TALLINN UNIVERSITY OF TECHNOLOGY
School of Business and Governance
Department of Economics and Finance

Raol Kallas

EQUITY MUTUAL FUND PERFORMANCE EVALUATION: EVIDENCE FROM SCANDINAVIA

Master's Thesis

Supervisor: Triinu Tapver, MA

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I hereby declare that I have compiled the paper independently and all works, important standpoints and data by other authors has been properly referenced and the same paper has not been previously presented for grading.
The document length is 11430 words from the introduction to the end of conclusion.

Raol Kallas ……

(signature, date)

Student code: 153360TAAM

Student e-mail address: raol.kallas@gmail.com

Supervisor: Triinu Tapver, MA

The paper conforms to requirements in force

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ABSTRACT

Mutual fund management utilizes two main investment strategies: active management and passive management. The main incentive of the study is to find out whether the actively managed mutual funds outperform their market benchmarks in the time period of 2013 to 2017. The study examines the performance of Scandinavian-domiciled equity mutual funds in comparison with market benchmarks. Secondly, author aims to evaluate home equity bias among the funds. The empirical analysis is conducted by several academically acknowledged performance measurement tools and metrics. Moreover, author employs the single-factor CAPM, Fama-French (1992) Three-Factor Model and Carhart (1997) Four Factor Model.

The findings of the single-factor CAPM and performance evaluation metrics indicate that actively managed equity mutual funds demonstrate risk-adjusted excess returns which are superior to their respective benchmark returns. However, multi-factor regression models display alphas that are statistically insignificant, thus not confirming the stated conclusions. Furthermore, author assesses strong equity home bias among the examined funds, which proves to be a beneficial strategy.

Keywords: equity mutual fund performance, active management, passive management, CAPM, multi-factor model, home equity bias

INTRODUCTION

For decades mutual funds have been an attractive option for private and institutional investors for diversifying their portfolio. Mutual fund industry has experienced tremendous growth since the introduction of first mutual funds. According to Investment Company Institute, at the end of third quarter of 2018 worldwide regulated open-end equity fund assets covered 22.7 trillion US dollars, whereas 35% of assets are based in Europe (Investment Company Institute 2018).

Mutual funds can categorized by their management style. First of all, there are actively managed mutual funds that are operated by fund managers and educated analysts. These funds constitute nearly two thirds of the whole mutual fund industry (ICI 2018). On the other hand, some investors are leaned towards passively managed index funds. These funds are set to follow market indexes and require no active management, hence they tend to have low expense ratios and transaction charges. A considerable amount of academical papers have been published to demonstrate that on average passive investing leads to superior returns in comparison with actively managed funds. French (2008) examined the US Stock market over 1980 to 2006 and concluded that investors could have increased their average annual return by 0.67% over the period if they had switched to a passive market portfolio. There are still proponents for both management styles, thus the topic is continuously relevant and actual. In current thesis, these two approaches will be evaluated with empirical evidence from the Scandinavian financial markets.

The first hypothesis is based on the assumption that actively managed Scandinavian-domiciled equity mutual funds do not outperform the market index. This will be tested by comparing two groups of mutual funds to their respective market benchmarks. In that regard, two sample portfolio groups with different geographical focuses are combined: 1) Nordic-focused sample fund portfolio 2) Global-focused sample fund portfolio. The respective indexes are the MSCI Nordic Countries Index and the MSCI All Country World Index. However, the second hypothesis postulates that Scandinavian equity

mutual funds with local geographical focus will outperform funds that diversify their investments globally. Provided that the actively managed funds in the first group show relatively better risk-adjusted excess returns than funds from the second group, it is possible to evaluate the home bias within Scandinavian equity mutual funds.

The data for the analysis is acquired from the Thomson Reuters Eikon financial database. The data period for the empirical analysis ranges between January 2013 and December 2017. The five year analysis period was chosen in order to find balance between large enough sample size and sufficient enough time period. The longer the time period, the more discrepancies will appear in the monthly data set. This approach is in line with previous mutual fund performance evaluation studies for example Vestergren and Redin (2009) and Dahlquist, Engström, Söderlind (2000) who examined Swedish mutual funds.

The study is divided into three sections. The first section starts with literature review and theoretical framework. The second section introduces data collection process and methodology of the empirical analysis. Third section includes an overview and interpretation of the analysis results, followed by conclusion of the thesis. The empirical analysis is carried out using various methods for mutual fund performance evaluation. Firstly, academically acclaimed performance metrics and ratios will be calculated and interpreted. Secondly, single-factor Capital Asset Pricing Model and the multifactor Fama-French (1992) and Carhart (1997) regression models are applied.

Author wishes to thank all who supported the writing of the thesis in any form. Specifically, author's supervisor, family and employer.

1. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Given chapter will begin with theoretical conceptions of mutual funds and portfolio management, followed by relevant selection of portfolio performance measures. This will allow us to have an overview of recognized standpoints of financial literature and major previous researches that have been conducted in the field of mutual fund performance evaluation.

1.1 Mutual Funds and the Efficient Market Hypothesis

CFA glossary defines mutual fund as a professionally managed investment pool in which investors in the fund typically each have a proportionate allocation on the income and value of the fund. Mutual funds can be characterized as open-end investment funds, which are inclined to repurchase their shares upon investors demand and closed-end investment funds, which do not repurchase their shares as they usually trade on stock exchanges (Madura 1995, 650).

Mutual funds are particularly important in portfolios of small investors - who struggle to diversify their assets due to their limited capital – offering these investors a way to diversify. All investors share the gains and losses generated by the fund, which are valued by fund NAV. (Madura 1995, 627). The net asset value (NAV) of a fund indicates the market value and is calculated by subtracting total value of fund's liabilities from fund's total value of assets which is then divided by the total number of outstanding shares.

There are three ways mutual funds can generate returns to their investors. First option is to pass on earned income via dividend payments. Secondly, fund managers can sell securities and pass on capital gains via dividend payments, capital gains distributions or repurchasing additional shares.

Third method of return to shareholders is through share price appreciation provided by increase of NAV, thus investors benefit when they sell their shares. (Madura 1995, 630)

There are also several economic functions a fund provides. First of all, risk reduction through diversification function, as investor can achieve the benefits of diversification even at a relatively little investment. Consequently, this also leads to reduced costs of contracting and information processing. The advisory fees are lower due to the scale effect of a large fund which can successfully negotiate transaction costs, custodial fees and bookkeeping costs. (Fabozzi, Modigliani 2013)

The mutual funds that are analysed in current thesis invest exclusively in equities. Based on management type mutual funds can be categorized into two groups - active and passive. Over the next paragraphs theoretical background will be set for both active and passive equity mutual fund types, after providing an overview of the Efficient Market Hypothesis.

An important principle in financial economics that portfolio managers keep in mind when making their decisions is the Efficient Market Hypothesis (EMH). In 1970, Eugene Fama published his article "Efficient Capital Markets: A Review of Theory and Empirical work" where he states that at any given time stock prices already hold and reflect all relevant information thus making it impossible to beat the market. Also, this situation where all prices fully reflect all available information defines an efficient market. As the same information is available for all buyers and sellers, price fluctuations are unpredictable. (Fama, 1970)

Fama brings out three types of efficiency, which illustrate how the price of an asset may vary around its value. Firstly, the strongly efficient market is the case when all information, anything from public information to private, is reflected in the share prices. This indicates that investors do not have competitive advantage over market. However, semi-strong efficient market hypothesis proposes that share prices only reflect publicly available information – for example annual reports and company announcements – leading to more variance in asset prices. In weakly efficient markets asset prices vary the most, as all information is reflected in asset prices, maintaining that past performance is not relevant to future strategies. (Francis 1993)

Investors who choose between active and passive management take the degree of market effectiveness into account when making their decisions. Proponents of passive management tend to support the hypothesis of strong or semi-strong form efficiency, whereas active investors rather believe in weak form market efficiency. (Ibid.)

According to CFA glossary, active management is an approach to investing in which the investor seeks to outperform a given benchmark. Actively managed mutual funds aim to deliver superior returns than the market as a whole (Ross, Westerfield, Jaffe, Jordan 2016, 444).

There are several incentives that drive investors to actively managed mutual funds – one of those derives directly from the EMH**.** Basu (1977), Shiller (1981), Jacobs and Levy (1988) have all provided scientific evidence and argued that market inefficiencies produce opportunities for investors to gain profits from undervalued and overvalued assets. Asset pricing anomalies and predictable patterns can appear over time and even persist for a short period as a result of occasional mistakes by the collective judgement of investors (Malkiel, 2003).

Proponents of active management believe that it is possible to generate higher returns at the same risk level as passive position on the capital market line. It requires active changes in the portfolio weights over time. Consequently, it is necessary for the active manager to successfully forecast asset returns. Moreover, the expected return of portfolio p can be broken down into active and passive component, as follows:

$$E(R_{pt}) = \sum_{i=1}^{n} \mathrm{Cov}[\omega_{it}, R_{it}] + \sum_{i=1}^{n} E[\omega_{it}]E[R_{it}] \quad (1)$$

Where:

$\sum_{i=1}^{n} Cov[\omega_{it}, R_{it}]$ – active component, that is the sum of the covariances between portfolio weights and returns. This refers to the contribution of active changes in portfolio weights over time to the portfolio return.

$\sum_{i=1}^{n} E[\omega_{it}]E[R_{it}]$ – passive component, that is the sum of the products of expected portfolio weights and expected returns. (Lo, 2008)

The continuous belief in active portfolio management can be illustrated by the fact that at year-end 2017, 65% of total fund assets were active mutual funds (US-registered investment companies) (ICI

2018). It is clear that market inefficiencies exist and professional managers are in a position to exploit these anomalies. Managers are supposed to have the best education, finest access to information and low transaction costs in order to outperform the market, alas studies of mutual funds have proven the opposite. Namely, Jensen (1968), Malkiel (1995), Gruber (1996), Carhart (1997), and Fama and French (2008) all conclude that returns of active mutual funds have been lower than the returns of passive index funds, net of fees. Furthermore, an important study on this subject was carried out by Sharpe (1991) in his article "The Arithmetic of Active Management". Sharpe concluded that "properly measured, the average actively managed dollar must underperform the average passively managed dollar, net of costs." (Sharpe 1991, 8). These tendencies can be witnessed on Figure 1, that represents the portion of actively managed portfolios beating the market index from years 1986-2011.

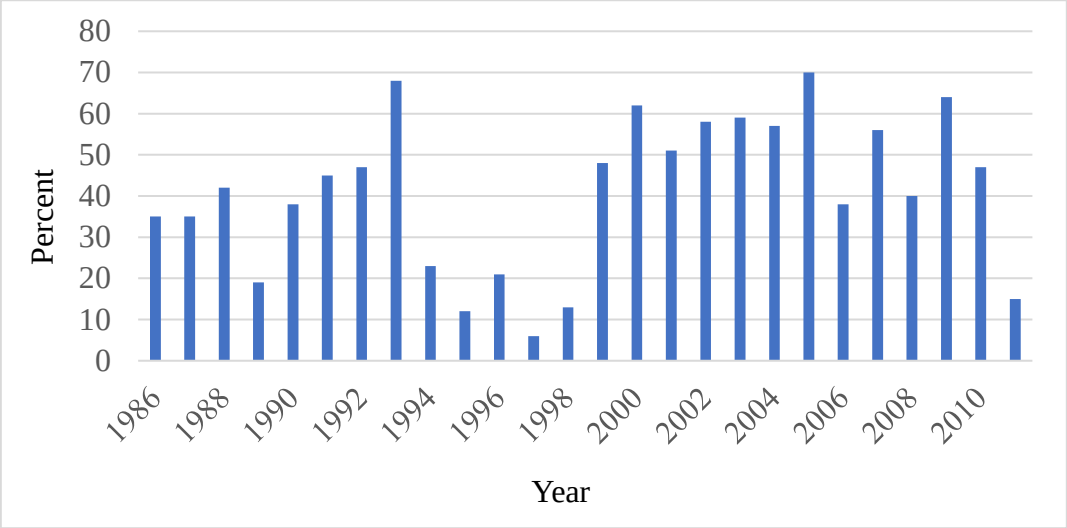

Figure 1. Percentage of Managed Equity Funds Beating the Vanguard 500 Index Fund, One-Year Returns
Source: Jordan, Miller, Dolvin (2014), author's chart

Figure 1 explicitly shows that in most years less than half of all active managers fail to outperform the market index.

Moreover, active management fees are remarkably high. Since fees are calculated as percentage of assets already owned by the investor, the incremental fees add up to 50% of incremental returns, because most managers fail to reach their chosen benchmarks. After costs, taxes and fees it is highly improbable to identify a portfolio manager in advance who will be capable of beating the market.

There will always be some managers, who beat the market, but there is no trustworthy method for determining them beforehand. (Ellis 2012)

Contrary to actively managed mutual funds, proponents of passive management have confidence in the principles of Efficient Market Hypothesis and that markets are strongly efficient, thus stating that investors cannot constantly beat the market. CFA glossary describes passive management as a "buy-and-hold approach to investing in which an investor does not make portfolio changes based upon short-term expectations of changing market or security performance." A passively managed fund or index fund can be defined as a mutual or exchange traded fund that tries to replicate the performance of certain stock market indexes (Ross *et.al.* 2016, 444). Since the introduction of first index mutual fund - the Vanguard 500 in 1976 - passive approach to portfolio management is becoming increasingly prevalent. At year-end 2017, US-registered index mutual funds and index ETFs accounted for 35% of the total mutual fund assets, reaching $6.7 trillion (ICI 2018).

1.4 Modern Portfolio Theory and the CAPM

The starting point of several financial theories, such as the Capital Asset Pricing Model and the Modern Portfolio Theory (MPT), was Harry Markowitz's 1952 article "Portfolio Selection". He introduced the idea that in order to maximize expected portfolio return, investors must take portfolio risk into account. Markowitz showed the difference between the risk of portfolio components taken individually and the overall risk of the portfolio, which came from the covariances of assets that combined the portfolio (Amenc, Le Sourd 2003). However, diversification is the cornerstone of the MPT. According to Markowitz, "efficient diversification of portfolios" is accomplished through mean-variance optimization. The riskiness of the portfolio can be reduced by investing into several assets – quantifying the benefits of diversification. Markowitz demonstrated that the risk is significantly lower when having several assets in portfolio. In other words, adding a risky asset to another brings down overall portfolio risk, as long as the assets do not have strong positive covariance. In contrast to simple diversification, the Markowitz portfolio selection is more scientific as it considers assets' correlation coefficients. In order to form an efficient portfolio, the Markowitz diversification involves combining assets that are less than perfectly positively correlated. (Francis 1993)

According to the MPT it is possible to construct the efficient frontier, demonstrated in figure 2:

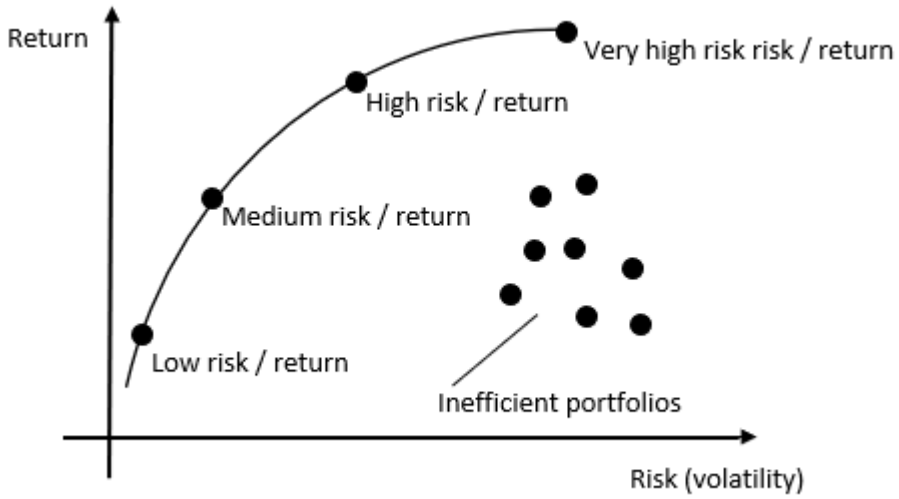

Figure 2. Efficient Frontier
Source: (Lhabitant 2007, 540), author's figure

The upward-sloping curve called the efficient frontier represents portfolios that maximize returns for the risk assumed. Portfolios below the curve are considered inefficient because it would be possible to find better risk/return combinations, i.e. greater return for the same risk or lower risk for the same return. No portfolios could be above the slope, as the frontier would shift correspondingly if they existed. Thus, the Markowitz Efficient Frontier demonstrates the trade-off between risk and return when combining assets in a portfolio. However, the slope also indicates that the relation between risk and return is not linear, meaning that adding more high-risk assets to a portfolio does not contribute equal amount of return. (Lhabitant, 2007, 540)

It is too simplistic and inaccurate to compare and rank equity mutual funds only by comparing their historical returns. In order to reach more truthful conclusions, one must take risk levels of different funds into account. Leaning onto the Markowitz modern portfolio theory, Jack Treynor (1961), William Sharpe (1964), John Lintner (1965) and Jan Mossin (1966) independently developed the capital asset pricing model, which seeks to explain the relationship between risk and return. The CAPM formula is as follows:

$$E(Rp) = Rf + \beta p[E(Rm) - Rf] \quad (1)$$

Where:

$E(Rp)$ - the expected return of portfolio p,

Rf - the risk-free rate of return,

βp - is the beta coefficient of portfolio p,

$E(Rm)$ - is the expected return of the market portfolio.

This theoretical result implies that the relationship between expected return of an investment and systematic risk or beta should be linear. The linear relation is also known as the Security Market Line. For the riskier asset (with higher beta), greater is the risk premium and higher is the expected rate of return. The beta factor will be reviewed in more detail in later sections.
The entire theory of portfolio selection and the CAPM could only be implemented when following assumptions are taken into account. Firstly, investors on the average are risk-averse and seek to minimize risk for a given amount of return. They are rational and measure risk as standard deviation of portfolio return – this allows that risk measures such as beta can be applied. Also, the time horizon for investment decision making is common – this makes comparisons meaningful. Thirdly, it is assumed that all investors anticipate similar results in terms of future security returns and risks – reason why they choose different portfolios is distinction in systematic risk and in risk preferences. The fourth point is that there are no transaction costs or taxes and borrowing and lending rates are same for all investors – these conditions allow to derive the model so no frictional barriers arise. (Fabozzi, Modigliani 2013, 144)

However, there are several shortcomings and limitations to the CAPM model. Firstly, the model makes assumptions that can be regarded as unrealistic and may give an inadequate representation of the behaviour of financial markets (Karp, van Vuuren, 2017). Assumption that investors can borrow and lend at a risk-free rate is unfeasible as individual investors are unable to borrow at the same rate as governments. Another drawback concerns the proclaimed positive linear relationship between the expected rate of return on an asset and its beta (Džaja, Aljinovic 2013). Results from later research has shown that this not always the case. CAPM tests on the Greek market by Michailidis, Tsopoglou, Papanastasiou, Mariola (2006) concluded that greater risk (beta) does not mean higher returns. Choudhary and Choudhary (2010) examined the CAPM for the Indian stock market. The findings of

their study did not substantiate the CAPM theory's basic result that beta is associated with higher levels of return – they concluded that beta is not sufficient to determine the expected returns on portfolios. In addition to this, Mullins (1982) has pointed out that the historical estimates of betas are unstable through time.

1.5 Methods and Measures for Portfolio Evaluation

Given section will provide a range of academically acknowledged methods of portfolio performance evaluation. The assessment of stock portfolios can be carried out by measuring their risk-adjusted returns. Beforehand portfolio risk must be measured. According to Modern Portfolio Theory, total investment portfolio risk can be divided into two types of risks: unsystematic and systematic risk. Unsystematic risk, what is also referred to as diversifiable risk, is associated with single individual stock whereas systematic risk is associated with the volatility of the whole financial market. (Fabozzi, Modigliani 2013, 135)

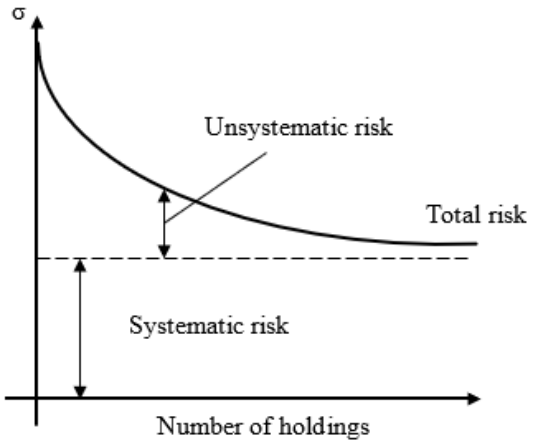

Figure 3. Systematic and unsystematic risk
Source: Fabozzi, Modigliani (2013, 136), author's figure

As demonstrated on figure 3, the part of risk that can not be diversified away needs to be taken into consideration and can be measured by standard deviation of portfolio return. Standard deviation along with variance are equivalent quantitative measures of total risk whereas standard deviation of the rates of return is the square root of variance of the rates of return (Francis 1993, 14). This is explained in formula (3):

$$VAR(r) = \sum_{i=1}^{T} P_i \, [r_i - E(r)]^2, \; \sigma = \sqrt{VAR(r)} \tag{3}$$

Where:

VAR(r) – variance of the rates of return

r – rate of return

Pi - probability

E(r) – expected rate of return

σ - standard deviation of rates of return. (Francis 1993, 14)

As mentioned before, a common tool for measuring risk is the beta, which captures the sensitivity of the portfolio's return to market return. As the beta value reflects total market risk or the systematic risk, it is most suitable provided that any unsystematic variability were diversified away. (Madura 1995, 283). The beta factor is a market sensitivity index that indicates how sensitive the asset's return is to changes in market return. Beta is calculated as follows:

$$\beta_p = \frac{\mathrm{cov}(R_p, R_m)}{var(R_m)} \tag{4}$$

Where:

β_p – beta of portfolio p

$\mathrm{cov}(R_p, R_m)$ – covariance between return of portfolio p and return of market

$var(R_m)$ – variance of the return of market in a period of time.

Higher beta reflects a higher covariance between asset's returns and market returns. This implies that investors require a higher return on asset that has higher beta. (Madura 1995, 260)

Having calculated the portfolio's risk, it is possible to determine risk-adjusted returns. One the most important risk-adjusted measures of fund performance is the Jensen alpha. This absolute measure of performance was developed by Michael Jensen (1968) and evaluates the performance of fund managers by describing the portion of the excess return on portfolio that is not explained by systematic risk. The Jensen alpha formula can be explained as follows:

$$R_{pt} - R_{ft} = \alpha_p + \beta_p \left(R_{mt} - R_{ft}\right) + e_{pt} \quad (2)$$

Where:

R_{pt} – return of portfolio p, at time t

R_{ft} – risk-free interest rate

α_p- excess return of portfolio p

β_p – beta of portfolio p

R_{mt} – market return at time t

e_{pt} – residual (Francis, Kim 2013, 446).

The Jensen alphas for two hypothetical portfolios are graphically shown on Figure 4.

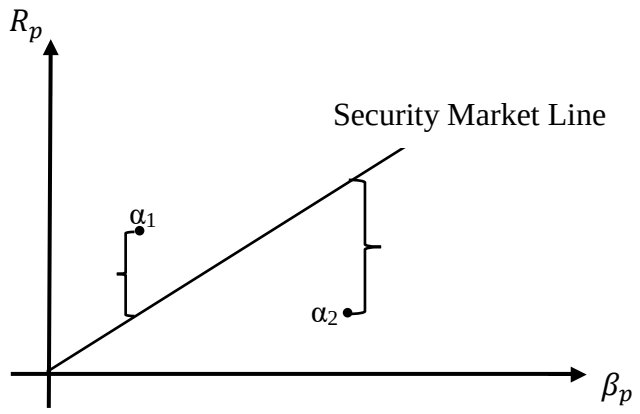

Figure 4. Jensen alphas for two portfolios.
Source: Francis, Kim (2013, 446), author's figure

Alphas measure the vertical distance between portfolio p's returns and the Security Market Line. Assets with positive alpha locate above the Security Market Line and are underpriced. Negative deviations from the SML can be interpreted as inferior performance and thus overpriced. All assets with alpha as zero are placed on the SML line and are fairly priced. (Francis, Kim 2013, 446)

There are notable benefits to using the Jensen alpha compared to other evaluation metrics. Firstly, the Jensen measure can be estimated from an asset pricing regression, which provides a measure of statistical significance. Moreover, the alphas are interpreted as percentage points, making it easier for

investors to interpret results, in contrast to other measures discussed below that quantify excess returns as a ratio. (Christensen, 2003)

Along with Jensen alpha, a number of widely used practices for measuring portfolio performance are introduced as follows. Namely, Sharpe ratio, Treynor ratio, Sortino ratio, Information ratio, the Modigliani-Modigliani measure and Omega ratio. The Sharpe ratio was developed by William F. Sharpe in 1966 in his article "Mutual Fund Performances". This tool helps to assign highest values to assets that have the best risk-adjusted average rate of return. (Francis 1993, 681). The formula for the equation:

$$S = \frac{R - R_f}{\sigma} \tag{5}$$

Where:
R – asset's average return
Rf – asset's average risk-free rate
σ – asset's standard deviation of rates of return (Sharpe, 1966)

Sharpe ratio indicates how fund's returns justify associated risk – higher ratios are considered more favourable (Ridley 2004, 119). It is a widely used metric for performance measurement in modern finance, although there are also shortcomings to the method. Kidd (2011) highlights the limitations of the ratio. Firstly, it is designed to be implemented in investment strategies that have normal expected return distributions and not for investments that are expected to have asymmetric returns. This is because it measures only variance as a proxy for risk. Secondly, the ratio can be manipulated by lengthening the measurement period as longer time periods tend to lead to lower volatility measures. (Kidd, 2011)

A modified version of the Sharpe ratio is Sortino ratio, which was proposed by Sortino and van der Meer (1991), and is computed as follows:

$$SR = \frac{R_p - R_f}{\sigma_{dp}} \quad (6)$$

Where:

R_p – return of fund p

R_f – return on the risk-free rate

σ_{dp}- downside deviation of the fund p return (Longo 2009, 205).

As the formula brings out, only negative returns contribute to the risk calculation. Some fund managers have the skill to produce strong returns in various market trends, thus showing strong Sortino ratios but only average Sharpe ratios. The Sharpe ratio penalizes funds that have shown solid upside volatility. (Longo 2009, 205) However, one can argue that upward volatility also reflects risk, thus Sharpe ratio may be more appropriate measure (Ridley 2004, 120).

Another common risk-adjusted measure is the Treynor index, developed by Jack Treynor (1965). This single-parameter investment performance index is measured by portfolios' beta coefficients and is defined by following equation:

$$\mathrm{T} = \frac{\mathrm{E}(r) - R_f}{\beta} \quad (7)$$

Where:

$E(r)$ – portfolio's average rate of return

R_f – riskless rate of interest

β – portfolio's beta coefficient (Francis 1993, 685).

In practice the ratio is most useful in cases where investors are choosing between several actively managed funds (Hübner 2007). As well as the Sharpe index, higher Treynor index refers to higher performance, alas both Treynor and Sharpe indexes are negative in case the average return of an asset is less than average risk-free rate. (Madura 1995, 284-285)

One more relevant volatility-adjusted measure is called the Information Ratio (initially "appraisal ratio"). It was introduced by Treynor and Black (1973) and has proven to be a valuable indicator: in his 1989 publication Grinold stated that "The information ratio is an important – perhaps the single most important – measure of investment performance. Investment managers will desire to have an

investment strategy with the highest possible information ratio." (Grinold, 1989, 31). By calculating this ratio, it is possible to determine how much value is added or reduced by the active portfolio manager. It is called Information Ratio because the portfolio manager has to determine whether to overweight or underweight certain assets according to his information, thus taking additional risk in anticipation of generating additional return. (Goodwin 1998) The formula is as follows:

$$IR = \frac{R_p - R_m}{\sigma_{ER}} \tag{8}$$

Where:

R_p – return of portfolio p

R_m – return of the benchmark

σ_{ER} – volatility of the excess return, that is the standard deviation of α (Treynor, Black 1973).

Modigliani and Modigliani (1997) proposed a different measure of risk-adjusted performance. In this case the measure reflects fund's performance in relation to the market. They believed that this measure will be easier for average investor to understand, because the measure is expressed in percentage terms. The equation is as follows:

$$MM = \frac{R_p - R_f}{\sigma_p}\sigma_m \tag{9}$$

Where:

R_p – return of fund p

R_f – return on the risk-free rate

σ_p- standard deviation of the fund p

σ_m- standard deviation of market excess return. (Simons, 1998)

The measure is equivalent to the return fund p would have achieved if it had the same risk as the market index (Simons, 1998). The Modigliani-Modigliani measure and Sharpe ratio lead to the same ranking of funds as it can be expressed as Sharpe ratio times the standard deviation of the market index (Le Sourd, 2007).

Keating and Shadwick (2002) introduced the Omega ratio, that provides a ranking of portfolios that is more consistent to investors' intuition (Longo 2009, 205). The ratio is calculated as follows:

$$\Omega(\mathrm{r}) = \frac{\int_r^b (1-F(x))dx}{\int_a^r F(x)dx} \tag{10}$$

Where:

a,b – interval of returns

F(x) – cumulative distribution of returns

r – minimum acceptable return that defines what is considered a gain or a loss.

The method considers the ratio of probability weighted gains versus losses relative to a threshold return level. This ratio takes the entire return distribution in account and is particularly valuable when the returns are not normally distributed. (Keating, Shadwick 2002)

1.5.1 Multifactor CAPM-s

Although the CAPM is a scientifically significant and well-acknowledged single risk factor model, there are several shortcomings. It is based on the premise that the only risk relevant to investors is systematic risk as measured by beta, thus not being a good model in practice (Madura 1995, 261). Ross (1976) introduced an alternative pricing model - the arbitrage pricing theory (APT). The APT differs from the CAPM in that it includes factors such as economic growth, inflation, commodities prices, market indices and exchange rates. This is particularly beneficial as it allows for aspects other than the market to influence the expected return of assets. (Madura 1995, 262). Researchers Fama and French (1992) based their Three-Factor Model on the APT by adding two additional factors to the beta factor. The formula for the Fama-French Three-Factor Model is as follows:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1\left(R_{mt} - R_{ft}\right) + \beta_2 SMB_t + \beta_3 HML_t + \epsilon_{it} \tag{10}$$

Where:

R_{it} – return of portfolio i in period t

R_{ft} – risk-free rate

α_{it} – portfolio i alpha

$R_{mt} - R_{ft}$ – excess market return

SMB_t – small minus big - historic excess returns of small-cap companies over large-cap companies
HML_t – high minus low – historic excess returns of value stocks over growth stocks
$\beta_{1,2,3}$ – factor coefficients. (Fama, French 1992)

The three-factor model explains how the expected excess return of a portfolio is affected by the sensitivity of its return to the three factors as described in formula 10. Firstly, there is the market factor (excess market return), that is also included in the CAPM. Secondly, the size factor (SMB) is based on company market capitalization. It is the difference between the return on small stock portfolios compared to large-capitalization portfolios. The Small Minus Big factor indicates the extra return that investors have historically received from stocks of companies with relatively small market capitalization. It is implied that small companies are more receptive to risk factors due to their undiversified nature and reduced ability to absorb negative financial events. Thirdly, the value factor (HML) is the difference between high book to market stock portfolios and low book to market stock portfolios. (Allen, 2009) The value factor was further examined by Fama and French (1998) – they demonstrated that value stocks performed better than growth stocks in twelve major markets around the world during the 1975-1995 period. On the whole, supported by the results from the 1998 study - it had become clear that the Fama-French Three-Factor Model performed better in explaining portfolio returns in comparison to a single-factor CAPM.

Furthermore, Fama and French (2015) decided to add two additional factors to their 3-factor model, namely profitability (stocks of firms with high operating profitability perform better) and investment patterns (stocks of firms with high total asset growth have below average returns). Subsequently Chiah, Chai, Zhong, and Li (2016) demonstrated that the five-factor model outperforms a selection of other multi-factor models in explaining the variation in asset return across international equity markets. In contrary, Kubota and Takehara (2018) found that the model underperforms in explaining the variation in portfolio returns. Correspondingly, Racicot and Rentz (2016) investigated the five-factor model and the Fama-French six-factor model that includes liquidity factor. They concluded that the only consistently significant factor is the market factor.

As an extension to the Three-Factor Model, Carhart (1997) proposed the Carhart four-factor model by adding an additional factor called the momentum factor. The equation is as follows:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 MOM_t + \epsilon_{it} \quad (11)$$

Where MOM_t is the one-year momentum factor, that was first demonstrated in 1993 by Jegadeesh and Titman. The momentum factor is difference between monthly returns between portfolios with high returns and portfolios with low returns (Ross, *et.al.* 2016, 431). Thus, the factor is also referred to as WML (winners minus losers).

Carhart (1997) indicates that the 4-factor model can be interpreted as a performance attribution model with four basic strategies including the high versus low beta stocks, small versus big market capitalization stocks, value versus growth stocks and one-year return momentum versus contrarian stocks. After employing the model, all these strategies are allocated with respective proportions of mean return. (Carhart, 1997)

1.6 Home Equity Bias

This subchapter will explain the curious puzzle that has been under investigation in many financial studies over past 30 years, namely the home equity bias. It occurs when a large portion of a portfolio is invested in domestic assets in contrast to optimal international portfolio. It overlooks the Modern Portfolio Theory that suggests diversifying in foreign equities and ignores the benefits of lowering systematic risk as foreign investments are less influenced by domestic market fluctuations. However, the phenomenon is pervasive across the world. The subject was first identified by French and Poterba (1991), who showed that investors in each nation expect returns in their home equity market to be higher than returns in other markets. They concluded that the lack of diversification appeared to be the result of investor choices instead of institutional constraints. Later on, Chan, Covrig, and Ng (2005) reported the existence of home bias in 26 developed and developing countries in their study based on worldwide equity fund data from 1999 to 2000. Strong home bias has also been observed in Scandinavian markets. For example, Grinblatt and Keloharju (2001) show the home bias in the investment decisions of both individual and institutional investors in Finland. A recent study carried out by Scholz and Maier (2018) investigated European equity mutual funds that were all European-focused. This was a monthly return based approach revealing that four of fifteen fund portfolios exhibit a significant home bias whereas the Danish domicile portfolio being the only one showing

negative home bias. There is also strong home bias in Swedish markets but this has been a profitable strategy as the value of Swedish markets has increased by a larger margin than the Global markets (Hilmersson, Malmgren 2018).

It is difficult to create a theoretical model to appropriately describe portfolio choice, because the home bias phenomenon can be explained as a mixture of institutional-based and behavioural-based reasons. The institutional-based explanations include hedging options against domestic risks, trading expenses and border controls, information irregularities and macro-and micro level governance. Behavioural explanations focus on investor-related characteristics such as familiarity, patriotism and overconfidence. (Sercu, Van Pee 2007)

1.7 Previous Empirical Research and Methodology

The objective of this subchapter and specifically Table 1 is to share examples of methodologies and results of previous research in the subject. Substantial amount of studies have been carried out in the field of mutual fund performance evalution. In that regard, the following studies involve mostly Scandinavian mutual funds which is in compliance with current thesis. Articles mentioned in Table 1 have offered support in choosing methodologies, statistical measures and setting empirical framework to evaluate equity mutual funds. In particular, the study conducted by Dahlquist, Engström, Söderlind (2000) demonstrated that five-year time period can be sufficient to conduct a panel data regression analysis. Furthermore, Johansson, Jacobsson (2012) set a methodogical example which inspired the author in compiling the analysis sample.

Table 1. Overview of Selected Empirical Research

Authors	Objective	Data and Methodology	Variables	Results
Johansson, Jacobsson (2012)	Examine whether there is a positive effect, a negative effect or any effect at all on the following attributes as a fund grows larger: management fees, performance and persistence in performance.	91 Swedish mutual funds during a six year period (2006-2011). Results based on regressions and significance tests	Size, performance, persistence in performance, management fees	Past performance is not a good measure for predicting future returns regardless of the size of the funds
Dahlquist, Engström, Söderlind (2000)	Study relation between fund performance and fund attributes in the Swedish market	Panel data regressions on Swedish mutual funds from the end of 1992 to the end of 1997. Weighted Least Squares approach to measure alphas	Fund size, administration fee, Load/exit fee, Turnover commission, flow	Well-performing funds were found among small equity funds, low fee funds, high trading activity funds and in some cases, funds with good past performance

Hilmersson, Malmgren (2018)	Determine correlation between specific market conditions and the home bias spread of the Swedish and Global stock market indexes	Data from the index MSCI Sweden Net Return, MSCI World Net Return and the Volatility index S&P 500. Multiple linear regression analysis to assess correlation	Accumulated increase in MSCI Sweden Net Appreciation of the SEK/USD return, dummy variables explaining VIX, bull and bear market results showed close to no correlation between the market volatility and the home bias spread.	Results showed close to no correlation between the market volatility and the home bias spread.
Scholz, Maier (2018)	Identify home bias of European equity funds of 15 European countries	European market, size, value and momentum factors and country market indices for European countries obtained from MSCI for the period January 1999 to December 2014. Augmented Carhart (1997) four-factor model is used to analyze home bias of equity funds	The mean returns of the European market, size, value and momentum factor	Portfolios of four domicile show significant home bias. Home bias of individual funds is not related to superior performance, but actually results in higher investment risk consistent with underdiversification

Source: author's table based on studies referred in column 1

2. DATA AND METHODOLOGY

Empirical analysis and results on Scandinavian equity mutual funds will constitute the second and third part of present study, respectively. The primary goal of the study is to evaluate the performance of Scandinavian mutual equity funds in comparison with market indexes. By generating two samples of funds with different geographical focus, the author also aims to identify and assess the existence of home equity bias among the funds. As follows, an overview of the data collection and validation process will be provided. Furthermore, the methodology section will explain and justify the models used for the analysis. Finally, the descriptive statistics chapter provides insightful information about the groups of mutual fund data.

2.1 Mutual Fund Data

Information required for the empirical analysis was gathered from Thomson Reuters Eikon financial database using the fund screener application. The data was pulled from the Eikon database and afterwards filtered and validated in Microsoft Excel spreadsheet. Two datasets were generated to test the hypotheses.

The following monthly data was obtained from the Eikon database for each fund in period December 2012 to December 2017:

- Fund Net Asset Value
- Fund Total Expense Ratio
- Fund Asset Universe
- Asset Status
- Geographical Focus
- Asset type
- Domicile

The first collection of data consists of equity mutual funds with geographical investment focus on Nordic markets. Initially the total number of equity funds with domicile in Finland, Sweden, Norway or Denmark was 1789. After filtering out liquidated and merged funds, it came down to 1049. Nearly 30% of all the operating Scandinavian equity funds had Scandinavian geographical focus. Based on the high percentage, author argues that this is a clear case of home equity bias. Since only actively managed funds were to be included in data group, all passive funds had to be excluded. Eikon database does not have a filter for categorizing funds between passive and active management type. Therefore, the excluding process was carried out manually using information from the Eikon Total Expense Ratio filter and fund name filter. Funds that included the words "Index" or "Indeks" in their names were excluded. Also, funds with very low Total Expense Ratio were double checked using public databases, e.g. Morningstar, Bloomberg, fund homepage. In addition to that, funds that had gaps in historical NAV data were excluded in order to contribute to more accurate analysis. The total number of analysed funds in the first dataset is 227. The total list of funds examined in the empirical analysis is included in appendices of current study. The following Table 2 describes the setup process of Nordic-focused portfolio group.

Table 2. Overview of the first dataset

Domicile	Total number of operating Scandinavian equity funds	Total number of operating funds with Scandinavian geographical focus	Total number of funds included in analysis after data validation process
Finland	240	56	36
Sweden	362	147	102
Norway	175	70	57
Denmark	272	39	32

Source: author's calculations, data from Thomson Reuters Eikon database

An overview of data validation results is displayed in Table 1 and 2. In order to reach an outcome that is correctly interpretable, one has to select an appropriate benchmarks for both sample portfolios. The benchmark market index for the first group is MSCI Nordic Countries Index fund. The second data group was compiled of Nordic-based funds that invest globally. There are 220 funds in the second dataset after filtering out merged and liquidated funds and funds with inconsistent NAV data. The benchmark for the globally invested data group is MSCI All-Country World Equity Index.

Table 3. Overview of the second dataset

Domicile	Total number of operating equity funds with global investment focus	Total number of funds included in analysis after data validation process
Finland	52	34
Sweden	109	69
Norway	76	45
Denmark	112	72

Source: author's calculations, data from Thomson Reuters Eikon database

Tables 2 and 3 reflect the relatively high number of funds left out of the analysis. 214 funds altogether with both datasets had issues were either passively managed funds or funds with discrepancies in NAV monthly data. As a number of funds were excluded from the samples, there is exposure to survivorship bias to some extent. This aspect must be taken into account when interpreting the analysis results. Once the filtering process was complete, funds' monthly NAV-s must be extracted. The fund NAV data must be continuous and without gaps from December 2012 until December 2017, that is 61 observations allowing to calculate monthly returns for 60 months. The NAV monthly returns are visually demonstrated on figure 5 below. The returns are calculated using the logarithmic equation:

$$R_{i,t} = \ln(\frac{NAV_{i,t}}{NAV_{i,t-1}}) \quad (12)$$

Where:

$R_{i,t}$ – return on fund i at period t

$NAV_{i,t}$ – NAV of fund i, at period t

$NAV_{i,t-1}$ – NAV of fund i, at period t-1

2.2 Methodology

This subchapter will give details about the methods used for fund performance evaluation in the empirical analysis. The analysis started off with panel-data of monthly NAV-s of Scandinavian-domiciled mutual equity funds. The main goal of the study is to evaluate the performance of Scandinavian equity funds in comparison with respective benchmarks. For that purpose, two equally-weighted Scandinavian domiciled portfolios were combined. One portfolio has geographical investment focus in Nordic countries and is based on the 227 equity mutual funds. The other fund is global-focused and represents monthly average returns of 220 funds. Both portfolios contain 60 observations from period 2013-2017. To compare returns the portfolios with their respective indexes and with each other average monthly returns of both groups are calculated. This method is in line with previous studies – for example Johansson and Jacobsson (2012) who examined the performance of Swedish mutual funds and Chowdfury and Ying (2016) study on Norwegian stock market. It is necessary to select appropriate benchmark indexes in order to interpret the results as correctly as possible. The benchmark index funds included in the analysis were the MSCI All-Country World Equity Index for comparison with Global-focused portfolio and MSCI Nordic Countries Index Fund for assessing the Nordic-focused funds. The MSCI Nordic Countries Index Fund captures large and mid cap representation across Finland, Sweden, Norway and Denmark. The index covers about 85% of the free float-adjusted market capitalization in each country. The statistical analysis will be carried out using statistical software R and STATA and spreadsheet software Excel.

Most common risk-adjusted measures of fund performance evaluation are the Sharpe ratio (1966), Jensen's alpha (1968) and the Treynor index (1965). The theoretical background of the mentioned measures has been introduced in the first section of the thesis. These measures – as well as the Information

ratio and Sortino ratio - are implemented in the analysis. In other words, the first part of the research is based on the single-factor CAPM developed by Sharpe (1964), where the fund alphas are calculated as follows:

$$\alpha_p = Rp - (Rf + \beta_p (R_m - R_f)) \quad (12)$$

Where:

Rp – Expected return of portfolio p

Rf – Risk free rate

β_p – Beta of portfolio p

R_m- Market return. (Sharpe 1964)

In the second part of the research author employs multi-factor models that expand on the CAPM, namely the Fama-French Three Factor Model (1992), Carhart Four Factor Model (1997). As pointed out in the first part of the study, several studies have concluded contradictory results regarding the Fama-French Five Factor and Six Factor Models. In that light author decided to continue with models that are acknowledged both by academics and practitioners – the F-F Three Factor Model and Carhart Four Factor Model. Thus, the multi-factor performance measurement research applies the following equations:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \epsilon_{it} \quad (13)$$

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 MOM_t + \epsilon_{it} \quad (14)$$

Where:

R_{it} – return of portfolio i in period t

R_{ft} – risk-free rate

α_{it} – portfolio i alpha

$R_{mt} - R_{ft}$ – excess market return

SMB_t – small minus big - historic excess returns of small-cap companies over large-cap companies at time t

HML_t – high minus low – historic excess returns of value stocks over growth stocks at time t

MOM_t - one-year momentum factor at time t

$\beta_{1,2,3}$ – factor coefficients

Equations 13 and 14 describe the Fama-French Three Factor Model and Carhart Four Factor Model. These estimations are calculated using the ordinary least squares (OLS) regression. Conclusions on the performance of funds are based on regression alpha estimates as the alphas measure over- or underperformance of the portfolio. The estimates on factor loadings SMB, HML, MOM characterize various risks regarding the mentioned factors. The theoretical framework of the implemented multi-factor models is explained in the first part of the thesis. In order to get a better overview of the factor portfolios, the origins and characteristics of the factors will be explained in more detail as follows.

Kenneth R. French data library is source of all the factor proxies required for both models – market factor, SMB, HML, MOM. The database contains current benchmark returns and historical benchmark returns data from year 1990 to present. Two market factors, that include dividends and capital gains, are implemented because there are two sample portfolios with different geographical focus. The Nordic-focused portfolio includes European market factor, whereas global-focused portfolio requires global market return factor. Moreover, the market factor takes only the excess returns into consideration by subtracting risk-free rate (US one-month Treasury bill rate).
Secondly, the SMB factor aims to capture risk associated with company size and is calculated as follows:

$$SMB = \frac{1}{3}(Small\ Value\ +\ Small\ Neutral\ +\ Small\ Growth) - \frac{1}{3}(Big\ Value\ +\ Big\ Neutral\ +\ Big\ Growth) \quad (15)$$

Equation 15 shows the equal-weight average of the returns on the three small stock portfolios for the region minus the average of the returns on the three big stock portfolios. For constructing the SMB and HML factor, stocks are regionally sorted into three book-to-market equity groups and two market cap groups. Furthermore, stocks are categorized by growth (low book-to-market), neutral and value (high book-to-market). Finally, the SMB factor is calculated as shown in equation 15. Thirdly, the HML factor is designed to capture the risk and return associated with company value. It is the equal-weight average of the returns for the two high B/M portfolios for a region minus the average of the returns for the two low B/M portfolios:

$$HML = \frac{1}{2}(Small\ Value\ +\ Big\ Value) - \frac{1}{2}(Small\ Growth\ +\ Big\ Growth) \quad (16)$$

In order to evaluate the risk and return associated with momentum factor, the fourth factor is added to form the Carhart (1997) four-factor model. The momentum factor is based on the assumption that investors can gain from buying stocks that have shown positive returns in the past year and selling stocks that are trailing behind. It is calculated as the equal-weight average of the returns for the two loser portfolios subtracted by the returns for the two winner portfolios:

$$MOM = 1/2\ (Small\ High + Big\ High) - 1/2\ (Small\ Low + Big\ Low) \quad (17)$$

The last step before starting to interpret the outcomes of statistical models is to check whether the findings can be considered reliable and valid. Several robustness checks are carried out to determine any problems or issues that may arise with the data series. It is common academic practice to test the statistical models for autocorrelation, heteroscedasticity and multicollinearity. In this study, the Durbin-Watson (1950, 1951, 1971) and Breusch-Godfrey (1978) test are applied to detect possible autocorrelation in the residuals. Secondly, problems with heteroscedasticity are checked with White's (1980) test. In addition, the applied independent variables are tested for correlation in correlation matrixes. Also, the variance inflation factors of the explaining variables are calculated to measure multicollinearity. The test results are demonstrated in the appendices of the study.

2.3 Descriptive Statistics

The objective of the chapter is to summarize the most important outcomes of the descriptive statistics section of the study. Mean returns, standard deviations, minimum and maximum returns, variance, skewness and kurtosis in tables 4, 5, 6 and 7 are calculated based on the equally weighted sample fund portfolios.

Table 4. Summary statistics of the Nordic-focused portfolio and the respective benchmark

Variable	Mean return (annualized)	Std. Dev.	Min	Max	Variance	Skewness	Kurtosis
Nordic-focused sample portfolio	10.68	3.18	-7.11	7.26	10.13	-0.37	3.25
MSCI Nordic Countries Index	6.84	3.36	-8.30	8.81	11.27	-0.07	3.37

Source: author's calculations

Table 4 contains the output from statistical analysis performed on Nordic-focused portfolio and its benchmark – MSCI Nordic Countries Index. There were 60 observations from period between 2013-2017. The annualized mean return of Nordic-focused portfolio is 10.68% which outperforms the respective index with annualized mean return at 6.84%. Risk levels of the portfolios are basically equal as the standard deviations of monthly returns are above 3%.

Table 5 reports descriptive statistics of the Global-focused fund sample and its respective comparison index under analysis in this study. The figures are rather similar to Table 4, while the Scandinavian-domiciled portfolio shows higher annual mean return than the passive MSCI ACWI index.

Table 5. Summary monthly statistics of the Global-focused portfolio and the respective benchmark

Variable	Mean return (annualized)	Std. Dev.	Min	Max	Variance	Skewness	Kurtosis
Global-focus sample portfolio	9.12	2.92	-8.04	8.02	8.53	-0.59	4.12
MSCI All-Country World Index	8.28	2.85	-7.30	7.47	8.14	-0.25	3.56

Source: author's calculations

For comparative purposes the yearly fund return statistics are measured and described in Table 6 below. Nordic-focused portfolio consists of 227 funds and Global-focused portfolio includes 220 funds.

Table 6. Portfolio return statistics, 2013-2017

Nordic-focused sample portfolio							
Year	Monthly mean return	Std. Dev.	Min	Max	Variance	Skewness	Kurtosis
2013	1.74	1.22	-0.34	8.72	1.50	7.06	82.69
2014	0.51	0.60	-3.05	9.56	0.36	-1.19	9.70
2015	1.18	0.88	-1.06	8.53	0.79	0.15	2.69
2016	0.51	1.09	-3.37	9.58	1.18	-0.47	4.50
2017	0.41	0.48	-1.87	8.90	0.24	-1.96	9.84
Global-focused sample portfolio							
2013	1.34	0.65	-2.79	3.15	0.43	-1.34	9.98
2014	0.95	0.98	-5.10	2.71	0.96	-2.85	15.87
2015	0.69	0.69	-2.48	2.50	0.47	-1.70	8.81
2016	0.27	0.74	-2.79	3.37	0.55	-0.29	5.74
2017	0.47	0.62	-3.41	1.90	0.39	-1.41	9.58

Source: author's calculations

As Tables 4 and 6 demonstrate, the NAV returns from the Nordic-focused portfolio are significantly higher than the returns from its respective market index and slightly higher than returns from the Global-focused portfolio. This aspect is in line with the previous studies, for example Hilmersson, Malmgren (2018) that demonstrate the strong and profitable home bias within Swedish mutual funds.

The correlation matrix of the independent variables is presented in Table 7. The Global factors are used in the models that explain the returns from the Global-focused portfolio and MSCI ACWI. The European 4 factors are used in the Nordic-focused portfolio and MSCI Nordic models. The positive correlation in coefficients indicate an increasing relationship and negative values indicate a decreasing relationship between two variables. The matrix demonstrates that the strongest positive correlation in both Global factors and European factors is between the Market factor and the value premium (HML): 0.0747 and 0.3704 respectively. Moderate negative correlation is noticed between the Market factor and size factor in Global figures and between momentum premium and value premium in both factor groups.

Table 7. Correlation matrix of the independent variables

Global 4 factors					
Market factor	SMB	HML	MOM		VIF
1.000	-0.414	0.0747	-0.2159	Market factor	1.054
	1.0000	-0.0093	0.0611	SMB	1.006
		1.0000	-0.5869	HML	1.534
			1.000	MOM	1.604
European 4 factors					
Market factor	SMB	HML	MOM		VIF
1.000	-0.1888	0.3704	-0.3107	Market factor	1.241
	1.000	-0.0293	0.0664	SMB	1.040
		1.000	-0.4253	HML	1.326
			1.000	MOM	1.264

Source: author's calculations

In order to correctly interpret the dependent variables, one must check that independent variables are not too strongly correlated. This is measured by the Variance Inflation Factor (VIF). It is calculated as follows:

$$VIF_j = \frac{1}{(1 - R_j^2)} \tag{18}$$

Where:

R_j - multiple correlation coefficient between variable j and the other independent variables.

VIF values greater than 10 may indicate a collinearity problem, thus there are no multicollinearity issues within dataset. In the following chapter the results of the empirical analysis are discussed.

3. RESULTS

The third part of the study will demonstrate and explain the outputs from the empirical models and the statistical analysis of two sets of Scandinavian equity mutual funds and their respective benchmarks. Initially, an overview of outcomes, findings from several portfolio return evaluation tools and the single-factor CAPM will be provided. Afterwards, analysis will proceed to explain empirical results drawn from the Fama-French Three Factor Model and Carhart Four Factor Model. The study will be summed up in the last paragraph.

3.1 Performance Measuring Tools and the CAPM

Current chapter will provide an interpretation of the performance assessment tools used in the analysis. In Table 8 all the calculated ratios and results from the performance measuring tools for the whole period of 5 years are represented.

Table 8. Annualized performance metrics

Measure	Nordic-focused sample portfolio	Global-focused sample portfolio	MSCI ACWI	MSCI Nordic
Sharpe ratio	0.95	0.88	0.81	0.57
Sortino ratio	1.37	1.17	1.22	1.00
Information ratio	0.98	0.11	-	-
Treynor ratio	3.43	3.81	-	-
Modigliani and Modigliani measure	8.92%	11.24%	-	-

Source: author's calculations

The first performance measure tested in the portfolios was the Sharpe ratio - described by Kidd (2011) as the industry standard for measuring risk-adjusted return. In order to make the calculation the mean of monthly excess returns was divided by the standard deviation of the monthly excess returns. Afterwards, the results were annualized. With Sharpe ratio at 0.95, the Nordic-focused portfolio shows slightly better result than the Global-focused portfolio with Sharpe ratio at 0.88. This indicates that Global-focused funds have a lower return per unit of total risk than the Nordic-focused portfolio. However, it must be kept in mind that the Sharpe ratio is based on the mean-variance theory. It means that Sharpe ratio can be properly interpreted when the return distributions are symmetric (not skewed), allowing the risk factor, standard deviation to be adequately measured (Koekebakker, Zakamouline 2007). Whereas the Sharpe ratio uses total risk in the calculation, the Sortino ratio only operates with downside deviation. Moreover, the higher Sortino ratio – 1.37 vs 1.17 – of the Nordic-focused sample signifies, that the investment is earning more return per unit of the negative risk that it takes on. When assessing the sample portfolios against the respective benchmark indexes, both actively managed sample portfolios demonstrate higher Sharpe ratio. Thus, indicating that market indexes have lower return per unit of total risk than actively managed portfolios.

However, according to the results of the Treynor ratio, Global-focused portfolio outperforms the Nordic-focused portfolio. As discussed earlier, this measure considers the systematic risk created by market fluctuations. The Global-focused portfolio annualized Treynor ratio 3.81 indicates that the investment has better risk-adjusted return and ranks above the Nordic-focused portfolio with Treynor ratio of 3.43.

The Information Ratio uses the difference in returns between sample portfolio and its respective benchmark. Consequently, the Nordic-focused portfolio sample has significantly higher Information ratio demonstrating the remarkable capability to produce excess returns compared to the MSCI Nordic index. Oppositely, the Global-focused portfolio indicates low information ratio, it may be interpreted that the investment is not considered particularly good. This is also supported by Grinold and Kahn (2000), who argued that top-quartile active equity managers generally have information ratios of 0.50 or higher.

The last risk-adjusted measure tested within the samples was the Modigliani and Modigliani measure. The calculated results marked in Table 8 are in percentages. The five-year annual average of 11.24% for the Global-focused portfolio shows the return it would have achieved if the risk of the fund would have been the same as its representative benchmark MSCI ACWI. The corresponding measure for the Nordic-focused portfolio is lower, at 8.92%.

Table 9 represents outputs from the single-factor CAPM-s on two sample portfolios and also on two benchmark portfolios. Results below are outputs from simple OLS regression models for the sample period January 2013 to December 2017 with 60 observations each. The summaries of the regression series are demonstrated in the Appendices.

Table 9. Results from single factor models

Factor	Nordic-focused sample portfolio	Global-focused sample portfolio	MSCI ACWI	MSCI Nordic
Jensen alpha (annualized)	4.55*** (2.69)	3.41 (0.98)	-3.70*** (-5.35)	0.88 (0.22)
Beta (market)	0.89*** (21.41)	0.69*** (6.91)	1*** (51.37)	0.62*** (6.80)
Adjusted R^2	0.88	0.44	0.98	0.43

Source: author's calculations
Significance at 1% risk level is marked as ***, higher significance level than 10% is marked with no stars.

Following conclusions can be drawn from the Table 9. The Jensen alpha can be interpreted as the intercept of the regression line and beta as the slope. Alpha expresses the manager's ability to capture excess returns, while beta describes portfolio's sensitivity to broad market movements. Additionally, t-stats that describe the significance of the coefficients are in the brackets. The adjusted R^2 describes model's explanatory power or the goodness of fit. The Nordic-focused portfolio shows relatively good model fit, whereas Global-focused portfolio model indicates relatively low model fit. The alpha estimate for the Nordic-focused portfolio is statistically significant and outperforms both the Global-focused sample portfolio and MSCI Nordic benchmark. The negative MSCI ACWI alpha can partially be explained by the aspect that the Fama-French Market factor applied in the model was based on 23 developed markets whereas the MSCI ACWI represents 23 developed markets plus 24 emerging

markets. In addition, it must be noted that the alpha values for the Global-focused portfolio and MSCI Nordic are statistically insignificant. Moreover, the adjusted R^2 for Global sample portfolio is relatively low – 0.44. Therefore, the conclusions are not exhaustive. With regards to exposure to market fluctuations the beta results indicate that both sample portfolios tend to be less volatile than respective market indexes.

3.2 Multi-Factor Models

The empirical analysis continues with the multi-factor regression models. Initially the outputs from the Fama-French Three Factor Model are examined. Then the results from the Carhart Four Factor Model are discussed. There are 60 observations in each model and the time period is January 2013 to December 2017.

Before discussing the results from the multi-factor regression models, a number of robustness checks have to be conducted in order to ensure that all the prerequisites of the models are met. All robustness checks were performed with Gretl software and demonstrated in the Appendices section of the study. Firstly, the White's test is carried out to check for heteroskedasticity among the OLS models. Heteroscedasticity can be a problem because OLS regression assumes that all residuals are drawn from a sample that has a constant variance. To satisfy the regression assumptions, the residuals should be homoscedastic. P-values of the all the White's tests were above 0.05 which means that the null hypothesis is applied. Secondly, the normality in regression residuals were tested. Again, the null hypothesis stood with p-values above 0.05 in all the models confirming that errors are normally distributed. Thereafter, autocorrelation between the residuals was checked by the Durbin-Watson statistic and by the Breusch-Godfrey test. All Durbin-Watson values remain slightly under 2 indicating non-autocorrelation. Furthermore, the Breusch-Godfrey test for autocorrelation up to order 12 was performed which also confirmed no autocorrelation in residuals. Next, multicollinearity among independent variables was tested. Strong multicollinearity between two or more explaining variables may reduce the precision of the factor estimates. The variance inflation factors (VIF) for the variables demonstrated no multicollinearity – all values were less than 10. The VIF-s quantify how much the standard errors of the estimated coefficients are inflated in case of multicollinearity.

As follows, the results from Table 10 will be discussed. All alphas represent annual returns in percentages, the t-values are in the brackets. T-stats are denoted in the brackets following the estimates. The adjusted R^2 values show that they are in the range of 0.47-0.51 for three portfolios, suggesting that the model does not explain most of the time-series variations in stock returns.

Table 10. Fama-French Three Factor Model results

Factor	Nordic-focus Sample Portfolio	MSCI Nordic Countries Index	Global-focus Sample Portfolio	MSCI All-Country World Equity Index
Alpha (annualized)	5.04 (1.34)	2.83 (0.73)	0.63 (0.182)	-3.57*** (-5.65)
Market	0.66*** (7.24)	0.66*** (7.03)	0.70*** (7.23)	0.98*** (56.05)
SMB	-0.13 (-0.69)	-0.48** (-2.36)	-0.23 (-1.12)	-0.14*** (-3.70)
HML	-0.23 (-1.61)	-0.32** (-2.18)	-0.30* (-1.78)	-0.01 (-0.47)
Adjusted R^2	0.48	0.51	0.47	0.98
P-value	8.96e-9	2.37e-9	1.71e-9	2.2e-16

Source: author's calculation
Statistical significance at 1% risk level is marked as ***, 5% risk level is marked as ** and higher risk level than 10% has no marking.

In correspondence to the results obtained from the single-factor model for the total period - based on alphas - the actively managed Nordic-focused portfolio outperforms the passively managed MSCI Nordic index. Alpha estimate for the Nordic-focus portfolio is 5.04% compared to 2.83% for the MSCI Nordic index. The market factor loading 0.66 for the MSCI Nordic Countries Index model raises questions as it would normally be near 1. This discrepancy may be caused by the aspect that the Fama-French factors that were acquired from the Kenneth French Data Library and applied in the MSCI Nordic index regression models were European factors and not exclusively Nordic market factors.

However, the p-values of alphas in all the mentioned portfolios are higher than 0.1. This means the alpha values are statistically insignificant. The actively managed Global-focused portfolio alpha exceeds the alpha estimate for the passive World Index. The negative alpha of the MSCI ACWI may raise questions whether the dependent variables have been appropriately chosen. This may be

explained by the aspect that the Fama-French Factors used in the model were based on 23 developed markets whereas the MSCI ACWI represents 23 developed markets plus 24 emerging markets.
In terms of the market factor, both active portfolios show similar exposure to market volatility. Beta of 0.66 indicates that the movements of sample portfolios will theoretically be about 66% of the respective index's movements. Both market factor loadings are statistically significant at 1% risk level. All sample portfolios are negatively exposed to the size factor. Furthermore, the negative SMB coefficients indicate that the portfolios have a tilt towards large cap stocks. However, the SMB factor loadings for the created sample portfolios are statistically insignificant. The value factors are also negative indicating exposure towards growth (low book-to-market) stocks. Value premiums are statistically significant in the Global-focused portfolio but not in the Nordic-focused portfolio.

After testing the Three-Factor model and examining results, author then proceeds with the Carhart Four-Factor Model. The outputs and figures for the models are described in table 11 and discussed below. All the regression series are demonstrated in the Appendices section of the study.
The results from the previous robustness checks also ensure the reliability of the results from the four-factor models introduced in Table 11.

Table 11. Carhart Four Factor Model results

Factor	Nordic-focus Sample Portfolio	MSCI Nordic Countries Index	Global-focus Sample Portfolio	MSCI All-Country World Equity Index
Alpha (annualized)	3.81 (0.92)	0.92 (0.217)	0.38 (0.103)	-3.52*** (-5.25)
Market	0.67*** (7.24)	0.09*** (7.138)	0.70*** (7.051)	0.98*** (54.27)
SMB	-0.13 (-0.70)	-0.48** (-2.39)	-0.23 (-1.12)	-0.14 *** (-3.64)
HML	-0.19 (-1.24)	0.16 (-1.65)	-0.27 (-1.30)	-0.02 (-0.47)
MOM	0.11 (0.75)	0.17 (1.12)	0.03 (0.21)	-0.05 (-0.216)
Adjusted R^2	0.48	0.51	0.46	0.98
p-value	7.99e-9	6.62e-9	7.99e-8	2.2e-16

Source: author's calculation
Statistical significance at 1% risk level is marked as ***, 5% risk level is marked as ** and higher risk level than 10% has no marking.

The framework, setup and reporting procedures of the model outputs are similar to the Three-Factor model discussed previously. In order to test exposure to momentum strategies another variable was

added to the model. Namely the monthly momentum factor for the total period of January 2013 to December 2017, acquired from the Kenneth French data library. As expected, alpha estimates and all other factor coefficients were adjusted only by a small margin in the Carhart model compared to previous 3-factor models. Again, the strongly negative MSCI ACWI alpha value can be explained by the Fama-French factors that do not wholly represent the global index. The momentum factor shows slightly positive coefficients in three portfolios, while the all the values are statistically not significant. Positive loading suggests that the Nordic-focused and Global-focused portfolios tend to follow the momentum strategies rather than contrarian.

3.3 Discussion of Results

The empirical analysis of the study consisted of various methods for mutual fund performance measurement. At first, the monthly NAV returns of sample portfolios were evaluated by five academically acclaimed measurement tools. Based on the results of the tools, author argues that the actively managed portfolios tend to outperform respective market indexes. The well-known Sharpe ratio and its derivation the Sortino ratio both describe portfolio's risk-adjusted performance. These were highest for the Nordic-focused sample portfolio, consisting of 227 equally weighted Scandinavian-domiciled equity mutual funds that are geographically focused to Nordic countries. Furthermore, the Sharpe and Sortino ratios of the Global-focused sample portfolio were also higher than the ratios of its respective index MSCI ACWI. The Nordic-focused portfolio also showed superior results in the Information ratio measurement which supports the former implications.

The single-factor models were set up as the second method for portfolio performance evaluation. The statistically significant higher alpha value detected from the Nordic-focused sample portfolio model imply better active manager performance. Furthermore, the adjusted R^2 was at 88% suggesting the model explains changes in the dependent variable fairly well.

Finally, the results from the Fama French Three Factor model and Carhart Four Factor Model do not entirely support the outcomes from the CAPM-s and the performance measurement tools. As the alphas calculated in the multi-factor regressions did not reach statistical significance, author can not confirm that actively managed portfolios tend to produce better risk-adjusted returns than the

respective market indexes. In order to reach statistical significance, achieve better model fits and verify the conclusion, further studies with higher number of observations and more appropriate dependent variables may be needed.

During the initial data processing, author observed that 30% of all the operating equity mutual funds in Scandinavian countries in the inspected time period were investing exclusively into Nordic countries. This aspect arose the question whether such strong occurrence of home equity bias was justified. Based on the findings from the performance ratios and single-factor CAPM, author finds that the returns of actively managed funds with Nordic geographical focus exceed the returns of Global-focused mutual funds. Thus, one may argue that the home equity bias strategy has proven to be beneficial and is in line with previous studies in the subject (e.g. Hilmersson, Malmgren 2018).

CONCLUSION

The goal of the study was to evaluate the performance of Scandinavian-domiciled equity mutual funds and find out whether investing in actively managed funds is more beneficial than investing in funds that follow market indexes. Secondly, author aimed to determine the level of home equity bias among Scandinavian equity mutual funds and assess whether the strategy to invest in geographically proximate geographical regions is justified and rational.

The first section of the thesis introduced theoretical conceptions of mutual funds and portfolio management, followed by a selection of portfolio performance measures. Furthermore, author gave an overview of relevant financial literature and previous studies conducted in the topic. The second and third section demonstrated the data acquiring and processing methods, methodology of the empirical analysis and finally discussed results and interpretations of the analysis.

The research questions were answered by conducting an empirical analysis on mutual fund data acquired from the Thomson Reuters Eikon database. The chosen time period was five years ranging from January 2013 to December 2017. The examined dataset included monthly data for 447 Scandinavian-domiciled equity mutual funds. Author calculated and analysed a number of academically acknowledged performance measurement ratios – Sharpe and Sortino ratio, Information ratio, Treynor ratio, Modigliani and Modigliani measure. Afterwards, the portfolios and their respective market indexes were analysed in single-factor CAPM and the Fama-French (1992) Three-Factor Model and the Carhar (1997) Four-Factor Model. Kenneth French Data Library was used for acquiring the European and Global factors that included the Market factor, size factor (SMB), value factor (HML) and momentum factor (MOM).

In summary, the results from both performance ratios and single-factor models indicate that actively managed Scandinavian-domiciled equity mutual funds have demonstrated superior risk-adjusted

returns in comparison with respective market indexes. These findings support the conclusions from several authors, e.g. Basu (1977), Shiller (1981), Jacobs and Levy (1988), Malkiel (2003), who have all provided scientific evidence and argued that market inefficiencies produce opportunities for investors to gain profits from undervalued and overvalued assets. However, the multi-factor models displayed alphas that were not statistically significant. Therefore, author can not decisively confirm the superiority of the risk-adjusted returns of the actively managed Scandinavian equity mutual funds in comparison with their respective indexes.

The findings from the performance ratios and single-factor CAPM imply that actively managed funds with Nordic geographical focus exceed the returns of Global-focused mutual funds. Thus, the second research question regarding the home equity bias was answered when examining the analysis results. The home equity bias strategy has proven to be justified and even strongly beneficial. These conclusions are in line with previous researches, for example the Hilmersson and Malmgren (2018) study on Swedish mutual funds.

However, there are certain limitations and shortcomings to the analysis that include: 1) statistical insignificance of the actively managed sample portfolio alphas in multi-factor models 2) relatively low adjusted R^2-s for some of the regression models – meaning that the input variables do not explain the variation of the independent variable overly well, resulting in low model fit 3) the Fama-French factors for the MSCI Nordic index comparison were based on the whole European region and not the Nordic region exclusively 4) the Fama-French factors applied in the MSCI ACWI three and four factor modelling were based on 23 developed countries, whereas the MSCI ACWI represents 23 developed markets and 24 emerging markets. Studies conducted in the future may want to choose more appropriate factors and benchmarks when assessing actively managed portfolios. Thus, the adjusted R^2-s describing the model fit may improve when adding more relevant factors to the model. Furthermore, the explanatory variables of the models may reach more accurate levels and higher statistical significance when selection a longer time period and applying more observations to the models.

KOKKUVÕTE

Järgnevalt kirjeldab autor lühidalt magistritöö ülesehitust ja tulemusi eesti keeles.

Investeerimisfondid on aastakümneid olnud atraktiivne varaklass, tõmmates ligi tohutul hulgal investoreid ja kapitali. Fonde saab juhtimisstiili poolest jagada kaheks: esiteks aktiivselt hallatud fondid ja teiseks passiivsed fondid ehk fondid, mis järgivad turuindekseid ja mille tootlus muutub vastavalt turuliikumistele.

Magistritöö eesmärk on teada saada, kas ja millisel määral on Skandinaavias asuvate fondide riskiga korrigeeritud tootlused aastatel 2013-2017 ületanud keskmist turutootlust. Teiseks on autori huvi leida, kas Skandinaavia fondide seas on esinenud koduturu kallutatust (*home equity bias*) ja kas see on olnud õigustatud.

Esimene hüpoteesi kontrollimiseks moodustas autor kaks andmekogumit. Fondide osaku puhasväärtused ja teised vajalikud andmed pärinevad Thomson Reuters Eikoni andmebaasist. Võrdlusbaasi loomiseks arvutati fondide kuised tootlused. Mitmefaktoriliste mudelite sisendandmed ehk sõltumatud muutujad pärinevad Kenneth Frenchi kodulehel asuvast andmebaasist. Esimene grupp koosneb 227. Põhjamaade-fookusega fondidest, millele vastavaks turuindeksiks valiti MSCI Nordic Countries Indeks. Teine andmegrupp koosneb 220. globaalse fookusega fondist, mille võrdlusindeksiks sai MSCI All Countries indeks. Teisisõnu, luuakse kaks portfelli, mis koosnevad 60. kuu agregeeritud fondide tootlustest. Töö empiirilises osas kasutatakse akadeemiliselt tunnustatud mõõdikuid ja suhtarve, millega saab hinnata portfellide tootlust ja võrrelda neid omavahel. Lisaks moodustatakse fondide Jenseni alfade ehk peamise fondi edukuse hindamise mõõdiku leidmiseks kapitalivarade hindamise mudelid (*CAPM*) ning lisaks Fama-Frenchi (1992) kolmefaktoriline mudel ning Carharti (1997) neljafaktoriline mudel. Teise hüpoteesi kontrollimiseks võrreldakse esimese ja teise portfelli riskiga korrigeeritud tootlusi.

Magistritöö koosneb kolmest peatükist. Esmalt antakse ülevaade teoreetilistest lähtepunktidest, investeerimisfondide olemusest, aktiivsest ja passiivsest juhtimisest, portfelliteooriast ja tähtsamate mõõdikute ja töös kasutatavate regressioonmudelite teoreetilisest taustast. Teises osas kirjeldatakse andmete kogumise protsessi, empiirilise osa metodoloogiat, sõltumatute muutujate valikut ja mudelite ülesehitust. Kolmandas osas kirjeldatakse tootlusmõõdikute, ühe-faktorilise ning mitmefaktoriliste regressioonmudelite tulemusi. Tulemustele tuginedes tehakse järeldused ja antakse vastused töös esitatud uurimisküsimustele.

Vastuseks esimesele hüpoteesile leidis autor, et aktiivselt juhitud fondide riskiga korrigeeritud tootlused on ajaperioodil 2013-2017 ületanud turutootlust. Need järeldused põhinevad tulemuslikkuse hindamiseks arvutatud suhtarvude analüüsil ja ühefaktorilise kapitalivarade hindamise mudelil (*CAPM*). Mitmefaktoriliste regressioonmudelite tulemusel leitud alfad olid statistiliselt mitteolulised, mis seega ei kinnita eeltoodud väidet.

Vastuseks teisele hüpoteesile leidis autor, et analüüsitavates fondides esines märgatavat koduturu kallutatust, mida olid varasemalt täheldanud ka näiteks Hilmersson ja Malmgren (2018). Lisaks väidab autor, et koduturule panustamise strateegia on Põhjala-fookusega riikide puhul ennast õigustanud, kuivõrd nimetatud fondide riskiga korrigeeritud tootlus ületab globaalse fookusega fondide riskiga korrigeeritud tootlust.

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APPENDICES

Appendix 1. List of funds in the Nordic-focused equally weighted portfolio

Domicile	Fund name
Finland	Nordea Nordic Small Cap Kasvu
Finland	OP-Arvo A
Finland	Nordea Pro Suomi I Kasvu
Finland	Nordea Pohjoismaat Kasvu
Finland	Danske Invest Suomi Yhteisoosake Kasvu
Finland	Aktia Capital B
Finland	Fondita Nordic Micro Cap B
Finland	SEB Finlandia B
Finland	Saastopankki Kotimaa B
Finland	Nordea Suomi Kasvu
Finland	Fondita Nordic Small Cap B
Finland	Evli Finnish Small Cap B
Finland	OP-Suomi Pienyhtiot A
Finland	Evli Finland Select B
Finland	Saastopankki Pienyhtio B
Finland	Danske Invest Suomi Osake Kasvu
Finland	Evli Nordic B
Finland	Danske Invest Suomi Osinko Plus K
Finland	Aktia Nordic Small Cap B
Finland	Alfred Berg Suomi Fokus B
Finland	Aktia Nordic B
Finland	Saastopankki Itameri B
Finland	FIM Fenno
Finland	Taaleri Arvo Markka Osake A Kasvu
Finland	Danske Invest Suomen Pienyhtiot K
Finland	LahiTapiola Suomi A
Finland	eQ Pohjoismaat Pienyhtio 2 K
Finland	Seligson & Co Phoebus A
Finland	SEB Finland Small Cap B
Finland	POP Suomi
Finland	Nordea Suomi Small Cap K
Finland	Fondita Equity Spice B
Finland	eQ Suomi 1 K
Finland	POP Pohjoismaat
Finland	WIP Hakkapeliitat A1
Finland	Evli Swedish Small Cap B
Denmark	Nordea Invest Danmark
Denmark	Danske Invest Danmark KL
Denmark	BankInvest Danske Aktier A
Denmark	Fundamental Invest Stock Pick
Denmark	Nykredit Invest Danske Aktier AKK
Denmark	I&T Aktier KL
Denmark	Danske Invest Danmark Akkumulerende KL
Denmark	Nordea Invest Danske Aktier Fokus
Denmark	Nykredit Invest Danske Fokusaktier
Denmark	SEBinvest Danske Aktier P
Denmark	Danske Invest Danmark Fokus KL
Denmark	BLS Invest Danske Aktier KL
Denmark	C WorldWide / Danmark KL
Denmark	LI Aktier Danmark
Denmark	Lan & Spar Invest Danske Aktier
Denmark	Handelsinvest Danmark
Denmark	Nykredit Invest Danske Aktier
Denmark	Sparinvest Danske Aktier KL
Denmark	BIL Danmark Danske Small Cap aktier
Denmark	Sydinvest Danmark A DKK
Denmark	Nordea Invest Nordic Small Cap
Denmark	Jyske Invest Danske Aktier KL
Denmark	Maj Invest Danske Aktier
Denmark	PFA Invest Danske Aktier
Denmark	Sydinvest SCANDI KL
Denmark	Alm. Brand Invest Nordiske Aktier
Denmark	SEBinvest Danske Aktier Akkumulerende P
Denmark	Absalon Invest Danske Aktier
Denmark	Nordea Invest Nordic Stars
Denmark	Handelsinvest Norden
Denmark	Jyske Invest Danish Equities CL
Denmark	SEBinvest Nordiske Aktier P
Sweden	Agenta Svenska Aktier
Sweden	Aktie-Ansvar Sverige A

Sweden	Aktiespararna Topp Sverige
Sweden	Alfred Berg Fastighetsfond Norden A
Sweden	Alfred Berg Sverige Plus A
Sweden	AMF Aktiefond Smabolag
Sweden	AMF Aktiefond Sverige
Sweden	Avanza Zero
Sweden	Carnegie Smabolagsfond
Sweden	Carnegie Sverige Select
Sweden	Carnegie Sverigefond
Sweden	Catella Smabolagsfond
Sweden	Catella Sverige Aktiv Hallbarhet
Sweden	Cicero Focus A
Sweden	Cliens Sverige A
Sweden	Cliens Sverige Fokus A
Sweden	Didner & Gerge Aktiefond
Sweden	Didner & Gerge Smabolag
Sweden	Enter Select
Sweden	Enter Select Pro
Sweden	Enter Sverige
Sweden	Enter Sverige Pro
Sweden	Ethos Aktiefond
Sweden	Folksam LO Sverige
Sweden	Folksam LO Vastfonden
Sweden	Granit Smabolag
Sweden	Gustavia Sverige
Sweden	Handelsbanken Norden Selektiv (A1 EUR)
Sweden	Handelsbanken Nordenfond (A1 SEK)
Sweden	Handelsbanken Nordiska Smabolagsfond (A1 SEK)
Sweden	Handelsbanken Svenska Smabolagsfond
Sweden	Handelsbanken Sverige Selektiv (A1)
Sweden	Handelsbanken Sverigefond
Sweden	Handelsbankens Bosparfonden Bostadsratterna
Sweden	Handelsbankens Finlandsfond (A1 EUR)
Sweden	Humle Kapitalforvaltningsfond
Sweden	Humle Smabolagsfond

Sweden	Indecap Guide Sverige A
Sweden	Inside Sweden
Sweden	Lancelot Avalon
Sweden	Lannebo Smabolag SEK
Sweden	Lannebo Sverige
Sweden	Lannebo Sverige Plus
Sweden	Lannebo Utdelningsfond
Sweden	Lansforsakringar Fastighetsfond A
Sweden	Lansforsakringar Smabolag Sverige A
Sweden	Lansforsakringar Sverige Aktiv A
Sweden	Nordea Alfa
Sweden	Nordea Inst Aktief Sverige icke-utd
Sweden	Nordea Olympiafond
Sweden	Nordea Smabolagsfond Sverige
Sweden	Nordea Swedish Stars icke-utd
Sweden	Nordic Equities Strategy
Sweden	Nordic Equities Sweden
Sweden	Nordiska Fonden
Sweden	Nordnet Superfonden Sverige
Sweden	Ohman Smabolagsfond A
Sweden	Ohman Sverige Smart Beta
Sweden	Ohman Sweden Micro Cap
Sweden	PriorNilsson Sverige Aktiv A-klass
Sweden	Quesada Sverige
Sweden	SEB Nordenfond
Sweden	SEB Stiftelsefond Sverige
Sweden	SEB Sverige Expanderad
Sweden	SEB Sverigefond
Sweden	SEB Sverigefond Smabolag
Sweden	SEB Sverigefond Smabolag Chans/Risk
Sweden	SEB Swedish Ethical Beta Fund
Sweden	SEB Swedish Value Fund
Sweden	SEB WWF Nordenfond
Sweden	Simplicity Norden
Sweden	Skandia Cancerfonden
Sweden	Skandia Ideer For Livet

Sweden	Skandia Norden
Sweden	Skandia Smabolag Sverige
Sweden	Skandia Sverige
Sweden	Skandia Varldsnaturfonden
Sweden	Spiltan Aktiefond Dalarna
Sweden	Spiltan Aktiefond Investmentbolag
Sweden	Spiltan Aktiefond Smaland
Sweden	Spiltan Aktiefond Stabil
Sweden	Spiltan Aktiefond Sverige
Sweden	SPP Aktiefond Sverige A
Sweden	Strategi Varlden
Sweden	Swedbank Robur Access Sverige
Sweden	Swedbank Robur Ethica Sverige
Sweden	Swedbank Robur Ethica Sverige Mega
Sweden	Swedbank Robur Exportfond
Sweden	Swedbank Robur Humanfond
Sweden	Swedbank Robur Nordenfond
Sweden	Swedbank Robur Ny Teknik
Sweden	Swedbank Robur Smabolagsfond Norden
Sweden	Swedbank Robur Smabolagsfond Sverige
Sweden	Swedbank Robur Sverigefond
Sweden	Swedbank Robur Sverigefond MEGA
Sweden	Swedbank Robur Sweden High Dividend
Sweden	XACT Bear
Sweden	XACT Bear 2
Sweden	XACT Bull
Sweden	XACT Bull 2
Sweden	XACT OMXS30
Sweden	XACT OMXSB Utdelande
Norway	DNB Norge (IV)
Norway	ODIN Norden C
Norway	Danske Invest Norske Aksjer Institusjon II
Norway	DNB Norge
Norway	ODIN Sverige C
Norway	Storebrand Norge I

Norway	KLP AksjeNorge
Norway	ODIN Norge C
Norway	Delphi Nordic
Norway	Nordea Norge Verdi
Norway	DNB Norden (III)
Norway	Danske Invest Norske Aksjer Institusjon I
Norway	Nordea Kapital
Norway	DNB Norge Selektiv (III)
Norway	Alfred Berg Gambak
Norway	Eika Spar
Norway	Nordea Avkastning
Norway	DNB Norden
Norway	Danske Invest Norge II
Norway	ODIN Finland C
Norway	Eika Norge
Norway	Eika Norden
Norway	Alfred Berg Aktiv

Norway	Holberg Norden
Norway	Holberg Norge
Norway	Alfred Berg Norge [Classic]
Norway	Landkreditt Utbytte
Norway	ODIN Eiendom C
Norway	Fondsfinans Norge
Norway	Delphi Norge
Norway	Storebrand Aksje Innland
Norway	Nordea Norge Pluss
Norway	Eika Egenkapitalbevis
Norway	FIRST Generator S
Norway	Storebrand Verdi A
Norway	C WorldWide Aksje Norge III
Norway	Pareto Investment Fund A
Norway	Danske Invest Norge Vekst
Norway	DNB Norge Selektiv (I)
Norway	DNB SMB

Norway	DNB Gront Norden
Norway	Danske Invest Norge I
Norway	Storebrand Vekst
Norway	C WorldWide Norge
Norway	Storebrand Optima Norge A
Norway	Storebrand Norge
Norway	Eika Alpha
Norway	FORTE Tronder
Norway	DNB Norge Selektiv (II)
Norway	FORTE Norge
Norway	PLUSS Markedsverdi
Norway	PLUSS Aksje
Norway	Alfred Berg Humanfond
Norway	DNB Norge (III)
Norway	Alfred Berg Nordic Best Selection
Norway	C WorldWide Norden
Norway	Verdipapirfondet Vibrand Norden

Appendix 2. List of funds in the Global-focused equally weighted portfolio

Domicile	Fund name
Finland	Nordea Maailma Osinko A Kasvu
Finland	Nordea Maailma Kasvu
Finland	Nordea Pro Stable Return Kasvu
Finland	PYN Elite A
Finland	Seligson & Co Global Top 25 Brands A
Finland	Evli Global B
Finland	Danske Invest Kestava Arvo Osake Kasvu
Finland	OP-Maailma A
Finland	Danske Invest Kompassi Osake Kasvu
Finland	LahiTapiola Hyvinvointi A

Finland	Seligson & Co Global Top 25 Pharmaceuticals A
Finland	OP-Ilmasto A
Finland	Danske Invest MediLife Kasvu
Finland	Fondita 2000+ B
Finland	LahiTapiola Kasvu A
Finland	Saastopankki Osake Maailma B
Finland	Danske Invest Global Tech Kasvu
Finland	LahiTapiola Kuluttaja A
Finland	Aktia Global B
Finland	FIM Maailma A K
Finland	FIM Varainhoito 100 A K

Finland	FIM Brands
Finland	LahiTapiola Osinko A
Finland	LahiTapiola Infra A
Finland	OP-Puhdas Vesi A
Finland	FIM Rohto
Finland	FIM Artificial Intelligence Fund A
Finland	eQ CO2 1 K
Finland	Seligson & Co Phoenix A
Finland	UB Real REIT
Finland	Alexandria Aggressive Manager
Finland	SEB Global Equity Multimanager B
Finland	Aurejarvi European Small & Mid Cap R

Finland	POP Maailma
Denmark	Nordea Invest Portefolje Aktier
Denmark	Danske Invest Engros Flexinvest Aktier KL
Denmark	Nordea Invest Engros Internationale Aktier
Denmark	Maj Invest Value Aktier
Denmark	Nordea Invest Stabile Aktier
Denmark	Nordea Invest Portefolje Aktier Strategi
Denmark	Sparinvest Value Aktier KL
Denmark	ValueInvest Global KL
Denmark	C WorldWide Globale Aktier Klasse A
Denmark	BLS Invest Globale Aktier KL
Denmark	Nordea Invest Globale UdbytteAktier
Denmark	Sparinvest INDEX Globale Aktier Min Risiko KL
Denmark	Multi Manager Invest Gl Aktier Akk Harding Loevner
Denmark	Danske Invest Global Indeks KL
Denmark	Jyske Invest Globale Aktier KL
Denmark	BankInvest Basis Globale Aktier A
Denmark	BankInvest Basis Globale Aktier Akk. A
Denmark	Nordea Invest Aktier
Denmark	Danske Invest Engros Aktier KL
Denmark	Nykredit Invest Engros Global Opportunities
Denmark	Jyske Invest Globale Aktier Special KL
Denmark	LI Aktier Globale
Denmark	BankInvest Hojt Udbytte Aktier A
Denmark	PFA Invest Globale Aktier
Denmark	Jyske Invest Global Equities CL
Denmark	Nykredit Invest Globale Aktier Basis
Denmark	Lan & Spar Invest Verden Selection
Denmark	Danske Invest Teknologi KL
Denmark	BankInvest Globalt Forbrug A
Denmark	Nordea Invest Aktier II
Denmark	ValueInvest Global Akk KL
Denmark	Jyske Invest Favorit Aktier KL

Denmark	Danske Invest Global Stockpicking KL
Denmark	Danske Invest Global StockPicking - Akk
Denmark	Nordea Invest Stabile Aktier Akkumulerende
Denmark	Alm. Brand Invest Globale Aktier
Denmark	Danske Invest Global StockPicking 2 KL
Denmark	Nordea Invest Ptf Inv.Inst Eksterne afdelinger
Denmark	Formuepleje Globale Aktier
Denmark	C WorldWide / Globale Aktier Etik- AK KL
Denmark	Stonehenge Globale Valueaktier KL
Denmark	Finansco Dynamisk Aktivaallokering
Denmark	StockRate Invest Globale Aktier Udloddende
Denmark	Nykredit Invest Globale Fokusaktier
Denmark	Nordea Invest Global Small Cap
Denmark	Nordea Invest Global Stars
Denmark	Nykredit Invest Globale Aktier SRI
Denmark	Nordea Invest Klima og Miljo
Denmark	Maj Invest Vaekstaktier
Denmark	Sparinvest Momentum Aktier KL
Denmark	Nykredit Invest Bredygtige Aktier
Denmark	Nordea Invest Eng Abs Return Eq II Etisk tilvalg
Denmark	Strategi Invest Aktier
Denmark	Independent Global
Denmark	Sparinvest Cumulus Value KL
Denmark	Handelsinvest Verden
Denmark	Sydinvest Verden Ligevaegt & Value KL
Denmark	Jyske Invest Aggressive Strategy
Denmark	Jyske Invest Favourite Equities CL
Denmark	Formuepleje Forbrugsaktier
Denmark	C WorldWide / Globale Aktier Stabil KL
Denmark	Lan & Spar Invest Europa Classics
Denmark	Maj Invest Global Sundhed
Denmark	Danske Invest Engros Global KL
Denmark	Danske Invest KlimaTrends KL

Denmark	Danske Invest Global Plus KL
Denmark	Independent Generations
Denmark	Nordea Invest Engros Absolute Return Eq
Denmark	Sparinvest Momentum Aktier Akk KL
Denmark	BankInvest Basis Globale Aktier Etik A
Denmark	Nielsen Global Value
Denmark	World Wide Invest
Sweden	Agenta Globala Aktier
Sweden	AMF Aktiefond Global
Sweden	AMF Aktiefond Mix
Sweden	AMF Aktiefond Varlden
Sweden	AP7 Aktiefond
Sweden	Didner & Gerge Global
Sweden	Folksam LO Varlden
Sweden	Fond i Fond Avanza 100
Sweden	GodFond Sverige & Varlden
Sweden	Handelsbanken Global Tema (A1 SEK)
Sweden	Handelsbanken Hallbar Energi (A1 SEK)
Sweden	Handelsbanken Lakemedelsfond (A1 SEK)
Sweden	Handelsbanken Multi Asset 100 (A1 SEK)
Sweden	HealthInvest Small & MicroCap Fund A
Sweden	HealthInvest Value Fund A
Sweden	Humle FondSelect
Sweden	ICA Banken Modig
Sweden	IKC Global Brand A
Sweden	IKC Opportunities A
Sweden	IKC Pension Variabel
Sweden	Indecap Fondguide Aktie A
Sweden	Indecap Guide Global A
Sweden	Inside Active Global
Sweden	KPA Etisk Aktiefond
Sweden	Lancelot Camelot A
Sweden	Lannebo Vision
Sweden	Lansforsakringar Global Hallbar A
Sweden	Lararfond 21-44 ar
Sweden	Naventi Offensiv

Sweden	Naventi Offensiv Flex
Sweden	Navigera Aktie 1
Sweden	Navigera Aktie 2
Sweden	Navigera Tillvaxt 1
Sweden	Nordea Inst Aktiefonden Stabil icke-utd
Sweden	Nordea Inst Aktiefonden Varlden icke-utd
Sweden	Nordea Stratega 100
Sweden	Ohman Global Growth
Sweden	Ohman Global Hallbar A
Sweden	Ohman Hjart-Lungfonden
Sweden	OPM Listed Private Equity
Sweden	ProxyPetroleum Energy
Sweden	SEB Aktiesparfond
Sweden	SEB Dynamisk Aktiefond
Sweden	SEB Fastighetsfond
Sweden	SEB Hallbarhetsfond Global
Sweden	SEB Lakemedelsfond
Sweden	SEB Stiftelsefond Balanserad
Sweden	SEB Stiftelsefond Utland
Sweden	SEB Teknologifond
Sweden	Skandia SMART Offensiv
Sweden	Skandia Time Global
Sweden	Skandia Varlden
Sweden	Solidar Aggressiv Plus
Sweden	Solidar Etisk Plus
Sweden	SPP Aktiefond Global A
Sweden	SPP Global Topp 100
Sweden	Swedbank Robur Aktiefond Pension
Sweden	Swedbank Robur Allemansfond Komplett
Sweden	Swedbank Robur Ethica Global
Sweden	Swedbank Robur Ethica Global Mega
Sweden	Swedbank Robur Globalfond MEGA
Sweden	Swedbank Robur IP Aktiefond
Sweden	Swedbank Robur Kapitalinvest
Sweden	Swedbank Robur Medica
Sweden	Swedbank Robur Ravarufond
Sweden	Swedbank Robur Realinvest
Sweden	Swedbank Robur Smabolagsfond Global
Sweden	Swedbank Robur Talenten Aktiefond Mega
Sweden	Swedbank Robur Technology
Norway	DNB Global (IV)
Norway	SKAGEN Global A NOK
Norway	Storebrand Global Multifaktor
Norway	DNB Teknologi
Norway	Nordea Stabile Aksjer Global
Norway	Nordea Stabile Aksjer Global Etisk
Norway	SKAGEN Vekst A NOK
Norway	Danske Invest Horisont Aksje
Norway	DNB Aktiv 100
Norway	DNB Global (I)
Norway	ODIN Global C
Norway	Delphi Global
Norway	SKAGEN Global II NOK
Norway	Storebrand Trippel Smart
Norway	DNB Miljoinvest
Norway	DNB Health Care
Norway	DNB Finans
Norway	Eika Global
Norway	Holberg Global A
Norway	Sparebanken Vest Aksje
Norway	C WorldWide Globale Aksjer Etisk
Norway	C WorldWide Globale Aksjer
Norway	Danske Invest Investeringsprofil Aksjer
Norway	Danica Pensjon Norge - Aksjer
Norway	ODIN Energi C (NOK)
Norway	Storebrand Global Verdi
Norway	Storebrand Aksjespar
Norway	SKAGEN m2 A
Norway	Nordea Plan 100
Norway	DNB Barnefond
Norway	Fondsfinans Global Helse
Norway	DNB Navigator (II)
Norway	Landkreditt Aksje Global
Norway	DNB Navigator (I)
Norway	DNB Telecom
Norway	Alfred Berg Global Quant NOK
Norway	C WorldWide Medical
Norway	Fondsfinans Global Energi
Norway	DNB Global (III)
Norway	FORTE Global
Norway	FRAM Global
Norway	Vekterfond Aksjer I
Norway	PLUSS Utland Aksje
Norway	PLUSS Utland Etisk
Norway	C WorldWide Stabile Aksjer

Appendix 3. Model outputs

F-F 3-Factor Model on Nordic-focused portfolio

```
Call:
lm(formula = fund.xcess ~ rmrf + smb + hml)

Residuals:
    Min      1Q  Median      3Q     Max
-4.9722 -1.2163  0.0413  1.3855  6.0434

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.42195    0.31593   1.336    0.187
rmrf         0.65845    0.09091   7.243 1.37e-09 ***
smb         -0.13480    0.19627  -0.687    0.495
hml         -0.23520    0.14574  -1.614    0.112
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.287 on 56 degrees of freedom
Multiple R-squared:  0.5106,   Adjusted R-squared:  0.4844
F-statistic: 19.48 on 3 and 56 DF,  p-value: 8.964e-09
```

F-F 3-Factor Model on Global-focused portfolio

```
Call:
lm(formula = fund.xcess ~ rmrf + smb + hml)

Residuals:
    Min      1Q  Median      3Q     Max
-3.3050 -1.4577 -0.0658  1.4920  6.3858

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.05292    0.29133   0.182   0.8565
rmrf         0.70466    0.09748   7.229 1.45e-09 ***
smb         -0.23013    0.20554  -1.120   0.2677
hml         -0.29861    0.16763  -1.781   0.0803 .
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.123 on 56 degrees of freedom
Multiple R-squared:  0.499,    Adjusted R-squared:  0.4722
F-statistic:  18.6 on 3 and 56 DF,  p-value: 1.708e-08
```

F-F 3-Factor Model on MSCI Nordic portfolio

```
Call:
lm(formula = fund.xcess ~ rmrf + smb + hml)

Residuals:
    Min      1Q  Median      3Q     Max
-4.6436 -1.6702  0.1597  0.9779  6.9448

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.23600    0.32521   0.726   0.4711
rmrf         0.65824    0.09358   7.034 3.04e-09 ***
smb         -0.47709    0.20204  -2.361   0.0217 *
hml         -0.32751    0.15002  -2.183   0.0332 *
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.354 on 56 degrees of freedom
Multiple R-squared:  0.5337,   Adjusted R-squared:  0.5087
F-statistic: 21.37 on 3 and 56 DF,  p-value: 2.367e-09
```

F-F 3-Factor Model on MSCI Global Portfolio

```
Call:
lm(formula = fund.xcess ~ rmrf + smb + hml)

Residuals:
     Min       1Q   Median       3Q      Max
-0.93799 -0.26741 -0.01118  0.24647  1.03484

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.29774    0.05270  -5.650  5.6e-07 ***
rmrf         0.98822    0.01763  56.048  < 2e-16 ***
smb         -0.13729    0.03718  -3.693 0.000505 ***
hml         -0.01418    0.03032  -0.468 0.641795
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3841 on 56 degrees of freedom
Multiple R-squared:  0.9828,   Adjusted R-squared:  0.9818
F-statistic:  1064 on 3 and 56 DF,  p-value: < 2.2e-16
```

Carhart Model Nordic-focus portfolio

```
Call:
lm(formula = fund.xcess ~ rmrf + smb + hml + mom)

Residuals:
    Min      1Q  Median      3Q     Max
-4.9405 -1.2620  0.0308  1.1562  5.8913

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.31815    0.34619   0.919    0.362
rmrf         0.67053    0.09268   7.235 1.56e-09 ***
smb         -0.13858    0.19711  -0.703    0.485
hml         -0.19402    0.15632  -1.241    0.220
mom          0.11188    0.14951   0.748    0.457
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.296 on 55 degrees of freedom
Multiple R-squared:  0.5156,   Adjusted R-squared:  0.4803
F-statistic: 14.63 on 4 and 55 DF,  p-value: 3.35e-08
```

Carhart Model on MSCI Nordic portfolio

```
Call:
lm(formula = fund.xcess ~ rmrf + smb + hml + mom)

Residuals:
    Min      1Q  Median      3Q     Max
-4.5949 -1.6725  0.0904  1.0055  6.7116

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.07688    0.35415   0.217   0.8289
rmrf         0.67676    0.09481   7.138 2.24e-09 ***
smb         -0.48290    0.20165  -2.395   0.0201 *
hml         -0.26438    0.15992  -1.653   0.1040
mom          0.17149    0.15295   1.121   0.2671
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.349 on 55 degrees of freedom
Multiple R-squared:  0.5441,   Adjusted R-squared:  0.511
F-statistic: 16.41 on 4 and 55 DF,  p-value: 6.625e-09
```

Carhart Model on MSCI Global portfolio

```
Call:
lm(formula = fund.xcess ~ rmrf + smb + hml + mom)

Residuals:
     Min       1Q   Median       3Q      Max
-0.94482 -0.24998 -0.00455  0.25560  1.06277

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.293933   0.056010  -5.248 2.54e-06 ***
rmrf         0.987388   0.018193  54.273  < 2e-16 ***
smb         -0.136792   0.037571  -3.641 0.000602 ***
hml         -0.018962   0.037766  -0.502 0.617611
mom         -0.005988   0.027760  -0.216 0.830008
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3874 on 55 degrees of freedom
Multiple R-squared:  0.9828,   Adjusted R-squared:  0.9815
F-statistic: 784.3 on 4 and 55 DF,  p-value: < 2.2e-16
```

Carhart Model on Global-focused portfolio

```
Call:
lm(formula = fund.xcess ~ rmrf + smb + hml + mom)

Residuals:
    Min      1Q  Median      3Q     Max
-3.2431 -1.4545 -0.0763  1.4685  6.3476

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.03191    0.30965   0.103    0.918
rmrf         0.70922    0.10058   7.051 3.11e-09 ***
smb         -0.23288    0.20771  -1.121    0.267
hml         -0.27225    0.20879  -1.304    0.198
mom          0.03302    0.15347   0.215    0.830
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.142 on 55 degrees of freedom
Multiple R-squared:  0.4995,   Adjusted R-squared:  0.4631
F-statistic: 13.72 on 4 and 55 DF,  p-value: 7.993e-08
```

Appendix 4. Robustness checks for the multi-factor models

White's test. Nordic-focused sample portfolio

```
White's test for heteroskedasticity
OLS, using observations 1-60
Dependent variable: uhat^2

              coefficient    std. error    t-ratio    p-value
  ------------------------------------------------------------
  const        0.000476111   0.000196271    2.426     0.0189  **
  Mkt_RF      -0.00378074    0.00381276    -0.9916    0.3262
  SMB         -0.00130457    0.00833633    -0.1565    0.8763
  HML         -0.00869396    0.00568532    -1.529     0.1325
  sq_Mkt_RF    0.0149685     0.0916767      0.1633    0.8710
  X2_X3       -0.0864128     0.215709      -0.4006    0.6904
  X2_X4        0.105748      0.175144       0.6038    0.5487
  sq_SMB      -0.217599      0.467633      -0.4653    0.6437
  X3_X4       -0.0170790     0.422881      -0.04039   0.9679
  sq_HML       0.0944473     0.177439       0.5323    0.5969

  Unadjusted R-squared = 0.114955

Test statistic: TR^2 = 6.897323,
with p-value = P(Chi-square(9) > 6.897323) = 0.647809
```

White's test. Global-focused sample portfolio

```
White's test for heteroskedasticity
OLS, using observations 1-60
Dependent variable: uhat^2

              coefficient   std. error   t-ratio    p-value
  -----------------------------------------------------------
  const        2.51567      1.32403       1.900     0.0632  *
  Mkt_RF      -0.881988     0.291593     -3.025     0.0039  ***
  SMB          0.0402708    0.578961      0.06956   0.9448
  HML         -1.59392      0.578925     -2.753     0.0082  ***
  sq_Mkt_RF    0.146918     0.0670371     2.192     0.0331  **
  X2_X3        0.0228232    0.165243      0.1381    0.8907
  X2_X4        0.684701     0.251878      2.718     0.0090  ***
  sq_SMB      -0.354671     0.326273     -1.087     0.2822
  X3_X4       -0.466647     0.370229     -1.260     0.2134
  sq_HML       0.593995     0.218690      2.716     0.0090  ***

  Unadjusted R-squared = 0.280311

Test statistic: TR^2 = 16.818641,
with p-value = P(Chi-square(9) > 16.818641) = 0.051633
```

White's test. MSCI World portfolio

```
White's test for heteroskedasticity
OLS, using observations 1-60
Dependent variable: uhat^2

              coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------
  const        0.189113     0.0492818     3.837    0.0004  ***
  Mkt_RF      -0.0166866    0.0108534    -1.537    0.1305
  SMB         -0.0285073    0.0215495    -1.323    0.1919
  HML          0.00905701   0.0215482     0.4203   0.6761
  sq_Mkt_RF    0.00229536   0.00249519    0.9199   0.3620
  X2_X3        0.00179868   0.00615053    0.2924   0.7712
  X2_X4        0.00355279   0.00937515    0.3790   0.7063
  sq_SMB      -0.0212206    0.0121442    -1.747    0.0867  *
  X3_X4        0.0200807    0.0137803     1.457    0.1513
  sq_HML      -0.00583791   0.00813987   -0.7172   0.4766

  Unadjusted R-squared = 0.143861

Test statistic: TR^2 = 8.631633,
with p-value = P(Chi-square(9) > 8.631633) = 0.471948
```

White's test. MSCI Nordic portfolio

```
White's test for heteroskedasticity
OLS, using observations 1-60
Dependent variable: uhat^2

              coefficient   std. error   t-ratio    p-value
  ----------------------------------------------------------
  const        3.23946      2.01303       1.609     0.1139
  Mkt_RF      -0.125935     0.391052     -0.3220    0.7488
  SMB         -0.610011     0.855009     -0.7135    0.4789
  HML         -0.867694     0.583110     -1.488     0.1430
  sq_Mkt_RF    0.00741423   0.0940274     0.07885   0.9375
  X2_X3        0.0563747    0.221240      0.2548    0.7999
  X2_X4        0.179817     0.179634      1.001     0.3216
  sq_SMB       0.358202     0.479624      0.7468    0.4587
  X3_X4        0.422018     0.433724      0.9730    0.3352
  sq_HML       0.177429     0.181988      0.9749    0.3343

  Unadjusted R-squared = 0.107007

Test statistic: TR^2 = 6.420421,
with p-value = P(Chi-square(9) > 6.420421) = 0.697214
```

Test for normality of the residuals, Nordic-focused portfolio

Test for normality of residual -

Null hypothesis: error is normally distributed

Test statistic: Chi-square(2) = 3.38584

with p-value = 0.183981

Test for normality of the residuals, Global-focused portfolio

Test for normality of residual -

Null hypothesis: error is normally distributed

Test statistic: Chi-square(2) = 1.97959

with p-value = 0.371653

Test for normality of the residuals, MSCI Nordic portfolio

Test for normality of residual -

Null hypothesis: error is normally distributed

Test statistic: Chi-square(2) = 2.96624

with p-value = 0.226928

Test for normality of the residuals, MSCI Global portfolio

Test for normality of residual -

Null hypothesis: error is normally distributed

Test statistic: Chi-square(2) = 1.24102

with p-value = 0.537671

Durbin-Watson statistics for autocorrelation check

Table 11. Durbin-Watson statistics

Portfolio name	Durbin-Watson
Nordic-focused portfolio	1.958015
Global-focused portfolio	1.907502
MSCI ACWI	1.775188
MSCI Nordic	1.801853

Source: author's table based on Gretl software

Multicollinearity checks, European factors

```
Variance Inflation Factors

Minimum possible value = 1.0
Values > 10.0 may indicate a collinearity problem

      Mkt_RF    1.241
         SMB    1.040
         HML    1.326
         MOM    1.264

VIF(j) = 1/(1 - R(j)^2), where R(j) is the multiple correlation coefficient
between variable j and the other independent variables

Properties of matrix X'X:

 1-norm = 1169.5165
 Determinant = 3.611972e+011
 Reciprocal condition number = 0.026340442
```

Multicollinearity checks, Global factors

```
Variance Inflation Factors

Minimum possible value = 1.0
Values > 10.0 may indicate a collinearity problem

      Mkt_RF    1.054
         SMB    1.006
         HML    1.534
         MOM    1.604

VIF(j) = 1/(1 - R(j)^2), where R(j) is the multiple correlation coefficient
between variable j and the other independent variables

Properties of matrix X'X:

 1-norm = 671.1387
 Determinant = 9.5668769e+010
 Reciprocal condition number = 0.050751352
```