MORE IS LESS

SCALABILITY IN SWEDISH MUTUAL EQUITY FUNDS

HANNA HÖIJE

JESPER JANSON

Bachelor Thesis
Stockholm School of Economics
2019

More Is Less - Scalability in Swedish Mutual Equity Funds

Abstract:

This thesis studies the relationship between fund size and performance of open-ended Swedish mutual equity funds between 2014-2019. The fund industry has been fast growing and the landscape has changed with extensive inflows and ever larger funds. When studying the scale impact on performance, we deepen the analysis by examining scalability across funds with different investment strategies. We find a negative relationship between fund size, a diseconomy of scale, significant at the 1% level. This is more prominent in funds investing in small- and mid-capitalisation stocks as well as in growth stocks. The results from our cross-sectional regressions and panel data analysis are aligned with the majority of previous research on other markets. Our findings have enabled us to further analyse how theories regarding organisational structures and liquidity affect the scalability of funds.

Keywords:

Sweden, Fund, Size, Return, Investment Strategy, Liquidity, Scalability

Authors:

Hanna Höije (23997)
Jesper Janson (23943)

Tutor:

Olga Obizhaeva, Assistant Professor, Department of Finance

Examiner:

Adrien d'Avernas, Assistant Professor, Department of Finance

Bachelor Thesis
Bachelor Program in Business and Economics
Stockholm School of Economics

Contents

1. Introduction

New Swedish funds are constantly emerging and the assets under management (AUM) have grown exponentially for many years. Different funds have developed during the last couple of decades and the market is constantly evolving. With the uncontested growth trend, as well as indications of increasing consolidation of the market, the size of funds become a substantial aspect when investing. A better understanding of the potential adverse relationship between fund size and performance will certainly become relevant for all investors. The purpose of this paper is to study the relationship between size and performance, in order to conclude if there exists a diseconomy of scale in Swedish mutual equity funds.

We analyse a group of open-ended mutual equity funds domiciled in Sweden during a period of five years, 2014-2019. Furthermore, we identify the relationship between size and performance in various investment strategies, such as growth and value as well as specific market capitalisations. To further examine the relationship between fund size and performance we run cross-sectional regressions and analyse panel data using fixed effects to accommodate for omitted variables.

The results of previous studies are not only conflicting but also limited in the sense of fund scope and geographical markets. Dahlqvist et al. (2000) have contributed to prominent research on the Swedish fund market with a study of the time period 1992-1997. Severe changes in market conditions and various results from previous studies makes it difficult to come to a clear conclusion regarding the current nature of the relationship. Fundamental changes have heavily influenced the industry in general as well as the ability to generate competitive returns in particular. Funds have grown larger, trading patterns have changed and the market has become more global which increases the relevance of the study carried out.

Our results support an adverse relationship and prove a diseconomy of scale in Swedish equity funds, using multiple performance measures. We also establish differences in the adverse size effect across different investment strategies. Our results and previous studies support the contention of decreasing returns to scale, proposed by Berk and Green's (2002) model of rational investor behaviour. The model also assumes that risk-adjusted expected returns ultimately are equal across all funds. Our quantitative analysis indicates that returns vary across funds with different AUM. This proposes that the self-adjusting market and outflow in ineffective funds is not as effective as their model proposes.

Perold and Salomon (1991) and Chen et al. (2004) argue that large funds become less agile and transaction costs challenge the returns. They argue that this is more prominent for funds investing in small-cap and growth, which is in line with our results. Additionally, we relate our findings to a systematic deviation in investment strategy, observed by Pollet and Wilson (2008). They find that funds in the largest segment and small-cap funds diversify their portfolios in response to growth. Since we conclude that some strategies are less scalable than others, managers may have to change focus in order to reduce the risk of opportunity cost that then emerge when funds are kept open-ended in order to maximise the manger fee capitalisation.

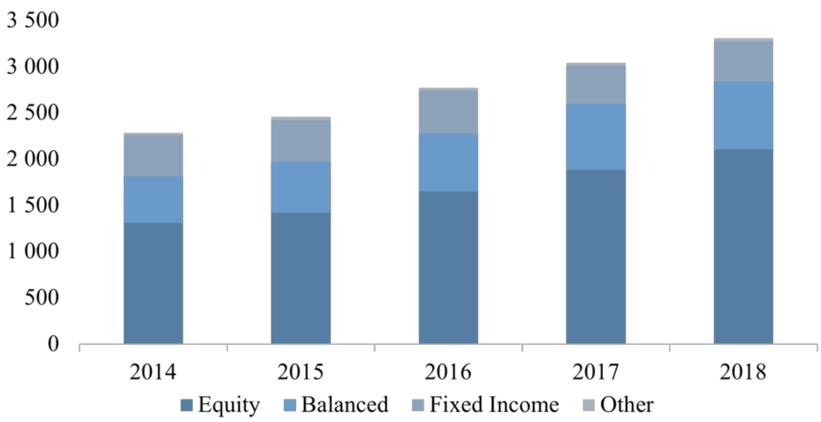
2. Industry Background

2.1. Swedish Fund History

When the Swedish Investment Fund Association was founded in 1979 there were only 17 funds and SEK 1 billion under management combined. There are now 3 000 funds on the Swedish market and over SEK 3 978 billion under management at the end of 2018 (The Swedish Investment Fund Association, 2019). The size of the industry has increased exponentially and so has the size of many individual funds. With a large increase in capital several different types of funds have emerged. The origin of Swedish investment funds growth was tax-free funds, introduced in 1978. This was also when corporate ownership was greatly debated. The funds were a way to increase the common people's ownership of firms which created a political backing of the product as an investment vehicle and a broad range of investors (Helgesson et al., 2009).

By the 1990s, equity and fixed income funds were dominant on the market although a combination of the two and hedge funds were also possible to invest in. In the early stages of the industry development, it was hard to invest abroad due to currency regulations. As the gradual deregulation took place during the decade, funds investing in foreign investments increased. A large change in investment behaviour occurred in 1997 when restrictions loosened, allowing a major segment of prominent funds to invest abroad (Helgesson et al., 2009). Funds ownership of stocks on the Swedish stock exchange has doubled since the lifting of restrictions, reaching 12% of the total Swedish stock market. The industry today is defined by a global market, high transparency and low fees compared other countries in the European Union (Nordström, 2019).

Figure 1. Sweden Domiciled Funds 2013-2018

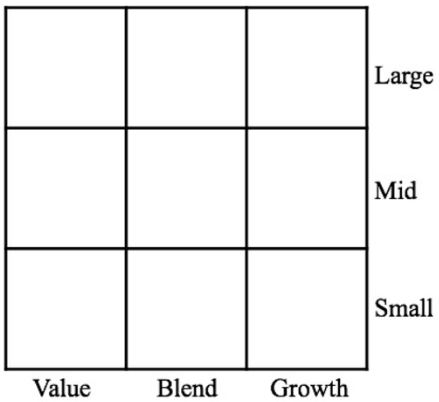


Note: An illustration of the development of AUM in Swedish funds, in SEK billion (Swedish Investment Fund Association, 2019)

2.2. Fund Styles

The main investment styles applied in this paper are related to growth factors, market capitalisation (market-cap) and value factors. Together, the combinations create nine different styles, illustrated in the Morningstar Equity Style Box. The three categories on the x-axis are funds investing in growth, blend and value stocks while the y-axis is divided into funds investing in small, mid and large capitalisation stocks. This is later referred to as small-, mid- and large-cap funds. The fund categorisation enables an informed comparison between funds and fund characteristics, based on the actual portfolio construction. This is done through screening on equity level. Morningstar determines the style of underlying equity based on value factors and growth factors and concludes the most prominent in each fund's portfolio. If the portfolio constituents are noisy or consisting of core equity, with no clear categorisation, the fund is denominated as *blend.*

Figure 2. Morningstar Equity Style Box



Note: A nine-square grid that provides a graphical representation of the investment style of and mutual funds. The styles are dived based on the market capitalisation, growth- and value factors of stocks.

Equity with value characteristics are defined as companies with low valuations, indicated by low price ratios, high dividend yields and slow growth (Morningstar, 2016). The idea behind the investment strategy is that there are inefficiencies in the market creating mispriced stocks where the price differs from the company's intrinsic value. This can be exploited according to a value investing fund (Athanassakos, 2011). Equity with growth characteristics are defined as companies with fast growth, indicated by high growth rates for earnings and large cashflow as well as high valuations (Morningstar, 2016).

The market capitalisation categorisation refers to the value of a company's total shares on the market. Morningstar base this categorisation on a relative value of assets, given the specific geographical markets, that is not affected by overall changes in the market. The top 70% in each market is defined as large cap, mid-cap is defined as the group that accounts for the next 20% and small-cap captures the rest of the market (Morningstar, 2016).

2.3. Investing in Expanding Funds

When considering the scalability of mutual funds, Yin (2016) formulates a theory to further understand the context and dilemma of growing assets. He raises the conflict of interest between managers and investors when it comes to hedge funds' sizes. The conclusion is that even though there exists a diminishing return to scale, funds still expand beyond the optimal size. The reason for this is the structure of compensation and that management gets paid in dollars while investors are looking for high percentage return. This study is also applicable to the mutual fund industry due to the similar structure of compensation. Yin (2016) showed that managers hold a larger than optimal amount in their funds but are motivated to restrict the growth to maintain their style-average performance and therefore protect themselves from capital outflow.

When funds expand, a change in investment behaviour has been observed in order to handle the inflow of capital (Pollet and Wilson, 2008). This occurs in the form of a changed investment focus and deviations from the original style. For example, a fund investing in the small-cap segment experiences difficulties to invest more capital in the same companies since the share owned is restricted in size. Furthermore, they describe a liquidity problem where small-cap funds and growth funds are affected the most. This theory is extended by Dahlqvist et al. (2000), arguing that large funds, trading considerable blocks of shares, are more effected by transaction costs due to unfavourable bid- and ask prices. These transaction costs are of different kinds and described in depth by Wagner and Edwards (1993). They argue that the explicit fee charged by the broker only constitutes a small fraction of the cost structure. Wagner and Edward (1993) emphasise the influence of order volume and trade urgency. They describe a trade-off between incurring a market impact and the suffering of timing costs when seeking liquidity.

When the net flow to a fund is positive it often indicates that investors feel confident in the fund's future performance as well as the manager's ability to choose the best investment opportunities (Pollet and Wilson, 2008). Berk and Green (2002) generate a greater depth to the subject when discussing the rational investor behaviour. They argue that fund managers increase AUM as well as their own compensation, given that the fund's expected return is competitive. The conclusion is an effective market with capital flows based on investors' expectations and perception of funds. According to Berk and Green (2002), investors' expectations of future alfa affects funds size and the capital flows.

3. Previous Literature

Over the last 20 years, many studies have examined the relationship between performance and fund size. Previous research has covered a few different aspects of the topic in various markets, mainly the U.S. Studies focusing on hedge funds and the behaviour of mutual equity funds are some of these additional aspects.

Table 1. Summary of Previous Research

Thesis	Author (date)	Research scope	Findings
Does Fund Size Erode Mutual Fund Performance? The Role of Liquidity and Organization	Chen et al. (2004)	Diversified U.S. equity mutual funds (1962-1999)	Negative relationship between fund size and performance due to liquidity issues and organisational diseconomies.
Does size affect mutual fund performance? A general approach	Bodson et al. (2011)	Actively managed equity mutual funds (2000- 2010)	There exists a relationship between mutual fund performance and size, it is quadratic and concave.
Liquidity, Investment Style and the Relation between Fund Size and Performance	Yan (2008)	U.S. actively managed equity mutual funds (1993- 2002)	Negative relationship between fund size and performance, especially among less liquid portfolios.
Mutual Fund Performance: Does Fund Size Matter?	Indro et al. (1999)	Nonindexed U.S. equity funds (1993-1995)	There is an optimal size for a portfolio due to diminishing marginal returns and high initial costs.
Size does not matter: Diseconomies of scale in the mutual fund industry revisited	Phillips et al. (2018)	U.S, actively managed, equity mutual funds (1992- 1998)	Fund size does not affect performance if tested with a set of instrumental variables that influence fund size but are unrelated to expected fund performance.
Performance and Characteristics of Swedish Mutual Funds	Dahlquist et al. (2000)	Swedish mutual funds (1993- 1997)	Good performance occurs among small equity funds, low fee funds, funds whose trading activity is high and, in some cases funds with good past performance.
Informative fund size, managerial skill, and investor rationality	Zhu (2018)	Actively managed domestic equity-only funds in U.S. markets (1995-2014)	Significant negative impact of fund size on performance.

3.1. Positive and Concave Relationship

Previous literature is to a large extent contradictory with different conclusions regarding the nature of the association between returns and AUM. Phillips et al. (2018) study actively managed equity mutual funds in the U.S. and conclude that there is not any diseconomy of scale while Indro et al. (1999) find a concave relation with an optimal size of a portfolio. To discard the theories regarding a diseconomy of scale some studies present other arguments regarding the cost-effectiveness of having a large fund. One argument is that large funds can spread out their fixed costs over a greater base which reduces the costs per invested dollar (Otten and Bams, 2002).

3.2. Negative Relationship

Despite the lack of continuity, the majority find a negative relationship suggesting that size impair performance. Chen et al. (2004) and Yan (2008) find a negative linear relationship when focusing on mutual equity funds in the U.S. Zhu (2018) carries out an empirical study with an extended focus on the neutralisation of econometric biases by constructing bias-free estimates and find a significant negative impact of fund size on performance. Previous literature has not only been unable to come to a unanimous conclusion regarding the existence but also incapable to establish a conclusive explanation for the diseconomy of scale. It has been shown that the diseconomy of scale stems from increased costs of different sorts associated with large transactions and organisations. The main reasoning involves the effect of liquidity in the underlying assets as well as increased indirect transaction costs as an extension of this theory. Chen et al. (2004) find a more negative size-performance relation in funds investing in small-cap stock. According to Chen et al. (2004) it is because these stocks tend to be more illiquid. The paper also investigates organisational diseconomies which cause large funds to underperform smaller ones due to disadvantageous hierarchies.

Indro et al. (1999) present areas where the performance is affected negatively as the funds grow bigger. The study presents the liquidity limitations and the informational asymmetry problem for market makers. This becomes more explicit as funds trade large blocks of stock, resulting in increased bid-ask spreads and lower returns. The paper also attends to the issue regarding organisational diseconomies and presents difficulties in coordination and overseeing the underlying stocks as a reason for decreasing.

In summary, previous literature conclude different types of size-performance relationships. The research has mostly been focused on actively managed mutual equity fund in the US. Several explanations for the adverse relationship have also been introduced with the most recurring reasoning involving liquidity problems and increased transaction costs as funds expand.

4. Research Objective and Purpose

4.1. Objective

The empirical results of previous studies that have focused on the relationship between fund size and performance are not only conflicting but also limited. The scope of investigation has generally been geographically restricted to U.S. funds and they do not analyse the impact of fund size on performance for different mutual fund categories. Many studies have been carried out with the aim of constructing performance measures to neutralise differences in funds with investment styles. Instead of neutralising the returns in order to treat the fund universe as a homogenous group, we aim to extract the different types of funds and compare differences in the size-performance relationship.

Therefore, our research objective is to use a measurement of performance that neutralises the heterogeneity in expected return of the different fund strategies, in order to compare their correlation with AUM. The intention is then to identify the relationship between size and performance within each category. Using our empirical result as a foundation as well as prior studies that explore reasons for the potential diseconomies, we aim to draw conclusions regarding the scale impact on different fund categories in terms of performance on the Swedish market. This is concluded in the following research question:

How does size affect performance in Swedish mutual funds and are different investment strategies affected equally?

4.2. Hypotheses

Many different studies presented in the literature review intend to establish the linkage between fund size and performance. Based on previous studies, it is reasonable to assume the presence of a relation between size and performance, although the studies are inconsistent in the conclusions regarding the relationship. The study carried out on the Swedish market (Dahlqvist et al., 2000) concludes that small funds perform better than large ones and explain the results by discussing the inert movement and unfavourable trading position in funds with more capital. The study examines mutual funds during 1992-1997, a different market compared to the one present today after an extensive development during the last decades, both in terms of regulations and size. Fund investments have become more common and the total AUM has grown rapidly and constant (Nordström, 2019).

With the changed market conditions in Sweden and the various results from previous studies, it is difficult to draw a clear conclusion regarding the nature of the relationship. Based on our research objectives as well as previous literature, we have formulated the following hypotheses in order to determine both the direction and the strength of the association:

H1: There exists a diseconomy of scale in Swedish mutual equity funds.
H2: The return of different fund styles is not equally affected by the size factor.

5. Data

5.1. Fund Scope

Our primary source of data is the investment analysis platform Morningstar Direct. The funds included in our sample must meet the following criteria:

- Domiciled in Sweden
- Mutual fund
- Open-ended
- Invest only in equity

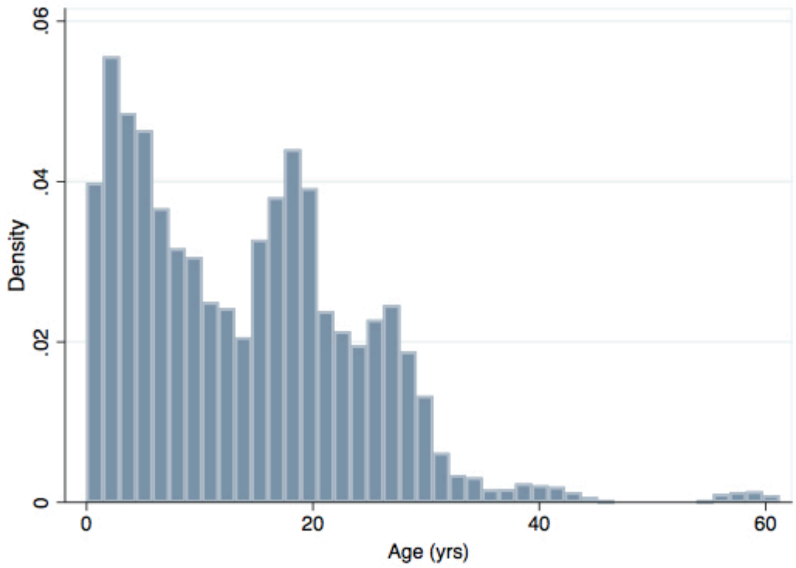
The sample contains funds during a time period of five years, 2014-2019. Elton et al. (2001) have found that the returns of the smallest funds, the ones with AUM less than $15 million, tend to be biased upward. We therefore, like Chen et al. (2004) and Yan (2008), choose to exclude the smallest funds. We eliminate those with less than EUR 15 million under management. This is also an approach in order to remove backfill bias, the inaccuracy in reporting which inflates the performance. It has been indicated that funds with extensive AUM do not suffer significant backfill bias (Chen et al. 2004).

Our sample consists of 257 funds covering 23 investment areas reported by Morningstar Direct. Furthermore, we use 37 benchmarks when calculating the adjusted returns, listed in the appendix. When testing our second hypothesis we divide funds into groups based on the Morningstar Style Box. The sample include 130 funds investing in growth stocks and 29 investing in value stocks. The number of funds investing in large-cap stocks is 166 and the aggregated sample of small- and mid-cap funds totals 91.

5.2. Incubation Bias

Many funds are kept private before opening to the public and this strategy is called incubation. According to Evans (2010) their risk-adjusted returns are on average 3.5% higher than non-incubated funds. However, their outperformance disappears after the incubation. This causes an incubation bias towards smaller funds and is not solved by a size filter but rather fund age and inception date. In order to minimise the impact of this bias, we choose to leave out the first 18 months of returns. Removal of these young funds also alleviates the concern that these funds are more likely to be cross-subsidised by their respective fund families (Gaspar et al., 2006). Figure 3 illustrates the dispersion between age in our sample and displays a relatively large group of young funds. Only a small number of funds existed before the 1990s and this is the reason why research within this field is limited in Sweden. We also see a group of funds being significantly older than the rest ranging from 55-60 years old.

Figure 3. Fund age distribution



Note: Distribution of age, observed in our sample of Swedish mutual funds, measured in years and calculated as the difference between inception date and return date.

5.3. Survivorship Bias

Most databases only show data of funds that are currently in operation which will create an overestimation of the overall performance, known as survivorship bias. This causes a selection of funds that does not reflect the historical data of funds. Carhart et al. (2002) found that this bias also increases with the historical length of the sample. In a one-year sample, the bias consisted of 0,07% of the return but increased to 1% for samples longer than 15 years. We therefore include both active and defunct funds within our scope.

6. Method

6.1. Statistical Methodology

To determine the relation between fund size and performance we extend the methodology used by Ammann and Moerth (2005) and Xiong et al. (2009) by comparing funds in their separate categories. We start by sorting the mutual funds according based on their AUM and group them in quartiles with the corresponding average size and return. Then we compare the average returns and how they differ across portfolios. To further examine the relationship between fund size and performance we follow Pastór et al. (2014) by conducting a panel data analysis with multiple fixed effects. We also take on the approach of Fama-MacBeth (1973) used by Yan (2008) where we run repeated cross-sectional regressions and report the average coefficients across the time-series.

6.1.1. Portfolio Approach

The procedure were funds are broken down into quartiles is carried out for each month during the selected time period. The constituents in each quartile can change during different months as a result of positive and negative capital flows, the demise of funds and the birth of new ones. The average performance of the smallest 25% of funds represent the first portfolio's performance. Similarly, the mean return of the largest 25% of mutual funds represent the performance of the fourth portfolio. The reasoning behind the portfolio-approach is Modern Portfolio Theory (Markowitz,1952), where the aim is to reduce the exposure to individual funds characteristics and risk by holding a well-diversified portfolio of funds. This results in four time-series of monthly average sizes and returns based on our chosen performance measure.

6.1.2. Panel Data Analysis with Fixed Effects

Since we have multidimensional data that contain multiple data points during several time periods for the same funds, it is managed as panel data. To further investigate the impact of fund size on returns and to test our hypothesis of the size-performance relationship, we run ordinary least square (OLS) regressions on our panel data and incorporate fixed effects. When doing a panel study, we can account for individual heterogeneity within-groups fixed effects (Dougherty, 2011). Panel data allows us to control for unobservable variables as well as variables that change over time but not across funds.

Since it is likely that both size and performance are affected by manager skill, the OLS estimate of the coefficient would not successfully identify the relationship between the variables. This results in an omitted-variable bias since the unobservable variable, skill, is likely to affect both our independent and dependent variable. To mitigate this, we add a fund fixed effect in order to absorb differences in skill across the funds in our sample. The fixed effect removes the unobserved heterogeneity between our funds.

We also aim to control for time-variant effects within groups. First, we conclude that time fixed effects were needed using a joint test to examine whether the dummy-variables for all years are equal to zero. We can after doing this test reject the null hypothesis that the coefficients for all years are jointly equal to zero, and therefore include them and expand our model. The combined model, with both fixed effects, results in the elimination of bias from variables that differ across funds but are constant over time. It also controls for variables that are constant across funds but differ over time (Dougherty, 2011). The unobservable factor could be an improved skill across the entire industry, where managers are getting better over time. Equation (1) specifies the regression model with fixed effects.

$$Y_{i,t} = \beta_0 + \lambda_t \times d_t + \lambda_i \times d_i + \beta_i \times IV_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

Where λ_t are time fixed effects, λ_i are fund fixed effects, d_i and d_t are dummy variables indicating specific funds and return dates.

6.1.3. Cross-Sectional Regressions

In order to test the robustness of our panel study, we attempt to run monthly regressions on the entire sample. The coefficient of interest is the one capturing relation performance and the individual fund size, while controlling for other fund characteristics. Each month, we estimate the cross-sectional regressions of returns and fund characteristics using repeated monthly regressions following Fama-MacBeth (1973). We report the time-series average of the monthly coefficients in order to form our overall estimate of the scale impact. A negative and significant mean coefficient indicates that there exists a diseconomy of scale. When running the regressions, we also add Newey-West adjustment in order to mitigate for the time-serial correlation (Petersen, 2005). The statistical significance of the average coefficients is evaluated based on Newey-West standard errors.

6.1.4. Differences Across Fund Styles

When studying the size-impact across different styles we run the same regression as we did on the total sample but with a modification. The model then includes fund size together with indicator variables for style. This allows for a review of the scale-impact across different investment strategies and sectors. The coefficients will indicate how the style interact with fund size in the analysis. We generate four indicator variables based on the Morningstar Equity Style Box; small/mid, large, value and growth. In order to declare if funds with different investment strategies are affected differently by a diseconomy or economy of scale, we choose to isolate contrary groups. We do not isolate the group of funds with the investment strategy “Blend”, since there is no clear singularity within the group. We start by looking at the first dimension, the characteristics of the stocks, where we run the regression with funds investing in value stocks and then compare those with funds investing in growth stocks. Similarly, small- and midcap funds are being merged and isolated in one group and then compared with funds investing in large cap stocks.

6.1.5. OLS Regression

The variables chosen will be analysed through the OLS regression. The dependent variable is the benchmark-adjusted monthly return and Sharpe ratio. The independent variable of interest is the lagged natural log of the fund AUM. We run the following regression when following the Fama-MacBeth method. For the panel regressions we add fixed effects to accommodate for level differences between funds and to control for the time-dimension within funds.

$$\text{Return}_{i,\,t} = \beta_0 + \beta_1 \text{lnSize}_{i,t\text{-}1} + \beta_\text{n}\,\text{Control Variables}_{i,\,t\text{-}1} \tag{2}$$

6.1.6. Adjusted Return and Sharpe Ratio

The adjusted returns are calculated using the monthly cumulative returns and the return of the appointed benchmark index within the same investment category. The performance measure is defined as the difference between the monthly return of the fund and the benchmark-return the same month:

$$\text{Adjusted Return}_{i,\,t} = \text{Cumulative Gross Return}_{i,\,t} - \text{Benchmark Return}_{\,j,\,t} \tag{3}$$

We calculate the adjusted return since we study the managers ability to outperform the market across different fund sizes, not the net value to the investor. It is essential to choose a measurement which allow for comparison between funds across different markets and investment conditions. Yin (2016) argues that the adjusted return is less noisy compared to risk-adjusted returns estimated using factor models, portraying the returns in a more accurate way. These factors are commonly used throughout mutual fund studies since they are freely available for many geographical markets. We follow Pàstor el al. (2008) who argue that the Fama-French factors are less appropriate and choose a more precise measurement on individual fund level. Cremers et al. (2013) also argue that conducting studies using the Fama-French model generates results with biased assessments of the returns.

Sensoy (2008) shows that the benchmark given by U.S. equity funds prospectus is in a third of the cases incorrect, creating a cherry-picking bias. Therefore, Morningstar's benchmark is used since it is based on the fund's holdings rather than the benchmark portrayed in the prospectus (Pàstor el al., 2008). Morningstar also ensures that their benchmarks are free from survivorship biases by considering categories or funds that have been liquidated. When calculating the adjusted return, we use the index portfolio assigned by Morningstar.

Our other dependent variable and performance measure is a risk-adjusted return, the Sharpe ratio. The Sharpe ratio is based on the annualised return using the specific monthly return. The adjusted return is calculated by dividing the excess return, the risk premium, with the standard deviation of the fund excess return.

6.1.7. Independent Variables

Our dependent variable has drawbacks resulting in the need for control variables when analysing the independent variable in isolation. Therefore, we have compiled a group of variables that previous research has proven to affect performance. These variables must therefore be accounted for when running the regressions. Morningstar Direct reports a host of fund characteristics that we utilise in our analysis. The variables of interest that are included in our analysis is summarised in Table 2.

Table 2. An Illustration of Independent Variables

lnSIZE	The natural logarithm of Fund Size (Total Net Assets)
ind_lnSize_SM	Indication variables with together with lnSize for funds investing in small- and mid-cap stocks
ind_lnSize_L	Indication variables with together with lnSize for funds investing in large-cap stocks
ind_lnSize_V	Indication variables with together with lnSize for funds investing in value stocks
ind_lnSize_G	Indication variables with together with lnSize for funds investing in growth stocks
lnAGE	The natural logarithm of Fund Age, measured in years since inception
lnFAMSIZE	The natural logarithm of the Fund Family Size (Total Net Assets)
FLOW	Flow, the percentage of new capital flows into the fund, calculated by the difference between fund size and lagged fund size
ADJ_FLOW	Adjusted flow, calculated as the flow adjusted for the increase in value of the current assets.
RET_LAG	Adjusted Return, lagged by one month

We include the lagged fund size, which is the size during previous month, since we are examining the impact size has on performance and how it affects return in the coming period. We have therefore created the lagged fund size variable to reflect the previous month's fund size. Age is calculated by subtracting the inception date of the fund from the return date, following Chen et al. (2004). This is an attempt to capture the impact of a longer fund history and the potential experience effect. Additionally, we include the fund family size. This has previously been done by Chen et al. (2004) on U.S. data and has proven to have statistical significance, supported by theories regarding administrative support and differences in bargaining positions.

We define net flow of assets each month as an attempt to illustrate the direction of capital in association with performance. We have also introduced the independent variable lagged adjusted return to test the persistence in performance. It is to test if there exists a correlation between existing returns and last month's return. Our data will likely to suffer from an omitted- variable bias which primarily stems from the unobservability of fund skill. This is controlled for with the panel regressions including fixed effects, though with the assumption that skill is constant over time. The fixed effects therefore aim to absorb return variation that are caused by cross-sectional differences in manger skill.

6.2. OLS Assumptions

A few assumptions regarding the variables and observations need to be made in order to conduct an OLS regression (Dougherty, 2011). Firstly, we run the Wald test for panel data to see if the standard error is constant and therefore homoscedastic. We find an inconsistency within the residuals, meaning the data is heteroscedastic. Furthermore, we test the independency of the variables in our regression models. Multicollinearity leads to inflated variances of the estimated coefficients. We start with generating a correlation matrix and find weak to moderate correlation between certain variables, primarily fund size and fund family size, as seen in the appendix. Thereafter, we generate the variance inflation factor (VIF) to get a greater understanding of the total correlation across all independent variables and conclude that no considerable tendency to multicollinearity existed in the data.

Another assumption is that residuals are normally distributed which is examined by conducting a Jarque-Bera test and we find that the residuals are not normally distributed. Furthermore, to test for correlation between the residuals and the independent variables, we run a Wooldridge test. The results indicate that there is autocorrelation in our regression models. The last assumption of OLS is that the parameters are linear and correctly specified. We assume separate beta values for each independent variable and that there is no relationship between them. To test this, we use the Ramsey RESET test. The results show that no non-linear combinations of the explanatory variables have any power in explaining the dependent variable. Therefore, the model is not misspecified in the sense that the data would be better explained by a quadratic or cubic functional form. Furthermore, the dataset contains several outliers for the different fund characteristics, mainly the return measure. Despite the result from the assumption tests, we have chosen not to correct for any outliers since we cannot verify that any incorrect data exists in the sample.

In order to mitigate the effect of the violations of the OLS regression assumption, we apply robust standard errors in the regressions. Apart from mitigating these effects the application of robust standard errors is since we can observe a small amount of highly positive and highly negative observations when examining the dependent variable. Since the OLS regression model is highly sensitive to these outliers, the effect will be disproportionate when looking at the regression output. When adjusting the standard errors, we will reduce the effect on the results of these extreme observations by giving them less weight in the regression model.

Table 3. Summary of Tests for OLS Assumptions

Assumption	**Test**
Homoscedasticity	Wald test
Zero multicollinearity	Correlation matrix, VIF
Normally distributed residuals	Jarque-Bera test
Zero autocorrelation	Wooldridge test
Linear regression in the parameters	Ramsey RESET test

7. Results

7.1. Descriptive Statistics

Table 4. Total Sample – Descriptive Statistics

Variable	Mean	Std.Dev.	Min	Max
Adjusted Return %	.0260	1.4558	-13.3233	11.6484
Sharpe ratio	2.67	6.77	-153.75	75.16
Age (yrs)	16.55	9.75	1.50	61.20
Fund Size (mn)	725.7	2 290.8	15.0	44 332.2
Fund Family Size (mn)	13 747.1	16 743.0	15.0	58 851.2
Adjusted Flow (mn)	-1.24	57.18	-1 506.48	2 205.02
Flow (mn)	5.93	97.70	-2 920.20	3315.86

Note: Summary statistics for our sample of equity mutual funds from 2014-2019, illustrating the mean of various fund characteristics. Funds with total net assets less than EUR 15 million are excluded as well as the first 18 months of data for each sample fund. Assets under management for different share classes are aggregated into a single fund. The unit of observation is one month. Adjusted returns are in percent per month. Sharpe ratio is calculated by annualising the monthly return. Fund size, fund family size and flow-calculations are denoted in EUR.

The average adjusted return for our sample is positive. This suggests that the funds in average outperform their benchmarks before fees in our sample. The standard deviation is however large indicating a spread of performance with a substantial number of funds that have underperformed their benchmarks. We also see a considerable variation in Sharpe ratio as well as in age. The minimum age is 1.5 years, in order to adjust for potential incubation bias. Furthermore, age is ranging up to 61 years, giving us a broad sample in terms of experience and historical performance. The smallest fund is EUR 15 million in order to avoid the biases resulting from the smallest segment of funds. The big spread in fund size is illustrated by the largest fund being more than 3 000 times the size of the smallest. This is also the case for fund family size.

Table 5. Fund Strategies – Descriptive Statistics

Number of funds	Growth n=130	Value n=29	Total n=159
Adjusted Return %	.0663	-.0069	.0535
	(1.16)	(-0.08)	(0,87)
Sharpe ratio	2.80	2.71	2.79
Age (yrs)	17.63	18.24	17.74
Fund Size (mn)	573.6	321.0	529.2
Fund Family Size (mn)	13 620.3	12 012.1	13 337.5
Adjusted Flow (mn)	-1.63	-1.11	-1.54

Note: Summary statistics for our sample of equity mutual funds from 2014-2019, illustrating the mean of various fund characteristics. The statistics are divided into strategies based on the Morningstar Style Box, but excluding funds defined as "Blend". Funds with total net assets less than EUR 15 million are excluded as well as the first 18 months of data for each sample fund. Assets under management for different share classes are aggregated into a single fund. The unit of observation is one month. Adjusted returns are in percent per month, annualised in parenthesis. Sharpe ratio is calculated by annualising the monthly return. Fund size, fund family size and flow-calculations are denoted in EUR.

Table 5. displays data for two of the investment styles investigated considered when examining differences across strategies. The adjusted returns of the growth funds have been larger than the value funds during the investment period while the Sharpe ratio has been relatively similar. The value funds have been smaller in size both for individual funds as well as their families. The adjusted flow has been larger for the growth funds which is to be expected since they present a higher average AUM.

Table 6. Market cap- descriptive statistics

Number of funds	Large n=166	Mid/Small n=91	Total n=257
Adjusted Return %	-.0230	.1173	.0260
	(-0,24)	(2.78)	(0.36)
Sharpe ratio	2.51	2.98	2.67
Age (yrs)	16.39	16.85	16.55
Fund Size (mn)	861.9	472.2	725.7
Fund Family Size (mn)	13 711.2	13 813.9	13 747.1
Adjusted Flow (mn)	-.83	-1.99	-1.24

Note: Summary statistics for our sample of equity mutual funds from 2014-2019, illustrating the mean of various fund characteristics. The statistics are divided into sectors based on the Morningstar Style Box, but aggregating funds investing in Small- and Mid-cap stocks. Funds with total net assets less than EUR 15 million are excluded as well as the first 18 months of data for each sample fund. Assets under management for different share classes are aggregated into a single fund. The unit of observation is one month. Adjusted returns are in percent per month, annualised in parenthesis. Sharpe ratio is calculated by annualising the monthly return. Fund size, fund family size and flow-calculations are denoted in EUR.

When sorting funds by market capitalisation, we can conclude differences in both performance and other characteristics, summarised in table 6. The monthly adjusted return for small- and mid-cap funds has been significantly higher than for large funds.

The difference in Sharpe is smaller but still substantial. While the age is similar between the two groups the size is noticeably different with the large-cap funds being almost twice as large as the mid- and small-cap funds.

7.2. Size and Performance

7.2.1. Portfolio Approach

Table 7. Descriptive Statistics, by Portfolio

Portfolio	Adj. Return	Sharpe Ratio	AGE	Fund Size	Fund Family Size
1	.0593	2.64	12.75	64.3	475.4
2	.0230	2.52	16.11	207.0	12 473.1
3	.0236	2.91	16.98	489.1	16 842.2
4	.0082	2.62	20.43	2 155.8	21 073.2
1-4 (diff)		.0512***	.19		

Note: Statistics for mutual equity funds sorted into quartiles based on their monthly assets under management. The sample period is 2014-2019. Funds with total net assets less than EUR15 million are excluded as well as the first 18 months of data for each sample fund. Assets under management for different share classes are aggregated into a single fund. The unit of observation is one month. Adjusted returns are in percent per month. Sharpe ratio is calculated by annualising the monthly return. Fund size, fund family size and flow-calculations are denoted in EUR million. We compare the performance of Portfolio 1 and 4 and report the associated t-statistics. The level of significance is illustrated as following: *** p<0.01, ** p<0.05, * p<0.1.

In table 7, we report the descriptive statistics on the generated portfolios based on fund size. Upon examining the differences in performance across the quartiles, the descriptive statistics indicate that small funds in Portfolio 1 experience a higher adjusted return compared to large funds that are grouped in Portfolio 4. The two middle portfolios generate similar returns, but the overall return follows a downward trend across the quartiles, which confirms our hypothesis. Moreover, when examining the Sharpe ratios, the portfolio with the smallest funds overperform the largest ones even though this performance measure follows a more uneven pattern. When further examining Portfolio 1 and 4, we test the mean returns using an unpaired t-test. We find strong evidence for the difference in mean performance and confirm that the average return is larger for Portfolio 1 compared to Portfolio 4, statistically significant at the l% level. Our findings are the same considering Sharpe ratio but not significant. Detailed statistics of t-tests is found in the appendix.

7.2.2. Panel Data Analysis and Cross-sectional Regressions

Table 8. Panel Data Analysis with Fixed Effects: Total Sample

VARIABLES	Adjusted return	Sharpe
lnSIZE	-0.00208***	-0.679***
	(-4.259)	(-3.106)
lnAGE	0.000630	0.730*
	(0.517)	(1.650)
ADJ_FLOW	0.000	-5.15e-11
	(1.489)	(-0.0984)
lnFAMSIZE	-6.34e-05	-0.121
	(-0.0814)	(-0.362)
RET_LAG	-0.111***	
	(-8.064)	
Constant	0.0428**	16.07***
	(2.519)	(2.931)
Observations	13,659	13,659
R-squared	0.137	0.579
Fund FE	YES	YES
Time FE	YES	YES

Note: The regression table above summarises regressors association with fund performance. Columns 1 and 2 report OLS coefficient estimates from panel regressions of the performance measures, adjusted return and Sharpe ratio, on various explanatory variables during the time period 2014-2019. Both specifications include fund- and time fixed effects. Funds with total net assets less than EUR 15 million are excluded as well as the first 18 months of data for each sample fund. Assets under management for different share classes are aggregated into a single fund. The unit of observation is one month. Adjusted return measures are in percent per month. Sharpe ratio is calculated by annualising the monthly return. Fund size, fund family size and flow-calculations are denoted in EUR. Robust t-statistics in parentheses. The level of significance is illustrated as following: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

The sample included in the panel regression consists of funds in all size quartiles and are included on an individual basis as opposed to the portfolio approach. The estimated coefficient on the independent variable of interest, fund size, is negative and statistically significant at the 1% level. We can therefore reject the null hypothesis that there is no association present. This evidence is suggestive of decreasing returns to scale at a fund level.

When looking at the other performance measure, the Sharpe ratio, the evidence of decreasing returns to scale is also present. The fixed effects raise the amount of variance explained, compared to running the same model in a pooled OLS regression. The R-squared when using adjusted return as performance measure is 0.137 and 0.579 when looking at the Sharpe ratio. The lagged adjusted return is found to have a strong association with our dependent variable, the current performance. No other control variable shows any statistical significance in the regression.

Table 9. Monthly Cross-sectional Regressions

VARIABLES	Adjusted return	Sharpe
lnSIZE	-0.000169*	-0.0137
	(-1.893)	(-0.537)
lnAGE	0.000235	0.0740**
	(1.382)	(2.475)
ADJ_FLOW	0.00	-1.57e-09***
	(0.380)	(-2.881)
lnFAMSIZE	-2.46e-05	-0.0143
	(-0.251)	(-0.642)
RET_LAG	-0.0804***	
	(-4.873)	
Constant	0.00337	3.069***
	(1.217)	(9.949)
Observations	13,659	13,659
R-squared	0.068	0.037
Number of groups	60	60

Note: Columns 1 and 2 present the time-series averages of the OLS coefficients from cross-sectional regressions of adjusted return and Sharpe ratio from 2014 until 2019. On fund characteristics lagged 1 year. The repeated regressions follow the Fama-MacBeth (1973) method. Funds with total net assets less than EUR 15 million are excluded as well as the first 18 months of data for each sample fund. Assets under management for different share classes are aggregated into a single fund. The unit of observation is one month. Adjusted return measures are in percent per month. Sharpe ratio is calculated by annualising the monthly return. Fund size, fund family size and flow-calculations are denoted in EUR. T-statistics that are based on Newey-West standard errors and reported in the parentheses. Robust t-statistics are presented in parentheses. The level of significance is illustrated as following: *** p<0.01, ** p<0.05, * p<0.1.

In table 9, we report the results for the monthly repeated regression specification defined in equation 1. The presented coefficients are the average values from the 60 regressions that has been carried out. The t-statistics are adjusted for Newey-west standard errors in order to control for time-serial correlation between the observations. The R-squared of 6.8% and 3.7%, is in accordance with previous research within this topic using this approach. The coefficient of the independent variable, fund size, presents a negative association between performance and size, both when examining the adjusted return and Sharpe ratio. When examining the impact of size on adjusted return, we find a negative coefficient significant at the 10% level. When looking at the regression using Sharpe ratio, no significant result was possible to retrieve from the made regressions. However, a tendency can be seen that a growing fund size decreases the fund’s Sharpe ratio, albeit not statistically significant. Based on our empirical findings, we conclude that there exists a diseconomy of scale in Swedish mutual equity funds. Our first hypothesis is therefore supported.

7.3. Differences in Strategy

Table 10. Panel Data Analysis with Fixed Effects: Adjusted Return

VARIABLES	Small/Mid-cap	Large-cap	Value	Growth
ind_lnSize_SM	-0.00349***			
	(-2.594)			
ind_lnSize_L		-0.00171***		
		(-3.714)		
ind_lnSize_V			-0.00215**	
			(-2.187)	
ind_lnSize_G				-0.00219***
				(-3.559)
lnAGE	-0.000118	0.00116	-9.78e-05	-0.00269
	(-0.0458)	(0.878)	(-0.0251)	(-1.381)
lnFAMSIZE	0.00113	-0.000441	0.00176	-0.000233
	(0.651)	(-0.552)	(0.321)	(-0.273)
ADJ_FLOW	0.00	0.00	0.00	0.00
	(0.599)	(0.770)	(0.0145)	(0.580)
RET_LAG	-0.0930***	-0.125***	-0.0533	-0.102***
	(-4.085)	(-7.150)	(-1.283)	(-6.103)
Constant	0.0476	0.0416**	0.00787	0.0557***
	(1.630)	(2.142)	(0.0663)	(2.788)
Observations	4,775	8,884	1,508	7,067
R-squared	0.161	0.153	0.179	0.162
Fund FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES

Note: The regression table above summarises regressors association with adjusted return, during the time period 2014-2019. Columns 1 through 4 report OLS coefficient estimates from panel regressions divided in four style-categories. Both specifications include fund- and time fixed effects. Funds with total net assets less than EUR 15 million are excluded as well as the first 18 months of data for each sample fund. Assets under management for different share classes are aggregated into a single fund. The unit of observation is one month. Adjusted return measures are in percent per month. Sharpe ratio is calculated by annualising the monthly return. Fund size, fund family size and flow-calculations are denoted in EUR. ind_lnSize_X are indication variables with together with lnSize. Robust t-statistics are presented in parentheses. The level of significance is illustrated as following: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

The results of the regression regarding our second hypothesis is displayed in table 10 using adjusted return as the performance measurement. We use an OLS regression with time and fund fixed effect. We find that funds investing in small- and mid-cap have a negative coefficient with a significance at 1%. Large-cap funds also have a negative coefficient with strong significance. The same pattern follows for both value and growth funds, having an adverse relationship between size and adjusted return. Our test of value funds has statistical significance at the 5% significance level and growth at 1% giving strong proof of the negative relationship.

We can also see that funds in both small-, mid- and large Cap as well as growth funds show a negative relationship between the control variable Return and the performance measurement. This means that a fund will have inverse effect on the performance the coming month compared to the previous. The coefficient of the variable differs between the groups but remains negative with significance at highest of the 5% level with the majority at the 1% level. We find some different trends in other control variables, but they are not statistically significant.

Table 11. Panel Data Analysis with Fixed Effects: Sharpe Ratio

VARIABLES	Small/ Mid-cap	Large-cap	Value	Growth
ind_lnSize_SM	-0.582			
	(-0.782)			
ind_lnSize_L		-0.657***		
		(-5.418)		
ind_lnSize_V			-0.631**	
			(-2.094)	
ind_lnSize_G				-0.670***
				(-3.705)
lnAGE	0.699	0.604**	1.285	-0.0216
	(0.646)	(1.961)	(1.238)	(-0.0527)
ADJ_FLOW	1.91e-09	1.07e-10	2.16e-09	5.94e-10
	(0.892)	(0.243)	(0.407)	(0.615)
lnFAMSIZE	0.0310	-0.193	-2.334	-0.114
	(0.0328)	(-0.682)	(-1.158)	(-0.446)
Constant	12.20	16.91**	63.66	17.55***
	(1.383)	(2.447)	(1.465)	(3.014)
Observations	4,775	8,884	1,508	7,067
R-squared	0.613	0.624	0.533	0.643
Fund FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES

Note: The regression table above summarises regressors association with the Sharpe ratio, during the time period 2014-2019. Columns 1 through 4 report OLS coefficient estimates from panel regressions divided in four style-categories. Both specifications include fund- and time fixed effects. Funds with total net assets less than EUR15 million are excluded as well as the first 18 months of data for each sample fund. Assets under management for different share classes are aggregated into a single fund. The unit of observation is one month. Adjusted return measures are in units per month. Sharpe ratio is calculated by annualising the monthly return. Fund size, fund family size and flow-calculations are denoted in EUR. ind_lnSize_X are indication variables with together with lnSize. Robust t-statistics are presented in parentheses. The level of significance is illustrated as following: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 11 shows the results from the same regression model as in Table 10, but with Sharpe ratio as the dependent variable. The results in the two tables are similar which strengthens our findings further. We find even more evidence of diminishing returns for large- cap funds. This trend continues when looking at growth funds. Small- and mid-cap is though no longer significant, and value's significance decreases slightly but is still at the 1% level. Age has a positive coefficient for large-cap and is significant at 5%. All control variables still remain insignificant, but the patterns change slightly with adjusted flow moving from zero. Based on our empirical findings, we conclude that the return of different fund styles is not equally affected by the size factor. Our second hypothesis is therefore supported.

8. Analysis and Implications

8.1. Size and Performance

As can be confirmed in the empirical results, there is significant support for the first hypothesis, that increasing size affects the performance in a negative manner. In accordance with previous studies, we find that fund performance is negatively related to fund size regardless of our choice of performance measure.

When comparing our results to Dahlquist et al. (2000) who also study Swedish funds, we can conclude that the diseconomy prevails despite a radically changed market. Our quantitative analysis is also consistent with previous studies of Yan (2008), Chen et al. (2004) and Zhu (2018) who examine the U.S. market. One important aspect to consider is the great differences between the Swedish and U.S. fund market, mainly with respect to the differences in size. When looking at the scope of funds in the US, the spread between the largest and smallest funds is considerably larger than in our sample containing Swedish funds. This highlights the results even further. Despite this, we conclude the diseconomy of scale with significant results.

8.1.1. Transaction Costs and Manager Limitations

As funds grow larger the trades become larger and the manoeuvrability decreases. One explanation for the diseconomy of scale is that large funds become less agile and transaction costs challenge the returns (Chen [2004], Perold and Salomon, [1991]). When net assets increase, it initially provides cost advantages in some areas, meaning an increasing return to scale. For example, the costs of accessing information, conducting research as well as administrative tasks, do not rise in direct proportion to the growing AUM. Since large funds hold a more advantageous position when signing agreements with brokerage firms, substantial transaction volume is equivalent to lower brokerage commissions. However, fees only constitute a small fraction of the cost structure (Wagner and Edwards, 1993). In addition to the explicit fee charged by the broker, other indirect costs will challenge the positive outcome of the trade.

According to Perold and Salomon (1991), another potential cost of trading is the price impact, which is especially distinct for larger funds trading large amounts. The fund's block trading causes adverse reactions to the market. The reasoning behind this market impact is purely the price determination which reflects supply and demand, the formation and removal of liquidity. The less beneficial price is necessary in order to create enough demand and therefore liquidity to close the desired trade. Wagner and Edward (1993) emphasise the influence of order volume and trade urgency when examining price impact which implies that large funds are more exposed to this cost.

Another potential loss according to Wagner and Edward (1993) is the cost of timing. It represents the cost of seeking liquidity and the price movements before the trade can be completed. The cost movements can be very costly, and the greater the volume, the greater the cost. The manager faces a trade-off between timing costs and incurring a market impact. Wagner and Edward (1993) conclude that institutional investors can experience more extreme prices and fluctuations since the trading volumes have a significant negative impact in this trade-off which the diseconomy of scale in Swedish mutual funds.

8.1.2. Organisational Diseconomies

Chen et al. (2004) underline the impact of organisational diseconomies when funds expand and argue that large funds require more ideas in order to allocate the total capital. They find that funds with multiple managers perform worse than solo managed funds. A larger number of managers increase the competitiveness of ideas. Stein (2002) argues that fund managers focus on constructing convincing arguments, for the management to take on their ideas and overlook fundamental parts of the analysis in the process. Smaller funds are less affected by this phenomenon which help explain the limits to scalability in funds. Pollet and Wilson (2008) find evidence that managers do not increase their investment ideas but rather try to scale up their existing investments. This increases the competition for investment ideas even further. The theory of Stein (2002) is not existent on a fund family level due to the lack of decision power of investment. This is in line with our findings where we do not find a significant association between the size of the fund families and performance.

8.1.3. Rational Investor Behaviour

The study aims to test the potential diseconomy of scale in Swedish funds and identify limits to scalability of fund portfolios. Increased AUM occurs at the expense of investor's returns which is in line with diminishing returns to scale assumed by Berk and Green (2002). Both our results and those of previous studies support the contention concerning decreasing returns to scale in fund portfolios. Nevertheless, the fund return predictability is not consistent with the model of Berk and Green (2002). Their model also assumes that risk-adjusted expected returns ultimately are equal across all funds regardless of size. However, our quantitative analysis indicates that returns vary across funds with different AUM, proposing that the equalisation and outflow in underperforming and ineffective funds is not as effective as in their model.

8.2. Style Limitations in Scalability

8.2.1. Market Capitalisation

As seen in the results of our second hypothesis, the limits to scalability differ across market cap sectors. Our study shows that the size effect is most prominent among funds investing in small- and mid-cap stocks compared to large-cap stocks. These findings correspond with Dahlquist et al. (2000), who find a significantly negative impact of increasing AUM in small cap funds. Chen et al. (2004) find that funds investing in small-cap are affected the most negatively by growth in AUM and argues that liquidity constraints are the key factors. Connecting to the theory behind increased transaction costs, a fund investing in small-cap stocks would experience an increased market impact since the proportion of a company traded is significantly larger than in a large-cap companies. When considering the trade-off between searching for liquidity and the negative market impact, the volatile characteristics of a small cap increase the risk of large timing costs.

8.2.2. Investment Strategy

We discover slightly more limitations to scalability when looking at the growth funds which is in line with previous research conducted on the U.S. market. The empirical results are consistent with the assumption that trading patterns in growth funds implicate more urgency and immediacy in trades compared to other strategies (Beckers and Vaughan, 2001). As regards to the implications of transaction costs, the liquidity constraints become determinant when considering the growth stocks. Growth and high turnover funds tend to employ short-term trading strategies. The cost of timing is minimised, and trades are executed more immediately. Instead managers face the negative effects of a market impact. For this reason, limitations in scalability are more prominent among these funds, compared to value funds which generally represent a more distinct buy-and-hold strategy.

8.2.3. Strategy Constraints to Scalability

Fund management have an incentive to scale up funds considering the fee structure which is mainly based on a fixed percentage of AUM. This keeps funds open-ended even though the increased inflows and AUM may impair performance to the loss of the investor, creating a conflict of interest (Yin, 2016).

The phenomena of deviation from the original strategy have been observed by Pollet and Wilson (2008) who find that funds in the largest segment and small-cap funds diversify their portfolios in response to growth. In line with our results, Beckers and Vaughan (2001) argue that this is because some investment styles are more scalable than others. Given that the management keeps the fund open-ended and the AUM growing, funds invest in the most scalable strategy which is still a suboptimal portfolio. Therefore, the choice of a suboptimal portfolio is a way of mitigating potential increases in costs, however a change in focus, where managers invest outside their area of expertise, could instead impair the performance further. A reason for the change in fund behaviour could be another indirect potential loss stemming from liquidity constraints. The failure to close trades without occurring either timing costs or market impact losses, results in limitations in strategies, which explains the adaptation of strategy observed by Pollet & Wilson (2008).

9. Conclusion

We examine the relationship between size and performance in general and the effect on different investment strategies. The sample consists of Swedish open-end equity funds during the time period 2014-2019. When grouping funds in portfolios depending on size, we conclude that the smallest funds overperform the portfolio consisting of the largest funds. Using Fama-MacBeth regression and OLS regression with fixed effects covering the entire period, we find a diseconomy of scale both when analysing the market-adjusted returns and the risk-adjusted return as performance measures. We find a negative impact on performance caused by increasing fund size, using several adopted methods. When considering the scalability of different fund categories, we find that both funds investing in growth and value stocks experience a negative impact on returns when AUM increases, proving our second hypothesis.

Our findings have enabled us to further analyse how theories regarding organisational structures and liquidity has affected our results. Reasoning behind potential losses from market impact and cost of timing helps explain the limits of scalability. When looking at our findings in the light of the behaviour of a rational investor, Berk and Green’s (2002) model suggests that investors choose funds depending on performance. The capital flows until a certain point when managers’ abilities are fully extracted. This implies a market adjusting in- and outflow of capital where no fund will outperform any other. Our results in accordance with previous studies point in another direction. The findings in our analysis indicates that returns vary across funds with different AUM proposing a constant diseconomy of scale.

This study has several implications for fund investors across all categories. First, this study shows that while managers and fund families have incentives to increase fund assets, the expansion impairs fund performance at the expense of investors. Secondly the ambition to illustrate how differences characteristics across fund strategies contributes with the insight regarding differences in scalability. The additional analysis suggests that strategies requiring more liquidity will experience a more severe diseconomy of scale. Investors should therefore consider the impact of fund size when choosing to invest in these strategies.

10. Limitations and Implications for Further Research

When considering the relationship between scale and performance we encounter a potential regression-to-the-mean bias. A fund could have a month of surprisingly good returns which increases the fund size. The return next month could however move back to its previous normal level making the size seem to have a negative effect on return. This could be one reason that we find returns to be negatively correlated with the AUM during the previous month. This also relates to the finite-sample bias proposed by Pástor et al. (2005), resulting from the positive contemporary correlation between changes in fund size and unexpected fund returns. An existing correlation between an independent variable, such as fund size, and the regression standard errors introduces a finite-sample bias in the results, which extends to the fixed effects approach. Since the independent variables are not uncorrelated with past, present, and future disruptions, fixed-effects estimators face a risk of being biased.

We also acknowledge a limitation in our scope of funds. The study does not include a broad range of different investment categories which constitutes a large part of the Swedish fund market such as blend funds, fixed income funds and alternative investment instruments. Our study therefore only covers one part of the market but could be substantially enlarged in further research in order to conclude the scalability of such funds. Additionally, since our limit of scope includes open-ended mutual funds, the vast majority of funds are actively managed. It is however possible that the sample include funds that may be constructed as indexers. This might be problematic since we are examining the potential impact of size, and more investors put their money in such funds, increasing their size for reasons outside our composed model.

There are plenty of studies to be conducted to further enhance the understanding of the field. A study of reasons for changes of mutual fund behaviour would deepen the understanding of actions to mitigate the negative effects caused by size. The adverse relationship could be further explained by examining the change in behaviour on an individual fund level. This could also clarify the liquidity constraint as block trading increases. Further studies with attempt to understand why outflow of larger funds is not occurring due to their lack of performance would further deepen the theory of Berk and Green (2002). We have chosen gross return in our regressions, but fees also have an impact when investors choose their investments in funds. This could be further analysed when trying to understand the mechanism and incentives of investors.

11. References

Ammann, M., & Moerth, P. (2005). Impact of fund size on hedge fund performance. *Journal of Asset Management, 6*(3), 219-238. Retrieved from https://search.proquest.com/docview/194495007?accountid=39039

Athanassakos, G. (2011). Do value investors add value? *Journal of Investing, 20*(2), 86-100.

Beckers, S., & Vaughan, G. (2001). Small is beautiful: An attempt to quantify the comparative disadvantage of large asset managers. *Journal of Portfolio Management, 27*(4), 9-17. doi:10.3905/jpm.2001.319808

Berk, J., & Green, R. (2004). Mutual fund flows and performance in rational markets. *Journal of Political Economy, 112*(6), 1269-1295. doi:10.1086/424739

Bodson, L., Cavenaile, L., & Sougné, D. (2011). Does size affect mutual fund performance? A general approach. *Journal of Asset Management, 12*(3), 163-171. doi:10.1057/jam.2011.30

Carhart, M. M., Carpenter, J. N., Lynch, A. W., & Musto, D. K. (2002). Mutual fund survivorship. *Review of Financial Studies, 15*(5), 1439. doi:10.1093/rfs/15.5.1439

Chen, J., Hong, H., Huang, M., & Kubik, J. D. (2004). Does fund size erode mutual fund performance? the role of liquidity and organization. *American Economic Review, 94*(5), 1276-1302. doi:10.1257/0002828043052277

Cremers, M., Petajisto, A., & Zitzewitz, E. (2013). Should benchmark indices have alpha? revisiting performance evaluation. *Critical Finance Review, 3*(1), 001-048.

Dahlquist, M., Engström, S., & Söderlind, P. (2000). Performance and characteristics of swedish mutual funds. *Journal of Financial & Quantitative Analysis, 35*(3), 409-423. doi:10.2307/2676211

Dougherty, C. (2011). *Introduction to econometrics* (Fourth ed.). the United States: Oxford University Press Inc.

Elton, E. J., Gruber, M. J., & Blake, C. R. (2001). A first look at the accuracy of the CRSP mutual fund database and a comparison of the CRSP and morningstar mutual fund databases. *The Journal of Finance, 56*(6), 2415-2430. Retrieved from http://www.jstor.org/stable/2697828

EVANS, R. B. (2010). Mutual fund incubation. *Journal of Finance, 65*(4), 1581-1611. doi:10.1111/j.1540-6261.2010.01579.x

Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. *Journal of Political Economy, 81*(3), 607. doi:10.1086/260061

Gaspar, J., Massa, M., & Matos, P. (2006). Favoritism in mutual fund families? evidence on strategic cross-fund subsidization. *The Journal of Finance, 61*(1), 73-104. Retrieved from http://www.jstor.org/stable/3699335

Helgesson, H., Hård, F., Nilsson, P., & Pettersson, F. (2009). *30 years of investment funds*. The Swedish Investment Fund Association: The Swedish Investment Fund Association.

Indro, D. C., Jiang, C. X., Hu, M. V., & Lee, W. Y. (1999). Mutual fund performance: Does fund size matter? *Financial Analysts Journal, 55*(3), 74-87. doi:10.2469/faj.v55.n3.2274

Markowitz, H. (1952). Portfolio selection. *The Journal of Finance, 7*(1), 77-91. doi:10.1111/j.1540-6261.1952.tb01525.x

Morningstar Research. (2016). *Fact sheet: The morningstar style Box^{TM}*. Retrieved 03/01, 2019, from http://www.morningstar.com/InvGlossary/morningstar_style_box.aspx

Morningstar Research. (2017). *The morningstar category average methodology.* Retrieved 03/11, 2019, from https://www.morningstar.com/content/dam/marketing/shared/research/methodology/823671_CategoryAverage.pdf?fbclid=IwAR0aX4t5lpX67m6Z7sEoLafuWyn6RvLszyVuvDickyr07GSXpRha1K-IWfk

Nordström, F. (2019). Retrieved 05/12, 2019, from https://www.fondbolagen.se/fakta_index/fondmarknadens-utveckling/

Otten, R., & Bams, D. (2002). European mutual fund performance. *European Financial Management, 8*(1), 75-101. doi:10.1111/1468-036X.00177

Pástor, Ľ., Stambaugh, R. F., & Taylor, L. A. (2015). Scale and skill in active management. *Journal of Financial Economics, 116*(1), 23-45. doi:10.1016/j.jfineco.2014.11.008

Perold, A. F., & Salomon Jr., R. S. (1991). The right amount of assets under management. *Financial Analysts Journal, 47*(3), 31-39. doi:10.2469/faj.v47.n3.31

Petersen, M. A. (2009). Estimating standard errors in finance panel data sets: Comparing approaches. *Review of Financial Studies, 22*(1), 435-480. doi:10.1093/rfs/hhn053

Phillips, B., Pukthuanthong, K., & Rau, P. R. (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

POLLET, J. M., & WILSON, M. (2008). How does size affect mutual fund behavior? *Journal of Finance, 63*(6), 2941-2969. doi:10.1111/j.1540-6261.2008.01417.x

Sensoy, B. A. (2009). Performance evaluation and self-designated benchmark indexes in the mutual fund industry. *Journal of Financial Economics, 92*(1), 25-39. doi:10.1016/j.jfineco.2008.02.011

Stein, J. (2002). Information production and capital allocation: Decentralized versus hierarchical firms. *Journal of Finance, 57*(5), 1891-1921. doi:10.1111/0022-1082.00483

Den svenska fondförmögenhetens fantastiska utveckling. (2019). Retrieved 03/05, 2019, from http://www.fondbolagen.se/sv/Aktuellt/Aktuellt/2019/Den-svenska-fondformogenhetens-fantastiska-utveckling/

Swedish Investment Fund Association. *Ordlista.* Retrieved 04/21, 2019, from https://www.fondbolagen.se/fakta_index/ordlista/#a

Wagner, W. H., & Edwards, M. (1993). Best execution. *Financial Analysts Journal, 49*(1), 65. Retrieved from https://search.proquest.com/docview/219231791?accountid=39039

XIONG, J., IDZOREK, T., CHEN, P., & IBBOTSON, R. (2009). Impact of size and flows on performance for funds of hedge funds. *Journal of Portfolio Management, 35*(2), 120-130. doi:10.3905/JPM.2009.35.2.118

Yan, X. (. (2008). Liquidity, investment style, and the relation between fund size and fund performance. *Journal of Financial & Quantitative Analysis, 43*(3), 741-767. doi:10.1017/S0022109000004270

YIN, C. (2016). The optimal size of hedge funds: Conflict between investors and fund managers. *Journal of Finance, 71*(4), 1857-1894. doi:10.1111/jofi.12413

Zhu, M. (2018). Informative fund size, managerial skill, and investor rationality. *Journal of Financial Economics, 130*(1), 114-134. doi:10.1016/j.jfineco.2018.06.002

Appendix

Appendix 1. List of Benchmarks and Categories

Benchmark Index	Morningstar Category	Investment Area
FTSE/JSE All Africa 40 TR EUR	EAA Fund Africa Equity	Africa
FTSE AW Asia Pacific TR USD	EAA Fund Asia-Pacific inc. Japan Equity	Asia Pacific
FTSE AW AP Ex JPN AUS NZL TR USD	EAA Fund Asia ex Japan Equity	Asia Pacific ex Japan ex Australia
FTSE AW Greater China TR USD	EAA Fund Greater China Equity	China (Greater)
FTSE Denmark TR EUR	EAA Fund Denmark Equity	Denmark
FTSE Gbl SmallCap Europe TR EUR	EAA Fund Europe Small-Cap Equity	Europe
FTSE RAFI Dv Europe Equity Income TR USD	EAA Fund Europe Equity Income	Europe
FTSE RAFI Europe TR EUR	EAA Fund Europe Large-Cap Value Equity	Europe
FTSE World Europe TR EUR	EAA Fund Europe Large-Cap Blend Equity	Europe
FTSE Nordic Small Cap TR EUR	EAA Fund Nordic Small/Mid-Cap Equity	Europe (North)
FTSE World Nordic TR EUR	EAA Fund Nordic Equity	Europe (North)
FTSE Emerging Europe TR USD	EAA Fund Emerging Europe Equity	Europe Emerging Mkts
FTSE Finland TR EUR	EAA Fund Finland Equity	Finland
FTSE All World TR USD	EAA Fund Global Large-Cap Blend Equity	Global
FTSE AW Consumer Services TR USD	EAA Fund Sector Equity Consumer Goods & Services	Global
FTSE AW Health Care TR USD	EAA Fund Sector Equity Healthcare	Global
FTSE AW High Dividend Yield TR USD	EAA Fund Global Equity Income	Global
FTSE AW Oil&Gas TR USD	EAA Fund Sector Equity Energy	Global
FTSE AW Tech TR USD	EAA Fund Sector Equity Technology	Global
FTSE EPRA Nareit Global TR USD	EAA Fund Property - Indirect Global	Global
FTSE Gbl SmallCap TR USD	EAA Fund Global Small-Cap Equity	Global
FTSE RAFI All-World 3000 TR USD	EAA Fund Global Large-Cap Value Equity	Global
FTSE World Mining TR USD	EAA Fund Sector Equity Natural Resources	Global
FTSE Emerging TR USD	EAA Fund Global Emerging Markets Equity	Global Emerging Mkts
FTSE India TR USD	EAA Fund India Equity	India
Benchmark	Category	Investment Area
FTSE Japan TR JPY	EAA Fund Japan Large-Cap Equity	Japan
FTSE AW Latin America TR USD	EAA Fund Latin America Equity	Latin America
FTSE Norway TR EUR	EAA Fund Norway Equity	Norway
FTSE Russia TR USD	EAA Fund Russia Equity	Russia & CIS
FTSE Sweden Small Cap TR EUR	EAA Fund Sweden Small/Mid-Cap Equity	Sweden
FTSE Sweden TR EUR	EAA Fund Sweden Equity	Sweden
FTSE Switzerland TR EUR	EAA Fund Switzerland Large-Cap Equity	Switzerland
FTSE Turkey TR USD	EAA Fund Turkey Equity	Turkey
Russell 1000 Growth TR USD	EAA Fund US Large-Cap Growth Equity	United States of America
Russell 1000 TR USD	EAA Fund US Large-Cap Blend Equity	United States of America
Russell 2000 TR USD	EAA Fund US Small-Cap Equity	United States of America
Russell Mid Cap TR USD	EAA Fund US Mid-Cap Equity	United States of America

Appendix 2. Matrix of Correlation – Independent Variables

Variables	(1)	(2)	(3)	(4)	(5)
(1) lnSIZE	1.000				
(2) lnAGE	0.286	1.000			
(3) ADJ_FLOW	-0.013	-0.035	1.000		
(4) lnFAMSIZE	0.553	0.330	-0.011	1.000	
(5) RET	0.002	0.011	0.031	0.001	1.000

Note: This table shows the correlation between all independent variables used for regressions. The sample period is 2014-2019. Funds with total net assets less than EUR15 million are excluded as well as the first 18 months of data for each sample fund. Assets under management for different share classes are aggregated into a single fund.

Appendix 3. Variance Inflation Factors

Variable	VIF	1/VIF
lnFAMSIZE	1.51	0.662461
lnSIZE	1.46	0.682668
lnAGE	1.14	0.875010
ADJ_FLOW	1.00	0.998784
RET_LAG	1.00	0.998784
Mean VIF	1.22	

Note: This table shows the variance inflation factor of the independent variables. The sample period is 2014-2019. Funds with total net assets less than EUR15 million are excluded as well as the first 18 months of data for each sample fund. Assets under management for different share classes are aggregated into a single fund.

Appendix 4. T-test – Portfolio Comparison: Adjusted Return

T-test	**Portfolio 1** n= 3 440		**Portfolio 4** n= 3 392		**Difference in Portfolios** n= 6 832		
	μ	σ	μ	σ	Diff.	P-value	T-value
Adjusted return (%)	0.05927	0.48915	0.00822	0.56666	0.05105***	0.0001	3.9838

Note: Difference in average adjusted return of Portfolio 1 compared to Portfolio 4. The sample period is 2014-2019. Funds with total net assets less than EUR15 million are excluded as well as the first 18 months of data for each sample fund. Assets under management for different share classes are aggregated into a single fund. The unit of observation is one month. Adjusted returns are in percent per month. We compare the performance of Portfolio 1 and 4 and report the associated t-statistics. The level of significance is illustrated as following: *** p<0.01, ** p<0.05, * p<0.1

Appendix 5. T-test – Portfolio Comparison: Sharpe Ratio

T-test	**Portfolio 1** n=3 440		**Portfolio 4** n=3 392		**Difference in Portfolios** n=6832		
	μ	σ	μ	σ	Diff.	P-value	T-value
Sharpe ratio	2.756058	5.198182	2.567449	5.132420	0.1886092	0.1313	1.5091

Note: Difference in Sharpe ratio of Portfolio 1 compared to Portfolio 4. The sample period is 2014-2019. Funds with total net assets less than EUR15 million are excluded as well as the first 18 months of data for each sample fund. Assets under management for different share classes are aggregated into a single fund. The unit of observation is one month. Sharpe ratio is calculated by annualising the monthly return. We compare the performance of Portfolio 1 and 4 and report the associated t-statistics. The level of significance is illustrated as following: *** p<0.01, ** p<0.05, * p<0.1