recession in our sample since this gives a better perception of the market. The sample is constrained to open-end actively managed Norwegian equity mutual funds. VFF (2019d) categorizes funds as mutual funds if a minimum of 80 % of the portfolio is invested in shares. Further, the requirements for mutual funds are that the fund must be well diversified with at least 16 different stocks, where the weight of each stock cannot exceed 10 % (Oslo Børs, 2019). In order to limit our analysis to only one benchmark, our dataset is further limited to mutual funds that have a primarily investment focus in Norway.

Monthly TNA from VFF has been extracted, structured and complemented with data from Thompson Reuters Lipper Eikon, and further organized in order to calculate the fund family size. Additionally, monthly net asset values (NAV), total expense ratio and age of the funds were obtained from the Thompson Reuters Lipper Eikon database. Fund returns and the risk-adjusted fund return have been calculated from NAV. Additionally, the inflows and outflows have been calculated from the TNA. For a mutual fund to be included in our dataset, it needs to have data on TNA, fund family TNA, NAV, total expense ratio and age. Finally, the last condition is that a fund needs at least 12 months of observation in order to be included in the data sample to obtain reliable statistical inference.

Further, we excluded funds that did not have available data for all the requirements above. We tried to gather the missing data from Bloomberg but failed, so the unobtainable data is not included in our dataset. The dataset ends up with 67 distinct mutual funds over 14 years, which are all presented in Appendix 3. Our final dataset is a sample of both cross-sectional and time-series data on monthly observations, also called a panel data sample. Furthermore, it is considered as an unbalanced panel as some funds are older than others.

4.2 Survivorship Bias

Th3e data sample should account for survivorship bias in order to obtain the most reliable result. Many researchers argue that it is necessary to include both surviving and non-surviving funds in the sample to prevent an upward bias of the mutual funds' performance (Brown, Goetzmann, Ibbotson & Ross, 1992). The performance of the funds may be overestimated as many funds tend to be liquidated when their performance is inferior over some time or because their total market value is sufficiently small that management does no longer pay to maintain the fund (Elton, Gruber and Blake, 1996b). Further, survivorship bias can occur when funds that merge with other funds are excluded from the sample. The chosen data sample is constructed to handle the potential survivorship bias, by including both liquidated and merged funds over the sample period.

4.3 Market Proxy

The most appropriate choice of market proxy is the Oslo Stock Exchange Mutual Fund Index (OSEFX), which is in line with performance analyzes of Norwegian mutual funds. OSEFX fulfills the same requirements, as the Norwegian mutual equity funds must comply with. OSEFX is a capped version of OSEBX. The capping is made in accordance with UCITS Fund Investment Directives. The total allowable weight for a security is 10% of the total market value in index, and securities exceeding 5% must not exceed 40% overall (Oslo Børs, 2019). These funds purpose is to active allocate the fund's investments with the goal of obtaining the representative sample of the Norwegian stock market's long-term excess return.

4.4 Risk-free Rate

The risk-free rate data is collected from the Oslo Børs Information (OBI) database. The OBI database is publicly available and contains comprehensive asset pricing data regarding Oslo Stock Exchange created by Bernt Arne Ødegaard. Most researchers such as Fama and French (1993) and Carhart (1997) uses monthly Treasury bills as a proxy for the risk-free rate. However, Ødegaard (2019) suggests using forward-looking one-month risk-free rates, estimated from government securities and Norwegian Inter Bank Offered Rate (NIBOR). NIBOR is considered more volatile than Treasury-bills. However, as NIBOR is close to risk-free (Hull, 2018)(Norges Bank, 2018), we find it appropriate to use NIBOR as our proxy.

4.5 Factor Returns

The Norwegian risk factor portfolios are also gathered from the OBI Database and constructed by Fama and French (1993) and Carhart (1997). The factors are small-minus-big (SMB), high-minus-low (HML), and prior 1-year momentum

(PR1YR). The source of the raw data is daily observations of stock market data from the Oslo Stock Exchange Data Service. The monthly data is calculated, which includes asset pricing factors for the Oslo Stock Exchange, similar to those developed by Fama and French (1993) and Carhart (1997) (Ødegaard, 2019).

4.6 Monthly Returns

Net asset value (NAV) is commonly used in the context of open-end funds. NAV represents the total book-value of a company's assets. A fund's NAV per share is calculated by dividing the total value of the fund's assets, less the total value of its liabilities, by the number of funds' shares outstanding. By using NAV, we can calculate the monthly net return for each fund, using its historically NAV collected from Thomson Reuter Lipper Eikon. The formula for net monthly return ($R_{i,t}$) is illustrated below (Equation 7):

$$R_{i,t} = \frac{NAV_{i,t}}{NAV_{i,t-1}} - 1 \qquad (7)$$

Additionally, we want to investigate the gross returns to see what investors would get if they had not paid any expenses. Equation 8 illustrates how we estimate the gross return:

$$GR_{i,t} = \frac{(R_{i,t} + 1)}{\left(1 - \frac{TER_{i,t}}{12}\right)} - 1 \qquad (8)$$

Where $GR_{i,t}$ is the gross return for fund *i* in moth *t*, $R_{i,t}$ is the net return for fund *i* in month *t*, and $TER_{i,t}$ is the total expense ratio for the fund *i* for the fiscal year that covers month *t.*

4.6 Size Portfolios

The size of a mutual fund is measured by the fund's TNA in NOK. Our sample of Norwegian mutual funds has an average TNA of NOK 1,100 million, with a standard deviation of NOK 1,521 million (Table 1). This tells us that there is a substantial spread in the TNA among our funds. The median is NOK 499 million. The positive kurtosis of 6.679 tells us that the profusion of outliers characterizes our data sample. Further, our data consists of some non-normality as we have a positive skewness of 2.483. This suggests that we have more small funds than large funds.

We split our data sample into three equally-weighted size portfolios based on "TNA-rankings", namely small, medium and large funds. The funds are sorted at the beginning of each month based on their previous month TNA. The funds are sorted into three equal-sized segments of the funds, namely tertiles. This is to create a natural cut-off point in data in order to capture the fund's relative size each period. As we only have 67 funds, we find it natural to split the data into only three portfolios. By doing this, we avoid getting too few observations in each portfolio. We found sorting the funds into tertiles appropriate because as the fund's TNA grow over the 14 years, it will be more appropriate to use relative size measures to capture the change in size. It is not given that a fund stays in the same size portfolio throughout its life; this depends on the other fund's relative size. In Portfolio 1 the funds with the lowest TNA, and thus 1st-tertile is gathered. Portfolio 2 contains all funds in the 2nd-tertile, which is measured as the medium funds. Lastly, the large funds are in Portfolio 3, which holds the funds with the highest TNA measured by the 3rd-tertile.

The average monthly TNA in Portfolio 1 is NOK 150.54 million, while the funds in Portfolio 2 have an average monthly TNA of NOK 588.99 million. The funds in Portfolio 3 for the largest funds have an average TNA of NOK 2,584.50 million. Table 2 reports the loadings of the three portfolios.

Table 1: Size Portfolio

The table reports summary statistics for all fund's TNA based on their size portfolio. The sample is from January 2005 to December 2018.

Total Net Assets (TNA)	MNOK
Max	10397.406
Min	2.069
Mean	1100.802
Median	499.297
Standard Deviation	1521.225
Skewness	2.483
Kurtosis	6.679

Size Portfolios		Average TNA
(1) Small	33.33%	150.54
(2) Medium	33.33%	588.99
(3) Large	33.33%	2584.50

4.7 Regression Variables

The proxy we will use for fund size in our analysis is the log of a fund's TNA (LOGTNA), which is the variable of interest as this captures the relationship between fund size and fund performance. The other fund characteristics that might have an impact on mutual fund performance and that we want to control for in our regression are LOGFAMSIZE, AGE, EXPRATIO, FLOW and LAGFUNDRET. All the explanatory variables are lagged one-month.

Fund family size is the first variable of interest and is defined as the TNA of a fund's family excluding its own TNA. The variable is of interest since economies of scale can exist at the fund family level, meaning that expenses like research and administrative expenses can be shared among the funds in the family. In our regression, we want the variable LOGFAMSIZE that is the natural logarithm of one plus the TNA of the family that the fund belongs to excluding the TNA of the fund itself. Further, we want to control for age since it has been argued that age can affect fund performance due to growing experience with time. Fund age (AGE) is defined as the number of years since launch. Another fund characteristic is the expense ratio (EXPRATIO) defined as total operating expenses divided by year-end TNA. We include this variable, as we believe expenses have a negative effect on return. In Thompson Reuters Lipper Eikon there exists limited data on historical total expense ratios for Norwegian mutual funds, meaning that for some funds we only have the total expense ratio per today or by the closing date of the fund. In that regard, we will assume that the total expense ratio has been constant throughout the funds lifetime. For some funds, where the expense ratio is not available at all, we will use the management fee.

The fourth characteristic of interest is fund flows (FLOWS). Academic literature argue that investors are smart enough to direct their investments towards funds managed by skilled managers with the ability to perform better than average in the future (Gruber, 1996) (Sirri and Tufano, 1998). Consequently, fund flows should have a positive correlation with future returns and are therefore of interest in our analysis. FLOW is defined as the percentage growth in total assets under management between the beginning and the end of month t, net of internal growth. FLOW is measured through Equation 9, illustrated below:

$$FLOW_{i,t} = \frac{TNA_{i,t} - TNA_{i,t-1}}{TNA_{i,t-1}} \tag{9}$$

Where TNA_t is monthly total net assets for fund i and R_t is the monthly return for fund i.

Lastly, we include the variable of past performance (LAGFUNDRET) to test for performance persistence. Ferreira et al. (2013) argues that past performance on future performance may be economically meaningful for fund persistence, and thus an interesting fund characteristic to include in our analysis. Table 2 reports the means and standard deviations for the variables of interest for each size portfolio and all funds.

Table 2: Summary Statistics

This table reports the means and standard deviations for the variables of interest for each size portfolio and for all funds. The standard deviations are presented in the parentheses. TNA is the total net assets under management in millions of NOK. LOGTNA is the natural logarithm of TNA. LOGFAMSIZE is the natural logarithm of one plus the TNA of the family excluding the TNA of the funds itself. AGE is the number of years since the launch date of the fund. EXPRATIO is the total expense ratio or annual management fee. FLOW is the percentage of new fund flow into the mutual fund over the past month. LAGFUNDRET is the fund return lagged one month. RETURN is the monthly net return. The sample is from 2005 to 2018.

	Mutual fund size portfolios			
	1 (small)	2 (medium)	3 (large)	All funds
TNA	150.54	588.99	2584.50	1100.80
(NOK million)	*(68.3971)*	*(232.4580)*	*(996.5862)*	*(1521.2253)*
LOGTNA	4.7066	6.2594	7.6029	6.1854
(NOK million)	*(0.3922)*	*(0.3878)*	*(0.4130)*	*(1.3813)*
LOGFAMSIZE	9.7360	10.1306	10.5034	10.1321
(NOK million)	*(0.3455)*	*(0.5086)*	*(0.4156)*	*(1.3008)*
AGE	11.4491	14.7277	16.8202	17.9552
(Years)	*(2.4561)*	*(3.0710)*	*(2.1039)*	*(9.25799)*
FLOW	1.8900	2.7100	1.9700	2.223
(% per month)	*(8.120)*	*(17.820)*	*(8.030)*	*(49.277)*
EXPRATIO	0.12	0.12	0.11	0.1153
(% per month)	*(0.0010)*	*(0.0006)*	*(0.0009)*	*(0.0005)*
RETURN	0.90	0.91	0.90	0.89
(% per month)	*(0.0542)*	*(0.0550)*	*(0.0548)*	*(0.568)*

5.0 Empirical Findings

This section will present and discuss the empirical findings with respect to the research question "Does mutual fund size matter for fund performance in Norway?". We will start by evaluating fund performance by studying the alpha estimates for the three equally weighted portfolios. Then, we look at the correlation matrix between the fund characteristics. Further, the effects between the fund size and performance, controlled for different fund characteristics, will be evaluated. Additionally, we will do a robustness analysis in order to check if our results are mostly independent by changes in conditions. We will finish the section by discussing our findings.

5.1 Risk Adjusted Performance of the Mutual Funds

Appendix 3 reports the single index estimations for each individual fund over the entire sample period. These estimations show the fund's exposure to the market, and the statistically significant betas close to one suggest heavy loadings and exposure to the market portfolio. Additionally, the relatively high R^2 for almost every fund implicates that the market variation explains most of the variation in funds' return. The results show that approximately 75 % of the funds have a positive alpha. Furthermore, we have estimated the alphas for each fund using the three-factor and four-factor model. The results are presented in Appendix 4 and 5 respectively and show that when adding additional risk factors, there are more negative alphas among the funds. However, a small number of the funds have alphas that are statistically significant. The results presented in these appendices will be used as a basis for comparison when estimating the performance of the size portfolios. Furthermore, Appendix 6 shows the correlation matrix of the various factors for the models we have utilized in our analysis.

The three equally-weighted size portfolios consist of the return for each fund in our sample. The portfolios monthly average return is used as the dependent variable against various factors from the single index model, the three-factor model and the four-factor model throughout the sample period from 2005-2018. We have chosen to do this analysis by calculating the loadings using both monthly gross and net fund returns as the dependent variables. Table 3 and Table 4 report the different factor loadings for the three portfolios, both gross and net returns respectively. From the tables, we can see that the loadings are quite similar.

Table 3: Fund Performance Gross Return

This table reports the different factor loadings of the three TNA-sorted fund portfolios on various factors. The coefficients t-statistic is stated in parentheses and is corrected using the Newey-West (1987) procedure. The portfolios are compared to the single index model, the Fama-French three-factor model and the Carhart four-factor model throughout the whole sample period from 2005-2018. The results are shown gross of operational fees.

Factors	Alpha	MKT	SMB	HML	PR1YR	R2	Adj. R2
Portfolio			*Single index model*				
1	0.0013	0.9111				0.977	0.977
	(1.9442)	*(83.707)*					
2	0.0010	0.9210				0.972	0.972
	(1.4528)	*(76.776)*					
3	0.0010	0.9250				0.976	0.976
	(-1.536)	*(81.072)*					
			Three-Factor Model				
1	0.0007	0.9506	0.0992	-0.0006		0.980	0.980
	(1.0655)	*(71.514)*	*(4.8764)*	*(-0.0342)*			
2	0.0004	0.9699	0.1180	0.0163		0.977	0.977
	(0.5266)	*(67.065)*	*(5.3301)*	*(0.8804)*			
3	0.0003	0.9619	0.1077	0.0046		0.980	0.979
	(0.5451)	*(70.979)*	*(5.1957)*	*(0.2625)*			
			Four-Factor Model				
1	0.0005	0.9517	0.0986	0.0003	0.0133	0.980	0.980
	(0.7553)	*(71.174)*	*(4.8364)*	*(0.0199)*	*(0.8694)*		
2	0.0002	0.9714	0.1172	0.0174	0.0158	0.977	0.977
	(0.2189)	*(66.788)*	*(5.2889)*	*(0.9371)*	*(0.9442)*		
3	0.0001	0.9634	0.1069	0.0057	0.0176	0.980	0.979
	(0.1924)	*(70.761)*	*(5.1538)*	*(0.3228)*	*(1.1096)*		

Table 4: Fund Performance Net Return

This table reports the different factor loadings of the three TNA-sorted fund portfolios on various factors. The coefficients t-statistic is stated in parentheses and is corrected using the Newey-West (1987) procedure. The portfolios are compared to the single index model, the Fama-French three-factor model and the Carhart four-factor model throughout the whole sample period from 2005-2018. The results are shown net of operational fees.

Factors	Alpha	MKT	SMB	HML	PR1YR	R2	Adj. R2
Portfolio			*Single index model*				
1	0.0011	0.9121				0.977	0.977
	(1.6395)	*(84.165)*					
2	0.0009	0.9210				0.973	0.973
	(1.3294)	*(75.74)*					
3	0.0009	0.9193				0.976	0.976
	(1.3829)	*(81.072)*					
			Three-Factor Model				
1	0.0005	0.9511	0.0978	0.0001		0.980	0.980
	(0.7578)	*(71.757)*	*(4.821)*	*(0.0056)*			
2	0.0003	0.9699	0.1179	0.0165		0.977	0.977
	(0.3999)	*(67.013)*	*(5.319)*	*(0.8917)*			
3	0.0003	0.9628	0.1077	0.0045		0.980	0.979
	(0.4462)	*(70.789)*	*(5.1738)*	*(0.2553)*			
			Four-Factor Model				
1	0.0003	0.95238	0.0971	0.0011	0.0148	0.980	0.980
	(0.4319)	*(71.467)*	*(4.9282)*	*(0.0690)*	*(0.9711)*		
2	0.0001	0.9787	0.1216	0.0175	0.0163	0.977	0.977
	(0.09933)	*(66.194)*	*(5.3721)*	*(0.922)*	*(0.9442)*		
3	0.0001	0.9643	0.1069	0.0056	0.0168	0.980	0.979
	(0.1049)	*(70.559)*	*(5.2672)*	*(0.3228)*	*(1.0716)*		

Comparing the adjusted R^2, we see a minimal difference among the models, where both the three-factor and the four-factor model achieve the highest average adjusted R^2 of 0.979. From Table 3 reporting gross of fees, we can observe that all three portfolios using the three different factor models exhibit positive and non-significant alphas. When looking at the monthly net return in Table 4, we see that the alpha of the three portfolios is lower than for gross, however still positive and non-significant.

First, looking at the single index model, the average alpha of the three portfolios is 0.11 % per month gross of fees, meaning that when only including the exposure to the market, the funds will outperform. The average alpha net of fees is 0.10 % per month, which indicates that the funds will still outperform the benchmark after fees. However, the alphas are very small and only significant at a 10 % level. We identify significant market coefficients for the portfolios with an average beta of 0.9190 in gross return and 0.9175 in net return. The high beta values indicates that the funds' returns are highly correlated with the market, and this may reflect the fact that most of the mutual funds are largely passive in their strategies. We notice that there is only a slight variation in the market beta from the smallest to the largest portfolio, whereas the smallest funds have a relatively smaller beta, however the difference is minor.

Looking at the three-factor model, we observe an average monthly alpha of 0.05% gross of fees and an average monthly alpha of 0.04 % net of fees. The market coefficients are statistically significant and close to one for all portfolios. Additionally, every portfolio has a positive and significant exposure to the SMB factor, which indicates that the funds are also exposed to the average return of small companies. We see that the portfolio with the medium-sized funds tends to have a marginally higher loading on SMB. Furthermore, the exposure to the HML factor is positive and non-significant for nearly every portfolio. Portfolio 2 tends to have a slightly higher exposure to the HML factor. Nevertheless, this is non-significant.

Finally, looking at the four-factor model, the average alpha is 0.03 % per month gross of fees, and 0.02 % per month net of fees. This indicates that when controlling for even more factors, we get the lowest average value of alpha. The exposure to the SMB and the HML factors is somewhat the same as when using the three-factor model, positive and significant for the SMB and positive and non-significant for the HML. Further, the model shows a positive and non-significant exposure towards the PR1YR factor.

Looking at the estimated alphas, we see that every portfolio delivers positive and non-significant alphas at a 5 % level. Although the single index estimation finds significance at a 10 % level, the results show that there is little evidence that Norwegian mutual funds are able to outperform their benchmark. The result suggests that there is a tendency that the largest funds have the lowest alphas. This may indicate that it can be harder for a manager to generate abnormal return for the largest funds. However, since the findings are not statistically significant we do not have any clear evidence.

Further in our analysis we use the three- and four-factor model as a measure of risk-adjusted performance in the regressions for fund size on performance. The models will be a better fit then the single index model, since they control for more undiversifiable risk factors.

5.2 Correlation Matrix Between Fund Characteristics

Table 5 reports the time-series averages of the monthly cross-sectional correlations between the various fund characteristics using all funds. Firstly, we observe that LOGTNA is strongly correlated with LOGFAMSIZE (0.9385). Second, EXPRATIO varies inversely with LOGTNA (-0.8105). Our strong correlation between LOGTNA and LOGFAMSIZE could be explained by the size of the asset base in the Norwegian mutual fund market. Furthermore, we find that AGE has a strong positive correlation with LOGTNA (0.8403), which indicates that a fund grows during its lifetime. Based on the results from the correlation matrix and our initial argumentation of the effect of the variables on performance, we find it interesting to control for these fund characteristics when estimating the cross-sectional relationship between fund size and performance.

Table 5: Correlation Matrix Between Fund Characteristics

This table reports the time-series averages of the correlations between fund characteristics (using all funds).

	TNA	LOGTNA	LOGFAMSIZE	AGE	EXPRATIO	FLOW
TNA	1.00	0.9802	0.9353	0.8217	-0.8718	0.0148
LOGTNA		1.00	0.9385	0.8403	-0.8105	0.0565
LOGFAMSIZE			1.00	0.9428	-0.8080	-0.0092
AGE				1.00	-0.7043	-0.0136
EXPRATIO					1.00	0.0542
FLOW						1.00

The strong correlation between several of the variables could indicate multicollinearity, and we wanted to test for this by calculating the variance inflation factor (VIF) for each variable. The results are shown in Table 6.

Table 6: Variance Inflation Factor (VIF) for the Fund Characteristics

The table reports the variance inflation factor (VIF) for the fund characteristics, which detect multicollinearity in the regression analysis.

	LOGTNA	LOGFAMSIZE	EXPRATIO	AGE	FLOW
VIF	10.6453	29.2534	11.1401	3.2867	1.0576

Table 6 shows high values for VIF, which indicates that multicollinearity exists. A VIF over 10, may be a cause of concern. The problem with multicollinearity is that the coefficients are estimated with large standard errors. By including the highly correlated variables, it will be harder to determine whether the coefficient of interest is statistically significant from zero. However, we expected the variables to be highly correlated. The reason why we wanted to include the variables in our regression is that they are potential variables, in addition to size, that may drive performance. Nevertheless, we wanted to run an additional regression without LOGFAMSIZE to see how it influences the multicollinearity and in order to see how it will affect the regression results. The VIF values when excluding LOGFAMSIZE are shown in Table 7.

Table 7: Variance Inflation Factor (VIF) for the Fund Characteristics less the LOGFAMSIZE

The table reports the variance inflation factor (VIF) for the fund characteristics, which detect multicollinearity in the regression analysis.

	LOGTNA	EXPRATIO	AGE	FLOW
VIF	5.2025	3.4691	3.1115	1.0420

We observe that the VIF has been reduced when taking out the LOGFAMSIZE variable. As the VIFs are now 5 or below, we conclude that multicollinearity is no longer a big issue in the data sample. We discuss the different regressions result in the next section.

5.3 The Effect of Size on Performance

Table 8 reports the estimation results for the regression specification giving in Equation 4. The sample consists of all the 67 funds, and we use both the three-factor model and the four-factor model as a measure of risk-adjusted performance. The variable of interest is the coefficient in front of LOGTNA since this captures the relationship between fund size and fund performance when controlling for the fund characteristics. From our results, we observe that all the LOGTNA coefficients are negative and statistically significant at a 5 % level across the two performance measures. When looking at the reported results for the gross fund returns, the coefficients in front of LOGTNA are very similar for both performance models. The coefficients are -0.0003 and -0.0004, with t-statistics around minus two. This implies that a standard deviation shock to fund size will change the performance by -0.0003/-0.0004 times 1.3813 (one standard deviation of LOGTNA). The net fund returns report very similar results.

Furthermore, Table 8 reports other interesting findings from the regressions. The coefficient of LOGFAMSIZE shows that higher family fund size will to some extent have an adverse effect on performance, which means that belonging to a large fund family will reduce the fund's performance. As this is only at a 10 % significant level for three out of four loadings, we can only draw some conclusions from these findings. Further, the coefficients in front of LAGFUNDRET suggest that there is some persistence in fund returns.

Additionally, this is only significant at a 10 % level using the three-factor model as a performance measure.

Table 8: Regression of Fund Performance on Lagged Fund Size

The table reports estimates of monthly fund returns regressed on fund characteristics lagged one month. The returns are estimated gross and net of fees. The dependent variable is FUNDRET, which is the return adjusted by using the three-factor model and the four-factor model. LOGTNA is the natural logarithm of TNA. LOGFAMSIZE is the natural logarithm of one plus the TNA of the family excluding the TNA of the funds itself. AGE is the number of years since the launch date of the fund. EXPRATIO is the total expense ratio or the annual management fee. FLOW is the percentage new fund flow into the mutual fund over the past month. LAGFUNDRET is the fund return lagged one month. The t-statistics are shown in parentheses and are adjusted for serial correlation using Newey-West (1987) lags of order six. The data sample is from 2005 to 2018.

	Gross Fund Returns		Net Fund Returns	
	3-Factor	4-Factor	3-Factor	4-factor
INTERCEPT	-0.0003	-0.0002	-0.0011	-0.0014
	(-0.1031)	*(-0.0828)*	*(-0.4690)*	*(-0.5716)*
$\mathrm{LOGTNA}_{\mathrm{i,t-1}}$	-0.0004	-0.0003	-0.0004	-0.0003
	(-2.6230)	*(-2.2534)*	*(-2.2819)*	*(-2.3027)*
$\mathrm{LOGFAMSIZE}_{\mathrm{i,t-1}}$	-0.0003	-0.0003	-0.0002	-0.0003
	(-1.4269)	*(-1.6391)*	*(-1.2115)*	*(-1.3239)*
$\mathrm{FLOW}_{\mathrm{i,t-1}}$	0.0047	0.0042	0.0046	0.0044
	(1.2292)	*(1.2372)*	*(1.2427)*	*(1.2999)*
$\mathrm{AGE}_{i,t-1}$	0.0001	0.0001	0.0001	0.0001
	(1.9142)	*(2.4600)*	*(1.9679)*	*(2.5426)*
$\mathrm{EXPRATIO}_{\mathrm{i,t-1}}$	-1.5865	-1.1115	-1.4015	-1.0066
	(-2.7336)	*(-1.9101)*	*(-2.4261)*	*(-1.7159)*
$\mathrm{LAGFUNDRET}_{i,t-1}$	0.0509	0.03091	0.0529	0.0323
	(1.7179)	*(1.0800)*	*(1.7894)*	*(1.1340)*

As explained in the correlation matrix section, the results above are influenced by some multicollinearity. We ran an additional regression without LOGFAMSIZE, presented in Table 9. When taking out the LOGFAMSIZE, we observed that the coefficients in front of the intercept and LOGTNA obtain higher t-statistics and thus become statistically significance at a 1 % level.

Table 9: Regression of Fund Performance on Lagged Fund Size less the LOGFAMSIZE

The table reports estimates of monthly fund returns regressed on fund characteristics lagged one month. The returns are estimated gross and net of fees. The dependent variable is FUNDRET, which is the return adjusted by using the three-factor model and the four-factor model. LOGTNA is the natural logarithm of TNA. AGE is the number of years since the launch date of the fund. EXPRATIO is the total expense ratios or the annual management fees. FLOW is the percentage new fund flow into the mutual fund over the past month. LAGFUNDRET is the fund return lagged one month. The t-statistics are shown in parentheses and are adjusted for serial correlation using Newey-West (1987) lags of order six. The data sample is from January 2005 to December 2018.

	Gross Fund Returns		Net Fund Returns	
	3-Factor	4-Factor	3-Factor	4-factor
INTERCEPT	-0.0029	-0.0031	-0.0033	-0.0037
	(-2.2274)	*(-2.4635)*	*(-2.7109)*	*(-3.1761)*
$\mathrm{LOGTNA}_{\mathrm{i,t-1}}$	-0.0004	-0.0004	-0.0004	-0.0004
	(-2.7795)	*(-2.5235)*	*(-2.8763)*	*(-2.6192)*
$\mathrm{FLOW}_{\mathrm{i,t-1}}$	0.0032	0.0028	0.0032	0.0030
	(0.8371)	*(0.7366)*	*(0.8525)*	*(0.8494)*
$\mathrm{AGE}_{i,t-1}$	0.0000	0.0000	0.0000	0.0000
	(1.0850)	*(1.4076)*	*(1.2760)*	*(1.9256)*
$\mathrm{EXPRATIO}_{\mathrm{i,t-1}}$	-1.4626	-0.9852	-1.3121	-0.9243
	(-2.5703)	*(-1.8248)*	*(-2.3457)*	*(-1.6152)*
$\mathrm{LAGFUNDRET}_{i,t-1}$	0.0505	0.0312	0.0535	0.0335
	(1.6996)	*(1.1071)*	*(1.7887)*	*(1.1564)*

Initially, we thought that family size would give economies of scale advantages for funds' performance. Nevertheless, Table 8 shows that the coefficients for LOGFAMSIZE are very small, negative, and statistically significant at only a 10 % level. Hence, the impact caused by the family fund size on performance will be low. We can argue that it is irrelevant to include LOGFAMSIZE in the regression. The main difference when removing LOGFAMSIZE is that the effect of size on performance is even more statically significant. However, we found it interesting to investigate how and to what extent the family size would affect performance, even though the regression results without the variable is stronger and more reliable.

The negative and statistically significant coefficient for LOGTNA shows that size has a negative effect on fund performance. Thus, we have found the answer to our research question:

Mutual fund size matters for fund performance in Norway.

5.4 Robustness analysis

In order to check if our data is robust, meaning that it is mostly independent by changes in conditions, we have chosen to do two types of tests. Firstly, we test if a change in the division of the portfolios would have a high impact on the estimated alphas. Secondly, we exclude the ten largest funds to see if this changes the coefficient estimates from the regression of fund performance on lagged fund size.

First, we divide the funds into seven equally-weighted portfolios based on their last month TNA, to see if this lead to a significant variation in the parameters from the factor models in comparison to when splitting into three portfolios. This is done for both gross and net returns, and the results are shown in Appendix 7 and Appendix 8 respectively. From the result, we see that they are somewhat the same as when dividing into three portfolios. Using the single index model and the three-factor model, every portfolio exhibit positive alphas, both gross and net of fees. The only difference is that the four-factor model exhibits negative alphas for some of the portfolios. Nevertheless, the three factor models still exhibit alphas close to zero and non-significant at a 5 % level for each of the portfolios. When dividing the funds into three we could see a trend where the smallest funds always perform better than the largest. When splitting the funds into seven portfolios, it is harder to see the same trend. From the results we see that Portfolio 1 and 3 have the highest estimated alpha, meanwhile, Portfolio 6 performs the worst. The reason for this could be that when splitting the funds into numerous portfolios, each fund will receive a higher weight since the portfolios will hold fewer funds. This makes the portfolios more sensitive for a change in return. However, some of the portfolios with the largest funds are the ones to perform the worst, and the smallest Portfolios such as 1, 2 and 3 perform the best. It should be emphasized that the alphas are non-significant. Furthermore, we see that the exposure to the different factors is somewhat the same as when splitting into three portfolios.

Secondly, we wanted to do a test in order to see if excluding some of the largest funds would affect our cross-sectional regression results. We chose to remove the ten funds with the largest average TNA. The results are reported in Appendix 9. The coefficients from the regression are relatively similar to those reported in Table 8. The estimated alphas are slightly higher for both net and gross return, and even positive for gross return. The reason for this could be that when removing the largest funds we exclude the funds that perform the worst.

In conclusion, the robustness analysis strengthens our results, as we obtain fairly similar estimates compared to the findings of our main analysis.

5.5 Discussion of the Findings

In our research we tried to find out if funds could become so large that their performance weakens and there is no longer possible to find funds with positive alphas. We initially looked at performance by dividing the funds into three portfolios based on their size and evaluated each portfolios ability to generate alphas. The results, shows that when grouping the funds into three equally-weighted portfolios they are able to generate positive alphas. However, since the estimates are not statistically significant, we find no evidence of that on average, Norwegian mutual funds are able to beat their benchmark, both gross of fees and net of fees.

One interesting observation from the fund performance analysis is that the findings may indicate that large funds are performing worse. When comparing the estimated alphas for the three portfolios gross of fees, we observed that the small funds have a higher alpha, and that the alpha gets lower with size. Comparing the three portfolios net of fees, the results indicate that the medium and the large funds appear to perform at the same level when applying all three models. This result suggests that the medium-sized funds in Norway have higher expenses, which also is supported in the estimates in our summary statistics in Table 2. Nevertheless, the difference is quite little. As expected, the alphas is higher using gross returns rather than using net returns. Our findings indicate that the investor does not get much out of the positive alpha due to the fees charged. Hence, a large part of the abnormal return is charged as fees. However, it is important to empathize that there are no strong evidence.

There is a lot of academic literature regarding fund size and performance. However, most of the research is for the U.S. market, and to the best of our knowledge, there is no isolated research on the relationship between size and performance in Norway. The findings in the literature about the U.S. provide conflicting evidence and there seems to be little consensus on the topic. The Literature Review section presents that researchers such as Chen et al. (2004) and Berk and Green (2004) argue that size matter for performance. However, studies such as Phillips et al. (2018) and Ferreira et al. (2013) find that size does not matter, or that size only matters for US funds and not for non-US funds. Although there is contradicting results among the literature, most conclude that size matters for performance. We find our results very interesting, as this unambiguously shows that the size of mutual funds matter for performance in Norway.

Our findings might be a bit surprising as the Norwegian market is a lot smaller than the U.S. market (Ferreira et al., 2013), and that the funds in the U.S. have a more substantial spread between the size of the funds. Based on this, one might have thought that the Norwegian market would be so small compared to the U.S. market that size would not matter. In 2018, 186 companies were listed on the Oslo Stock Exchange, compared to a total of 4,397 companies in the U.S. stock exchange (The World Bank, 2018). Our analysis focuses on domestic mutual funds in Norway, which restricts our analysis to mutual funds that have most of their holdings invested in companies on the Oslo Stock Exchange. Thus, our investigated mutual funds have fewer options to spread their investments compared to US domestic mutual funds. The mutual fund market in Norway is continuously growing, and consequently the TNA of the funds are rising. The limitation in the Norwegian market is that there are fewer stocks to choose from, and thus the Norwegian mutual funds have constrained investment opportunities. This can lead to that investors only expand their number of shares in already existing investments and thus dilute their best ideas. This may be a possible explanation of our findings, which indicates that the funds with the smallest TNA are the funds that perform best in Norway. These funds are more likely to be able to invest all their assets in their “best ideas”, whereas larger funds are constrained to invest in their “not so good ideas” and have to take larger positions in shares than what is optimal, thereby reducing the performance.

Another factor that could explain our findings is a higher degree of inefficiency due to larger administration, and a more complex decision-making process for larger funds. Smaller funds often have only one or few managers, and accordingly, shorter decision-making processes. These funds can therefore easier make investment decisions in line with incorporated fund investment strategy compared to larger funds that are administrated by more complex organizations (Stein, 2002). This should be investigated further for the Norwegian market in another study in order to confirm that this actually is one important factor for why fund size matters for performance.

Lastly, large funds often need to sell at a discount to meet demand in order to unload their positions in a share, and additionally pay a premium when uploading their positions. This price mechanism may also be a factor that can explain the relationship between size and performance. Further, this will influence a larger fund’s performance compared to smaller players, as it is more difficult for a large fund to change their positions in shares because of this costs. Hence, this mechanism may reduce performance.

6.0 Conclusion

Using a comprehensive survivorship bias free dataset of 67 Norwegian equity mutual funds from January 2005 to December 2018, we investigate the relationship between fund size and performance in Norway.

The results from our evaluation of the performance of the three equally-weighted portfolios suggest that on average, Norwegian equity mutual funds are not able to beat their benchmark, both gross of fees and net of fees. Additionally, the results may indicate that largest funds are the funds that perform the worst. Furthermore, our results from the individual fund regressions show quite similar results as for the portfolios, whereas very few managers are able to beat their benchmark net of fees. The abnormal returns found in our analysis are rather small and non-significant. Our findings are somewhat consistent with Sørensen (2009), who observed little to no evidence of any abnormal return of actively managed funds in the Norwegian mutual fund market.

Further, we studied the relationship between fund performance and size by controlling for different fund characteristics. When running the cross-sectional regression motivated by Chen et al. (2004), we find a statistically significant negative relationship between fund size and performance. Thus, we find that this relationship is not driven by fund size being correlated with other observable fund characteristics. From this, we find strong evidence that fund size reduces fund performance in Norway, implicating that investing in a large fund may erode the investors' return. The thesis considers various explanations for why this might be the case. We suggest that this comes from the fact that the Norwegian mutual fund market causes investors to dilute their best ideas. It is easier for small funds to invest in their "best ideas" compared to larger funds. Furthermore, we suggest that price mechanisms and complex decision-making processes contribute to reduced performance for larger funds.

For further research, we suggest investigating whether the Norwegian mutual fund market is affected by liquidity constraints or management style, and whether this influences the relationship between size and performance. We have considered this only as an alternative explanation, and would find it interesting to investigate this. Lastly, it would be interesting to study the equity mutual funds in Scandinavia to see if there is some consensus in our findings.

8.0 Bibliography

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

Berk, J., & Green, R. (2002). Mutual Fund Flows and Performance in Rational Markets. *IDEAS Working Paper Series from RePEc,* IDEAS Working Paper Series from RePEc, 2002.

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

Bhojraj, S., Jun Cho, Y., & Yehuda, N. (2012). Mutual Fund Family Size and Mutual Fund Performance: The Role of Regulatory Changes. *Journal Of Accounting Research, 50*(3), 647-684. doi: 10.1111/j.1475-679x.2011.00436.x

Bodie, Z., Kane, A., & Marcus, A. (2014). *Investments and portfolio management* (9th ed., global ed.). New York: McGraw-Hill/Irwin.

Brooks, C. (2014). *Introductory econometrics for finance* (3rd ed.). Cambridge: Cambridge University Press.

Brown, K., Harlow, W., & Starks, L. (1996). Of Tournaments and Temptations: An Analysis of Managerial Incentives in the Mutual Fund Industry. *The Journal Of Finance*, *51*(1), 85. doi: 10.2307/2329303

Brown, S., Goetzmann, W., Ibbotson, R., & Ross, S. (1992). Survivorship Bias in Performance Studies. *The Review of Financial Studies, 5*(4), 553-580.

Carhart, M. (1997). On Persistence in Mutual Fund Performance. *The Journal Of Finance*, *52*(1), 57. doi: 10.2307/2329556

Chen, J., Hong, H., Huang, M., & Kubik, J. (2004). Does Fund Size Erode Mutual Fund Performance? The Role of Liquidity and Organization. *American Economic Review*, *94*(5), 1276-1302. doi: 10.1257/0002828043052277

Edelen, R., Evans, R., & Kadlec, G. (2007). Scale Effects in Mutual Fund Performance: The Role of Trading Costs. *SSRN Electronic Journal*. doi: 10.2139/ssrn.951367

Elton, E., Gruber, M., & Blake, C. (1996a). The Persistence of Risk-Adjusted Mutual Fund Performance. *The Journal Of Business*, *69*(2), 133. doi: 10.1086/209685

Elton, E., Gruber, M., & Blake, C. (1996b). Survivor Bias and Mutual Fund Performance. *The Review of Financial Studies*, *9*(4), 1097-1120

Fama, E. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal Of Finance*, *25*(2), 383. doi: 10.2307/2325486

Fama, E., & French, K. (1993). Common risk factors in the returns on stocks and bonds. *Journal Of Financial Economics*, *33*(1), 3-56. doi: 10.1016/0304-405x(93)90023-5

Fama, E., & MacBeth, J. (1973). Risk, Return, and Equilibrium: Empirical Tests. *Journal Of Political Economy*, *81*(3), 607-636. doi: 10.1086/260061

Ferreira, M., Keswani, A., Miguel, A. and Ramos, S. (2013). The Determinants of Mutual Fund Performance: A Cross-Country Study*. *Review of Finance*, 17(2), pp.483-525.

Gallefoss, K., Hansen, H., Haukaas, E., & Molnár, P. (2015). What daily data can tell us about mutual funds: Evidence from Norway. *Journal Of Banking & Finance*, *55*, 117-129. doi: 10.1016/j.jbankfin.2015.02.001

Gjerde, Ø., & Sættem, F. (1991). Performance evaluation of Norwegian mutual funds. *Scandinavian Journal Of Management*, *7*(4), 297-307. doi: 10.1016/0956-5221(91)90005-l

Grinblatt, M., & Titman, S. (1989). Mutual Fund Performance: An Analysis of Quarterly Portfolio Holdings. *The Journal Of Business*, *62*(3), 393. doi: 10.1086/296468

Grinblatt, M., & Titman, S. (1992). The Persistence of Mutual Fund Performance. *Journal of Finance, 47*(5), 1977-1984.

Gruber, M. (1996). Another Puzzle: The Growth in Actively Managed Mutual Funds. *The Journal Of Finance*, *51*(3), 783. doi: 10.2307/2329222

Hull, John C. (2018). *Options, Futures, and Other Derivatives, Global Edition* (9th ed.). Harlow: Pearson Education M.U.A.

Innskuddspensjonsloven. (2000). Lov om innskuddspensjon i arbeidsforhold LOV-2018-12-20-104). Retrieved from: https://lovdata.no/dokument/NL/lov/2000-11-24-81

Investment Company Institute. (2019). *2019 Investment Company Fact book - A Review of Trends and Activities in the Investment Company Industry.* Washington, D.C. Retrieved from: https://www.ici.org/pdf/2019_factbook.pdf

International Investment Fund Association. (2018). *Worldwide Regulated Open-End Fund Assets and Flows - Fourth Quarter 2018*. Retrieved from: https://www.iifa.ca/files/1553793497_IIFA%20-%20Worldwide%20Open-End%20Fund%20Report%20-%20Q4%202018.pdf

Ippolito, R. (1992). Consumer Reaction to Measures of Poor Quality: Evidence from the Mutual Fund Industry. *The Journal Of Law And Economics*, *35*(1), 45-70. doi: 10.1086/467244

Jegadeesh, N., & Titman, S. (1993). Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *The Journal Of Finance*, *48*(1), 65. doi: 10.2307/2328882

Jensen, M. (1968). The Performance of Mutual Funds in the Period 1945-1964. *The Journal Of Finance*, *23*(2), 389. doi: 10.2307/2325404

Kosowski, R., Timmermann, A., Wermers, R., & White, H. (2006). Can Mutual Fund “Stars” Really Pick Stocks? New Evidence from a Bootstrap Analysis. *The Journal Of Finance*, *61*(6), 2551-2595. doi: 10.1111/j.1540-6261.2006.01015.x

Newey, W., & West, K. (1987). A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica*, *55*(3), 703. doi: 10.2307/1913610

Norges Bank. (2018). *Working Group on Alternative Reference Rates for the Norwegian Krone*. Retrieved from: https://static.norges-bank.no/contentassets/81885ab218dd4eeb9129f5cdb6c293fc/konsultasjonsrapport-alternative-referanserenter-eng.pdf

Norges Bank. (2019). Finanskrisen i 2008. (2019). Retrieved from: https://www.norges-bank.no/tema/Om-Norges-Bank/Tidslinje/Pengepolitikk-finansiell-stabilitet-og-kapitalforvaltning/Finansiell-stabilitet/2008-krisen/

Oslo Børs. (2019). Markedsaktivitet. Retrieved from https://www.oslobors.no/ob_eng/markedsaktivitet/#/details/OSEFX.OSE/overview

OTP-loven. (2005). Lov om obligatorisk tjenestepensjon (LOV-2015-05-22-31). Retrived from: https://lovdata.no/dokument/NL/lov/2005-12-21-124

Perold, A., & Salomon, R. (1991). The Right Amount of Assets Under Management. *Financial Analysts Journal*, *47*(3), 31-39. doi: 10.2469/faj.v47.n3.31

Phillips, B., Pukthuanthong, K., & Rau, P. (2018). Size does not matter: Diseconomies of scale in the mutual fund industry revisited. *Journal Of Banking & Finance*, *88*, 357-365. doi: 10.1016/j.jbankfin.2017.12.005

Phillips, B., Pukthuanthong, K., & Rau, P. (2016). Past Performance May Be an Illusion: Performance, Flows, and Fees in Mutual Funds. *Critical Finance Review*, *5*(2), 351-398. doi: 10.1561/104.00000032

Pollet, J. and Wilson M. (2008). How Does Size Affect Mutual Fund Behavior?. *The Journal of Finance,* 63(6), pp.2941-2969.

Regjeringen. (2013). The Norwegian Economy – Key Facts. Retrieved from: https://www.regjeringen.no/contentassets/455b1741a3814eb8823ce404fc0de3a0/norwegian_economy_2013.pdf

Regjeringen. (2017). Ordning om aksjesparekonto fra 1. september. Retrived from: https://www.regjeringen.no/no/tema/okonomi-og-budsjett/skatter-og-avgifter/ordning-om-aksjesparekonto-fra-1.-september/id2569039/

Roger Lowenstein. (1997). Frightened Funds: Is There a Master in the House? *Wall Street Journal*, p. C1.

Sirri, E., & Tufano, P. (1998). Costly Search and Mutual Fund Flows. *The Journal Of Finance*, *53*(5), 1589-1622. doi: 10.1111/0022-1082.00066

Skatteetaten. (2019). Om Aksjesparekonto. Retrieved from: https://www.skatteetaten.no/bedrift-og-organisasjon/rapportering-og-bransjer/tredjepartsopplysninger/bank-finans-og-forsikring/aksjesparekonto/om-aksjesparekonto/

Stein, J. (2002). Information Production and Capital Allocation: Decentralized versus Hierarchical Firms. *Journal of Finance, 57*(5), 1891-1921.

Sørensen, L. (2009). Mutual Fund Performance at the Oslo Stock Exchange. *SSRN Electronic Journal*. doi: 10.2139/ssrn.1488745

The World Bank. (2018). Listed domestic companies, total. Retrieved from:

https://data.worldbank.org/indicator/CM.MKT.LDOM.NO?locations=US-NO

VFF. (2018). Stadig flere sparer i fond. Retrived from: https://www.vff.no/news/2018/rekordmange-sparer-i-fond

VFF. (2019a). Rekordhøy forvaltningskapital i verdipapirfond i februar. Retrieved from: https://www.vff.no/news/2019/rekordhoy-forvaltningskapital-i-verdipapirfond-i-februar

VFF. (2019b). Historikk Totalmarkedet (2005-2018). Retrieved from https://vff.no/historisk-statistikk

VFF. (2019c). IPS - individuell pensjonssparing. Retrieved from: https://vff.no/fondshandboken/artikler/ips-individuell-pensjonssparing

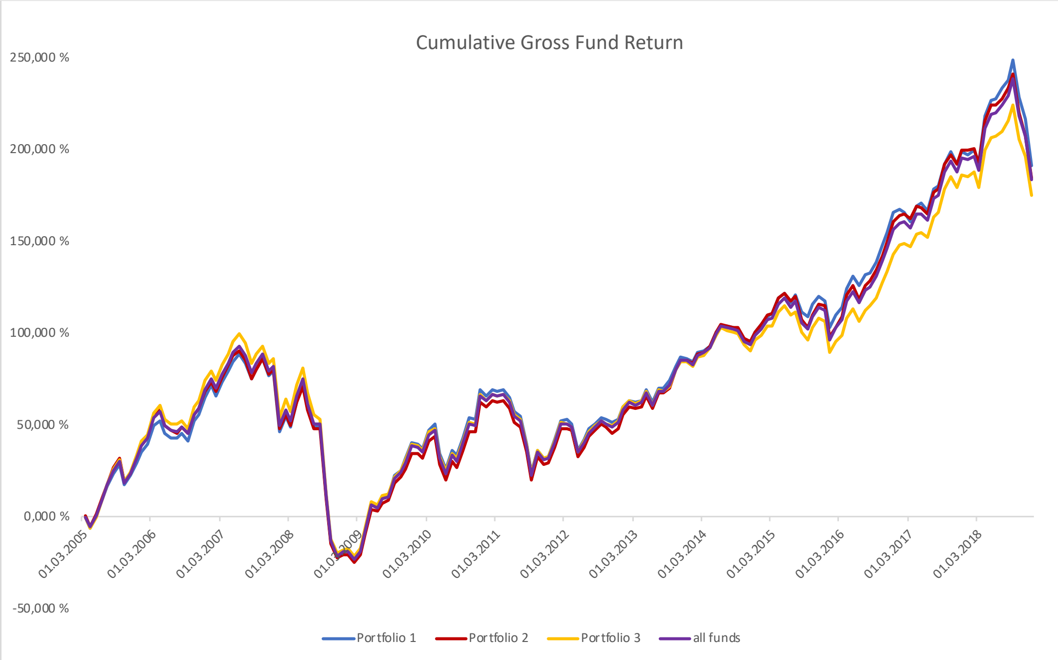
VFF. (2019d). Hva er verdipapirfond?. Retrieved from: https://vff.no/fondshandboken/tema/hva-erverdipapirfond

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. doi: 10.1111/0022-1082.00263

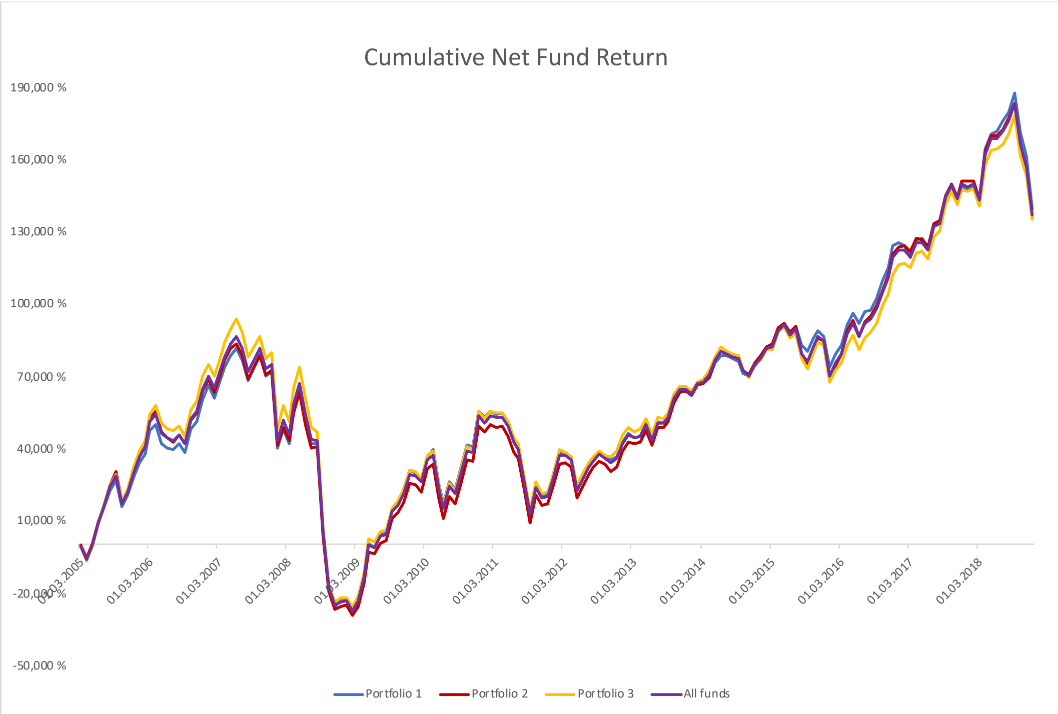
Ødegaard, B. A. (n.d.). Asset pricing data at OSE. Retrieved from http://finance.bi.no/~bernt/financial_data/ose_asset_pricing_data/index.html

9.0 Appendix

Appendix 1 – Cumulative Gross Return



Appendix 2 – Cumulative Net Return



Appendix 3 – Single Index Estimation of the Individual Funds

The table reports each individual fund's alpha, factor loadings and adjusted R^2 obtained from time-series regression. The funds are compared to the single index model throughout the whole sample period from 2005-2018. The results are shown net of operational fees. Each coefficients t-statistic is corrected using the Newey-West (1987) procedure. Additionally, the table shows the average gross and net return for each individual fund.

Fund name	Launch Date	Closed Date	Average Gross return	Average Net return	Alpha	t-Stat	Beta	t-Stat	Adj. R2
Alfred Berg Aktiv	29.12.1992		0.987 %	0.860 %	0.0021	1.9387	0.9669	51.949	0.942
Alfred Berg Aktiv II	15.09.1997	01.10.2012	0.844 %	0.705 %	0.0010	0.6278	0.9747	44.281	0.956
Alfred Berg Gambak	01.11.1990		1.027 %	1.014 %	0.0037	2.0873	0.9599	32.186	0.862
Alfred Berg Humanfond	23.12.1999		0.707 %	0.563 %	-0.0007	-0.9372	0.9459	70.843	0.968
Alfred Berg Norge [Classic]	01.10.1990		0.849 %	0.841 %	0.0019	2.7262	0.9686	81.715	0.976
Alfred Berg Norge +	03.12.1997	23.04.2014	0.904 %	0.900 %	0.0020	2.1677	0.9732	74.721	0.981
Alfred Berg Norge Etisk	14.03.2002	23.04.2014	0.686 %	0.681 %	-0.0002	-0.2060	0.9839	69.938	0.978
Alfred Berg Norge (INST)	23.04.2014		0.809 %	0.818 %	0.0032	2.8252	0.9188	26.001	0.925
C WorldWide Norge	30.04.2002		0.753 %	0.729 %	0.0007	0.9558	0.9766	79.079	0.974
C WorldWide Norge III	07.07.1995		0.898 %	0.797 %	0.0014	1.8603	0.9760	77.270	0.973
DNB Norge	27.07.1995		0.767 %	0.622 %	-0.0001	-0.1082	0.9358	73.280	0.970
DNB Norge (Avanse I)	01.10.1966	21.03.2014	0.835 %	0.684 %	-0.0002	-0.4100	0.9749	134.50	0.994
DNB Norge (Avanse II)	01.01.1990	24.10.2014	0.834 %	0.733 %	0.0001	0.2289	0.9764	134.160	0.994
DNB Norge (I)	16.10.1981	21.03.2014	0.929 %	0.771 %	0.0010	1.1427	0.9257	77.101	0.982
DNB Norge (III)	06.02.1996		0.766 %	0.681 %	0.0005	0.6740	0.9365	73.286	0.970
DNB Norge (IV)	25.11.2002		0.767 %	0.704 %	0.0007	0.9543	0.9393	73.232	0.970
DNB Norge Selektiv (I)	19.04.1996		0.789 %	0.635 %	0.0000	0.0264	0.9356	54.928	0.948
DNB Norge Selektiv (II)	19.12.2001		0.789 %	0.704 %	0.0007	0.7333	0.9324	54.532	0.947
DNB Norge Selektiv (III)	13.06.1994		0.784 %	0.717 %	0.0009	0.8540	0.9388	54.758	0.948
DNB SMB	16.03.2001		0.927 %	0.764 %	0.0014	0.5254	0.9372	21.438	0.735
Danske Invest Norge I	03.01.1994		0.904 %	0.740 %	0.0013	1.5738	0.9167	65.593	0.963
Danske Invest Norge II	03.01.1994		0.907 %	0.802 %	0.0020	2.3377	0.9109	64.715	0.962
Danske Invest Norge Vekst	03.01.1994		0.839 %	0.692 %	0.0011	0.7916	0.8791	37.205	0.893
Danske Invest Norske Aksjer Institusjon I	13.04.2000		0.913 %	0.838 %	0.0023	2.7775	0.9168	66.189	0.964
Danske Invest Norske Aksjer Institusjon I	28.11.2006		0.716 %	0.641 %	0.0026	2.9318	0.9146	62.049	0.964
Delphi Norge	03.06.1994		0.924 %	0.756 %	0.0014	0.8908	0.9337	35.730	0.885
Delphi Vekst	20.10.1997	15.10.2013	0.718 %	0.548 %	-0.0001	-0.0601	0.8505	25.208	0.861
Eika Norge	08.09.2003		0.747 %	0.579 %	-0.0005	-0.359	0.9210	42.307	0.916
Eika SMB	30.04.1998	22.10.2013	0.672 %	0.265 %	-0.0023	-1.1399	0.7516	22.189	0.749
Eika Vekst	03.04.1998	08.11.2013	0.512 %	0.194 %	-0.0030	1.6569	0.7297	23.918	0.776
FIRST Generator S	03.09.2010		1.098 %	0.927 %	0.0006	0.2134	1.2639	16.788	0.741
FORTE Norge	01.03.2011		0.806 %	0.636 %	0.0009	0.3698	0.9874	15.359	0.719
FORTE Tronder	01.01.2013		1.304 %	1.137 %	0.0059	1.8477	0.7741	7.5745	0.446
Fondsfinans Norge	16.12.2002		1.057 %	0.973 %	0.0034	2.4729	0.9454	40.465	0.908
Holberg Norge	28.12.2000		0.768 %	0.642 %	0.0008	0.5177	0.8264	31.108	0.854
KLP AksjeNorge	12.03.1999		0.791 %	0.728 %	0.0008	0.8675	0.9627	60.072	0.956
Landkreditt Norge	24.05.2006	23.06.2016	0.516 %	0.379 %	0.0003	0.1909	0.8625	31.766	0.895
Landkreditt Utbytte A	28.02.2013		0.828 %	0.712 %	0.0029	1.1543	0.5958	7.5096	0.449
NB Aksjefond	30.08.1996	17.10.2013	0.570 %	0.385 %	-0.0020	-1.2241	0.9360	40.762	0.942
Nordea Avkastning	01.02.1981		0.873 %	0.714 %	0.0007	1.0768	0.9710	92.772	0.981
Nordea Kapital	01.01.1995		0.839 %	0.755 %	0.0011	1.9876	0.9617	98.876	0.983
Nordea Norge Pluss	27.04.2011		0.725 %	0.647 %	0.0009	0.6384	0.9992	28.251	0.898
Nordea Norge Verdi	06.02.1996		0.863 %	0.737 %	0.0021	1.5552	0.7841	34.509	0.878
Nordea SMB	21.05.1997	31.01.2015	0.407 %	0.241 %	-0.0037	-1.2704	0.8366	19.158	0.756
Nordea Vekst	02.01.1981	31.01.2015	0.762 %	0.595 %	-0.0008	-0.7892	0.9634	62.194	0.970
ODIN Norge C	26.06.1992		0.639 %	0.472 %	-0.0007	-0.4523	0.7910	28.487	0.831
ODIN Norge II	05.10.2004		0.314 %	0.236 %	-0.0031	-1.4226	0.7679	22.818	0.804
PLUSS Aksje	18.10.1996		0.838 %	0.737%	0.0016	1.8044	0.8790	60.384	0.957
PLUSS Markedsverdi	11.01.1995		0.825 %	0.749 %	0.0013	2.1022	0.9340	88.796	0.979
Pareto Aksje Norge A	09.09.2002		0.641 %	0.604 %	0.0005	0.3037	0.8033	28.262	0.829
Pareto Aksje Norge B	03.01.1985		0.543 %	0.377 %	-0.0001	-0.0840	0.8001	26.933	0.825
Pareto Aksje Norge C	31.12.2005		0.872 %	0.785 %	0.0033	1.1465	0.8879	10.627	0.737
Pareto Aksje Norge D	13.07.2015		0.890 %	0.827 %	0.0037	1.2905	0.8883	10.630	0.737
Pareto Aksje Norge I	13.07.2015		0.775 %	0.733 %	0.0016	0.9515	0.8263	28.290	0.829
Pareto Investment Fund A	06.09.2001		0.932 %	0.782 %	0.0014	0.9674	0.9761	40.577	0.909
Pareto Investment Fund B	29.11.2013		0.959 %	0.878 %	0.0034	1.2094	0.9546	10.628	0.651
Pareto Investment Fund C	29.11.2013		0.959 %	0.915 %	0.0037	1.3433	0.9547	10.628	0.651
Sbanken Framgang Sammen	15.01.2016		0.887 %	0.809 %	-0.0017	-1.3429	1.0556	24.632	0.947
Storebrand Aksje Innland	01.07.1996		0.695 %	0.645 %	0.0001	0.1555	0.9352	67.096	0.965
Storebrand Norge	14.09.1983		0.895 %	0.769 %	0.0012	1.5804	0.9687	73.712	0.971
Storebrand Norge I	03.04.2000		0.695 %	0.671 %	0.0003	0.3126	0.9450	54.464	0.947
Storebrand Norge Institusjon	10.12.2010	25.02.2014	0.356 %	0.349 %	-0.0002	-0.1260	0.9180	32.835	0.968
Storebrand Norge Pluss	27.04.2017		0.617 %	0.515 %	0.0020	0.7388	0.5874	7.2706	0.732
Storebrand Optima Norge A	28.12.2000		0.746 %	0.662 %	0.0003	0.1993	0.9414	42.261	0.915
Storebrand Vekst	10.11.1992		1.023 %	0.855 %	0.0029	1.2375	0.8932	22.528	0.754
Storebrand Verdi A	22.12.1997		0.902 %	0.733 %	0.0009	0.8078	0.9136	48.384	0.934
Terra Norge	03.04.1998	17.10.2013	0.923 %	0.738 %	0.0009	0.5964	0.9729	46.484	0.955

Appendix 4 – Alpha Estimations Using the Three-factor Model

The table reports each individual fund's alpha and adjusted R^2 obtained from time-series regression. The funds are compared to the Fama-French three-factor model throughout the whole sample period from 2005-2018. Each coefficients t-statistic is corrected using the Newey-West (1987) procedure. The results are shown net of operational fees.

Fund name	Alpha	t-Stat	Adj. R2
Alfred Berg Aktiv	0.124 %	1.1529	0.948
Alfred Berg Aktiv II	0.004 %	0.0255	0.961
Alfred Berg Gambak	0.210 %	1.2341	0.878
Alfred Berg Humanfond	-0.095 %	-1.1727	0.968
Alfred Berg Norge [Classic]	0.146 %	2.0932	0.977
Alfred Berg Norge +	0.137 %	1.5506	0.981
Alfred Berg Norge Etisk	-0.049 %	-0.4971	0.979
Alfred Berg Norge (INST)	0.290 %	2.5020	0.923
C WorldWide Norge	0.064 %	0.8464	0.974
C WorldWide Norge III	0.132 %	1.7162	0.973
DNB Norge	-0.014 %	-0.1746	0.970
DNB Norge (Avanse I)	-0.008 %	-0.1583	0.994
DNB Norge (Avanse II)	0.021 %	0.4235	0.994
DNB Norge (I)	0.109 %	1.2685	0.982
DNB Norge (III)	0.046 %	0.5847	0.970
DNB Norge (IV)	0.067 %	0.8614	0.970
DNB Norge Selektiv (I)	0.008 %	0.074	0.948
DNB Norge Selektiv (II)	0.080 %	0.7711	0.947
DNB Norge Selektiv (III)	0.092 %	0.8840	0.947
DNB SMB	-0.158 %	-0.6615	0.785
Danske Invest Norge I	0.103 %	1.2224	0.964
Danske Invest Norge II	0.167 %	1.9804	0.963
Danske Invest Norge Vekst	0.039 %	0.2757	0.896
Danske Invest Norske Aksjer Institusjon I	0.219 %	2.6141	0.964
Danske Invest Norske Aksjer Institusjon II	0.247 %	2.7445	0.964
Delphi Norge	0.008 %	0.0537	0.897
Delphi Vekst	-0.145 %	-0.6337	0.879
Eika Norge	-0.163 %	-1.3284	0.927
Eika SMB	-0.364 %	-1.8309	0.764
Eika Vekst	-0.323 %	-1.7417	0.775
FIRST Generator S	-0.121 %	-0.4163	0.760
FORTE Norge	0.037 %	0.1492	0.716
FORTE Tronder	0.561 %	1.6534	0.431
Fondsfinans Norge	0.258 %	1.8699	0.913
Holberg Norge	-0.070 %	-0.4704	0.874
KLP AksjeNorge	0.035 %	0.3661	0.958
Landkreditt Norge	-0.012 %	-0.0668	0.901
Landkreditt Utbytte A	0.206 %	0.8048	0.470
NB Aksjefond	-0.279 %	-1.7654	0.948
Nordea Avkastning	0.037 %	0.5915	0.982
Nordea Kapital	0.089 %	1.5301	0.984
Nordea Norge Pluss	-0.006 %	-0.0443	0.908
Nordea Norge Verdi	0.127 %	0.9866	0.894
Nordea SMB	-0.640 %	-2.5151	0.821
Nordea Vekst	-0.112 %	-1.0677	0.971
ODIN Norge C	-0.239 %	-1.5348	0.855
ODIN Norge II	-0.462 %	-2.2076	0.827
PLUSS Aksje	0.174 %	1.9721	0.957
PLUSS Markedsverdi	0.146 %	2.2817	0.979
Pareto Aksje Norge A	-0.087 %	-0.5284	0.829
Pareto Aksje Norge B	-0.135 %	-0.7839	0.839
Pareto Aksje Norge C	0.109 %	0.3831	0.768
Pareto Aksje Norge D	0.151 %	0.5284	0.768
Pareto Aksje Norge I	0.025 %	0.1493	0.844
Pareto Investment Fund A	0.083 %	0.5768	0.911
Pareto Investment Fund B	0.247 %	0.8755	0.668
Pareto Investment Fund C	0.284 %	1.0076	0.667
Sbanken Framgang Sammen	-0.181 %	-1.3425	0.946
Storebrand Aksje Innland	0.029 %	0.3470	0.966
Storebrand Norge	0.107 %	1.3447	0.970
Storebrand Norge I	0.042 %	0.4085	0.950
Storebrand Norge Institusjon	0.015 %	0.1135	0.967
Storebrand Norge Pluss	0.196 %	0.7049	0.724
Storebrand Optima Norge A	0.011 %	0.0799	0.917
Storebrand Vekst	0.183 %	0.7815	0.766
Storebrand Verdi A	0.115 %	1.0385	0.938
Terra Norge	0.036 %	0.2429	0.957

Appendix 5 – Alpha Estimations Using the Four-factor Model

The table reports each individual fund's alpha and adjusted R^2 obtained from time-series regression. The funds are compared to the Carhart four-factor model throughout the whole sample period from 2005-2018. Each coefficients t-statistic is corrected using the Newey-West (1987) procedure. The results are shown net of operational fees.

Fund name	Alpha	t-Stat	Adj. R2
Alfred Berg Aktiv	0.001 %	0.0056	0.952
Alfred Berg Aktiv II	-0.059 %	-0.3778	0.963
Alfred Berg Gambak	-0.069 %	-0.4233	0.898
Alfred Berg Humanfond	-0.168 %	-2.0306	0.970
Alfred Berg Norge [Classic]	0.062 %	0.88028	0.979
Alfred Berg Norge +	0.093 %	1.0497	0.983
Alfred Berg Norge Etisk	-0.067 %	-0.6616	0.979
Alfred Berg Norge (INST)	0.061 %	0.4932	0.937
C WorldWide Norge	-0.038 %	-0.5060	0.977
C WorldWide Norge III	0.031 %	0.4105	0.976
DNB Norge	-0.048 %	-0.5870	0.970
DNB Norge (Avanse I)	0.005 %	0.0923	0.994
DNB Norge (Avanse II)	0.039 %	0.7470	0.994
DNB Norge (I)	0.032 %	0.3979	0.985
DNB Norge (III)	0.012 %	0.1416	0.970
DNB Norge (IV)	0.034 %	0.4137	0.970
DNB Norge Selektiv (I)	-0.003 %	-0.0250	0.947
DNB Norge Selektiv (II)	0.070 %	0.6396	0.947
DNB Norge Selektiv (III)	0.082 %	0.7480	0.947
DNB SMB	-0.080 %	-0.3180	0.785
Danske Invest Norge I	0.108 %	1.2224	0.964
Danske Invest Norge II	0.172 %	1.9804	0.963
Danske Invest Norge Vekst	0.093 %	0.6278	0.897
Danske Invest Norske Aksjer Institusjon I	0.211 %	2.4005	0.964
Danske Invest Norske Aksjer Institusjon II	0.237 %	2.4927	0.964
Delphi Norge	-0.117 %	-0.7546	0.901
Delphi Vekst	-0.158 %	-0.6337	0.879
Eika Norge	-0.099 %	-0.7751	0.928
Eika SMB	-0.282 %	-1.3548	0.765
Eika Vekst	-0.371 %	-1.9104	0.774
FIRST Generator S	-0.107 %	-0.3329	0.758
FORTE Norge	0.066 %	0.2387	0.713
FORTE Tronder	0.563 %	1.4289	0.422
Fondsfinans Norge	0.330 %	2.2940	0.914
Holberg Norge	-0.065 %	-0.4108	0.873
KLP AksjeNorge	0.058 %	0.5795	0.957
Landkreditt Norge	0.075 %	0.4183	0.903
Landkreditt Utbytte A	- 0.008 %	-0.0282	0.478
NB Aksjefond	-0.204 %	-1.2967	0.951
Nordea Avkastning	0.028 %	0.4277	0.982
Nordea Kapital	0.089 %	1.5301	0.984
Nordea Norge Pluss	0.007 %	0.0443	0.908
Nordea Norge Verdi	0.229 %	1.7293	0.898
Nordea SMB	-0.505 %	-1.9216	0.824
Nordea Vekst	-0.132%	-1.2023	0.970
ODIN Norge C	-0.218 %	-1.5348	0.855
ODIN Norge II	-0.468 %	-2.1367	0.826
PLUSS Aksje	0.127 %	1.3814	0.957
PLUSS Markedsverdi	0.136 %	2.0276	0.979
Pareto Aksje Norge A	-0.037 %	-0.2155	0.844
Pareto Aksje Norge B	-0.002 %	-0.0134	0.845
Pareto Aksje Norge C	-0.096 %	0.31137	0.777
Pareto Aksje Norge D	-0.055 %	0.1781	0.777
Pareto Aksje Norge I	0.092 %	0.5187	0.845
Pareto Investment Fund A	0.005 %	0.0340	0.912
Pareto Investment Fund B	-0.312 %	-1.0591	0.730
Pareto Investment Fund C	-0.275 %	-0.9339	0.667
Sbanken Framgang Sammen	-0.244 %	-1.6510	0.946
Storebrand Aksje Innland	-0.033 %	-0.3887	0.967
Storebrand Norge	0.040 %	0.4890	0.971
Storebrand Norge I	-0.011 %	-0.1070	0.951
Storebrand Norge Institusjon	0.022 %	0.1516	0.966
Storebrand Norge Pluss	0.253 %	0.8338	0.712
Storebrand Optima Norge A	-0.027 %	-0.1915	0.917
Storebrand Vekst	0.283 %	1.1557	0.766
Storebrand Verdi A	0.001 %	0.0064	0.942
Terra Norge	0.037 %	0.2459	0.957

Appendix 6 – Correlation Matrix of Factor Variables

This table reports the cross-correlation of the factors from the four-factor model over the entire sample period from 2005 – 2018. 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 that has a long position in high book-to-market stocks and a sport position in low book-to-market stocks. PR1YR is the return on a portfolio that has a long position in stocks that are past-12-month winners and a short position in those that are past-12-month losers.

Factors	Mean Monthly Return	Std Dev of return	Cross-Correlation			
			MKT	SMB	HML	PR1YR
MKT	0.63%	0.059	1.00	-0.6204	-0.1992	-0.1490
SMB	0.35 %	0.038		1.00	0.0743	0.1248
HML	-0.25 %	0.036			1.00	-0.0329
PR1YR	1.25 %	0.040				1.00

Appendix 7 – Robustness Analysis of Gross Fund Performance

The table reports the different factor loadings obtained from time-series regression of seven equally weighted portfolios. The coefficients t-statistic is stated in parentheses and is corrected using the Newey-West (1987) procedure. The portfolios are compared to the single index model, the Fama-French three-factor model and the Carhart four-factor model throughout the whole sample period from 2005-2018. The results are shown gross of operational fees.

Factors	Alpha	MKT	SMB	HML	PR1YR	R2	Adj. R2
Portfolio			*Single index model*				
1	0.0015	0.9072				0.971	0.971
	(1.5356)	*(74.3603)*					
2	0.0009	0.9124				0.968	0.968
	(1.2009)	*(70.0412)*					
3	0.0016	0.9036				0.961	0.960
	(1.8568)	*(63.3038)*					
4	0.0007	0.9207				0.964	0.964
	(1.0439)	*(66.0694)*					
5	0.0009	0.9381				0.970	0.970
	(1.2034)	*(72.4044)*					
6	0.0008	0.9390				0.972	0.972
	(1.0410)	*(76.0211)*					
7	0.0007	0.8908				0.971	0.971
	(1.0528)	*(74.6380)*					
			Three-Factor Model				
1	0.00082	0.9526	0.1116	0.0080		0.975	0.975
	(1.1798)	*(63.9467)*	*(4.8912)*	*(0.4206)*			
2	0.00046	0.9413	0.0754	-0.0093		0.969	0.969
	(0.5958)	*(56.7892)*	*(2.9716)*	*(-0.4375)*			
3	0.00082	0.9502	0.1214	-0.0150		0.965	0.965
	(1.0013)	*(54.1298)*	*(4.5183)*	*(-0.6653)*			
4	0.00009	0.9798	0.1382	0.0334		0.970	0.969
	(0.1191)	*(58.6097)*	*(5.3988)*	*(1.5601)*			
5	0.00024	0.9856	0.1169	0.0074		0.974	0.973
	(0.3209)	*(62.1782)*	*(4.8186)*	*(0.3657)*			
6	0.00003	0.9877	0.1222	0.0004		0.977	0.976
	(0.0442)	*(66.3534)*	*(5.3636)*	*(0.0204)*			
7	0.00022	0.9273	0.0893	0.0078		0.974	0.973
	(0.3220)	*(62.1365)*	*(3.9080)*	*(0.4101)*			
			Four-Factor Model				
1	0.00060	0.9542	0.1107	0.0092	0.0174	0.975	0.974
	(0.8218)	*(63.7203)*	*(4.8499)*	*(0.4828)*	*(1.0145)*		
2	0.00041	0.9417	0.0752	-0.0090	0.0038	0.969	0.969
	(0.5077)	*(56.3431)*	*(2.9532)*	*(-0.4231)*	*(0.1971)*		
3	0.00081	0.9502	0.1214	-0.0149	0.0004	0.965	0.964
	(0.9479)	*(53.6808)*	*(4.5005)*	*(-0.6608)*	*(0.0179)*		
4	-0.00013	0.9813	0.1373	0.0346	0.0172	0.970	0.969
	(-0.1536)	*(58.3561)*	*(5.3579)*	*(1.6114)*	*(0.8917)*		
5	-0.00015	0.9813	0.1154	0.0095	0.0303	0.974	0.973
	(-0.1915)	*(62.3603)*	*(4.7786)*	*(0.4704)*	*(1.6664)*		
6	-0.00030	0.9901	0.1209	0.0022	0.0261	0.977	0.976
	(-0.4154)	*(66.4323)*	*(5.3241)*	*(0.1152)*	*(1.5278)*		
7	0.00012	0.9280	0.0889	0.0084	0.0084	0.974	0.973
	(0.1607)	*(61.7139)*	*(3.8777)*	*(0.4386)*	*(0.4866)*		

Appendix 8 – Robustness Analysis of Net Fund Performance

The table reports the different factor loadings obtained from time-series regression of seven equally weighted portfolios. The coefficients t-statistic is stated in parentheses and is corrected using the Newey-West (1987) procedure. The portfolios are compared to the single index model, the Fama-French three-factor model and the Carhart four-factor model throughout the whole sample period from 2005-2018. The results are shown net of operational fees.

Factors	**Alpha**	**MKT**	**SMB**	**HML**	**PR1YR**	**R2**	**Adj. R2**
Portfolio			*Single index model*				
1	0.0012	0.9093				0.977	0.972
	(1.6521)	*(75.6788)*					
2	0.0008	0.9122				0.968	0.967
	(1.0553)	*(69.9527)*					
3	0.0015	0.9035				0.961	0.960
	(1.7609)	*(63.2351)*					
4	0.0008	0.9206				0.964	0.964
	(0.9215)	*(66.0779)*					
5	0.0008	0.9380				0.970	0.970
	(1.0837)	*(72.4635)*					
6	0.0007	0.9416				0.973	0.972
	(1.0171)	*(76.2294)*					
7	0.0006	0.8907				0.971	0.971
	(0.9337)	*(74.6428)*					
			Three-Factor Model				
1	0.00054	0.9538	0.1088	0.0103		0.976	0.975
	(0.7942)	*(64.9340)*	*(4.8376)*	*(0.5471)*			
2	0.00035	0.9408	0.0750	-0.0098		0.969	0.969
	(0.4529)	*(56.6872)*	*(2.9504)*	*(-0.4585)*			
3	0.00074	0.9502	0.1214	-0.0149		0.965	0.965
	(0.9029)	*(54.0636)*	*(4.5131)*	*(-0.6605)*			
4	0.00001	0.9797	0.1382	0.0334		0.970	0.969
	(-0.0112)	*(58.6210)*	*(5.4007)*	*(1.5605)*			
5	0.00015	0.9854	0.1166	0.0078		0.974	0.973
	(0.1990)	*(62.2050)*	*(4.8072)*	*(0.3826)*			
6	0.00001	0.9903	0.1221	0.0001		0.977	0.976
	(0.0196)	*(66.5092)*	*(5.3567)*	*(0.0077)*			
7	0.00014	0.9272	0.0893	0.0078		0.974	0.973
	(0.2005)	*(62.1417)*	*(3.9087)*	*(0.4104)*			
			Four-Factor Model				
1	0.00029	0.9557	0.1078	0.0117	0.0202	0.976	0.975
	(0.4001)	*(64.8025)*	*(4.7954)*	*(0.6210)*	*(1.1969)*		
2	0.00030	0.9412	0.0758	-0.0095	0.0042	0.969	0.969
	(0.3655)	*(56.2456)*	*(2.9314)*	*(-0.4427)*	*(0.2180)*		
3	0.00073	0.9502	0.1214	-0.0148	0.0004	0.965	0.964
	(0.8523)	*(53.6155)*	*(4.4951)*	*(-0.6559)*	*(0.0217)*		
4	-0.00022	0.9812	0.1373	0.0346	0.0172	0.970	0.969
	(-0.2778)	*(58.3673)*	*(5.3598)*	*(1.6118)*	*(0.8916)*		
5	-0.00023	0.9881	0.1151	0.0098	0.0300	0.974	0.973
	(-0.3032)	*(62.3745)*	*(4.7670)*	*(0.4862)*	*(1.6492)*		
6	-0.00031	0.9925	0.1208	0.0019	0.0253	0.977	0.976
	(-0.4243)	*(66.5529)*	*(5.3167)*	*(0.0994)*	*(1.4788)*		
7	0.00003	0.9279	0.0889	0.0084	0.0084	0.974	0.973
	(0.0447)	*(61.7195)*	*(3.8783)*	*(0.4389)*	*(0.4878)*		

Appendix 9 – Robustness Analysis of Size on Performance Without the 10 Largest Funds

The table reports estimates of monthly fund returns regressed on fund characteristics lagged one month. The returns are estimated gross and net of fees. The dependent variable is FUNDRET, which is the return adjusted by using the three-factor model and the four-factor model. LOGTNA is the natural logarithm of TNA. LOGFAMSIZE is the natural logarithm of one plus the TNA of the family excluding the TNA of the funds itself. AGE is the number of years since the launch date of the fund. EXPRATIO is the total expense ratio or the annual management fee. FLOW is the percentage new fund flow into the mutual fund over the past month. LAGFUNDRET is the fund return lagged one month. The t-statistics are shown in parentheses and are adjusted for serial correlation using Newey-West (1987) lags of order six. The data sample is without the ten largest funds based on average TNA, and is from 2005 to 2018.

	Gross Fund Returns		Net Fund Returns	
	3-Factor	4-Factor	3-Factor	4-factor
INTERCEPT	0.0011	0.0010	-0.00004	-0.00028
	(0.3446)	*(0.3793)*	*(-0.0162)*	*(-0.1137)*
$\mathrm{LOGTNA}_{\mathrm{i,t-1}}$	-0.0005	-0.0006	-0.0006	-0.0006
	(-2.9556)	*(-3.4584)*	*(-3.3666)*	*(-3.0193)*
$\mathrm{LOGFAMSIZE}_{\mathrm{i,t-1}}$	-0.0003	-0.0003	-0.0002	-0.0002
	(-1.5647)	*(-1.6335)*	*(-1.2385)*	*(-1.2181)*
$\mathrm{FLOW}_{\mathrm{i,t-1}}$	0.0037	0.0034	0.0036	0.0036
	(0.8906)	*(0.8873)*	*(0.8534)*	*(0.9329)*
$\mathrm{AGE}_{i,t-1}$	0.0001	0.0001	0.0001	0.0001
	(2.0933)	*(2.9626)*	*(2.2378)*	*(3.1274)*
$\mathrm{EXPRATIO}_{\mathrm{i,t-1}}$	-1.8741	-1.7035	-1.5487	-0.9497
	(-2.5766)	*(-1.6667)*	*(-2.1459)*	*(-1.3404)*
$\mathrm{LAGFUNDRET}_{i,t-1}$	0.0522	0.0342	0.0544	0.0347
	(1.7068)	*(1.1436)*	*(1.7853)*	*(1.1630)*