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Quantitative Momentum in the Nordic Markets

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TABLE OF CONTENTS

ABSTRACT

There is a considerable amount of research on momentum investing in the Nordic markets based on the Generic Momentum Strategy (GMS) of Jegadeesh & Titman (1993). In their Quantitative Momentum Strategy (QMS), Gray & Vogel (2016) proposes a modified momentum strategy that focuses on the path-dependency of momentum. This thesis aims to study if this variation of momentum investing not only yields better returns than the market but also improves the returns obtained with the conventional momentum approach. Our research finds that the QMS is an improvement of the GMS regardless the combination of formation and holding periods. Furthermore, the QMS(J12K3) is the only strategy consistently outperforming the broad-based indices across the Norwegian, Swedish, Danish and combined Nordic market. On a risk-adjusted basis, the QMS(J12K3) applied to the combined Nordic market delivers a positive and significant annualized alpha of 5.6% when regressed on the Carhart 4-factor model for the whole sample. We conclude that the QMS(J12K3) in the Nordic market delivers higher net returns than the MSCI Nordic Index, with lower volatility and lower maximum drawdowns. Similar conclusions are valid when looking at the markets in Norway, Sweden and Denmark. The results, however, are not conclusive for Finland. Based on our findings, we believe investors may enjoy the profitability and significant out-performance of the Quantitative Momentum Strategy in the Nordic markets.

1 INTRODUCTION

Throughout history, the main goal of investors has been to outperform the market by predicting the market direction. Though an endless number of investment strategies exists, we can gather most of them into two main categories: fundamental and technical analysis. Fundamentalists are often referred to as value investors and their strategy basically involves buying stocks trading at a low price versus various fundamentals. For a value investor, the fundamentals of the companies lead and their stock prices follow. Technical analysts, on the other hand, often described as speculators due to their short-term focus, buy securities because they "act" well and sell when they do not. Generally labelled as "momentum", this strategy is so straightforward that even your grandmother would understand it - buy the winners.

Can it be this simple? Does this strategy really work? Many successful and highly qualified investors within the art of finance have most certainly argued against the existence of the momentum anomaly. The famous value-investor guru, Benjamin Graham, expressed his scepticism about the topic in his reputable book "The Intelligent Investor":

> The one principle that applies to nearly all these so-called "technical approaches" is that one should buy because a stock or the market has gone up and one should sell because it has declined. This is the exact opposite of sound business sense everywhere else, and it is most unlikely that it can lead to lasting success on Wall Street. (Graham & Zweig, 2006, p. 2-3)

Other critics have acknowledged the existence of the momentum anomaly but argued it is not economically exploitable after considering transaction costs (Lesmond et al., 2004, Carhart, 1997). Novy-Marx & Velikov (2015) claim trading costs may harm the performance of quantitative strategies exploiting market anomalies, including momentum. However, Ross, Moskowitz, Israel & Serban (2017) use AQR's live momentum portfolio data to show that a long-only momentum strategy can earn the momentum premium after considering expenses, trading costs, tax burdens and other frictions.

Another criticism of the momentum strategy has been its occasional large crashes. Barroso & Santa-Clara (2014) suggest a risk managing method that virtually eliminates crashes and nearly doubles the Sharpe ratio of the momentum strategy, improving it from 0.53 for the unmanaged momentum to 0.97 for the risk-managed version. Daniel & Moskowitz (2016) show that the momentum crashes are driven by shorting the losers; the long position in the winners do well.

Today the momentum-effect is considered as one of the most important documented anomalies (Novy-Marx, 2015) and has even been acknowledged as the premier anomaly by the father of Efficient Market Hypothesis (EMH), Eugene Fama (Fama & French, 2008). In this thesis, we explore the existence of this anomaly in the Nordics and determine if momentum strategies built on the publications of Jegadeesh & Titman (1993) and Gray & Vogel (2016) outperform the market. Going forward, we investigate the intriguing universe of the momentum anomaly.

The literature contains two contradictory phenomena which are argued to have a long-term prevalence of time series data of asset prices. The first one, known as the "contrarian"-effect, relies on price reversals in assets and had its breakthrough with research done by De Bondt & Thaler (1985) and Lehman (1990). The second one is the above-mentioned momentum-effect, which was documented by Jegadeesh & Titman groundbreaking study in 1993. Jegadeesh & Titman (2001) confirmed that their previous findings persisted. Geczy & Samonov (2016) found evidence that the momentum effect appears to hold over 200 years. Rouwenhorst (1998), Rouwenhorst (1999), and Asness, Moskowitz & Pedersen (2013) concluded the momentum anomalies exist on different stock markets and across various asset classes such as bonds, commodities and currencies. Furthermore, Gray and Vogel (2016) claim their Quantitative Momentum Strategy (QMS) outperforms the American market both in absolute and in risk-adjusted terms. We want to verify if this strategy delivers similar results when applied in the Nordic markets.

An investor can exploit the momentum anomaly by constructing a long-only or self-financing long-short portfolio. To create the latter, one needs to buy winners and sell past losers (momentum effect). This leaves the investor with two critical decisions: (i) which strategy to invest according to, and (ii) how to time the investments.

Researchers debate over different explanations of the momentum anomaly. Most of the discussion revolves around whether the results are consistent with a risk-based explanation or with investors' behavioural biases. This leads to the discussion of market efficiency and the viability of the EMH. Though this thesis hopefully can contribute and add value to the extensive topic and discussion of the EMH, the main goal is to discover if implementing the QMS in the Nordic market is a profitable choice for the average Norwegian investor.

The last couple of decades have seen a rise of smart beta funds, factor investing and low-cost quantitative investment strategies. In Europe alone, the share of institutional investors adopting these strategies have gone from 40% in 2014 to 60% in 2017, and are being considered a mega-trend according to the FTSE Russell (2017). Even though these automated quantitative strategies empirically have proven their profitability, it does not seem to have convinced Norwegian investors to a large extent (Hegnar, 2017). Gray & Vogel (2016) find evidence and claim their Quantitative Momentum Strategy (QMS) is an improvement of the Generic Momentum Strategy[1] (GMS), a widely accepted momentum strategy in the academia and industry and that it outperforms the US Equity Market (S&P 500 index) after considering transaction costs. Our aim is to develop and study the effect of a practical long-only momentum-strategy, based on Gray & Vogel (2016), which could be accessible for the average Norwegian investor. We want to determine if this momentum strategy can outperform the market in each separate country and combined in a Nordic portfolio, using the returns of the companies listed on Oslo *Børs*, Stockholm Stock Exchange, Copenhagen Stock

[1] The Generic Momentum Strategy (GMS) is a long-only momentum strategy that follows Jegadeesh & Titman (1993) in using past returns over a determined formation period to define stocks with past good performance (winners), then forming a portfolio with these winners and holding this portfolio over a specific holding period. Specifically, the GMS skips the most recent month when calculating the stock returns over the formation period to rank the stocks because of the short-term reversal on the stock returns described in Jegadeesh (1990) and Asness (1994). In both references, the authors found evidence that stocks with high returns last month tend to perform poorly in the following month.

Exchange and Helsinki Stock Exchange between January 1996 and December 2017. The main contribution to the existing literature is an updated study on the momentum effect for the Nordic markets, with the addition of a new strategy which, to our best knowledge, has not been tested previously in the Nordic markets. Specifically, we want to answer the following research questions:

1. **Does the Generic Momentum Strategy yield higher net returns than the market?**
2. **Does the Quantitative Momentum Strategy yield higher net returns than the market?**
3. **Is the Quantitative Momentum Strategy an improved strategy when compared to the Generic Momentum Strategy?**
4. **Is there any combination of formation period J and holding period K that delivers consistently higher net returns than the market index across all the five Nordic markets? And if there is one, does it produce an excess return (alpha) after employing the Capital Asset Pricing Model, Fama & French three-factor model, and Carhart four-factor model?**

The structure of the thesis is as follows. Section 2 reviews the relevant literature. Section 3 describes the data. Section 4 explains the methods applied. Section 5 presents the results and robustness tests of our analysis. Section 6 concludes.

2 LITERATURE REVIEW

Relative strength strategies, which assume that past winners (losers) are future winners (losers), have been around for a long time. Robert Levy (1967, p. 602) concluded that "the profits attainable by purchasing the historically strongest stocks are superior to the profits from random selection". Despite Levy's early contribution to relative strength strategies, further research on the topic went dormant for a couple of decades. The main reason for this was the development and increasingly dominating position of the Efficient Market Hypothesis (EMH).

The EMH is one of the most debated topics in financial theory. Its foundation is that the price of an asset reflects all available information, making it impossible for investors to achieve any abnormal return, i.e. any return greater than the risk-adjusted return of the determined asset. Fama (1970) created this concept of market efficiency which quickly flourished across academia. Consequently, most of the academic research done during the 70s and 80s suggested that the market was efficient.

However, the development of technology and computers in the mid-80s allowed researchers to intensify their studies, and they found evidence of existing abnormal behaviour in asset returns. These abnormal behaviours challenged some elementary circumstances of the efficient market hypothesis. It was in this scenario, where several studies pointed out anomalies in the market, that the theory of behavioural finance arose.

Behavioural finance incorporates concepts from psychology, sociology and other sciences, with the aim to approximate the financial theory to the reality of the financial markets. In other words, behavioural finance uses psychology-based theories to analyse stock market anomalies and investment decisions. The theory takes into consideration that investors may show irrational behaviour, hence affecting the stock prices.

The vast majority of behavioural finance literature attributes the momentum effect to either an underreaction or overreaction to information (Hong, Lim, & Stein, 2000, and Jegadeesh & Titman, 2001). To illustrate the reaction to information,

consider the story of a frog placed in a pot of water. If the water is boiling, the frog will immediately jump out. However, if the water holds room temperature, and is gradually heated to the boiling point, the frog will remain still in the pot until it is fully cooked. The story serves as a good analogy to how investors react to stock price changes. A stock with an immediate 100% gain would quickly attract investor attention and its new price would typically reflect approximately a fair value. However, if a stock slowly achieves a 100% return, it would attract less attention and would be more likely to be priced less than its fundamental value.
Da, Gurun & Warachka (2014) investigated the limited attention of investors to gradual information diffusion and described their "Frog-in-the-Pan" hypothesis:

> A series of frequent gradual changes attracts less attention than infrequent dramatic changes. Investors, therefore, underreact to continuous information. (Da, Gurun & Warachka, 2014, p. 1)

The researchers concluded that momentum strategies that focus on the path-dependency of momentum generate a much stronger momentum effect. This goes in line with the findings of Barberis, Shleifer & Vishny (1998), which suggest that the momentum anomaly is due to underreaction to positive news.
An additional theory (Grey & Vogel, 2016) for why the momentum strategy will remain sustainable in the future revolves around marketplace constraints and career risk aspects for professional fund managers. Strategies like momentum presumably work because they sometimes fail spectacularly relative to passive benchmarks, introducing a "career risk" premium. Investors often assess the performance of their hired manager based on their short-term relative performance to a benchmark, which creates a warped incentive for the professional fund manager. Fund managers want to exploit mispricing opportunities because of the high expected long-term performance, but they can only do so to the extent to which their expected performance does not deviate too far from a standard benchmark.

The resurrection of Robert Levy's relative strength strategy, later renamed as "momentum", was formalised in the early 1990s through Jegadeesh & Titman's publication "Returns to Buying Winners and Selling Losers: Implications for

Market Efficiency." In this paper, the authors showed statistical evidence for a trading strategy, with a lookback period between one and four quarters, that outperformed their peers in comparative future periods. The strategy was to buy equities that had performed well in the past and to sell equities that had performed badly. They attributed the excess returns to an investor underreaction to firm-specific information. Since Jegadeesh & Titman (1993), academia has searched for the answer of whether the prevalence of momentum implies that markets are inefficient at processing information, or if the premium is reasonable compensation for bearing systematic risk. Believers of the joint hypothesis problem argue that market efficiency never can be rejected. Any test of efficiency must assume an equilibrium model that defines normal security returns. Thus, if efficiency is rejected, this could be because either the market is truly inefficient or an incorrect equilibrium model has been assumed (Campbell, Lo & MacKinlay, 1997).

While the theoretical explanations regarding the reason why the momentum-effect persist remain heavily debated, the existence itself is considered one of the main anomalies observed in stock markets around the world. Fama & French (2008) even refer to the momentum anomaly as the "premier anomaly".

The academic community has researched the momentum anomaly thoroughly over the last decades and as a result, the list of studies that document the momentum effect is extensive. The bulk of the existing literature suggests that momentum and contrarian effects are widely present both geographically and across asset classes.

Rouwenhorst (1998) examined the momentum effect in twelve European countries with data ranging from 1980 to 1995. With the use of Jegadeesh & Titman's method, he found the presence of the momentum effect on a 3 to 12-month horizon in all countries. Jegadeesh & Titman (2001) verified their previous findings and documented that their strategy still works, suggesting that the results did not suffer from bias in the database. Fuertes, Miffre & Tan (2009) showed that the momentum strategy features a negatively skewed leptokurtic return distribution that leaves investors with irregular but severe losses. Asness et al.

(2013) found consistent return premiums in both the value and momentum investments across eight different markets. In addition, they found that value and momentum are negatively correlated, suggesting that momentum (long-only) strategies are highly desirable in a portfolio context when they are combined with value strategies.

Twenty years after the discovery by Jegadeesh & Titman (1993), Asness, Frazzini, Israel & Moskowitz (2014) clarified a big part of what is known about the momentum effect and refuted some of their myths, using results of several academic works and public information available about the topic. Geczy & Samonov (2015) analysed several asset classes between 1800 and 2014, including 47 stock indexes from different countries, 43 bond indexes, 76 commodities, 301 global sectors indexes, 34,795 American stocks. The data of this study confirmed the momentum significance of these assets in the long term, but with an increase in the risk of this strategy. Barroso et al. (2014) claim that momentum has offered investors the highest Sharpe ratio when compared with the market, value or size factors. However, momentum has also displayed the worst crashes, making the strategy unappealing to investors who dislike negative skewness and kurtosis. Daniel and Moskowitz (2016) investigated what happens in turbulent times for momentum strategies, so-called “momentum crashes”. The authors found that momentum crashes normally occurred after a bear market followed by a quick market upswing. Through a closer investigation on momentum strategies during these periods, they discovered that market exposure was the problem. The short positions on the losers were the main cause of the momentum crashes. By buying the winners and selling the losers, a momentum strategy following a bear market will be long low-beta stocks and short high-beta stocks. Then, when the bear market is over and the market suddenly upswings, the short positions on the high-beta stocks will produce big losses. In sum, Daniel and Moskowitz show that all the momentum crashes were driven by being short the losers, not by being long in the winners. Therefore, a long-only momentum strategy can actually fare well even during the “momentum crashes”.

In recent years researchers have explored alternative methods of exploiting the momentum anomaly. Gray & Vogel (2016) developed the Quantitative

Momentum Strategy based on several empirical evidences from the academic literature, with ties back to behavioural finance in a coherent and logical way. Gray and Vogel (2016) propose two different strategies: i) Generic momentum strategy: approach inspired by the method described in Jegadeesh and Titman (1993, skipping most recent month in the ranking part to account for short-term reversals (Jegadeesh 1990, Asness 1994); ii) Quantitative Momentum, in which they develop the generic momentum strategy further and add a quality feature in the ranking process. They base the momentum quality feature on the algorithm described by Da, Gurun & Warachka (2014), which considers the "path" of the momentum. This momentum quality approach exploits the evidence on two aspects of investor behaviour: (1) a preference for lottery-like assets and (2) limited attention. In sum, Gray and Vogel (2016) propose a strategy that seeks to buy stocks with the highest momentum quality.

Seasonality is known as the idea of building timing signals based on the calendar. Most investors are familiar with the expression "sell in May and stay away" or the "January effect". Although Novy-Marx (2014) and Zhang & Jacobsen (2013) highlight the importance of having a healthy dose of scepticism towards seasonality-claims, many papers claim otherwise. Richard Sias (2007) found strong evidence to support the notion that momentum is a highly seasonal anomaly. He documented a five-fold difference between momentum profits for quarter-ending months versus non-quarter-ending months (excluding January). His results go in line with two institutional behaviours that potentially drive seasonality effects; the hypotheses of window-dressing and tax-minimization. The window-dressing hypothesis refers to institutional investors that have the incentive to buy winners before the quarter ends and sell losers. The tax-minimization hypothesis is that taxable investors want to sell losers and let winners ride at year-end to minimize tax burdens (Gray & Vogel, 2016)

Antonacci (2017) applies a strategy called "dual momentum" where he combines both cross-sectional and time-series momentum using only stocks. The rationale for the combination is to avoid the large drawdowns of the cross-sectional momentum long-only strategy. The author claims his strategy substantially outperforms both cross-sectional and time-series used on a stand-alone basis.

Blitz, Hanauer & Vidojevic (2017) claim that sorting stocks into portfolios based on their idiosyncratic returns generate comparable average returns, with half the volatility of the conventional momentum strategy. Their empirical results support the underreaction hypothesis for the idiosyncratic premium, and they document significant idiosyncratic momentum profits in international equity markets.

3 DATA

This research uses data exported from Datastream for the period from 29 December 1995 to 29 December 2017. This period has been chosen due to (i) the limited amount of listed companies at the different exchanges before 29 December 1995, and (ii) the availability of MSCI indices for all the markets[2]. Although we consider Datastream as a trustworthy source, we cannot rule out factual errors in the source material due to the extensive amount of data used in this thesis. Nonetheless, we consider the data inputs to be correct.

The dataset contains all listed and delisted stocks on Oslo Stock Exchange (Norway), Stockholm Stock Exchange (Sweden), Copenhagen Stock Exchange (Denmark) and Helsinki Stock Exchange (Finland); the Morgan Stanley International Capital (MSCI) Indices for the Nordic region and countries; and the Norwegian Interbank Offered Rate (Nibor)[3]. We include the companies delisted due to bankruptcy, merger & acquisition or any other reason to avoid survivorship bias in our sample. They are kept in the sample until they have repeating RI-values for more than 3 months. For every stock, we extract the daily values of its total return index (RI) denominated in Norwegian Kroner (NOK). The RI shows the theoretical growth in value of a share over a specific period, assuming reinvestment of the dividends to purchase additional units of an equity at the closing price applicable on the ex-dividend date. The value of the total return index of a stock at day t (RI_t) is:

$$RI_t = RI_{t-1} \cdot \frac{P_t}{P_{t-1}}$$

Except when t = ex-date of the dividend payment D_t then:

$$RI_t = RI_{t-1} \cdot \frac{P_t + D_t}{P_{t-1}}$$

Where P_{t-1} is the adjusted closing price on previous day t-1, P_t is the adjusted closing price on ex-date t, D_t is dividend payment associated with ex-date t.

[2] Quotes of MSCI Finland are not available before December 1995 in Datastream.

[3] The Norwegian Interbank Offered Rate (Nibor) is a collective term for Norwegian money market rates at different maturities. The Nibor reflects the interest rate level a bank requires for unsecured money market lending in NOK to another bank (Finans Norge, 2017). Oslo *Børs* is responsible for issuing the Nibor quotes.

We extract monthly RI values in NOK of the MSCI Indices described in Table 3-1 to use as benchmarks for the market returns.

Table 3-1 Description of Market Benchmarks

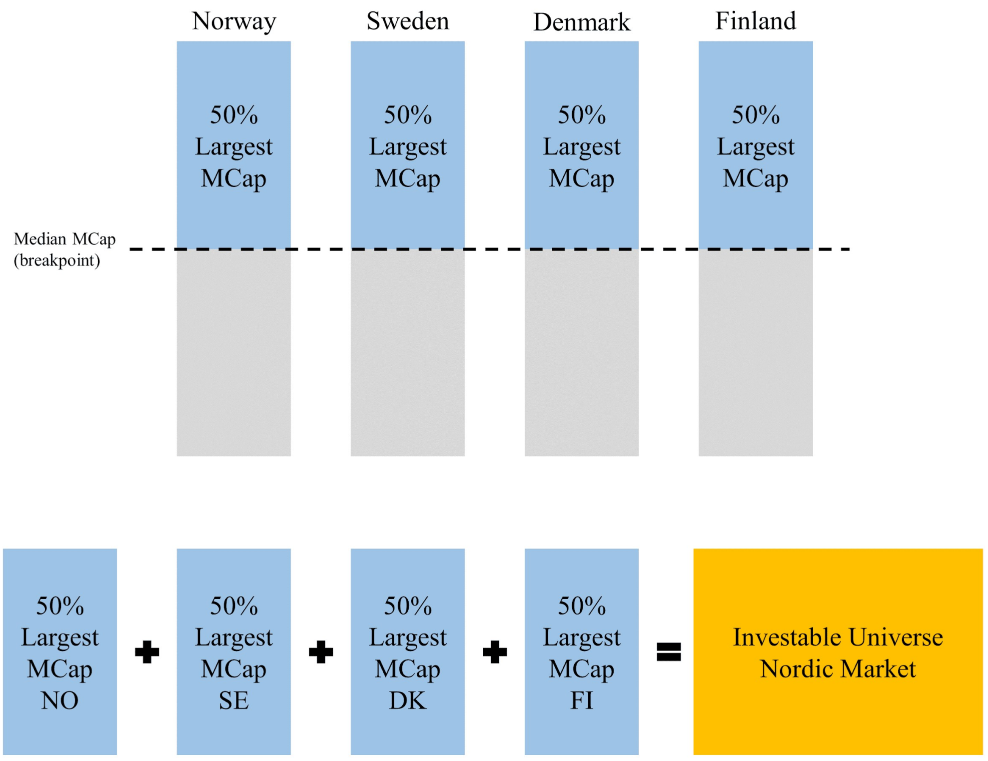
Benchmark	Description
MSCI Norway Index	This index measures the performance of the large and mid-cap segments of the Norwegian equity market. It contains 10 stocks and covers approximately 85% of the equity universe in Norway.
MSCI Sweden Index	This index measures the performance of the large and mid-cap segments of the Swedish equity market. It contains 31 stocks and covers approximately 85% of the equity universe in Sweden.
MSCI Denmark Index	This index measures the performance of the large and mid-cap segments of the Danish equity market. It contains 18 stocks and covers approximately 85% of the equity universe in Denmark.
MSCI Finland Index	This index measures the performance of the large and mid-cap segments of the Finnish equity market. It contains 12 stocks and covers approximately 85% of the equity universe in Finland.
MSCI Nordic Countries Index	This index captures large and mid-cap representation across Norway, Sweden, Denmark and Finland. It contains 69 stocks and covers approximately 85% of the equity universe in each country.

Descriptions of the MSCI indices (MSCI, 2017) used as market benchmarks.

Besides the total return index, we retrieve the monthly market capitalisation (MCap) and the monthly market-to-book ratio (MTBV) of every stock to create the risk factors used in the regression analysis, and Nibor 1-month rates to use as the proxy for the risk-free rate. Nibor is the chosen rate because this research aims to analyse the performance of momentum strategies for an investor who is resident or domiciled in Norway.

To create the investable universes for the Norwegian, Swedish, Danish and Finnish markets, we rank the stocks by market capitalisation at the end of a month t and keep the 50% largest companies[4] in the sample. This process is repeated monthly. The Nordic investable universe is then set up by merging the investable universes of the four Nordic countries as shown in Figure 3-1. Figure 3-2 shows the size of the different Investable Universes throughout the period we cover. Our sample covers many business cycles, e.g. the "dot-com" bubble in the late 1990s and the global financial crisis of 2007-2008.

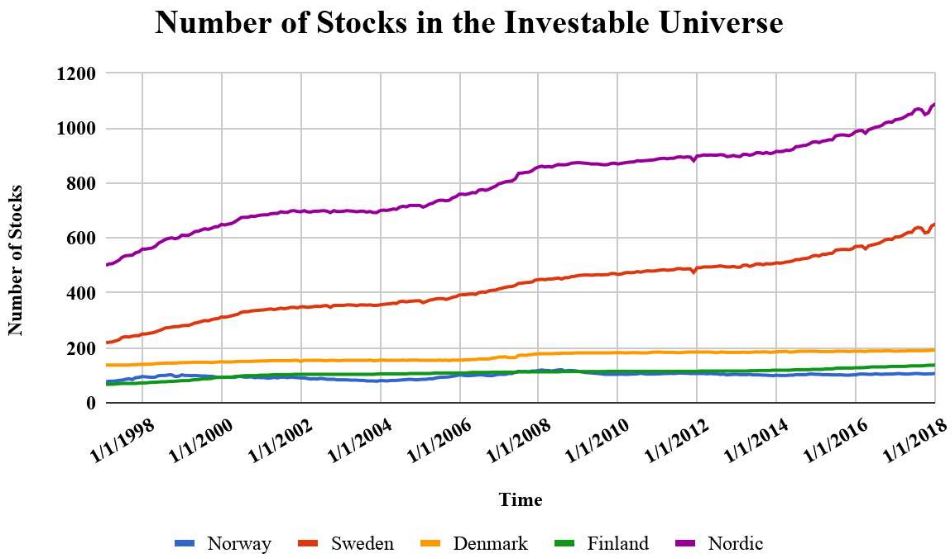
Figure 3-1 Creating the Investable Universes



This figure illustrates how we build the investable universes for each market. For Norway, Sweden, Denmark and Finland, we use the median market cap as breakpoint and select the 50% stocks with the largest market cap at the end of month t to include in the investable universe. The investable of the Nordic market is defined by combining the investable universes of the four Nordic countries. All the investable universes are updated monthly.

[4] We use large and mid-caps assuming that an investor will not face liquidity issues nor be able to affect the price of the shares when purchasing them. Additionally, most of the large bid/ask spreads will disappear.

Figure 3-2 Number of Stocks in the Investable Universes from 29 December 1995 to 29 December 2017



This graph presents the number of stocks in the Investable Universe from 29 December 1995 to 29 December 2017. The number of stocks available on each market is observed at the end of each month t.

4 METHODOLOGY

4.1 Return Definitions

The monthly log return[5] of a single stock i at the end of month t ($r_{i,t}$) is calculated as follows.

$$r_{i,t} = ln\left(\frac{RI_{i,t}}{RI_{i,t-1}}\right)$$

where $RI_{i,t}$ is the value of the total return index[6] of stock i at end of month t and $RI_{i,t-1}$ is the value of the total return index of the stock at the end of the previous month t-1.

The monthly log return of a portfolio p at the end of month t ($r_{p,t}$) is computed as follows.

$$r_{p,t} = ln\left(1 + \sum_{i=1}^{n} w_i \cdot R_{i,t}\right)$$

where w_i is the weight of stock i in portfolio p, $R_{i,t}$ is the one-month simple net return of stock i at end of month t, and n is the total number of stocks in portfolio p. The weight w_i is determined by dividing the NOK value of stock i by the total NOK value of the portfolio p. We choose to use equal-weighted portfolio because it is more straightforward for the average investor to implement in practice. Hence, the weight w_i of stock i is defined as:

$$w_i = \frac{1}{n}$$

The one-month simple net return of stock i at end of month t ($R_{i,t}$) is given below.

$$R_{i,t} = \frac{RI_{i,t}}{RI_{i,t-1}} - 1$$

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[5] We choose to use logarithmic returns for modelling and statistical purposes because the additivity property of multiperiod continuously compounded returns makes it more convenient for the statistical analysis (Campbell, Lo & MacKinlay, 1997).

[6] See definition of total return index (RI) in Section 3.

4.2 Construction of Momentum Portfolios

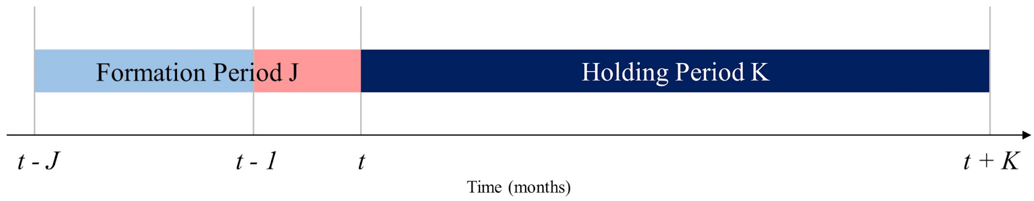
Jegadeesh & Titman (1993) and Gray & Vogel (2016) suggest that winners in the past 3-month to 12-month period are more likely to be future winners. Based on their findings, we test two different long-only momentum strategies described in Gray & Vogel (2016) that buy past winners. First, we analyse the Generic Momentum Strategy. This strategy consists of investing in a portfolio containing the top decile of stocks with relative strongest performance over a determined formation period (typically the past 12 months), skipping the previous month, at the end of month t, and then rebalancing this portfolio with top decile of stocks periodically. Secondly, we evaluate the Quantitative Momentum Strategy. This second strategy is built from the Generic Momentum Strategy and consists of investing in a portfolio containing the stocks with the highest "momentum quality" from the top decile of stocks with the relative strongest past performance at the end of month t, and then rebalancing this portfolio periodically.

In the following subsections, we detail how we construct the portfolios to analyse each of these momentum strategies.

4.2.1 Generic Momentum Portfolios

The construction of the Generic Momentum Portfolios follows the steps presented hereafter. First, at the end of each month t, the stocks in the Investable Universe are ranked in ascending order based on their cumulative returns over the past J months formation period, without considering the most recent month (Asness, 1994), as shown in Figure 4-1. We skip the most recent month return to remove the short-term reversal effect addressed by Jegadeesh (1990) and Lehmann (1990). Then, we divide the ranked stocks into deciles, select the ones with the best past performance (top decile) and construct an equal-weighted portfolio with them. Finally, we hold this portfolio over a holding period of K months as shown in Figure 4-1.

Figure 4-1 Construction of Generic Momentum Portfolios

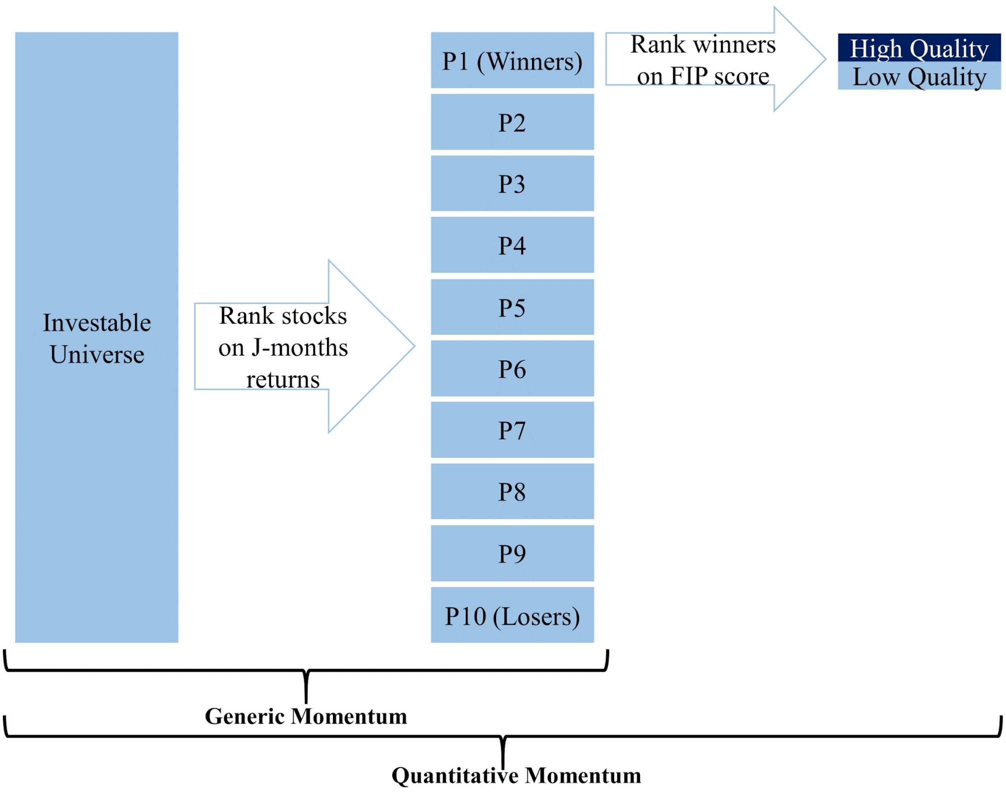


This figure illustrates the construction of a momentum portfolio according to the Generic Momentum Strategy. At the end of month t, a portfolio is formed with the stocks that had the best past J-months performance (formation period J), excluding the most recent month. Even though we skip the most recent month when calculating the cumulative compounded return over the formation period, we still refer as formation period J. When J=3 months, for example, it means that we calculate the cumulative return only from t-3 to t-1, i.e. we skip the return the stock had between t-1 and t.

4.2.2 Quantitative Momentum Portfolios

The construction of the Quantitative Momentum Portfolios starts with the similar steps done for the Generic Momentum Portfolios: ranking the stocks based on the past J months returns (skipping the most recent month); dividing the Investable Universe into deciles and selecting the winning stocks with the best past performance (top decile P1). After that, we sort the winners by ranking them based on their momentum quality and dividing them into "High-Quality Momentum" and "Low-Quality Momentum" stocks, as shown in Figure 4-2.

Figure 4-2 Construction of Quantitative Momentum Portfolios



This figure illustrates the stock screening process for constructing the winner portfolio of the Quantitative Momentum Strategy at the end of month t. First, we screen the stocks in the Investable Universe based on their past J-month (formation period) returns. The J-month returns are calculated excluding the return of the most recent month as shown in Figure 4-1. Then, the stocks in the winning decile P1 are ranked based on their "Frog-in-the-pan" score (FIP score) and sorted into low-quality momentum stocks (high FIP score) and high-quality momentum stocks (low FIP score). Finally, we build an equal-weighted portfolio with the winning stocks that had the lowest FIP scores (high-quality momentum).

To measure the momentum quality of each winning stock, we calculate its "Frog-in-the-pan" score (FIP score). The FIP score attempts to quantify the path of a high momentum stock (Da, Gurun & Warachka, 2014). It separates high momentum stocks into those that have more continuous price paths (i.e. smooth, with a slow diffusion of gradual information elements) versus those high momentum stocks that have more discrete price paths (i.e. jumpy, with immediate information elements).

$$FIP = sign\ (Past\ return) * [\%\ negative\ returns - \%\ positive\ returns]$$

The FIP score views the trading days in the past J-months of a stock and counts the percentage of trading days with negative and positive returns. The difference between these percentages is multiplied by the sign of the cumulative return over the formation period J[7]. For example, if a high momentum stock has a low (negative) FIP score, this stock will have a high-quality momentum, i.e. a more continuous price path that shows a slow diffusion of gradual information elements. Therefore, the winning stocks with the lowest FIP scores are placed in the "High-Quality Momentum" group.

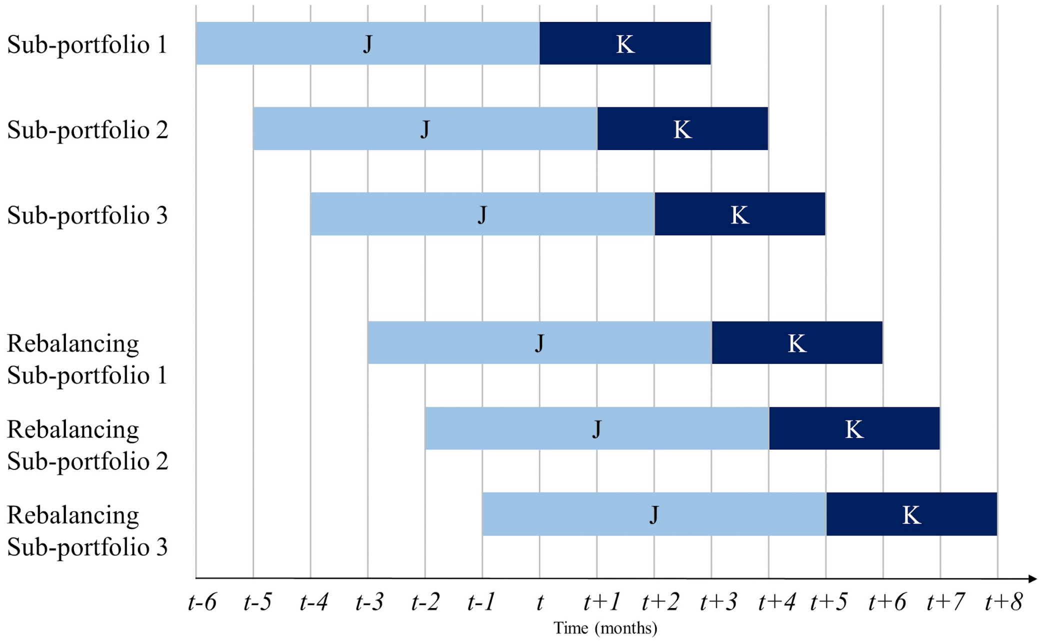
After screening the stocks by the quality of their momentum, we select the ones with high-quality momentum and construct an equal-weighted portfolio with them. Finally, we hold this portfolio over *K* months (holding period) as shown in Figure 4-2

4.3 Analysis of the Returns on the Momentum Portfolios

For each momentum strategy, we analyse 20 cases by combining four formation periods J (3, 6, 9 and 12 months) with five holding periods K (1, 3, 6, 9 and 12 months). Our research uses overlapping sub-portfolios to test each case because it increases the number of observations and the power of the statistical tests (Jegadeesh & Titman, 1993). To calculate the t-statistics for the mean monthly returns, we use the autocorrelation-consistent Newey-West standard errors (Newey & West, 1987) because the returns are autocorrelated and dependent (overlapping portfolios). Figure 4-3 shows how we use the overlapping sub-portfolios technique. At the end of each month t, we re-balance the weights of 1/K of the stocks in the whole portfolio and carry over all the other stock positions. In effect, we hold K sub-portfolios on each month t.

[7] The return on the most recent month is skipped when calculating the cumulative return over the formation period J.

Figure 4-3 Overlapping Sub-Portfolios Technique for Testing the Returns of the Momentum Strategies



This figure illustrates the overlapping sub-portfolios technique with formation period J equal to 6 months and holding period K equal to 3 months. For example, on June 30, 2015 (month t) we use one-third (1/K) of our cash to buy stocks with high momentum (sub-portfolio 1). We hold these stocks until September 30, 2015 (month t+3). On July 31, 2015 (month t+1), we use another one-third of our cash to buy stocks with high momentum (sub-portfolio 2). We hold these stocks until October 30, 2015 (month t+4). On August 31, 2015 (month t+2) we use another one-third of our cash to buy stocks with high momentum (sub-portfolio 3). We hold these stocks until November 30, 2015 (month t+5). We repeat the process every end of the month. Therefore, the return to the portfolio from August 31, 2015 (month t+2) to September 30, 2015 (t+3) is the returns to the stocks in the sub-portfolios originally formed on June 30,2015 (sub-portfolio 1), July 31, 2015 (sub-portfolio 2) and August 31, 2015 (sub-portfolio 3).

To test the momentum strategies, we use the monthly returns of all sub-portfolios from 31 January 1997[8] to 29 December 2017 to perform the hypothesis tests. First, we test if the Generic Momentum Portfolios yield better net returns than the broad market on average. Then we test if the Quantitative Momentum Portfolios yield better net returns than the broad market on average.

$$\begin{cases} H_0: \mu_{r_{GMS(k,j)}} = \mu_{r_M} \\ H_1: \mu_{r_{GMS(k,j)}} > \mu_{r_M} \end{cases}$$

$$\begin{cases} H_0: \mu_{r_{QMS(k,j)}} = \mu_{r_M} \\ H_1: \mu_{r_{QMS(k,j)}} > \mu_{r_M} \end{cases}$$

[8] The longest formation period analysed is 12 months. Hence, the first portfolio can be created on 31 December 1996. So our first observations are the returns on all strategies (including the return on the market index) obtained on 31 January 1997.

4.4 Transaction Costs

To consider the fact that costs affect the strategy performance, we incorporate transaction costs into the analysis of our momentum strategies and the indices. For simplicity, we incorporate a 30 basis points[9] rebalancing cost in the momentum strategies, charged each time we rebalance our portfolio, and a monthly fee of 2.5 basis points for holding the MSCI indices. Our study does not consider tax charges.

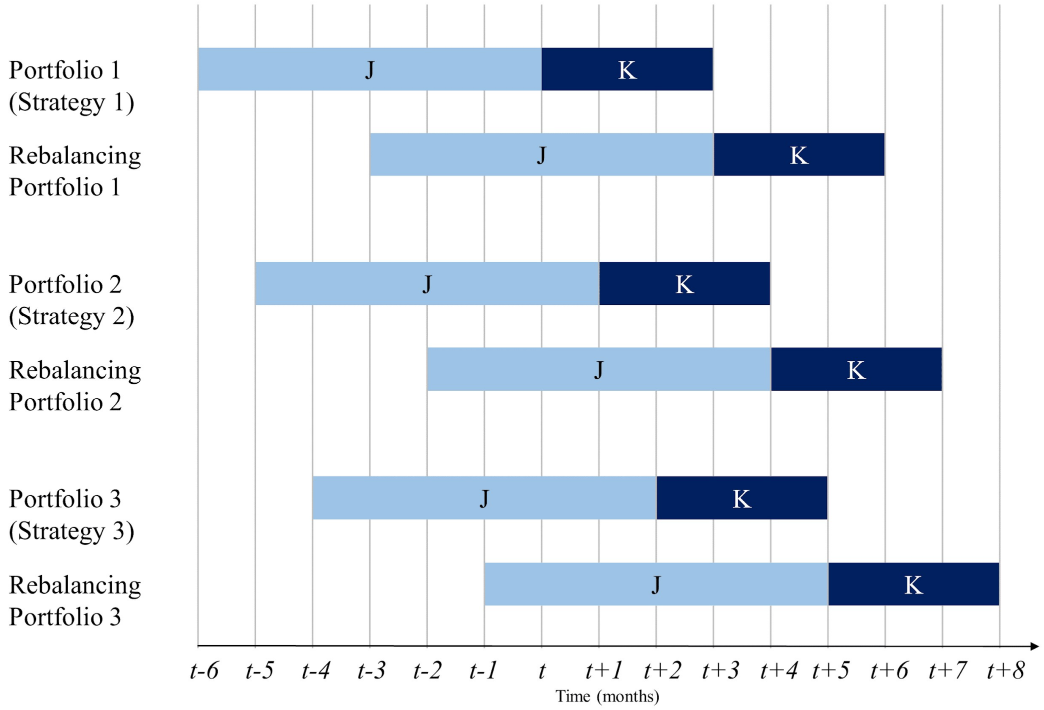
4.5 Test of Seasonality Effects

Once the momentum strategies with best returns are found, they will get tested for seasonality effects. Based on the K-month holding period, we create K portfolios starting at different months t and rebalance them after K months as per Gray & Vogel (2016), as shown in Figure 4-4. Afterwards, we compare the returns of these non-overlapping portfolios (seasonal portfolios) with the returns from the overlapping portfolios (agnostic portfolios) to verify if timing the rebalancing affects the strategy performance by testing the following hypothesis.

$$\begin{cases} H_0\colon \mu_{r_{seasonal}} = \mu_{r_{overlapping}} \\ H_1\colon \mu_{r_{seasonal}} > \mu_{r_{overlapping}} \end{cases}$$

[9] We consider a rebalancing cost based on the brokerage fee of 15 basis points per buy/sell order (minimum 29 NOK) charged by Nordnet to investors that buy/sell stocks for less than 52 667 NOK per transaction. The cost of spread and slippage are not considered. The full list of the brokerage fees is available at https://www.nordnet.no/tjenester/prisliste.html

Figure 4-4 Non-Overlapping Portfolios Technique Used to Test Seasonality Effects



This figure illustrates the non-overlapping portfolios technique to study seasonality effects. For example, if we want to examine the seasonality effect in a momentum strategy with 3-months holding period, we can examine 3 different strategies using non-overlapping portfolios formed in different months. First, we can trade the non-overlapping seasonal momentum portfolio 1 (Strategy 1) at the end of June (month t), September (month t+3), December (month t+6), etc. We hold this nonoverlapping portfolio for three months, which means there are four rebalances per year. Second, we can trade the non-overlapping seasonal momentum portfolio 2 (Strategy 2) at the end of July (month t+1), October (month t+4), January in the following year (month t+7), etc. Third, we can trade the non-overlapping seasonal momentum portfolio 3 (Strategy 3) at the end of month August (month t+2), November (month t+5), February in the following year (month t+8), etc. Then, we can compare the performance of the three portfolios against each other and verify if any of them performs better than the overlapping portfolio constructed with 3-months holding period (with no seasonality effect).

4.6 *Analysis of the Momentum Strategies' Alphas*

To evaluate the momentum strategies on a risk-adjusted basis, we estimate the alpha produced by them using Sharpe's (1964) capital asset pricing model (CAPM), Fama & French's (1993) three-factor model, and Carhart's (1997) four-factor model. We run regressions[10] of monthly returns of momentum strategies on the risk-factors returns as

$$r_{pt} = \alpha_{pT} + \beta_{pT} \cdot MKTRF_t + e_{pt} \quad t = 1, \ldots, T$$

$$r_{pt} = \alpha_{pT} + \beta_{pT} \cdot MKTRF_t + \gamma_{pT} \cdot SMB_t + \delta_{pT} \cdot HML_t + \varepsilon_{pt} \quad t = 1, \ldots, T$$

$$r_{pt} = \alpha_{pT} + \beta_{pT} \cdot MKTRF_t + \gamma_{pT} \cdot SMB_t + \delta_{pT} \cdot HML_t + \theta_{pT} \cdot WML_t + \varepsilon_{pt} \quad t = 1, \ldots, T$$

where r_{pt} is the net of trading costs return on momentum portfolio p in excess of the Nibor 1-month return; $MKTRF_t$ is the return on the MSCI index of the country of interest in excess of the Nibor 1-month return and in excess of a monthly fee[11] of 2.5 basis points; and SMB_t, HML_t, and WML_t are the returns on value-weighted zero-investment portfolios designed to mimic the risk factors in stock returns related to size, book-to-market equity, and one-year momentum, respectively (Fama & French, 1993. Carhart, 1997).

The derivation of the risk factors used in our regression analysis is described in the following subsections.

4.6.1 *Calculation of Risk Factors SMB (Size) and HML (Value)*

The construction of the size and value factors follows the method described by Fama & French (1993). The portfolios S/L, S/M, S/H, B/L, B/M, B/H are created following the steps below:

1. In June of each year t, we rank all stocks in the stock market on Market Cap.
2. The stock market is split into two groups using the median Market Cap as breakpoint: small (S) and big (B).
3. In June of each year t, we also rank all stocks in the stock market on book-to-market equity (BE/ME). Book-to-market equity is the book common

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[10] We use the autocorrelation-consistent Newey-West standard errors (Newey & West, 1987) to compute the t-statistics of the regression coefficients. These robust standard errors are required because the returns produced by the overlapping portfolios are autocorrelated and dependent.

[11] We subtract a monthly fee from the market proxy since we study the returns net of trading costs on the momentum strategies.

equity for the fiscal year ending in the calendar year t - 1, divided by market equity at the end of December of t - 1. Firms with negative book values of common equity are excluded.

4. The stock market is divided into three book-to-market equity groups based on the breakpoints for the bottom 30 per cent (L), middle 40 per cent (M). and top 30 per cent (H) of the ranked values of BE/ME for all stocks.
5. In June of each year t, we construct six portfolios (S/L, S/M, S/H, B/L, B/M, B/H**)** from the intersections of the two ME and the three BE/ME groups. For example, the portfolio S/L contains the stocks in the small-ME group that are also in the low-BE/ME group.
6. We calculate the monthly value-weighted returns (weighted based on Market Cap at the end of July of year t) on the six portfolios from July of year t to June of year t+1.
7. In June of year t+1, the steps (1) to (6) are repeated.

After calculating the returns for portfolios S/L, S/M, S/H, B/L, B/M, B/H during the sample period, we create the factors size (SMB) and value (HML). The portfolio SMB (small minus big) is the difference, each month t, between the simple average of the returns on the three small-stock portfolios (S/L, S/M and S/H) and the simple average of the returns on the three big-stock portfolios (B/L, B/M, and B/H). Likewise, the portfolio HML (high minus low) is the difference, each month t, between the simple average of the returns on the two high-BE/ME portfolios (S/H and B/H) and the average of the returns on the two low- BE/ME portfolios (S/L and B/L).

$$SMB_t = \left(\frac{R_{S/L,t} + R_{S/M,t} + R_{S/H,t}}{3}\right) - \left(\frac{R_{B/L,t} + R_{B/M,t} + R_{B/H,t}}{3}\right)$$

$$HML_t = \left(\frac{R_{S/H,t} + R_{B/H,t}}{2}\right) - \left(\frac{R_{S/L,t} + R_{B/L,t}}{2}\right)$$

4.6.2 Calculation of Risk Factor WML (Momentum)

We follow the method of Carhart (1997) and construct the momentum risk factor WML as the equal-weight average of firms with the highest 30 per cent eleven-month returns lagged one month (Winners) minus the equal-weight average of firms with the lowest 30 per cent eleven-month returns lagged one month (Losers). The portfolios are rebalanced every month.

5 RESULTS

The research is extensive and consists of 200 different cases, resulting from the analysis of two different momentum strategies (GMS and QMS) which are created by combining four formation periods (3, 6, 9 and 12 months) with five holding periods (1, 3, 6, 9 and 12 months) and applied to five different markets (Norway, Sweden, Denmark, Finland and Nordic). Presenting our findings for all five markets would make the thesis cluttered and difficult to follow. For this reason, we place our focus and emphasis on the Nordic portfolio going forward, with some relevant comments and comparisons with the different national markets. The results for Norway, Sweden, Denmark and Finland are presented in the Appendices.

This section starts off presenting the summary statistics of the monthly returns of the momentum strategies for the combined Nordic portfolio. The summary statistics for each separate country is found in Appendix 1 - Summary Statistics of Momentum Monthly Returns. Then, we enter the performance analysis for the combined Nordic portfolio. Similar analysis for each separate country is presented in Appendix 2 - Performance Analysis of Momentum Strategies. From this analysis, we identify the best performing strategies across the different markets. These strategies go then through a seasonality screening to test if it is possible to take advantage of seasonal aspects. After identifying the "winning" strategy, we test its level of robustness. The robustness tests entail drawdown analysis and finally, an evaluation of the strategies on a risk-adjusted basis with the estimation of alpha using the three models of performance measurement: CAPM, Fama-French-3 factor and Carhart 4-factor models. The robustness analyses for each separate country are presented in Appendix 5 - Annualized Average Net Returns Rolling Window and Appendix 6 - Maximum Drawdowns Rolling Window.

5.1 Summary Statistics - Log-return distributions (Nordic)

Table 5-1 presents the summary statistics of the monthly log-return distributions used as the basis for further performance analysis of the momentum strategies we cover in this thesis.

Table 5-1 Summary Statistics of Monthly Log Return Distributions for Portfolios with Formation Period J Months and Holding Period K Months, Nordic

J	3	3	3	3	3	6	6	6	6	6	9	9	9	9	9	12	12	12	12	12	MSCI Nordic	Nibor 1M
K	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12		
Panel A: Generic Momentum Portfolios (Nordic)																						
Mean	0.013	0.012	0.010	0.009	0.008	0.013	0.012	0.011	0.010	0.008	0.013	0.012	0.011	0.009	0.008	0.013	0.012	0.010	0.008	0.008	0.008	0.003
Std Dev	0.056	0.054	0.052	0.051	0.052	0.055	0.053	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.052	0.051	0.051	0.052	0.052	0.061	0.002
t-stat	3.658	3.450	3.147	2.880	2.581	3.654	3.518	3.356	3.064	2.557	4.006	3.831	3.410	2.896	2.494	3.886	3.638	3.098	2.606	2.342	2.088	25.114
Median	0.015	0.016	0.017	0.015	0.014	0.014	0.016	0.017	0.017	0.014	0.017	0.020	0.017	0.015	0.013	0.018	0.019	0.016	0.015	0.015	0.014	0.002
Min	-0.187	-0.167	-0.176	-0.169	-0.177	-0.175	-0.185	-0.170	-0.182	-0.189	-0.159	-0.174	-0.189	-0.196	-0.195	-0.169	-0.185	-0.184	-0.187	-0.192	-0.207	0.001
Max	0.237	0.221	0.193	0.179	0.184	0.251	0.193	0.168	0.172	0.158	0.223	0.171	0.164	0.161	0.164	0.170	0.160	0.148	0.154	0.163	0.189	0.007
Skewness	0.372	0.035	-0.382	-0.552	-0.618	0.216	-0.351	-0.490	-0.607	-0.752	-0.047	-0.420	-0.562	-0.714	-0.803	-0.342	-0.576	-0.707	-0.840	-0.893	-0.470	0.615
Kurtosis	5.500	5.077	4.629	4.383	4.587	5.819	5.051	4.383	4.460	4.584	4.695	4.186	4.245	4.505	4.813	3.952	4.068	4.251	4.734	5.138	4.314	1.982
Panel B: Quantitative Momentum Portfolios (Nordic)																						
Mean	0.013	0.013	0.012	0.011	0.010	0.014	0.014	0.013	0.012	0.010	0.014	0.014	0.013	0.011	0.010	0.014	0.014	0.012	0.011	0.010	0.008	0.003
Std Dev	0.055	0.051	0.050	0.049	0.050	0.054	0.052	0.050	0.050	0.050	0.052	0.050	0.050	0.050	0.051	0.053	0.051	0.051	0.051	0.052	0.061	0.002
t-stat	3.708	4.110	3.785	3.500	3.145	3.995	4.269	4.190	3.790	3.175	4.306	4.487	4.133	3.594	3.074	4.126	4.298	3.843	3.346	2.983	2.088	25.114
Median	0.015	0.016	0.016	0.016	0.016	0.016	0.015	0.016	0.016	0.016	0.017	0.020	0.017	0.015	0.014	0.018	0.019	0.018	0.016	0.016	0.014	0.002
Min	-0.145	-0.140	-0.150	-0.142	-0.162	-0.155	-0.177	-0.158	-0.160	-0.173	-0.142	-0.146	-0.165	-0.170	-0.168	-0.202	-0.185	-0.184	-0.176	-0.181	-0.207	0.001
Max	0.235	0.208	0.192	0.191	0.188	0.237	0.216	0.187	0.197	0.176	0.234	0.174	0.188	0.179	0.185	0.230	0.171	0.149	0.166	0.182	0.189	0.007
Skewness	0.250	0.093	-0.302	-0.435	-0.567	0.257	-0.161	-0.357	-0.463	-0.719	0.109	-0.331	-0.441	-0.615	-0.723	-0.378	-0.535	-0.697	-0.754	-0.806	-0.470	0.615
Kurtosis	4.800	4.701	4.384	4.243	4.493	4.967	5.001	4.389	4.654	4.857	5.069	3.901	4.176	4.428	4.982	4.943	4.224	4.237	4.635	5.223	4.314	1.982

This table shows the summary statistics for the monthly log-returns of the momentum strategies applied to the Nordic market. The number of observations is 252 in each strategy, covering the monthly returns observed between the end of January 1997 and the end of December 2017. The sample includes the stocks in the Nordic investable universe as defined in Figure 3-1. T-statistics are computed using autocorrelation-consistent Newey-West standard errors.

Table 5-1 shows that monthly returns tend to be lower on average the longer the holding period is, which is in line with findings from Jegadeesh & Titman (1993). Regardless of the formation period considered, the Nordic strategies with short holding periods (1, 3 and 6 months) performs better than strategies with long holding periods (9 and 12 months), both for the GMS and the QMS. On average, we also see that for any combination of formation period J and holding period K, the QMS consistently yields higher returns than the GMS. The momentum returns are negatively skewed with relatively high kurtosis for most of the strategies, which suggests that investors are exposed to irregular but severe losses (Fuertes, Miffre & Tan, 2009). Furthermore, the negatively skewed returns suggest that the momentum effect partly represents a skewness premium, in line with the findings of Barroso & Santa-Clara (2015) and Daniel & Moskowitz (2016).

5.2 Performance Analysis (Nordic)

Table 5-2 displays and compares the statistical analysis of the performance and risk profile of the QMS Nordic, GMS Nordic and MSCI Nordic.

Table 5-2 Performance Analysis of Momentum Strategies, Nordic

J	3	3	3	3	3	6	6	6	6	6	9	9	9	9	9	12	12	12	12	12	MSCI Nordic	Nibor 1M
K	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12		
Panel A: Generic Momentum Portfolios (Nordic)																						
Annualized Net Return (%)	15.36	14.03	12.30	11.16	10.08	15.32	14.11	12.99	11.80	9.82	15.59	14.83	13.17	11.20	9.68	15.18	14.07	11.97	10.17	9.19	9.67	3.55
Annualized Volatility (%)	19.24	18.63	17.92	17.75	17.90	19.22	18.38	17.74	17.64	17.59	17.83	17.75	17.70	17.71	17.78	17.90	17.72	17.71	17.88	17.98	21.22	0.65
Annualized Sharpe Ratio	0.61	0.56	0.49	0.43	0.36	0.61	0.57	0.53	0.47	0.36	0.68	0.64	0.54	0.43	0.34	0.65	0.59	0.48	0.37	0.31	0.29	
Annual Downside Volatility(%)	11.93	12.68	13.17	13.39	13.99	13.14	13.71	13.26	13.60	14.17	12.03	12.91	13.31	14.06	14.62	12.51	13.24	13.86	14.67	15.17	16.54	
Annualized Sortino Ratio	0.87	0.71	0.55	0.46	0.36	0.79	0.66	0.60	0.50	0.34	0.88	0.76	0.61	0.44	0.32	0.81	0.69	0.50	0.35	0.28	0.28	
Min Net Monthly Return (%)	-18.67	-16.68	-17.64	-16.89	-17.69	-17.51	-18.46	-17.04	-18.19	-18.93	-15.91	-17.40	-18.88	-19.57	-19.48	-16.92	-18.53	-18.40	-18.73	-19.17	-20.70	0.05
Max Net Monthly Return (%)	23.71	22.10	19.34	17.91	18.37	25.13	19.28	16.76	17.23	15.76	22.27	17.07	16.35	16.14	16.37	17.00	16.00	14.82	15.43	16.28	18.91	0.73
Max Net Drawdown (%)	-54.25	-55.74	-58.30	-60.48	-60.54	-45.60	-50.40	-53.02	-56.36	-57.71	-45.79	-49.65	-53.14	-57.05	-59.54	-51.80	-52.36	-55.11	-59.88	-60.45	-71.36	
P-value, Ha: μ(j,k)>μ(m)	***3.20%***	6.46%	16.48%	28.96%	43.63%	***3.75%***	7.68%	13.82%	22.92%	47.85%	***3.67%***	5.73%	12.97%	30.37%	49.87%	***4.44%***	8.25%	22.71%	43.31%	56.64%		
Panel B: Quantitative Momentum Portfolios (Nordic)																						
Annualized Net Return (%)	15.38	15.97	14.29	13.07	11.83	16.28	16.82	15.81	14.29	11.98	16.80	16.83	15.55	13.63	11.77	16.59	16.44	14.73	12.95	11.70	9.67	3.55
Annualized Volatility (%)	19.00	17.81	17.30	17.11	17.24	18.67	18.06	17.29	17.28	17.30	17.88	17.19	17.24	17.37	17.54	18.42	17.53	17.56	17.73	17.97	21.22	0.65
Annualized Sharpe Ratio	0.62	0.70	0.62	0.56	0.48	0.68	0.74	0.71	0.62	0.49	0.74	0.77	0.70	0.58	0.47	0.71	0.74	0.64	0.53	0.45	0.29	
Annual Downside Volatility(%)	12.25	11.84	12.24	12.51	13.31	11.82	12.67	12.48	12.95	13.96	11.91	12.04	12.52	13.56	14.35	13.49	12.89	13.55	14.27	15.01	16.54	
Annualized Sortino Ratio	0.85	0.93	0.76	0.65	0.51	0.95	0.93	0.87	0.72	0.50	0.99	0.98	0.84	0.64	0.47	0.86	0.89	0.72	0.56	0.45	0.28	
Min Net Monthly Return (%)	-14.51	-13.99	-14.99	-14.19	-16.16	-15.47	-17.69	-15.82	-16.03	-17.34	-14.20	-14.58	-16.51	-17.00	-16.83	-20.16	-18.54	-18.42	-17.57	-18.06	-20.70	0.05
Max Net Monthly Return (%)	23.46	20.79	19.22	19.05	18.78	23.71	21.56	18.70	19.66	17.58	23.38	17.38	18.77	17.91	18.53	23.04	17.09	14.92	16.63	18.21	18.91	0.73
Max Net Drawdown (%)	-50.52	-48.01	-51.06	-54.54	-56.24	-43.26	-49.59	-50.29	-49.90	-53.03	-44.65	-46.90	-47.92	-51.37	-55.56	-43.57	-45.56	-49.81	-53.23	-55.92	-71.36	
P-value, Ha: μ(j,k)>μ(m)	***3.96%***	***1.72%***	***4.48%***	10.25%	19.94%	***2.40%***	***1.37%***	***2.42%***	5.75%	20.32%	***1.69%***	***1.45%***	***2.94%***	9.30%	23.05%	***1.98%***	***1.74%***	5.08%	13.46%	23.83%		

Annualized net return is calculated by multiplying monthly returns by 12 and subtracting the annualized transaction costs. For a momentum strategy with holding period equal to K months, we assume annualized transaction costs equal to 12 * (0.3% / K). For holding a position in the market index, the annual fee is considered to be 0.3%. Annualized volatility is calculated by multiplying monthly standard deviation by sqrt (12). Annualized Sharpe ratio equals annualized net returns in excess of the Nibor 1-month rate divided by the annualized volatility. Annualized downside volatility is calculated by multiplying monthly downside deviation by sqrt (12), where the downside deviation is defined as the standard deviation of all negative net returns observed. Annualized Sortino ratio equals annualized net returns in excess of the Minimum Acceptable Return (MAR=5%) divided by the annualized downside volatility. We report Min and Max monthly net returns, and Maximum net drawdowns. P-values are given for the hypothesis tests where we test whether monthly net returns on momentum strategy (J,K) are greater than monthly net returns on market index. P-values are computed using autocorrelation-consistent Newey-West standard errors.

The empirics showcase evidence of the momentum effect across all markets, except Finland which has no momentum effect (Appendix 2). From Table 5-2 we find that among the twenty GMS, only four yield returns statistically significantly better than the market. Shifting to the QMS, the story is more appealing. In this case, eleven out of twenty QMS have better returns than the benchmark that are statistically significant. The same pattern with a greater number of QMS than GMS outperforming the market is observed in all markets except Finland.

When comparing the combined Nordic portfolio with the local portfolio of each particular country, we find that the QMS(J9K3) and the QMS(J12K3) are the strategies that perform consistently better than the market index across all the different markets (except Finland). Table 5-3 summarises the differences in performance between QMS(J9K3) and QMS(J12K3) across the different markets. Even though we find strategies that perform better on a country basis as shown in Table 5-4, performing a test of the best momentum strategy on only one type of market condition would likely yield unique results that may not function well in other market conditions, which may lead to false conclusions. Therefore, we select the QMS(J12K3) to further analysis for all markets because this is the combination of formation and holding periods adopted by Gray & Vogel (2016) and also the one found to be the most profitable by Jegadeesh and Titman (1993). Going forward we analyse QMS(J12K3) in comparison with both the market index and GMS(J12K3), the latter being used as a benchmark for momentum returns.

Table 5-2 shows that the QMS(J12K3) generated a statistically significant compounded annual growth rate of 16.44 per cent outperforming the GMS(J12K3) performance of 14.07 per cent. Additionally, the QMS(J12K3) significantly outperformed the MSCI Nordic, which returned 9.67 per cent.

The high return of the QMS(J12K3) was achieved with a volatility of 17.53 per cent, considerably lower than the MSCI benchmark volatility of 21.22 per cent, which makes the risk-adjusted parameters highly favourable for the QMS(J12K3). The strategy yields a Sharpe ratio of 0.74, substantially higher than the MSCI Nordic Sharpe ratio of 0.29.

The QMS(J12K3) has a downside deviation of 12.89 per cent, again considerably lower than the benchmark's 16.54 per cent, resulting in a remarkable Sortino ratio of 0.89 compared to the Sortino ratio of 0.28 obtained by the benchmark.

Regarding worst drawdowns, the QMS(J12K3) showcases that it can be painful to be a momentum-investor. The worst drawdown entailed by the strategy is -45.56 per cent. However, the benchmark suffered an even worse drawdown of -71.36 per cent. This difference opposes the general criticism of the momentum strategy and its occasional large crashes.

Table 5-3 Comparison of Performance of QMS(J9K3) and QMS(J12K3) Across the Different Markets

Market	Norway			Sweden			Denmark			Finland			Nordic		
Strategy	QMS (J9K3)	QMS (J12K3)	Diff	QMS (J9K3)	QMS (J12K3)	Diff	QMS (J9K3)	QMS (J12K3)	Diff	QMS (J9K3)	QMS (J12K3)	Diff	QMS (J9K3)	QMS (J12K3)	Diff
Annualized Net Return (%)	17.68	19.17	-1.49	16.85	15.81	1.04	17.04	19.32	-2.28	14.39	13.21	1.18	16.83	16.44	0.38
Annualized Volatility (%)	22.80	22.88	-0.09	19.83	19.81	0.01	17.62	17.99	-0.37	21.05	21.12	-0.08	17.19	17.53	-0.34
Annualized Sharpe Ratio	0.62	0.68	-0.06	0.67	0.62	0.05	0.77	0.88	-0.11	0.52	0.46	0.06	0.77	0.74	0.04
Annualized Downside Volatility (%)	16.40	15.97	0.42	12.80	13.33	-0.54	11.21	13.73	-2.53	13.43	14.28	-0.85	12.04	12.89	-0.85
Annualized Sortino Ratio (MAR = 5%)	0.77	0.89	-0.11	0.93	0.81	0.12	1.07	1.04	0.03	0.70	0.58	0.12	0.98	0.89	0.09
Min Net Monthly Return (%)	-27.06	-24.69	-2.37	-14.71	-16.39	1.68	-14.75	-24.09	9.34	-22.61	-22.38	-0.23	-14.58	-18.54	3.96
Max Net Monthly Return (%)	31.88	32.18	-0.30	17.79	17.04	0.75	17.58	13.82	3.76	23.71	22.56	1.15	17.38	17.09	0.29
Max Net Drawdown (%)	-44.74	-42.23	-2.50	-53.68	-58.66	4.98	-44.89	-49.51	4.62	-55.49	-65.13	9.64	-46.90	-45.56	-1.34
P-value, Ha: μ(j,k)>μ(m)	***0.61%***	***0.20%***	0.41%	***2.15%***	***3.88%***	-1.73%	9.15%*	***2.01%***	7.14%	18.70%	25.41%	-6.71%	***1.45%***	***1.74%***	-0.29%

Annualized net return is calculated by multiplying monthly returns by 12 and subtracting the annualized transaction costs. For a momentum strategy with holding period equal to K months, we assume annualized transaction costs equal to 12 * (0.3% / K). For holding a position in the market index, the annual fee is considered to be 0.3%. Annualized volatility is calculated by multiplying monthly standard deviation by sqrt (12). Annualized Sharpe ratio equals annualized net returns in excess of the Nibor 1-month rate divided by the annualized volatility. Annualized downside volatility is calculated by multiplying monthly downside deviation by sqrt (12), where the downside deviation is defined as the standard deviation of all negative net returns observed. Annualized Sortino ratio equals annualized net returns in excess of the Minimum Acceptable Return (MAR) divided by the annualized downside volatility. We report Min and Max monthly net returns, and Maximum net drawdowns. P-values are given for the hypothesis tests where we test whether monthly net returns on quantitative momentum strategy (J,K) are greater than monthly net returns on market index. P-values are computed using autocorrelation-consistent Newey-West standard errors.

*Significant at 10% level.

Table 5-4 Summary of Top Performing Momentum Strategies for the Different Markets

Market	Norway			Sweden			Denmark			Finland			Nordic		
	Best	Chosen		Best	Chosen		Best	Chosen		Best	Chosen		Best	Chosen	
Strategy	QMS (J12K1)	QMS (J12K3)	MSCI NO	QMS (J6K1)	QMS (J12K3)	MSCI SE	QMS (J12K3)	QMS (J12K3)	MSCI DK	QMS (J9K3)	QMS (J12K3)	MSCI FI	QMS (J9K1)	QMS (J12K3)	MSCI Nordic
Annualized Net Return (%)	21.35	19.17	7.73	19.66	15.81	9.34	19.32	19.32	12.29	14.39	13.21	9.63	16.80	16.44	9.67
Annualized Volatility (%)	24.28	22.88	21.83	21.13	19.81	23.17	17.99	17.99	18.09	21.05	21.12	29.92	17.88	17.53	21.22
Annualized Sharpe Ratio	0.73	0.68	0.19	0.76	0.62	0.25	0.88	0.88	0.48	0.52	0.46	0.20	0.74	0.74	0.29
Annualized Downside Volatility (%)	15.73	15.97	19.01	11.66	13.33	18.53	13.73	13.73	12.67	13.43	14.28	23.40	11.91	12.89	16.54
Annualized Sortino Ratio (MAR = 5%)	1.04	0.89	0.14	1.26	0.81	0.23	1.04	1.04	0.58	0.70	0.58	0.20	0.99	0.89	0.28
Min Net Monthly Return (%)	-28.82	-24.69	-28.51	-15.79	-16.39	-23.35	-24.09	-24.09	-16.71	-22.61	-22.38	-37.03	-14.20	-18.54	-20.70
Max Net Monthly Return (%)	42.48	32.18	15.16	25.49	17.04	22.03	13.82	13.82	14.18	23.71	22.56	28.74	23.38	17.09	18.91
Max Net Drawdown (%)	-42.80	-42.23	-57.55	-55.61	-58.66	-75.94	-49.51	-49.51	-52.46	-55.49	-65.13	-77.56	-44.65	-45.56	-71.36
P-value, Ha: μ(j,k)>μ(m)	***0.11%***	***0.20%***		***0.36%***	***3.88%***		***2.01%***	***2.01%***		18.70%	25.41%		***1.69%***	***1.74%***	

Annualized net return is calculated by multiplying monthly returns by 12 and subtracting the annualized transaction costs. For a momentum strategy with holding period equal to K months, we assume annualized transaction costs equal to 12 * (0.3% / K). For holding a position in the market index, the annual fee is considered to be 0.3%. Annualized volatility is calculated by multiplying monthly standard deviation by sqrt (12). Annualized Sharpe ratio equals annualized net returns in excess of the Nibor 1-month rate divided by the annualized volatility. Annualized downside volatility is calculated by multiplying monthly downside deviation by sqrt (12), where the downside deviation is defined as the standard deviation of all negative net returns observed. Annualized Sortino ratio equals annualized net returns in excess of the Minimum Acceptable Return (MAR) divided by the annualized downside volatility. We report Min and Max monthly net returns, and Maximum net drawdowns. P-values are given for the hypothesis tests where we test whether monthly net returns on quantitative momentum strategy (J,K) are greater than monthly net returns on market index. P-values are computed using autocorrelation-consistent Newey-West standard errors.

5.3 *Seasonality Analysis of QMS(J12K3) (Nordic)*

Table 5-5 shows the seasonality analysis for QMS(J12K3) applied in the Nordic Market. We compare the non-seasonal portfolio (overlapping portfolio) with three different timing strategies: (i) rebalancing the momentum portfolio quarterly at the end of December, March, June and September, (ii) rebalancing at the end of January, April, July, and October; and (iii) rebalancing at the end of February, May, August and November.

Table 5-5 Seasonality Analysis of QMS(J12K3) in the Nordic Market

J	12	12	12	12
K	3	3	3	3
Rebalancing Period	Overlapping	Dec, Mar, Jun, Sep	Jan, Apr, Jul, Oct	Feb, May, Aug, Nov
Seasonality Analysis (Nordic)				
Annualized Net Return (%)	16.44	16.27	16.11	16.95
Annualized Volatility (%)	17.53	18.27	17.70	18.02
Annualized Sharpe Ratio	0.74	0.70	0.71	0.74
Annualized Downside Volatility (%)	13.67	13.52	12.73	12.89
Annualized Sortino Ratio (MAR = 5%)	0.84	0.83	0.87	0.93
Min Net Monthly Return (%)	-18.54	-20.06	-19.96	-15.60
Max Net Monthly Return (%)	17.09	15.16	15.52	23.24
Max Net Drawdown (%)	-62.09	-63.74	-65.90	-68.91
P-value, Ha: μ(season)>μ(overlapping)		57.69%	64.25%	28.18%

Annualized net return is calculated by multiplying monthly returns by 12 and subtracting the annualized transaction costs. For a momentum strategy with holding period equal to k months, we assume annualized transaction costs equal to 12 * (0.3% / K). For holding a position in the market index, the annual fee is considered to be 0.3%. Annualized volatility is calculated by multiplying monthly standard deviation by sqrt (12). Annualized Sharpe ratio equals annualized net returns in excess of the Nibor 1-month rate divided by the annualized volatility. Annualized downside volatility is calculated by multiplying monthly downside deviation by sqrt (12), where the downside deviation is defined as the standard deviation of all negative net returns observed. Annualized Sortino ratio equals annualized net returns in excess of the Minimum Acceptable Return (MAR) divided by the annualized downside volatility. We report Min and Max monthly net returns, and Maximum net drawdowns. P-values are given for the hypothesis tests where we test whether monthly net returns on quantitative momentum strategy (J12K3) with timed rebalancing are greater than monthly net returns on quantitative momentum strategy (J12K3) without attempting to time the portfolio rebalancing (overlapping portfolios). P-values are computed using autocorrelation-consistent Newey-West standard errors.

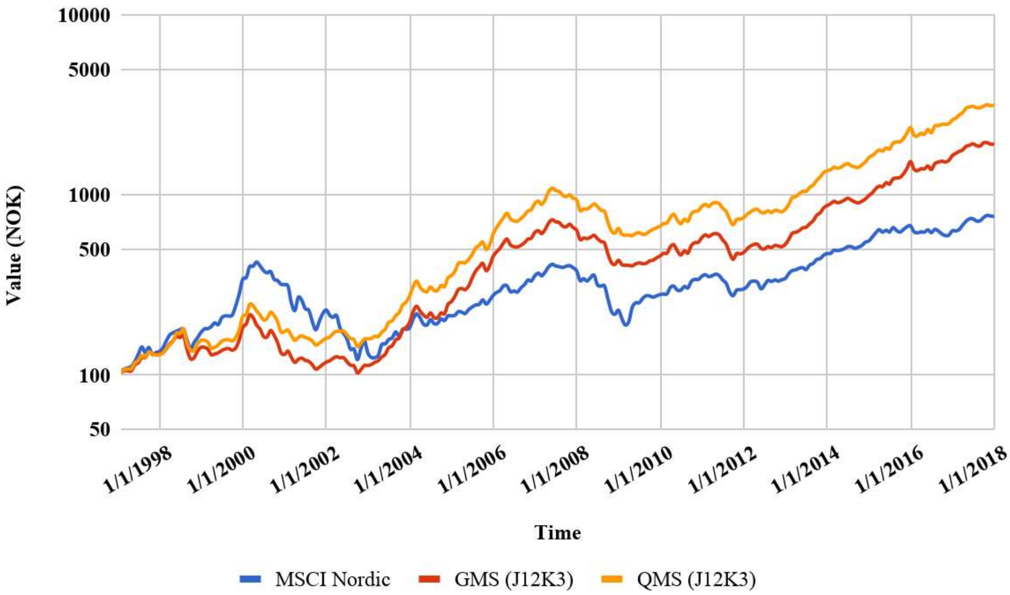
We find no evidence that timing the rebalancing of the momentum portfolios yields superior returns in the Nordic market. None of the seasonal strategies yields statistically significant higher average returns than the overlapping portfolio strategy. Furthermore, neither Norway nor Finland shows consistent evidence of seasonality effects. However, timing the portfolio rebalancing yields statistically significant higher results in Sweden and Denmark (Appendix 3). In Sweden, rebalancing the QMS(J12K3) on December, March, June and September yields an annual return of 17.76 per cent, an increase by 195 basis points from the return obtained by the QMS(J12K3) following the overlapping portfolio technique. On a risk-adjusted basis, the Sharpe ratio of QMS(J12K3) increases from 0.62 to 0.69 with timing the rebalancing. Its Sortino ratio increases from 0.78 to 0.91.

However, there is no improvement in terms of drawdown: the overlapping portfolio registers a maximum drawdown of -51.65 per cent versus -52.64 per cent with the seasonal strategy. In Denmark, the improvements from seasonality are even greater. By implementing the QMS(J12K3) with rebalancing at the end of February, May, August and November, the strategy achieves an annualized net return of 22.10 per cent, an outstanding improvement from the 19.32 per cent return achieved by its version using the overlapping portfolios. The seasonal portfolio also performs better in the risk-adjusted measures. Its Sharpe Ratio is 1.01 (compared to 0.88 for the overlapping portfolio), while its Sortino Ratio leaps from 0.88 (non-seasonal portfolio) to 1.24 (seasonal portfolio). The maximum drawdown is also improved with timing the rebalancing. The seasonal portfolio registers a maximum drawdown of -53.67 per cent while without timing the rebalancing the maximum drawdown was -68.93 per cent.

5.4 Analysis of Cumulative Performance

Figure 5-1 shows the cumulative performance of QMS(J12K3) compared to the GMS(J12K3) and the MSCI Nordic Index.

Figure 5-1 Value of 100 NOK Invested in the Nordic Market (Log Scale)



This figure presents the cumulative value for the QMS, GMS and the Market Index (Dec 1997-Dec 2017).

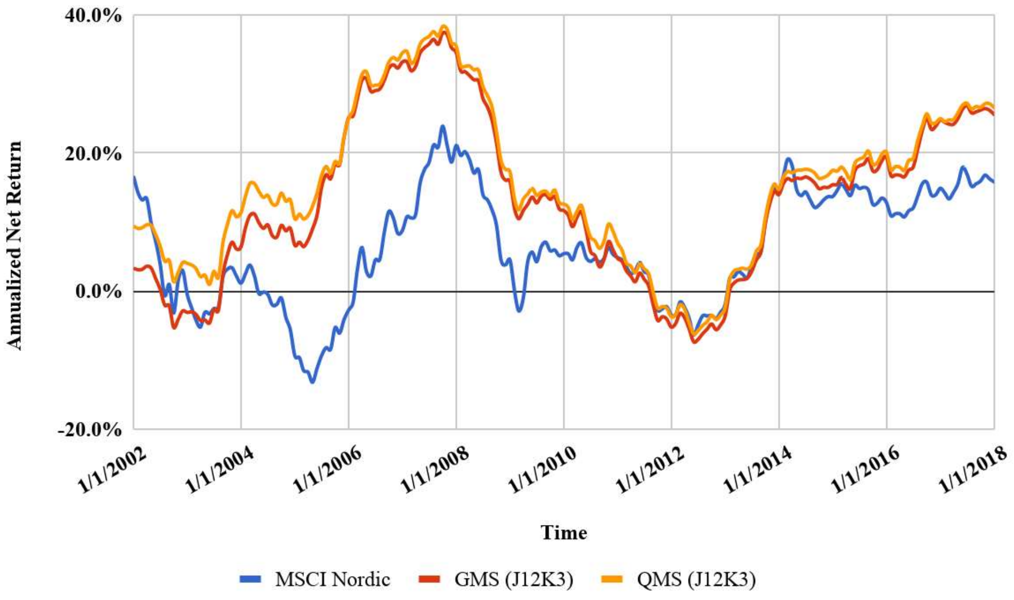
Figure 5-1 illustrates the effects of compounding 100 NOK invested over the whole testing period. The incremental advantages of the QMS(J12K3) lead to an impressive spread when compared to the passive benchmark, making the profits of the strategy in excess of four times the MSCI Nordic.

In a more nuanced analysis of the different markets, it becomes evident that the majority of the results are higher, making the profits even more impressive. For Sweden and Norway, the strategies are, on a cumulative basis, about six and eleven times as profitable as the passive benchmark (Appendix 4). For the top-performing market in Denmark, the result is staggering, leading to extraordinary profits about eight times the comparable passive benchmark.

Figures 5-2 and 5-3 show how consistently the QMS(J12K3) outperforms the MSCI Nordic Index in a 5-year and 10-year rolling window basis. Only in a few, rare occasions, it was preferable to invest in the index. Additionally, the QMS(J12K3) performs better than the GMS(J12K3) throughout the whole sample period for both the 5-year and 10-year rolling window.

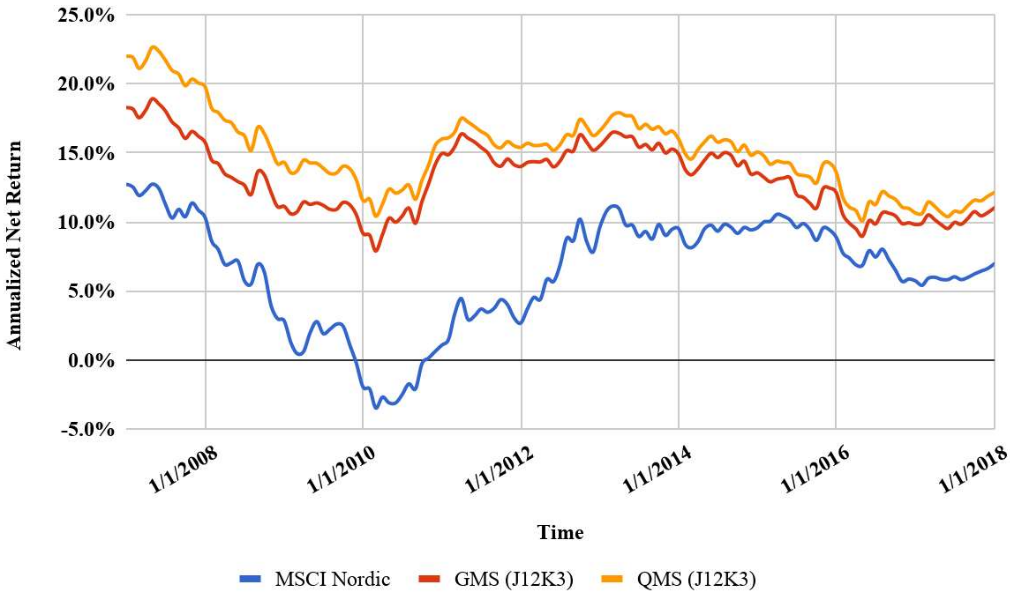
In the 5-year rolling window (Figure 5-2), the QMS(J12K3) suffers through a rough period with negative compound annual growth rate (CAGR) for investments started just ahead of the financial crisis in 2008-2009. However, if some lucky (or skilled) investor was fortunate enough to invest according to this strategy during 2001-2002, the QMS would really pay off in the bullish dot.com bubble, earning an average annual return superior to 20 per cent in the five-year investment horizon. Furthermore, scrutinising the 10-year rolling window, we see that both the QMS(J12K3) and the GMS(J12K3) are consistently profitable, with positive CAGR throughout the sample period, while the MSCI Nordic Index shows a brief period with negative annualized average net returns. This is an additional indication that the QMS(J12K3) is a sustainable idea for long-term investors if they persist with the discipline and ability to invest consistently in the strategy.

Figure 5-2 Five-Year Rolling Annualized Average Net Return, Nordic Market



Five-Year Rolling CAGR for the market index MSCI Nordic, QMS(J12K3) and GMS(J12K3) implemented in the Nordic Market.

Figure 5-3 Ten-Year Rolling Annualized Average Net Return, Nordic Market



Ten-Year Rolling CAGR for the market index MSCI Nordic, QMS(J12K3) and GMS(J12K3) implemented in the Nordic Market.

5.5 Robustness Analysis

To evaluate the level of robustness of the QMS(J12K3), we evaluate the maximum drawdowns and run regressions on well-accepted asset pricing models. The regressions help to discover what explains the returns from the QMS(J12K3) and explore if the QMS(J12K3) deliver excessive returns (alpha), which would make the strategy even more attractive.

5.5.1 Drawdown Analysis

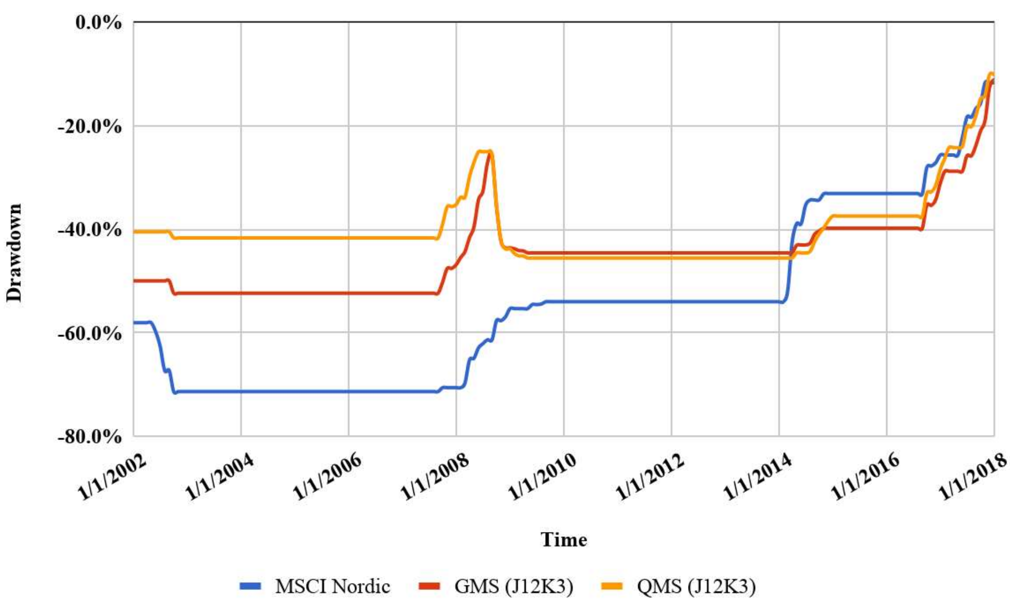
The maximum drawdown is defined as the maximum peak to trough loss an investor would face if he invested in the strategy during a determined time period. As Table 5-2 showed, the maximum drawdown of the QMS(J12K3) and the market index was -45.56 per cent and -71.36 per cent, respectively. In Figure 5-4 and 5-5, we identify how large maximum drawdowns the QMS(J12K3) and the market index experience over a 5-year and 10-year investment horizon.

Appendix 6 presents the 5-year and 10-year maximum drawdown rolling windows for each separate country. The figures in the Appendix showcase similar results as the QMS(J12K3) in the Nordic Market.

With a 5-year rolling perspective (Figure 5-4), it becomes apparent that from the beginning of the sample period until 2014, the QMS(J12K3) had a highly favourable exposure towards maximum drawdowns compared to the relative market index. For the last four years, the story is inverted and the passive benchmark stands out as the investment vehicle that protects capital slightly better. Another interesting observation is the decrease in maximum drawdowns during the recent years, which confirms the favourable long bull market (with low volatility) that investors have enjoyed.

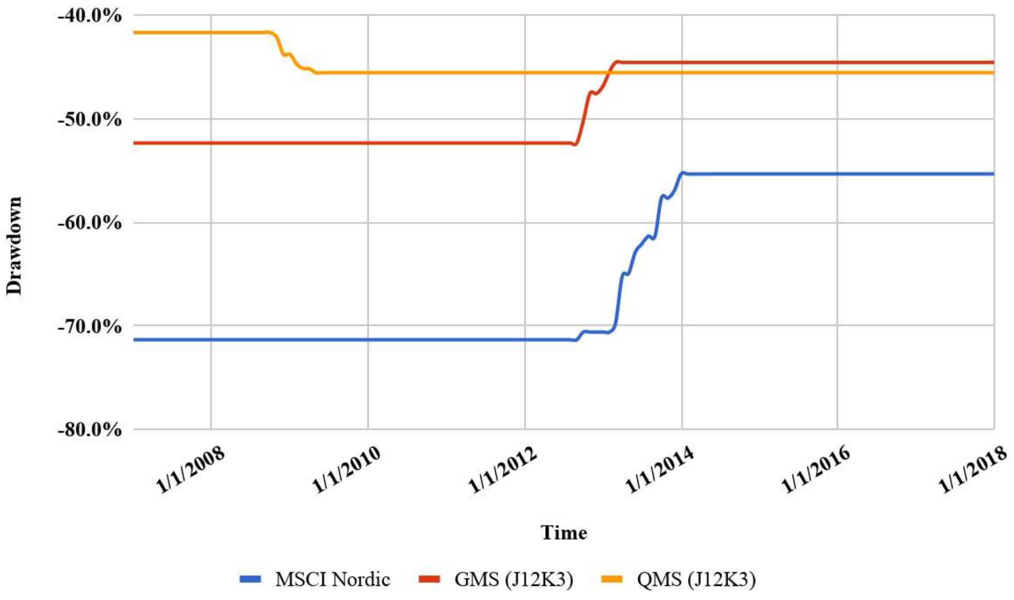
Extending the perspective to a 10-year rolling window (Figure 5-5), we see that the QMS(J12K3) outperform the index in the whole sample period. This suggests that the longer horizon the investor have, the more sustainable the QMS(J12K3) is.

Figure 5-4 Five-Year Rolling Maximum Net Drawdown, Nordic Market



Five-Year Rolling Max Drawdown for the market index MSCI Nordic, QMS(J12K3) and GMS(J12K3) implemented in the Nordic Market.

Figure 5-5 Ten-Year Rolling Maximum Net Drawdown, Nordic Market



Ten-Year Rolling Max Drawdown for the market index MSCI Nordic, QMS(J12K3) and GMS(J12K3) implemented in the Nordic Market.

5.5.2 Regression Analysis

This section revolves around the regression analysis and if the QMS(J12K3) creates excess return after we control for the most accepted risk factors in the finance literature. The regression analysis is performed using asset pricing models in an attempt to determine how the returns from the QMS(J12K3) can be explained and to verify if any of the QMS(J12K3) delivers alpha. Over the whole sample period, we find that the QMS(J12K3) delivers positive and significant alphas when CAPM and Fama & French 3-factor model (FF3) are used (Table 5-6). Roughly 9 per cent remains unexplained by the exposures to the market, size and value factors. Furthermore, after controlling for the Carhart 4-factor model, the QMS(J12K3) delivers a smaller, although significant annual alpha of 5.6 per cent. This suggests that part of the return that is not explained by the FF3 is captured by the momentum factor WML. However, it is evident that the model is not fully able to explain the returns of the strategy. A beta close to one for MKTRF indicates that the strategy moves with the market, which is expected due to the long-only feature of the strategy. The QMS(J12K3) loads positively on all factors, with HML acting as the smallest coefficient. With values close to zero (0.08 for FF3 and 0.28 for Carhart 4-factor), the QMS(J12K3) and the value factor seem to complement each other in terms of diversification benefits. The proportion of variation in observed returns that is explained by the Carhart 4-factor model is 67.8 per cent, thus exhibiting a high explanatory power.

Table 5-6 Asset Pricing Coefficient Estimates for the Quantitative Momentum Strategy (J12K3) - Nordic, 29 December 1996 to 29 December 2017

	Annual Alpha	MKTRF	SMB	HML	WML	N	R-squared	Adj R-Squared
CAPM	9.2%	0.61				252	53.9%	53.7%
	(3.44)	**(11.67)**						
FF3	8.9%	0.83	0.57	0.08		252	60.7%	60.2%
	(3.61)	**(12.98)**	**(5.89)**	**(2.38)**				
Carhart	5.6%	0.95	0.66	0.28	0.31	252	68.4%	67.8%
	(2.38)	**(16.42)**	**(7.05)**	**(4.19)**	**(6.04)**			

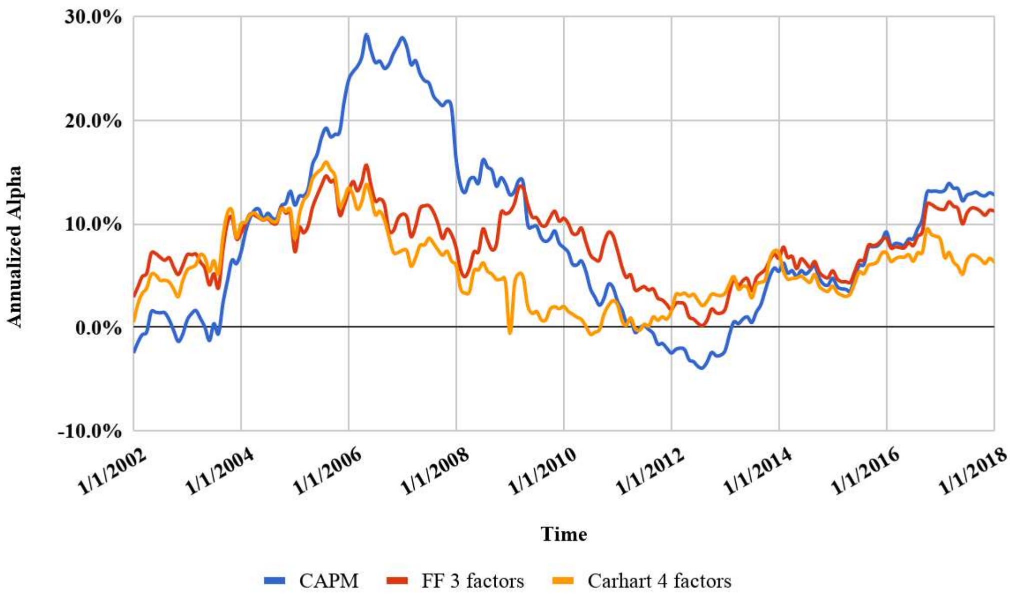
This table reports estimates from ordinary least squares regressions of the excess net returns on QMS(J12K3) using the CAPM, Fama-French 3-factor and Carhart 4-factor models in the Nordic market. The return of QMS(J12K3), net of transaction costs, in excess of the Nibor 1-month rate is dependable variable. The risk factors MKTRF, SMB, HML and WML are independent variables. MKTRF is defined as the market return in excess of the Nibor 1-month rate. SMB and HML are the risk factors related to the size and value effects as defined in Fama & French (1993). WML is the risk factor related to the momentum effect as described in Carhart (1997). Annual alpha corresponds to the alpha estimated by the regression multiplied by 12. N is the number of observations. The sample contains all firms included in the Nordic investable universe as described in Figure 3-1. T-statistics are reported in parentheses and are computed using autocorrelation-consistent Newey-West standard errors. All coefficients statistically significant at the 5% level are reported in bold.

For a more extensive understanding of the alphas, and to verify if the strategies delivered alpha in a 5-year and 10-year investment horizon, we perform a rolling window regression (Figure 5-6 & 5-7).

Considering the 5-year rolling window adjusted for the Carhart model (Figure 5-6), the QMS(J12K3) has delivered positive alpha for 5-year investments during the majority of the sample period. The exception is the period between January 2009 and January 2012, when the alpha is below zero in few occasions. This result shows that the QMS(J12K3) does not work all the time, at least not within a 5-year investment perspective.

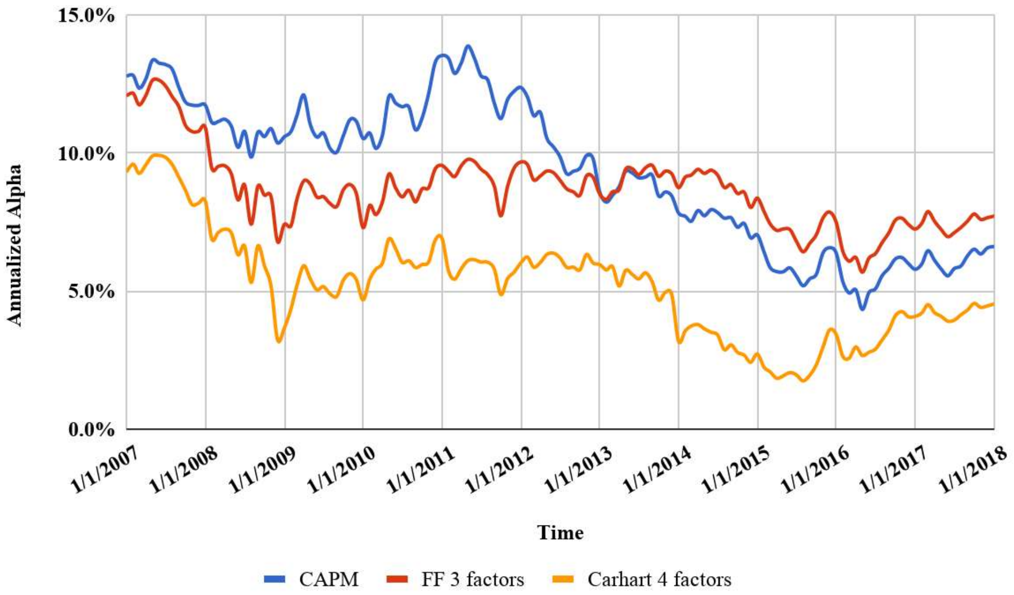
Extending the perspective with a 10-year rolling window (Figure 5-7), the QMS(J12K3) yielded consistently positive alphas throughout the sample period, which add strength to the sustainability of the strategy. The tested factors, including the WML, were unable to explain the QMS(J12K3) excessive returns. However, the values of the positive alphas seem to be trending downwards. This decreasing pattern could be coincidental or a natural fluctuation (shown if the sample period was larger), or it could be a sign of a diminishing momentum effect.

Figure 5-6 Five-Year Rolling Annualized Alpha, Nordic Market



Five-Year Rolling Alpha for the QMS(J12K3) implemented in the Nordic market. Annualized alphas correspond to the alphas estimated by the rolling regressions multiplied by 12

Figure 5-7 Ten-Year Rolling Annualized Alpha, Nordic Market



Ten-Year Rolling Alpha for the QMS(J12K3) implemented in the Nordic market. Annualized alphas correspond to the alphas estimated by the rolling regressions multiplied by 12

6 CONCLUSION

The main goal of this thesis was to determine if an average investor, resident or domiciled in Norway, would outperform the market by implementing a momentum strategy. We applied the long-only Quantitative Momentum Strategy (Gray & Vogel, 2016) to the combined Nordic market and compared its performance with the MSCI Nordic Index during the period from January 1996 to December 2017. Similar performance analysis was carried out for the Norwegian, Swedish, Danish and Finnish markets.

For the Nordic market, we found that the GMS with holding period one month yield higher net returns than the MSCI Nordic index, regardless of the formation period. The GMS, however, did not deliver similar consistent results when considering each country separately. The QMS in the Nordic market with holding periods one, three and six months outperformed the market index, for all formation periods. When applied to the different countries, the QMS also outperformed the benchmarks (except for Finland) for different combinations of formation and holding periods. The QMS(J12K3) was the only strategy that consistently outperformed the MSCI indices across the Norwegian, Swedish, Danish and Nordic markets. Furthermore, the QMS yielded higher net returns than the GMS for any combination of formation and holding periods when applied to all markets, except Finland.

The average investor would not benefit from enhanced average returns if he tried to time the rebalancing of his momentum portfolio when implementing the QMS(J12K3) in the Norwegian, Finnish and combined Nordic markets. However, we found that timing the rebalancing in Sweden and Denmark would have paid off for the investor. If the investor decided to rebalance his Swedish portfolio at the end of December, March, June and September, he would have achieved an annual return of 17.76 per cent, an increase by 195 basis points from the return he would have earned by having a seasonality-agnostic approach to the Swedish market. In Denmark, the improvements from seasonality are even greater. By implementing the rebalancing at the end of February, May, August and November, the investor would have earned an annualized net return of 22.10 per cent, an outstanding improvement from the 19.32 per cent return from the seasonality-agnostic portfolio.

We found that momentum rewards the patient and disciplined investor. The QMS(J12K3) outperforms the MSCI Nordic Index in a 5-year and 10-year rolling window basis. Only in a few, rare occasions, the investor would benefit more from investing in the passive index. Furthermore, the investor would enjoy positive average returns regardless when he started his investment, as long as he held it for 10 years in the Nordic Market. The fact that the QMS(J12K3) outperforms the benchmark in a 5-year and 10-year rolling window basis and the QMS(J12K3) always delivers positive average returns for 10-year investment horizon are applicable for Norway, Sweden, Denmark and Finland as well. The drawdown analysis showed that the momentum strategies are not immune from experiencing large drawdowns. The investor would experience a max drawdown of -45.56 per cent if he invested according to the QMS(J12K3) in the Nordic Market from December 1997 to December 2017. If he had invested in MSCI Nordic Index, the situation would have been even worse due to the market index maximum drawdown of -71.36 per cent during the same period. When we considered a 5-year rolling window, the QMS(J12K3) registered worse drawdowns than the market index only in some few occasions for all markets. For the 10-year rolling window, the QMS(J12K3) outperformed the market index throughout the entire sample period.

Severe drawdowns are well documented in the momentum literature and they could be addressed in different ways. A suggestion for extended research from our work is to address hedging strategies for the QMS. We have identified three main fronts researchers are examining to reduce the risk and downside of long-only momentum strategies. First, hedging can be performed by attempting to predict the downturns in the market. Gray & Vogel (2016) suggest using trend indicators, such as moving averages, in the broad market as signals to take long positions in a momentum strategy or go to cash (or short the market index). Their hedging strategy is basically to use two trend indicators that signal when one should go cash/short index. In summary, their hedging model seeks to minimize large drawdowns via trend-following. Faber (2017) also has a similar approach using moving averages to signal when to go cash. Second, a portfolio based on the value investing philosophy can be used as hedging instrument due to the historical negative correlation value has with momentum, as it is pointed out by both Gray & Vogel (2016) and Asness (2013). A third and more complex way of handling the drawdown issue would be to use an alternative way of weighing the stocks into the momentum portfolio. Moreira & Muir (2017) suggest that using a volatility-based weighting scheme (volatility managed portfolio) in the momentum portfolio can reduce risk, increase Sharpe Ratios and reduce drawdowns. Barroso & Santa-Clara (2015) study volatility timing related to momentum crashes and find evidence of exceptional performance for strategies (long-short) that manage to avoid large momentum crashes due to the adoption of volatility timing.

Another suggestion for future research is to test different momentum strategies available in the literature in the Nordic Markets, and compare their performance with the results we reported in this thesis. Besides the QMS, the Dual Momentum (Antonacci, 2017) and the Residual Momentum Strategy (Blitz, Hanauer & Vidojevic, 2017) stand out as recent discoveries that could be implemented in the Nordics.

Finally, we found that the QMS(J12K3) produced a positive and significant annual alpha of 5.6 per cent after employing the CAPM, Fama & French 3-factor model and Carhart 4-factor model. Considering the 5-year rolling window, the QMS(J12K3) delivered positive alpha for 5-year investments during the majority of the sample period. This result showed that the QMS(J12K3) did not work all the time, at least not within a 5-year investment perspective. The 10-year rolling window revealed that the QMS(J12K3) yielded positive alphas throughout the whole sample period. This conclusion is valid for all markets except Finland, which showed no significant alpha.

Do our results prove as a sound prediction for future strategies? Will the momentum anomaly persist? Nobody knows, but a sceptical investor would claim that “you cannot drive forward while looking through a rearview mirror”. In that regard, the only conclusion we really can draw is that the QMS(J12K3) was highly profitable during the sample period we tested. However, based on our analysis, we claim that the strategy yield consistent and sustainable results, which suggests that it may be a profitable strategy for the future as well. To remain sustainable as an active investment strategy, the QMS require both a mispricing component and a costly arbitrage one. We have a firm belief that investors will continue to suffer from irrationality, leading to underreaction of news and possibilities to exploit the preference for lottery-like assets and limited attention in the future. Additionally, even though it is reasonable to expect that the area of automatized strategies will continue its growth, we believe it is likely that the "career risk" premium will persist. Does this entail that the strategy serves as a fit for all investors? Most certainly not. If an investor seeks returns with low or no exposure towards the market, the QMS is not likely to be among his/her top picks. To withstand the high volatility and possible large drawdowns of the strategy, and to exploit the long-term compound growth average, we want to emphasize the importance of having a long-term horizon as the main focus. Risk should be considered as secondary when applying the strategy. With all these features in mind, we believe the investors may enjoy the profitability and significant outperformance of the Quantitative Momentum Strategy in the Nordic markets.

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APPENDIX 1 - SUMMARY STATISTICS OF MOMENTUM MONTHLY RETURNS

Table A1-0-1 Summary Statistics of Monthly Log Return Distributions for Portfolios with Formation Period J Months and Holding Period K Months, Norway

J	3	3	3	3	3	6	6	6	6	6	9	9	9	9	9	12	12	12	12	12	MSCI NO	Nibor 1M
K	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12		
Panel A: Generic Momentum Portfolios (Norway)																						
Mean	0.011	0.010	0.008	0.008	0.007	0.011	0.011	0.011	0.010	0.008	0.014	0.014	0.012	0.010	0.008	0.015	0.014	0.011	0.009	0.008	0.006	0.003
Std Dev	0.068	0.064	0.061	0.060	0.060	0.066	0.065	0.062	0.061	0.060	0.063	0.063	0.062	0.060	0.059	0.065	0.064	0.062	0.060	0.059	0.063	0.002
t-stat	2.558	2.463	2.082	2.119	1.856	2.643	2.676	2.845	2.722	2.227	3.463	3.434	3.117	2.708	2.282	3.598	3.371	2.790	2.322	2.070	1.623	25.114
Median	0.013	0.011	0.009	0.014	0.011	0.012	0.013	0.015	0.012	0.009	0.015	0.017	0.013	0.011	0.011	0.015	0.011	0.011	0.011	0.011	0.012	0.002
Min	-0.221	-0.291	-0.282	-0.266	-0.275	-0.321	-0.310	-0.290	-0.273	-0.298	-0.316	-0.306	-0.288	-0.286	-0.309	-0.269	-0.273	-0.282	-0.291	-0.302	-0.285	0.001
Max	0.268	0.222	0.188	0.181	0.197	0.249	0.168	0.172	0.195	0.173	0.257	0.216	0.239	0.229	0.185	0.294	0.273	0.227	0.197	0.182	0.152	0.007
Skewness	0.065	-0.669	-0.902	-0.887	-0.933	-0.477	-0.835	-0.782	-0.777	-0.963	-0.319	-0.623	-0.547	-0.673	-0.972	0.040	-0.267	-0.505	-0.748	-0.886	-1.322	0.615
Kurtosis	4.742	5.739	6.097	5.598	6.098	6.459	5.922	5.630	5.650	6.356	6.545	6.108	5.995	6.164	7.007	5.987	5.561	5.679	6.218	6.843	7.353	1.982
Panel B: Quantitative Momentum Portfolios (Norway)																						
Mean	0.012	0.012	0.010	0.010	0.008	0.013	0.013	0.014	0.012	0.010	0.016	0.015	0.013	0.012	0.010	0.018	0.016	0.013	0.011	0.010	0.006	0.003
Std Dev	0.068	0.061	0.061	0.059	0.059	0.069	0.066	0.063	0.062	0.062	0.072	0.066	0.064	0.061	0.059	0.070	0.066	0.064	0.063	0.061	0.063	0.002
t-stat	2.708	3.095	2.556	2.555	2.273	3.079	3.037	3.383	3.058	2.580	3.499	3.554	3.276	3.097	2.800	4.029	3.839	3.185	2.691	2.565	1.623	25.114
Median	0.014	0.012	0.012	0.013	0.012	0.017	0.016	0.015	0.014	0.012	0.012	0.012	0.014	0.014	0.014	0.017	0.016	0.014	0.015	0.013	0.012	0.002
Min	-0.195	-0.267	-0.270	-0.248	-0.251	-0.331	-0.339	-0.295	-0.267	-0.301	-0.310	-0.271	-0.252	-0.253	-0.276	-0.288	-0.247	-0.281	-0.306	-0.311	-0.285	0.001
Max	0.215	0.151	0.166	0.179	0.200	0.234	0.194	0.212	0.230	0.208	0.439	0.319	0.310	0.238	0.191	0.425	0.322	0.258	0.203	0.198	0.152	0.007
Skewness	-0.001	-0.575	-0.838	-0.826	-0.892	-0.573	-0.859	-0.550	-0.554	-0.905	0.374	-0.005	0.001	-0.331	-0.650	0.592	0.083	-0.339	-0.656	-0.774	-1.322	0.615
Kurtosis	3.680	4.713	5.609	5.360	5.963	6.522	6.777	6.178	6.158	7.041	9.269	6.395	6.216	5.683	6.167	8.700	6.071	5.875	6.423	6.906	7.353	1.982

Table A1-0-2 Summary Statistics of Monthly Log Return Distributions for Portfolios with Formation Period J Months and Holding Period K Months, Sweden

J	3	3	3	3	3	6	6	6	6	6	9	9	9	9	9	12	12	12	12	12	MSCI SE	Nibor 1M
K	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12		
Panel A: Generic Momentum Portfolios (Sweden)																						
Mean	0.013	0.013	0.011	0.009	0.008	0.015	0.013	0.011	0.009	0.008	0.012	0.012	0.010	0.008	0.007	0.012	0.011	0.010	0.008	0.007	0.008	0.003
Std Dev	0.064	0.062	0.060	0.059	0.059	0.064	0.061	0.059	0.058	0.058	0.060	0.059	0.058	0.058	0.059	0.059	0.058	0.058	0.059	0.060	0.067	0.002
t-stat	3.261	3.275	2.892	2.437	2.204	3.653	3.371	2.945	2.557	2.127	3.161	3.092	2.787	2.327	2.001	3.128	3.020	2.594	2.124	1.872	1.847	25.114
Median	0.015	0.020	0.020	0.019	0.016	0.017	0.019	0.021	0.018	0.016	0.019	0.020	0.019	0.017	0.015	0.020	0.020	0.017	0.017	0.016	0.011	0.002
Min	-0.190	-0.142	-0.170	-0.190	-0.182	-0.148	-0.161	-0.160	-0.176	-0.166	-0.170	-0.173	-0.164	-0.185	-0.216	-0.185	-0.166	-0.208	-0.241	-0.266	-0.234	0.001
Max	0.359	0.319	0.234	0.206	0.205	0.316	0.241	0.188	0.184	0.189	0.244	0.209	0.167	0.160	0.178	0.210	0.147	0.149	0.165	0.195	0.220	0.007
Skewness	0.554	0.482	-0.021	-0.283	-0.318	0.698	0.133	-0.243	-0.385	-0.430	-0.073	-0.292	-0.491	-0.593	-0.582	-0.296	-0.506	-0.682	-0.758	-0.692	-0.542	0.615
Kurtosis	6.717	5.649	4.278	3.868	3.865	6.049	4.512	3.725	3.583	3.755	4.143	3.692	3.480	3.810	4.185	3.620	3.331	3.858	4.505	4.970	4.609	1.982
Panel B: Quantitative Momentum Portfolios (Sweden)																						
Mean	0.011	0.014	0.012	0.011	0.010	0.016	0.015	0.013	0.012	0.010	0.016	0.014	0.012	0.010	0.009	0.012	0.013	0.012	0.011	0.010	0.008	0.003
Std Dev	0.061	0.061	0.057	0.056	0.056	0.061	0.059	0.056	0.055	0.055	0.061	0.057	0.057	0.056	0.057	0.058	0.057	0.058	0.059	0.060	0.067	0.002
t-stat	2.957	3.687	3.400	3.029	2.829	4.264	4.060	3.724	3.417	2.952	4.174	3.894	3.348	2.959	2.640	3.406	3.656	3.321	2.875	2.543	1.847	25.114
Median	0.013	0.019	0.021	0.019	0.018	0.016	0.018	0.020	0.020	0.018	0.016	0.018	0.018	0.017	0.018	0.020	0.020	0.018	0.017	0.016	0.011	0.002
Min	-0.150	-0.143	-0.162	-0.168	-0.159	-0.158	-0.168	-0.152	-0.148	-0.153	-0.164	-0.147	-0.158	-0.164	-0.206	-0.180	-0.164	-0.190	-0.222	-0.250	-0.234	0.001
Max	0.298	0.351	0.228	0.192	0.190	0.255	0.215	0.169	0.167	0.177	0.232	0.178	0.164	0.163	0.170	0.189	0.170	0.162	0.187	0.227	0.220	0.007
Skewness	0.374	0.694	0.009	-0.258	-0.319	0.432	-0.012	-0.298	-0.369	-0.405	0.293	-0.282	-0.428	-0.560	-0.582	-0.298	-0.394	-0.546	-0.644	-0.551	-0.542	0.615
Kurtosis	5.346	6.961	4.242	3.649	3.677	4.423	3.819	3.317	3.324	3.558	4.537	3.294	3.278	3.680	4.198	3.521	3.295	3.814	4.631	5.168	4.609	1.982

Table A1-0-3 Summary Statistics of Monthly Log Return Distributions for Portfolios with Formation Period J Months and Holding Period K Months, Denmark

J	3	3	3	3	3	6	6	6	6	6	9	9	9	9	9	12	12	12	12	12	MSCI DK	Nibor 1M
K	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12		
Panel A: Generic Momentum Portfolios (Denmark)																						
Mean	0.010	0.011	0.010	0.010	0.009	0.013	0.012	0.011	0.010	0.009	0.013	0.013	0.012	0.010	0.009	0.014	0.013	0.011	0.010	0.009	0.010	0.003
Std Dev	0.052	0.049	0.046	0.045	0.046	0.051	0.047	0.046	0.046	0.046	0.051	0.048	0.048	0.048	0.048	0.048	0.049	0.048	0.049	0.049	0.052	0.002
t-stat	3.142	3.716	3.560	3.369	3.009	4.171	4.105	3.883	3.464	3.071	4.155	4.271	3.904	3.403	2.970	4.523	4.296	3.672	3.248	2.914	3.113	25.114
Median	0.007	0.012	0.011	0.009	0.010	0.011	0.011	0.012	0.010	0.010	0.012	0.011	0.012	0.014	0.012	0.013	0.012	0.013	0.014	0.012	0.013	0.002
Min	-0.201	-0.166	-0.148	-0.144	-0.166	-0.211	-0.160	-0.139	-0.150	-0.167	-0.146	-0.127	-0.163	-0.176	-0.203	-0.165	-0.218	-0.218	-0.229	-0.240	-0.167	0.001
Max	0.149	0.150	0.152	0.143	0.138	0.187	0.191	0.175	0.160	0.146	0.238	0.212	0.184	0.147	0.138	0.165	0.177	0.147	0.143	0.137	0.142	0.007
Skewness	-0.132	-0.106	-0.319	-0.404	-0.626	-0.256	-0.173	-0.242	-0.482	-0.650	0.158	0.050	-0.352	-0.602	-0.848	-0.350	-0.532	-0.754	-0.928	-1.066	-0.511	0.615
Kurtosis	3.820	3.797	3.984	3.961	4.493	4.782	4.359	4.418	4.578	4.712	4.652	4.441	4.734	4.590	5.239	3.846	5.423	5.347	5.724	6.336	3.739	1.982
Panel B: Quantitative Momentum Portfolios (Denmark)																						
Mean	0.009	0.012	0.011	0.010	0.010	0.014	0.014	0.013	0.011	0.010	0.012	0.014	0.014	0.012	0.010	0.017	0.016	0.014	0.013	0.012	0.010	0.003
Std Dev	0.053	0.049	0.046	0.045	0.045	0.051	0.049	0.047	0.047	0.048	0.056	0.051	0.049	0.050	0.049	0.053	0.052	0.051	0.051	0.051	0.052	0.002
t-stat	2.557	3.809	3.871	3.657	3.330	4.292	4.438	4.436	3.820	3.312	3.554	4.433	4.409	3.845	3.384	5.085	4.921	4.413	4.034	3.585	3.113	25.114
Median	0.007	0.012	0.013	0.009	0.011	0.014	0.013	0.013	0.013	0.012	0.014	0.015	0.015	0.015	0.014	0.017	0.016	0.015	0.017	0.015	0.013	0.002
Min	-0.126	-0.137	-0.137	-0.152	-0.161	-0.132	-0.135	-0.154	-0.159	-0.194	-0.180	-0.147	-0.161	-0.189	-0.202	-0.150	-0.241	-0.247	-0.258	-0.272	-0.167	0.001
Max	0.203	0.169	0.146	0.140	0.126	0.161	0.161	0.131	0.120	0.117	0.179	0.176	0.131	0.115	0.124	0.161	0.138	0.123	0.122	0.130	0.142	0.007
Skewness	0.349	0.105	-0.308	-0.429	-0.794	-0.083	-0.244	-0.422	-0.738	-0.983	-0.241	-0.173	-0.528	-0.668	-0.862	-0.144	-0.743	-0.931	-1.030	-1.154	-0.511	0.615
Kurtosis	3.513	4.011	3.892	4.176	4.851	3.400	3.662	3.773	4.425	5.246	3.892	3.728	3.945	4.280	4.885	3.630	5.247	5.586	6.353	7.312	3.739	1.982

Table A1-0-4 Summary Statistics of Monthly Log Return Distributions for Portfolios with Formation Period J Months and Holding Period K Months, Finland

J	3	3	3	3	3	6	6	6	6	6	9	9	9	9	9	12	12	12	12	12	MSCI FI	Nibor 1M
K	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12		
Panel A: Generic Momentum Portfolios (Finland)																						
Mean	0.011	0.011	0.010	0.010	0.009	0.012	0.012	0.011	0.010	0.009	0.013	0.012	0.011	0.010	0.008	0.012	0.011	0.010	0.008	0.008	0.008	0.003
Std Dev	0.065	0.062	0.058	0.055	0.056	0.068	0.064	0.060	0.058	0.058	0.064	0.061	0.060	0.060	0.059	0.061	0.061	0.060	0.061	0.061	0.086	0.002
t-stat	2.602	2.839	2.717	2.742	2.474	2.836	2.951	2.989	2.820	2.436	3.176	3.173	2.884	2.577	2.196	3.036	2.879	2.627	2.169	1.996	1.475	25.114
Median	0.009	0.011	0.012	0.009	0.010	0.009	0.015	0.014	0.012	0.010	0.013	0.016	0.014	0.011	0.009	0.012	0.011	0.010	0.009	0.009	0.017	0.002
Min	-0.155	-0.179	-0.197	-0.176	-0.181	-0.205	-0.215	-0.209	-0.220	-0.209	-0.212	-0.227	-0.273	-0.270	-0.252	-0.215	-0.228	-0.273	-0.277	-0.282	-0.370	0.001
Max	0.473	0.365	0.306	0.251	0.250	0.399	0.336	0.272	0.268	0.252	0.259	0.250	0.264	0.246	0.223	0.225	0.223	0.225	0.207	0.201	0.287	0.007
Skewness	1.426	0.590	0.048	-0.106	-0.169	0.853	0.094	-0.137	-0.149	-0.362	0.136	-0.149	-0.288	-0.420	-0.591	0.081	-0.168	-0.416	-0.568	-0.734	-0.468	0.615
Kurtosis	12.419	7.621	6.170	4.702	4.890	8.461	6.668	5.148	5.257	5.301	4.372	4.944	5.920	5.880	5.837	4.490	4.699	5.477	5.854	6.415	5.507	1.982
Panel B: Quantitative Momentum Portfolios (Finland)																						
Mean	0.008	0.010	0.009	0.009	0.008	0.010	0.010	0.011	0.011	0.010	0.011	0.012	0.012	0.010	0.009	0.009	0.011	0.010	0.009	0.008	0.008	0.003
Std Dev	0.068	0.060	0.056	0.053	0.053	0.073	0.066	0.060	0.057	0.058	0.067	0.061	0.059	0.059	0.060	0.067	0.061	0.062	0.063	0.064	0.086	0.002
t-stat	1.923	2.645	2.474	2.651	2.417	2.150	2.421	2.905	3.082	2.619	2.563	3.134	3.121	2.777	2.241	2.056	2.866	2.455	2.253	2.012	1.475	25.114
Median	0.010	0.013	0.015	0.012	0.010	0.012	0.008	0.016	0.014	0.012	0.014	0.014	0.015	0.013	0.012	0.010	0.012	0.013	0.010	0.011	0.017	0.002
Min	-0.187	-0.199	-0.199	-0.203	-0.204	-0.277	-0.224	-0.198	-0.213	-0.229	-0.226	-0.226	-0.260	-0.297	-0.294	-0.225	-0.224	-0.273	-0.287	-0.324	-0.370	0.001
Max	0.420	0.242	0.228	0.173	0.189	0.484	0.344	0.263	0.274	0.249	0.306	0.237	0.274	0.277	0.235	0.315	0.226	0.224	0.240	0.234	0.287	0.007
Skewness	0.802	-0.110	-0.419	-0.443	-0.504	0.877	0.141	-0.226	-0.102	-0.389	0.104	-0.002	-0.116	-0.338	-0.652	0.083	-0.208	-0.523	-0.614	-0.839	-0.468	0.615
Kurtosis	8.047	4.784	5.110	4.060	4.371	10.739	6.457	5.164	5.252	5.271	4.743	4.254	5.853	7.113	6.821	5.000	4.219	5.659	6.927	7.638	5.507	1.982

APPENDIX 2 - PERFORMANCE ANALYSIS OF MOMENTUM STRATEGIES

Table A2-0-1 Performance Analysis of Momentum Strategies, Norway

J	3	3	3	3	3	6	6	6	6	6	9	9	9	9	9	12	12	12	12	12	MSCI NO	Nibor 1M
K	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12		
Panel A: Generic Momentum Portfolios (Norway)																						
Anlzd. Net Return (%)	13.11	11.84	9.64	9.60	8.36	13.25	13.10	13.42	12.53	10.07	16.59	16.23	14.50	12.33	10.18	17.70	16.29	12.98	10.58	9.25	7.73	3.55
Anlzd. Volatility (%)	23.48	22.04	21.21	20.75	20.64	22.98	22.44	21.61	21.10	20.73	21.96	21.66	21.32	20.87	20.45	22.54	22.14	21.32	20.88	20.48	21.83	0.65
Anlzd. Sharpe Ratio	0.41	0.38	0.29	0.29	0.23	0.42	0.43	0.46	0.43	0.31	0.59	0.59	0.51	0.42	0.32	0.63	0.58	0.44	0.34	0.28	0.19	
Anlzd. Downside Volatility (%)	15.96	17.51	17.43	16.93	17.24	17.91	18.63	17.55	17.37	17.73	15.64	16.79	16.91	17.19	17.65	15.56	16.43	16.69	17.28	17.46	19.01	
Anlzd. Sortino Ratio (MAR = 5%)	0.51	0.39	0.27	0.27	0.19	0.46	0.43	0.48	0.43	0.29	0.74	0.67	0.56	0.43	0.29	0.82	0.69	0.48	0.32	0.24	0.14	
Min Net Monthly Return (%)	-22.11	-29.12	-28.19	-26.59	-27.54	-32.10	-30.99	-29.04	-27.28	-29.81	-31.64	-30.63	-28.78	-28.56	-30.86	-26.92	-27.30	-28.15	-29.09	-30.21	-28.51	0.05
Max Net Monthly Return (%)	26.79	22.25	18.84	18.13	19.68	24.92	16.81	17.15	19.48	17.26	25.70	21.57	23.92	22.90	18.53	29.38	27.34	22.73	19.69	18.23	15.16	0.73
Max Net Drawdown (%)	-59.42	-55.02	-57.88	-58.24	-59.24	-49.68	-49.56	-50.39	-51.35	-52.49	-43.57	-44.33	-46.11	-49.32	-52.50	-46.49	-46.02	-48.56	-51.65	-52.64	-57.55	
P-value, Ha: μ(j,k)>μ(m)	8.20%	9.74%	25.13%	25.13%	40.65%	6.85%	5.82%	***3.88%***	5.81%	20.31%	***0.74%***	***0.76%***	***2.32%***	7.26%	20.09%	***0.66%***	***1.08%***	6.17%	18.28%	30.33%		
Panel B: Quantitative Momentum Portfolios (Norway)																						
Anlzd. Net Return (%)	13.90	14.19	11.72	11.49	10.18	15.94	15.23	16.23	14.40	12.04	18.98	17.68	15.80	14.36	12.59	21.35	19.17	15.36	12.73	11.90	7.73	3.55
Anlzd. Volatility (%)	23.53	21.01	21.02	20.60	20.53	23.73	22.98	21.99	21.58	21.38	24.86	22.80	22.11	21.26	20.60	24.28	22.88	22.10	21.68	21.25	21.83	0.65
Anlzd. Sharpe Ratio	0.44	0.51	0.39	0.39	0.32	0.52	0.51	0.58	0.50	0.40	0.62	0.62	0.55	0.51	0.44	0.73	0.68	0.53	0.42	0.39	0.19	
Anlzd. Downside Volatility (%)	15.59	15.71	17.00	16.68	17.19	18.54	18.96	17.39	17.30	18.42	17.44	16.40	15.93	16.35	16.94	15.73	15.97	16.66	17.51	17.85	19.01	
Anlzd. Sortino Ratio (MAR = 5%)	0.57	0.59	0.40	0.39	0.30	0.59	0.54	0.65	0.54	0.38	0.80	0.77	0.68	0.57	0.45	1.04	0.89	0.62	0.44	0.39	0.14	
Min Net Monthly Return (%)	-19.55	-26.71	-27.03	-24.83	-25.11	-33.06	-33.86	-29.51	-26.72	-30.15	-31.04	-27.06	-25.15	-25.31	-27.56	-28.82	-24.69	-28.10	-30.63	-31.07	-28.51	0.05
Max Net Monthly Return (%)	21.54	15.10	16.61	17.90	19.99	23.40	19.39	21.21	23.01	20.83	43.86	31.88	31.04	23.76	19.08	42.48	32.18	25.82	20.31	19.79	15.16	0.73
Max Net Drawdown (%)	-57.09	-51.43	-53.20	-55.90	-55.76	-46.58	-51.45	-52.85	-54.88	-57.81	-49.16	-44.74	-49.47	-49.71	-49.54	-42.80	-42.23	-48.90	-50.00	-49.98	-57.55	
P-value, Ha: μ(j,k)>μ(m)	6.32%	***2.28%***	7.74%	8.90%	17.80%	***2.25%***	***1.48%***	***0.54%***	***1.83%***	7.04%	***0.57%***	***0.61%***	***1.48%***	***2.44%***	5.83%	***0.11%***	***0.20%***	***1.63%***	6.48%	9.00%		

Table A2-0-2 Performance Analysis of Momentum Strategies, Sweden

J	3	3	3	3	3	6	6	6	6	6	9	9	9	9	9	12	12	12	12	12	MSCI SE	Nibor 1M
K	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12		
Panel A: Generic Momentum Portfolios (Sweden)																						
Anlzd. Net Return (%)	15.78	15.33	13.09	10.91	9.91	17.73	15.47	13.04	11.24	9.36	14.27	13.81	12.27	10.20	8.87	13.94	13.23	11.42	9.50	8.50	9.34	3.55
Anlzd. Volatility (%)	22.18	21.45	20.74	20.51	20.60	22.24	21.04	20.29	20.15	20.18	20.69	20.46	20.17	20.08	20.31	20.42	20.08	20.17	20.49	20.79	23.17	0.65
Anlzd. Sharpe Ratio	0.55	0.55	0.46	0.36	0.31	0.64	0.57	0.47	0.38	0.29	0.52	0.50	0.43	0.33	0.26	0.51	0.48	0.39	0.29	0.24	0.25	
Anlzd. Downside Volatility (%)	13.24	12.45	13.41	14.00	14.55	12.33	13.36	13.61	14.08	14.56	13.63	14.05	14.40	14.98	15.36	13.69	14.10	15.15	15.92	16.33	18.53	
Anlzd. Sortino Ratio (MAR = 5%)	0.81	0.83	0.60	0.42	0.34	1.03	0.78	0.59	0.44	0.30	0.68	0.63	0.50	0.35	0.25	0.65	0.58	0.42	0.28	0.21	0.23	
Min Net Monthly Return (%)	-19.02	-14.18	-17.04	-19.04	-18.17	-14.80	-16.06	-16.00	-17.56	-16.60	-16.99	-17.33	-16.44	-18.50	-21.65	-18.49	-16.55	-20.83	-24.14	-26.58	-23.35	0.05
Max Net Monthly Return (%)	35.93	31.94	23.37	20.61	20.52	31.60	24.12	18.77	18.36	18.87	24.45	20.90	16.71	15.99	17.81	21.04	14.68	14.85	16.47	19.48	22.03	0.73
Max Net Drawdown (%)	-64.94	-65.99	-68.93	-71.89	-71.90	-53.67	-57.21	-63.22	-66.55	-68.35	-62.09	-63.74	-65.90	-68.91	-71.44	-62.95	-65.47	-67.49	-72.22	-74.04	-75.94	
P-value, Ha: μ(j,k)>μ(m)	***3.52%***	***3.28%***	10.16%	29.04%	41.77%	***1.14%***	***3.60%***	12.92%	26.91%	49.67%	8.34%	10.51%	19.80%	39.69%	55.88%	10.36%	13.68%	27.19%	48.10%	60.27%		
Panel B: Quantitative Momentum Portfolios (Sweden)																						
Anlzd. Net Return (%)	13.74	16.96	14.74	12.81	11.97	19.66	18.03	15.66	14.26	12.32	19.11	16.85	14.32	12.56	11.29	14.93	15.81	14.49	12.80	11.46	9.34	3.55
Anlzd. Volatility (%)	21.29	21.08	19.87	19.38	19.39	21.13	20.35	19.27	19.12	19.12	20.98	19.83	19.60	19.45	19.60	20.08	19.81	19.99	20.40	20.66	23.17	0.65
Anlzd. Sharpe Ratio	0.48	0.64	0.56	0.48	0.43	0.76	0.71	0.63	0.56	0.46	0.74	0.67	0.55	0.46	0.40	0.57	0.62	0.55	0.45	0.38	0.25	
Anlzd. Downside Volatility (%)	13.19	12.15	12.56	12.86	13.36	11.66	12.60	12.43	12.67	13.28	12.13	12.80	13.19	14.05	14.72	13.09	13.33	14.52	15.80	16.03	18.53	
Anlzd. Sortino Ratio (MAR = 5%)	0.66	0.98	0.78	0.61	0.52	1.26	1.03	0.86	0.73	0.55	1.16	0.93	0.71	0.54	0.43	0.76	0.81	0.65	0.49	0.40	0.23	
Min Net Monthly Return (%)	-15.00	-14.27	-16.20	-16.80	-15.93	-15.79	-16.76	-15.19	-14.82	-15.31	-16.38	-14.71	-15.84	-16.35	-20.64	-17.99	-16.39	-18.98	-22.17	-25.01	-23.35	0.05
Max Net Monthly Return (%)	29.85	35.10	22.80	19.24	18.96	25.49	21.50	16.95	16.68	17.68	23.25	17.79	16.38	16.25	16.97	18.92	17.04	16.23	18.73	22.66	22.03	0.73
Max Net Drawdown (%)	-62.21	-53.92	-58.47	-63.25	-63.73	-55.61	-58.24	-55.29	-57.89	-60.68	-49.56	-53.68	-59.08	-63.90	-66.68	-53.68	-58.66	-62.46	-68.65	-71.50	-75.94	
P-value, Ha: μ(j,k)>μ(m)	11.08%	***1.28%***	***3.63%***	11.74%	17.46%	***0.36%***	***0.70%***	***2.99%***	6.05%	16.08%	***0.58%***	***2.15%***	8.11%	17.11%	27.34%	6.77%	***3.88%***	6.97%	15.45%	25.99%		

Table A2-0-3 Performance Analysis of Momentum Strategies, Denmark

J	3	3	3	3	3	6	6	6	6	6	9	9	9	9	9	12	12	12	12	12	MSCI DK	Nibor 1M
K	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12		
Panel A: Generic Momentum Portfolios (Denmark)																						
Anlzd. Net Return (%)	12.30	13.71	12.29	11.59	10.49	15.98	14.55	13.55	12.05	10.74	15.88	15.45	14.10	12.31	10.74	16.28	15.82	13.41	11.96	10.76	12.29	3.55
Anlzd. Volatility (%)	17.95	16.90	15.81	15.76	15.98	17.55	16.24	15.99	15.94	16.04	17.51	16.58	16.55	16.57	16.57	16.50	16.88	16.73	16.87	16.92	18.09	0.65
Anlzd. Sharpe Ratio	0.49	0.60	0.55	0.51	0.43	0.71	0.68	0.63	0.53	0.45	0.70	0.72	0.64	0.53	0.43	0.77	0.73	0.59	0.50	0.43	0.48	
Anlzd. Downside Volatility (%)	11.26	10.74	10.85	11.31	12.30	12.22	11.11	11.30	12.06	12.46	10.92	10.68	12.06	12.61	13.27	11.34	12.74	13.06	13.62	14.16	12.67	
Anlzd. Sortino Ratio (MAR = 5%)	0.65	0.81	0.67	0.58	0.45	0.90	0.86	0.76	0.59	0.46	1.00	0.98	0.75	0.58	0.43	0.99	0.85	0.64	0.51	0.41	0.58	
Min Net Monthly Return (%)	-20.15	-16.60	-14.82	-14.36	-16.56	-21.13	-15.97	-13.93	-15.02	-16.72	-14.59	-12.72	-16.27	-17.60	-20.32	-16.54	-21.76	-21.79	-22.95	-23.98	-16.71	0.05
Max Net Monthly Return (%)	14.92	14.95	15.20	14.29	13.75	18.72	19.15	17.52	16.00	14.56	23.76	21.22	18.45	14.67	13.79	16.51	17.66	14.65	14.26	13.70	14.18	0.73
Max Net Drawdown (%)	-51.38	-54.01	-55.63	-56.53	-60.35	-52.56	-51.44	-53.54	-57.44	-61.89	-47.18	-50.41	-57.90	-61.90	-66.22	-54.61	-56.82	-62.19	-65.50	-67.48	-52.46	
P-value, Ha: μ(j,k)>μ(m)	49.80%	31.65%	50.03%	60.41%	75.49%	13.85%	23.87%	33.52%	53.38%	71.68%	14.74%	16.37%	27.62%	49.74%	70.92%	11.17%	13.54%	35.56%	54.55%	70.29%		
Panel B: Quantitative Momentum Portfolios (Denmark)																						
Anlzd. Net Return (%)	10.22	14.06	13.38	12.45	11.40	16.68	16.42	15.78	13.54	12.01	14.95	17.04	16.48	14.41	12.54	20.51	19.32	17.12	15.68	13.95	12.29	3.55
Anlzd. Volatility (%)	18.32	16.91	15.84	15.60	15.69	17.81	16.95	16.30	16.25	16.61	19.28	17.62	17.13	17.18	16.98	18.48	17.99	17.77	17.82	17.83	18.09	0.65
Anlzd. Sharpe Ratio	0.36	0.62	0.62	0.57	0.50	0.74	0.76	0.75	0.62	0.51	0.59	0.77	0.76	0.63	0.53	0.92	0.88	0.76	0.68	0.58	0.48	
Anlzd. Downside Volatility (%)	9.78	10.45	10.98	11.48	12.62	11.20	11.54	11.54	12.80	13.95	12.92	11.21	12.58	13.02	13.55	11.90	13.73	14.40	14.85	15.47	12.67	
Anlzd. Sortino Ratio (MAR = 5%)	0.53	0.87	0.76	0.65	0.51	1.04	0.99	0.93	0.67	0.50	0.77	1.07	0.91	0.72	0.56	1.30	1.04	0.84	0.72	0.58	0.58	
Min Net Monthly Return (%)	-12.58	-13.70	-13.74	-15.16	-16.15	-13.19	-13.45	-15.39	-15.89	-19.39	-18.00	-14.75	-16.10	-18.87	-20.23	-14.96	-24.09	-24.70	-25.75	-27.25	-16.71	0.05
Max Net Monthly Return (%)	20.29	16.89	14.60	14.03	12.59	16.11	16.10	13.13	11.98	11.70	17.94	17.58	13.10	11.51	12.36	16.09	13.82	12.29	12.17	12.99	14.18	0.73
Max Net Drawdown (%)	-42.22	-47.33	-49.38	-51.01	-55.73	-43.45	-40.17	-43.76	-52.62	-58.66	-44.38	-44.89	-52.46	-57.72	-60.39	-34.71	-49.51	-57.18	-62.09	-63.21	-52.46	
P-value, Ha: μ(j,k)>μ(m)	70.24%	29.32%	35.85%	47.71%	62.88%	12.37%	11.61%	13.40%	33.00%	54.04%	24.41%	9.15%	9.86%	24.37%	46.56%	***1.71%***	***2.01%***	6.57%	13.36%	28.87%		

Table A2-0-4 Performance Analysis of Momentum Strategies, Finland

J	3	3	3	3	3	6	6	6	6	6	9	9	9	9	9	12	12	12	12	12	MSCI FI	Nibor 1M
K	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12		
Panel A: Generic Momentum Portfolios (Finland)																						
Anlzd. Net Return (%)	12.84	13.23	11.98	11.48	10.41	14.62	14.26	13.46	12.37	10.69	15.39	14.60	13.08	11.60	9.84	13.95	13.17	12.00	9.93	9.18	9.63	3.55
Anlzd. Volatility (%)	22.62	21.36	20.22	19.19	19.29	23.63	22.15	20.64	20.10	20.11	22.21	21.08	20.78	20.63	20.54	21.06	20.96	20.93	20.98	21.08	29.92	0.65
Anlzd. Sharpe Ratio	0.41	0.45	0.42	0.41	0.36	0.47	0.48	0.48	0.44	0.36	0.53	0.52	0.46	0.39	0.31	0.49	0.46	0.40	0.30	0.27	0.20	
Anlzd. Downside Volatility (%)	12.39	13.81	13.99	13.16	13.88	15.04	15.97	14.71	14.47	15.47	14.19	14.77	15.38	15.90	16.51	13.38	14.62	15.64	16.46	17.33	23.40	
Anlzd. Sortino Ratio (MAR = 5%)	0.63	0.60	0.50	0.49	0.39	0.64	0.58	0.58	0.51	0.37	0.73	0.65	0.53	0.42	0.29	0.67	0.56	0.45	0.30	0.24	0.20	
Min Net Monthly Return (%)	-15.52	-17.86	-19.70	-17.60	-18.09	-20.51	-21.52	-20.87	-21.98	-20.87	-21.21	-22.74	-27.32	-27.03	-25.16	-21.45	-22.84	-27.29	-27.73	-28.19	-37.03	0.05
Max Net Monthly Return (%)	47.27	36.52	30.61	25.12	24.98	39.90	33.63	27.22	26.80	25.21	25.93	24.97	26.37	24.64	22.34	22.50	22.29	22.47	20.69	20.13	28.74	0.73
Max Net Drawdown (%)	-52.98	-57.23	-57.25	-58.97	-64.22	-56.46	-57.95	-59.37	-64.95	-68.23	-55.81	-57.11	-60.97	-67.42	-70.64	-60.56	-64.80	-65.61	-70.12	-72.45	-77.56	
P-value, Ha: μ(j,k)>μ(m)	26.41%	22.67%	30.78%	34.84%	43.31%	16.34%	18.24%	22.74%	28.93%	41.30%	13.88%	17.52%	25.00%	34.78%	48.30%	21.35%	25.13%	32.45%	47.64%	53.58%		
Panel B: Quantitative Momentum Portfolios (Finland)																						
Anlzd. Net Return (%)	9.95	11.92	10.49	10.58	9.68	11.94	12.12	13.27	13.35	11.46	13.00	14.39	13.93	12.47	10.24	10.44	13.21	11.52	10.66	9.71	9.63	3.55
Anlzd. Volatility (%)	23.71	20.65	19.44	18.30	18.36	25.44	22.95	20.94	19.85	20.04	23.24	21.05	20.46	20.58	20.94	23.27	21.12	21.50	21.68	22.11	29.92	0.65
Anlzd. Sharpe Ratio	0.27	0.41	0.36	0.38	0.33	0.33	0.37	0.46	0.49	0.39	0.41	0.52	0.51	0.43	0.32	0.30	0.46	0.37	0.33	0.28	0.20	
Anlzd. Downside Volatility (%)	14.36	14.45	14.48	13.05	13.56	16.70	16.25	15.27	13.84	15.12	15.39	13.43	14.13	15.44	17.05	15.58	14.28	16.18	17.00	18.67	23.40	
Anlzd. Sortino Ratio (MAR = 5%)	0.34	0.48	0.38	0.43	0.35	0.42	0.44	0.54	0.60	0.43	0.52	0.70	0.63	0.48	0.31	0.35	0.58	0.40	0.33	0.25	0.20	
Min Net Return (%)	-18.65	-19.88	-19.92	-20.31	-20.38	-27.66	-22.43	-19.83	-21.33	-22.88	-22.65	-22.61	-26.02	-29.70	-29.38	-22.50	-22.38	-27.31	-28.72	-32.40	-37.03	0.05
Max Net Return (%)	41.96	24.20	22.82	17.28	18.86	48.44	34.44	26.31	27.41	24.89	30.59	23.71	27.40	27.69	23.51	31.47	22.56	22.37	24.00	23.43	28.74	0.73
Max Net Drawdown (%)	-54.43	-54.53	-55.32	-52.39	-60.99	-62.37	-63.29	-58.20	-59.55	-65.10	-54.64	-55.49	-57.10	-62.92	-67.73	-69.83	-65.13	-71.30	-70.70	-74.37	-77.56	
P-value, Ha: μ(j,k)>μ(m)	47.72%	32.64%	42.80%	42.01%	49.54%	34.47%	31.63%	23.59%	22.09%	34.95%	27.66%	18.70%	20.32%	28.82%	45.05%	44.21%	25.41%	35.64%	41.83%	49.36%		

APPENDIX 3 - SEASONALITY ANALYSIS

Table A3-0-1 Seasonality Analysis of QMS(J12K3) in Norway

J	12	12	12	12
K	3	3	3	3
Rebalancing Period	Overlapping	Dec, Mar, Jun, Sep	Jan, Apr, Jul, Oct	Feb, May, Aug, Nov
Seasonality Analysis (Norway)				
Annualized Net Return (%)	19.17	19.05	18.88	19.59
Annualized Volatility (%)	22.88	23.66	24.78	23.89
Annualized Sharpe Ratio	0.68	0.66	0.62	0.67
Annualized Downside Volatility (%)	17.72	17.63	13.86	15.97
Annualized Sortino Ratio (MAR = 5%)	0.80	0.80	1.00	0.91
Min Net Monthly Return (%)	-24.69	-27.80	-28.62	-18.76
Max Net Monthly Return (%)	32.18	26.87	38.12	42.68
Max Net Drawdown (%)	-52.50	-46.49	-46.02	-48.56
P-value, Ha: μ(season)>μ(overlapping)		52.81%	57.60%	40.61%

Table A3-0-2 Seasonality Analysis of QMS(J12K3) in Sweden

J	12	12	12	12
K	3	3	3	3
Rebalancing Period	Overlapping	Dec, Mar, Jun, Sep	Jan, Apr, Jul, Oct	Feb, May, Aug, Nov
Seasonality Analysis (Sweden)				
Annualized Net Return (%)	15.81	17.76	15.03	14.63
Annualized Volatility (%)	19.81	20.47	20.17	20.52
Annualized Sharpe Ratio	0.62	0.69	0.57	0.54
Annualized Downside Volatility (%)	13.85	14.03	13.76	13.33
Annualized Sortino Ratio (MAR = 5%)	0.78	0.91	0.73	0.72
Min Net Monthly Return (%)	-16.39	-17.71	-17.79	-17.26
Max Net Monthly Return (%)	17.04	16.76	19.12	16.66
Max Net Drawdown (%)	-51.65	-52.64	-64.94	-65.99
P-value, Ha: μ(season)>μ(overlapping)		***3.12%***	77.22%	86.50%

Table A3-0-3 Seasonality Analysis of QMS(J12K3) in Denmark

J	12	12	12	12
K	3	3	3	3
Rebalancing Period	Overlapping	Dec, Mar, Jun, Sep	Jan, Apr, Jul, Oct	Feb, May, Aug, Nov
Seasonality Analysis (Denmark)				
Annualized Net Return (%)	19.32	16.70	19.16	22.10
Annualized Volatility (%)	17.99	19.79	20.58	18.29
Annualized Sharpe Ratio	0.88	0.66	0.76	1.01
Annualized Downside Volatility (%)	16.32	16.42	11.50	13.73
Annualized Sortino Ratio (MAR = 5%)	0.88	0.71	1.23	1.24
Min Net Monthly Return (%)	-24.09	-26.92	-33.10	-15.55
Max Net Monthly Return (%)	13.82	15.37	17.00	14.92
Max Net Drawdown (%)	-68.93	-71.89	-71.90	-53.67
P-value, Ha: µ(season)>µ(overlapping)		93.56%	53.62%	***4.18%***

Table A3-0-4 Seasonality Analysis of QMS(J12K3) in Finland

J	12	12	12	12
K	3	3	3	3
Rebalancing Period	Overlapping	Dec, Mar, Jun, Sep	Jan, Apr, Jul, Oct	Feb, May, Aug, Nov
Seasonality Analysis (Finland)				
Annualized Net Return (%)	13.21	13.58	11.88	14.17
Annualized Volatility (%)	21.12	24.34	22.60	22.08
Annualized Sharpe Ratio	0.46	0.41	0.37	0.48
Annualized Downside Volatility (%)	18.17	16.09	13.24	14.28
Annualized Sortino Ratio (MAR = 5%)	0.45	0.53	0.52	0.64
Min Net Monthly Return (%)	-22.38	-30.00	-22.30	-18.67
Max Net Monthly Return (%)	22.56	20.24	20.39	31.67
Max Net Drawdown (%)	-57.21	-63.22	-66.55	-68.35
P-value, Ha: µ(season)>µ(overlapping)		42.78%	76.52%	32.63%

APPENDIX 4 - CAPITAL GROWTH

Figure A4-0-1 Value of 100 NOK Invested in Norway (Log Scale)

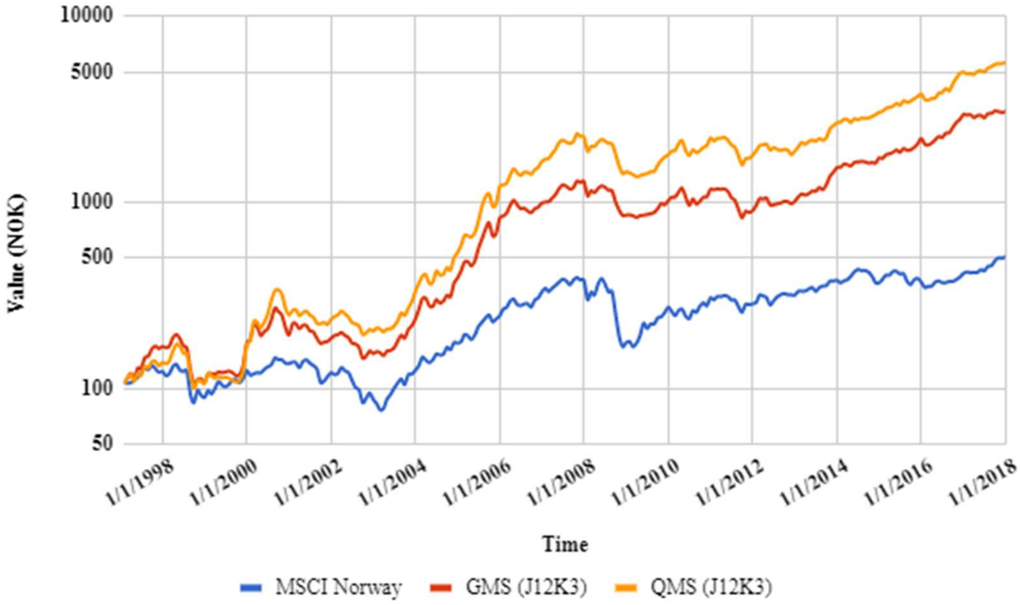


Figure A4-0-2 Value of 100 NOK Invested in Sweden (Log Scale)

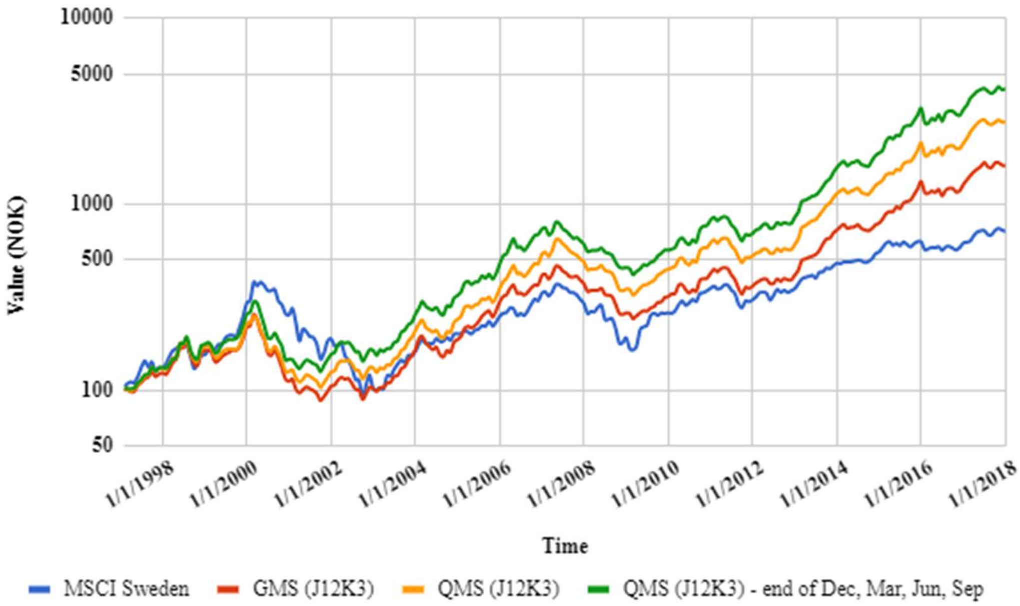


Figure A4-0-3 Value of 100 NOK Invested in Denmark (Log Scale)

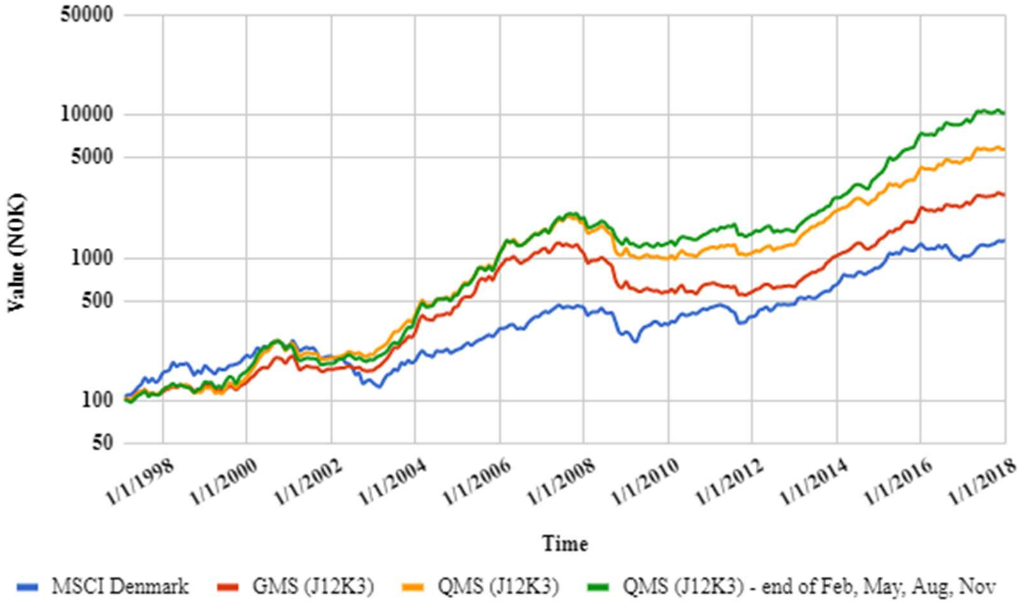
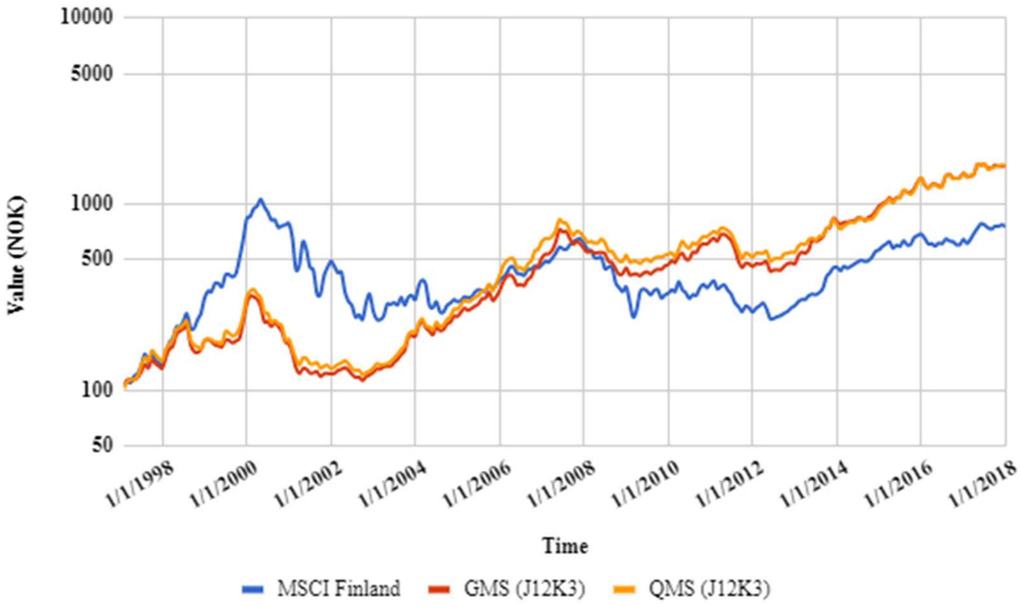


Figure A4-0-4 Value of 100 NOK Invested in Finland (Log Scale)



APPENDIX 5 - ANNUALIZED AVERAGE NET RETURNS ROLLING WINDOW

Figure A5-0-1 Five-Year Rolling Annualized Average Net Return (Norway)

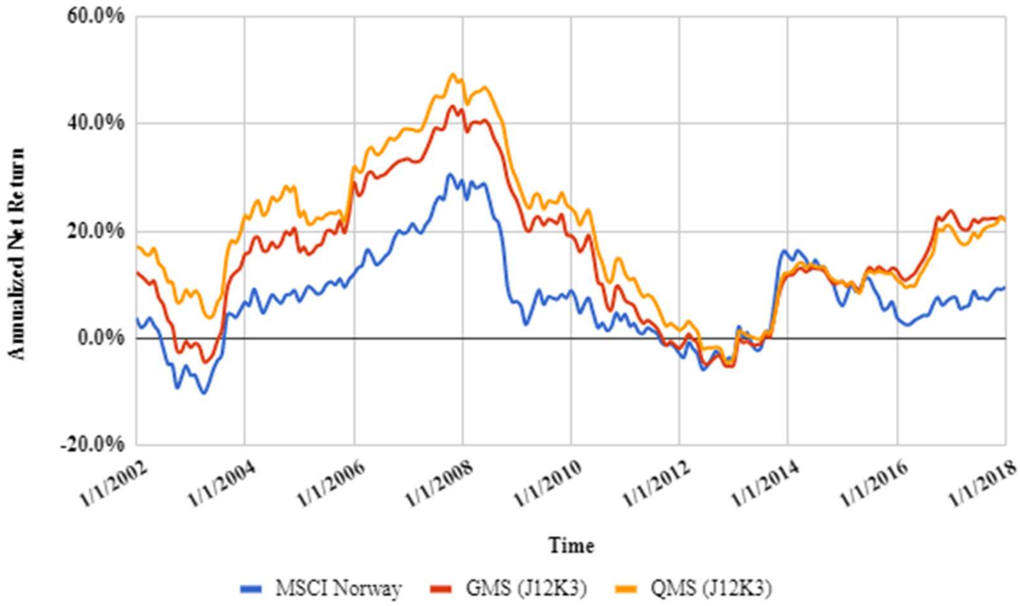


Figure A5-0-2 Ten-Year Rolling Annualized Average Net Return (Norway)

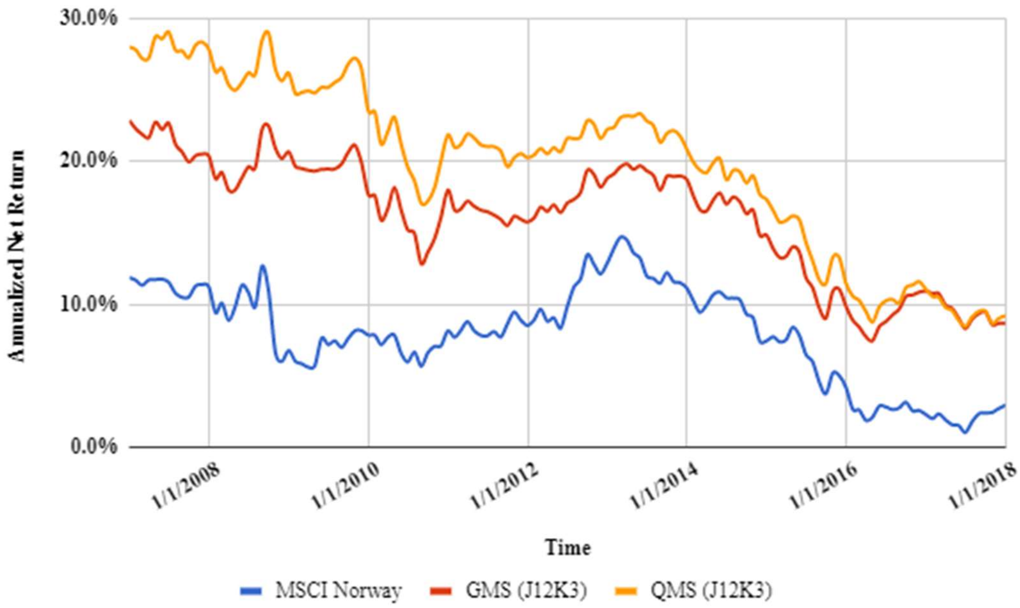


Figure A5-0-3 Five-Year Rolling Annualized Average Net Return (Sweden)

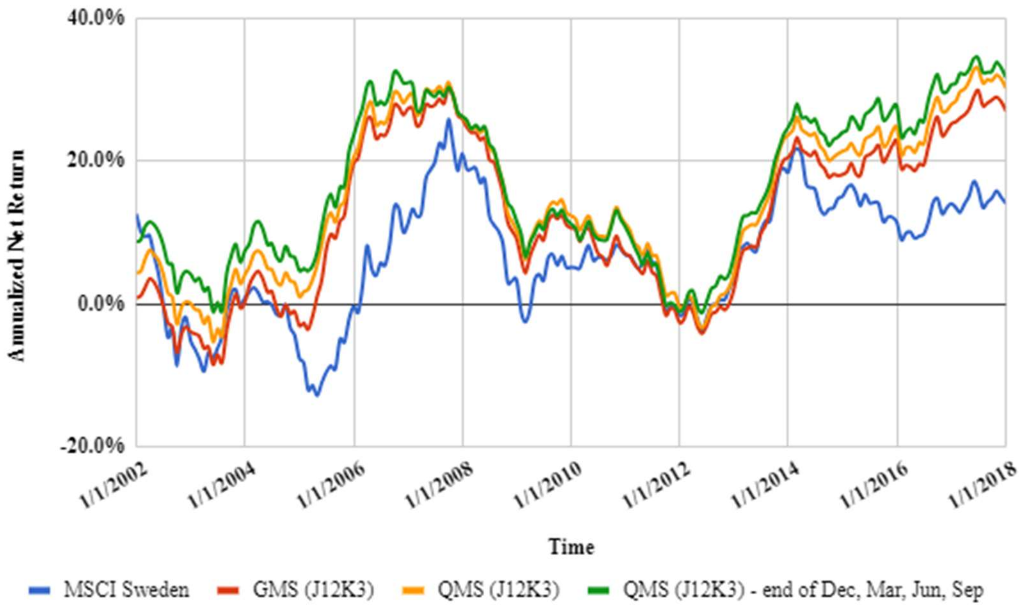


Figure A5-0-4 Ten-Year Rolling Annualized Average Net Return (Sweden)

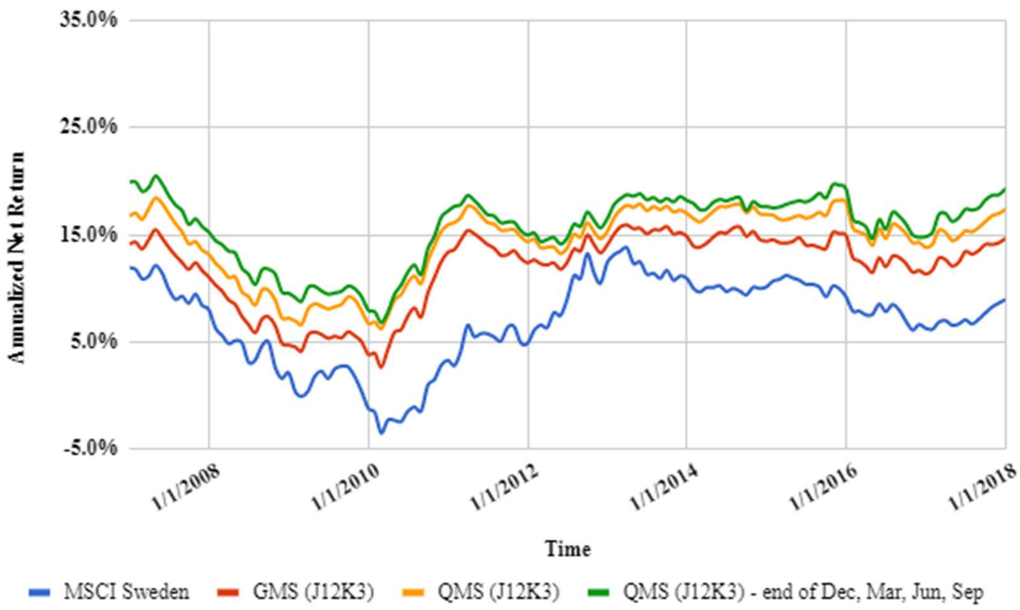


Figure A5-0-5 Five-Year Rolling Annualized Average Net Return (Denmark)

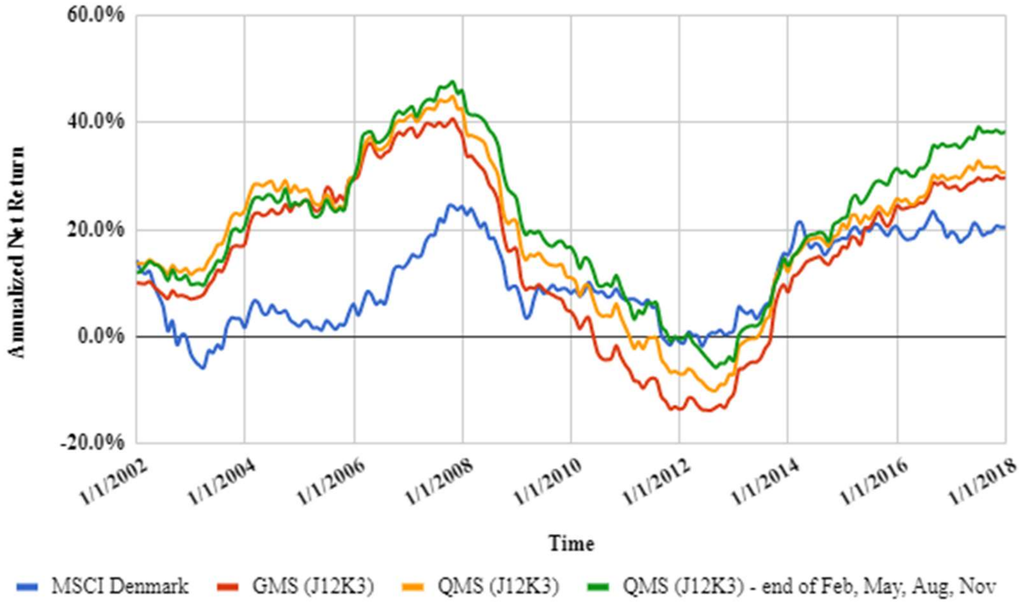


Figure A5-0-6 Ten-Year Rolling Annualized Average Net Return (Denmark)

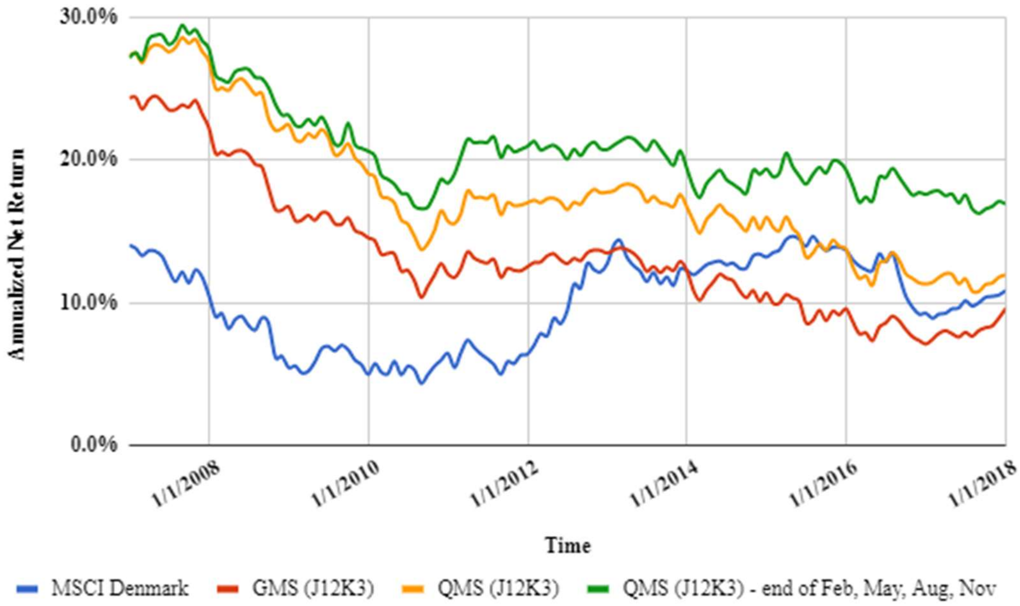


Figure A5-0-7 Five-Year Rolling Annualized Average Net Return (Finland)

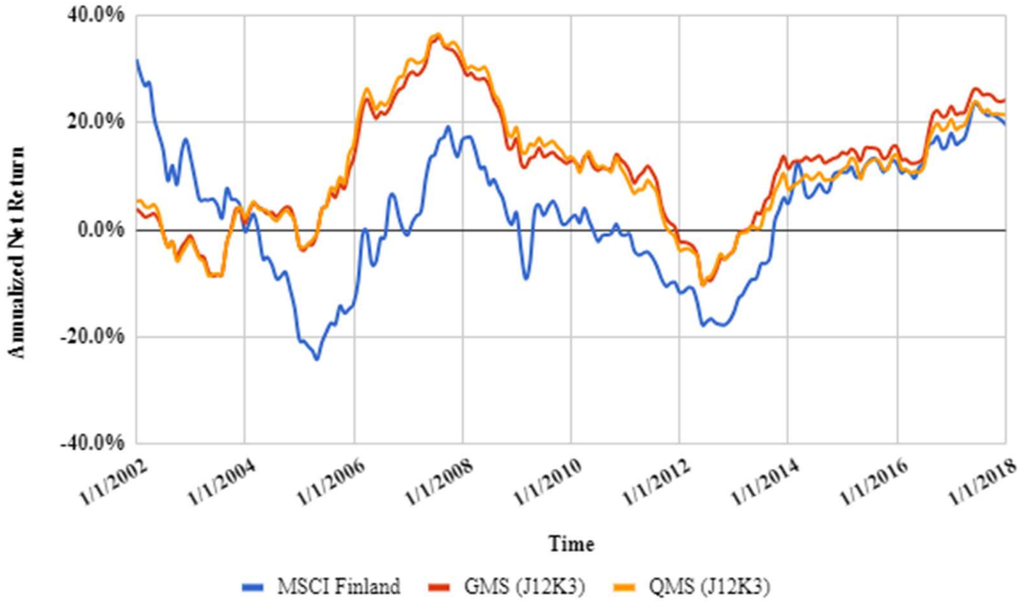
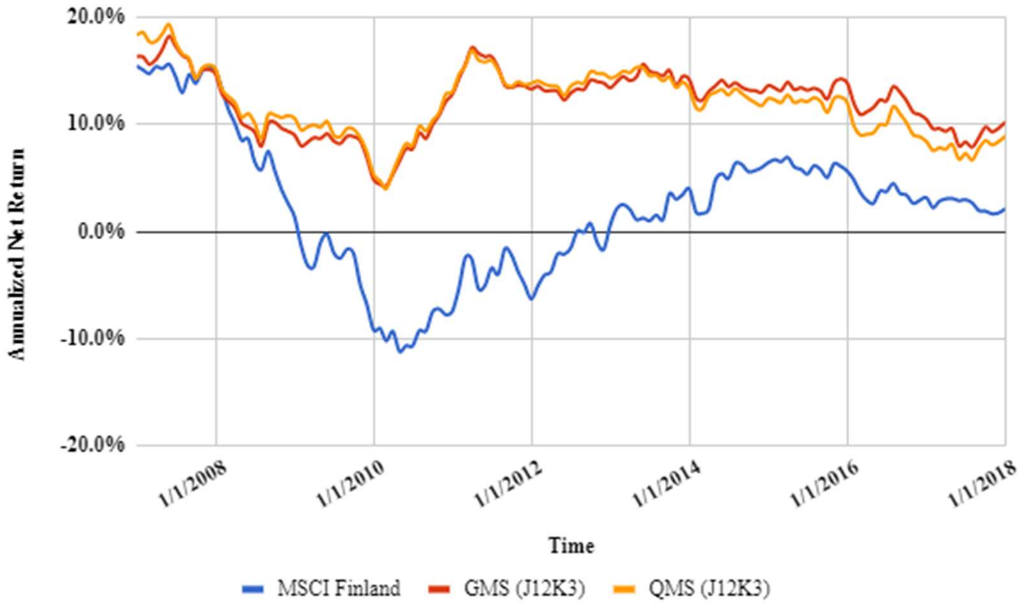


Figure A5-0-8 Ten-Year Rolling Annualized Average Net Return (Finland)



APPENDIX 6 - MAXIMUM DRAWDOWNS ROLLING WINDOW

Figure A6-0-1 Five-Year Rolling Max Net Drawdown (Norway)

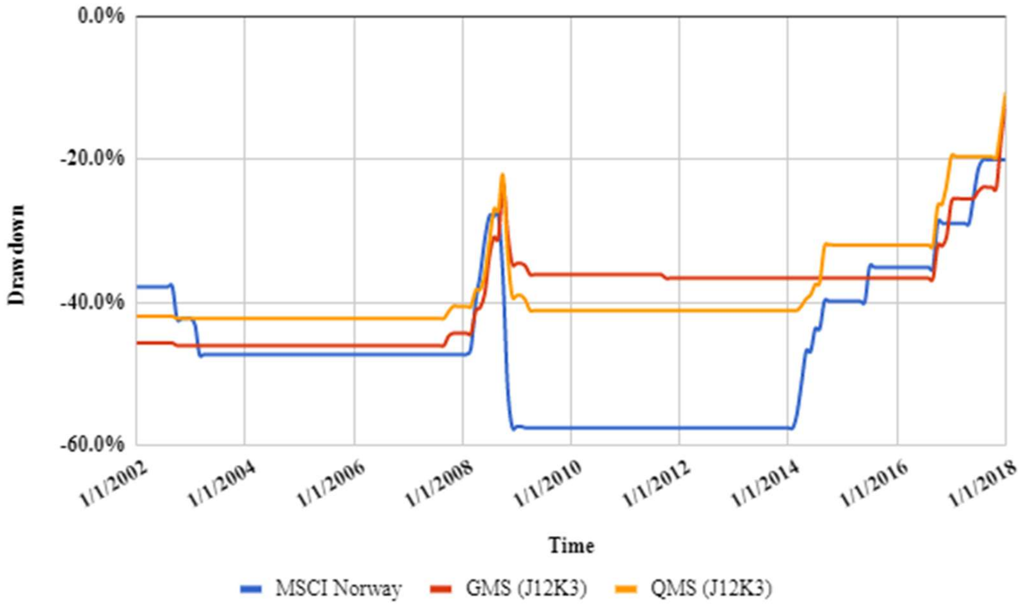


Figure A6-0-2 Ten-Year Rolling Max Net Drawdown (Norway)

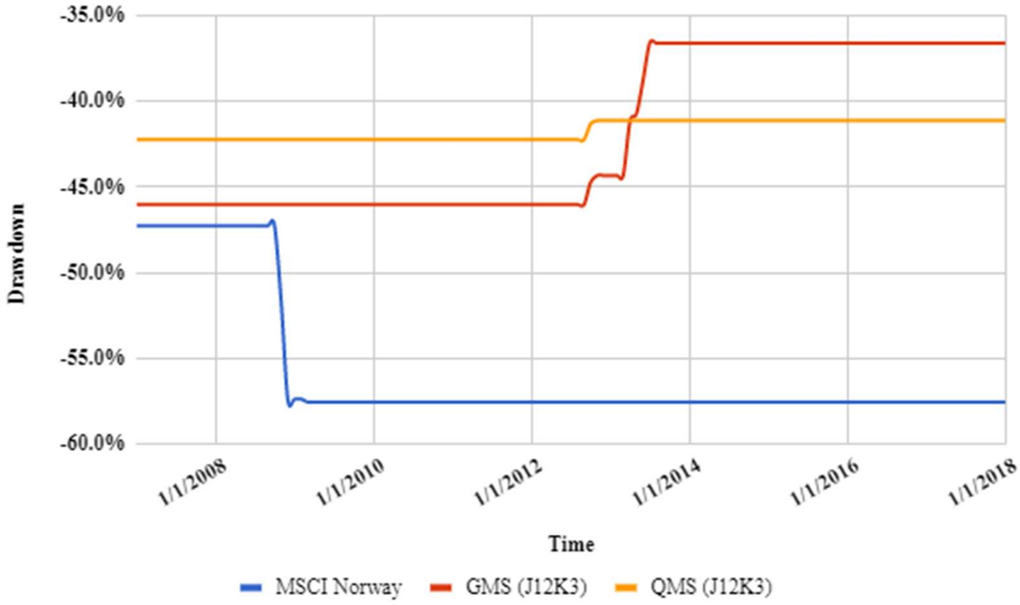


Figure A6-0-3 Five-Year Rolling Max Net Drawdown (Sweden)

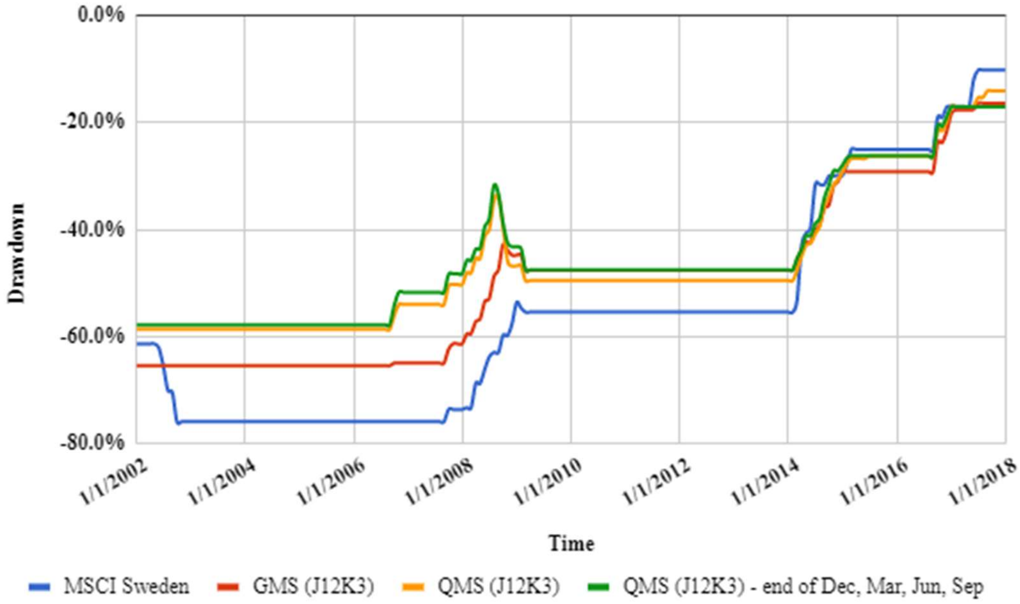


Figure A6-0-4 Ten-Year Rolling Max Net Drawdown (Sweden)

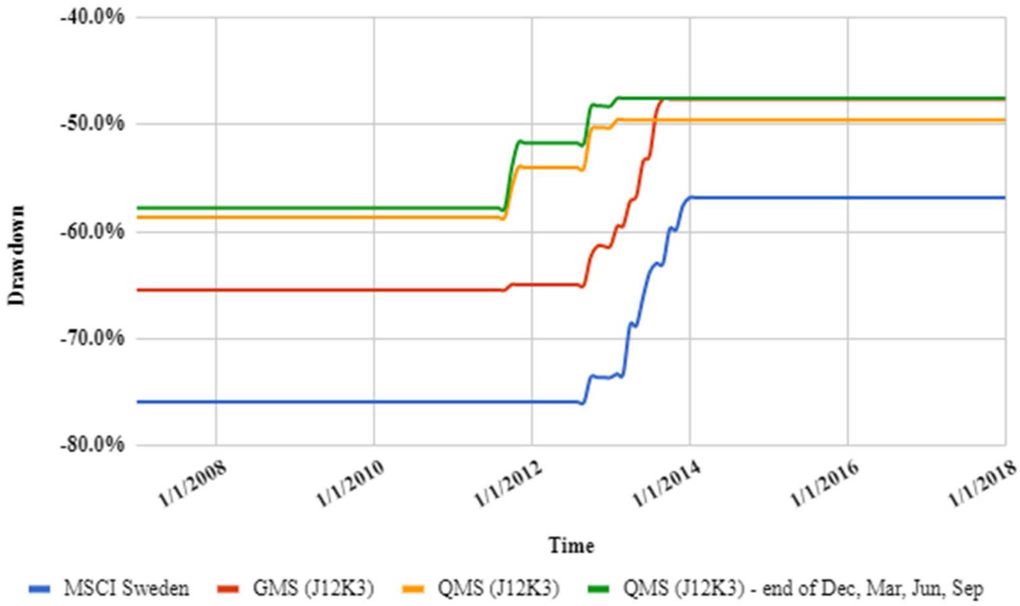


Figure A6-0-5 Five-Year Rolling Max Net Drawdown (Denmark)

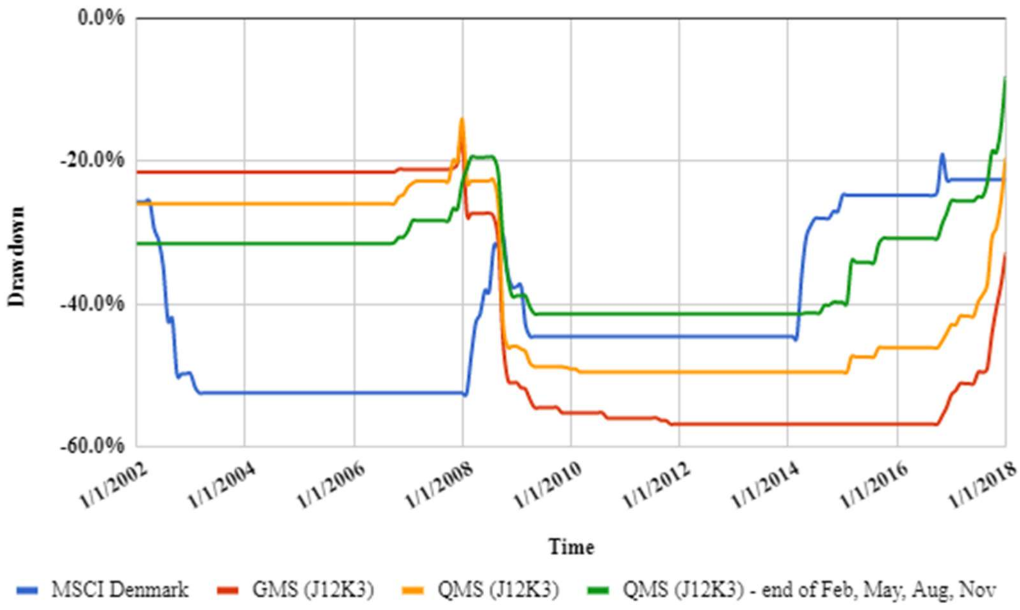


Figure A6-0-6 Ten-Year Rolling Max Net Drawdown (Denmark)

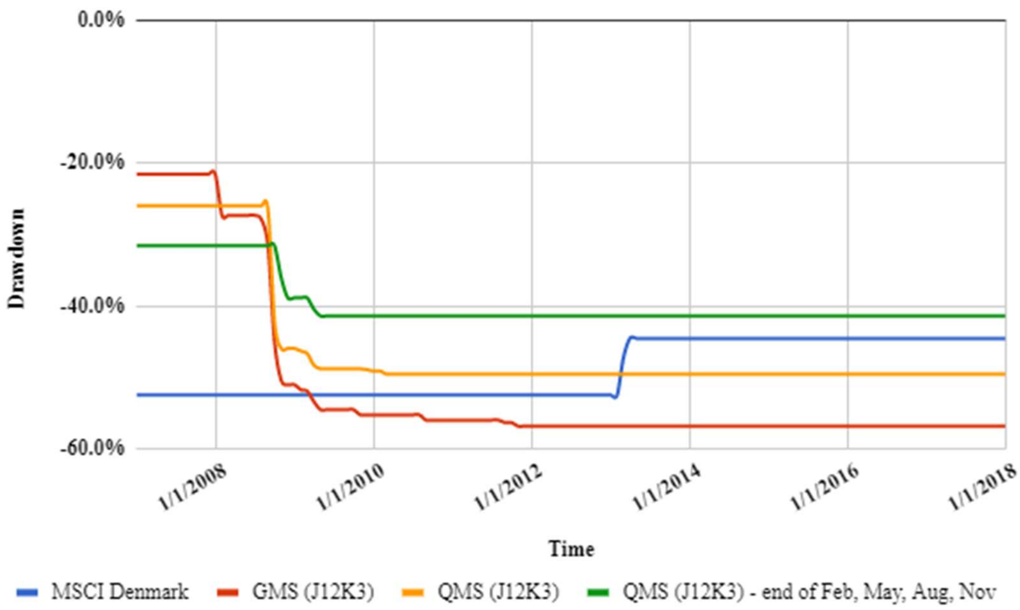


Figure A6-0-7 Five-Year Rolling Max Net Drawdown (Finland)

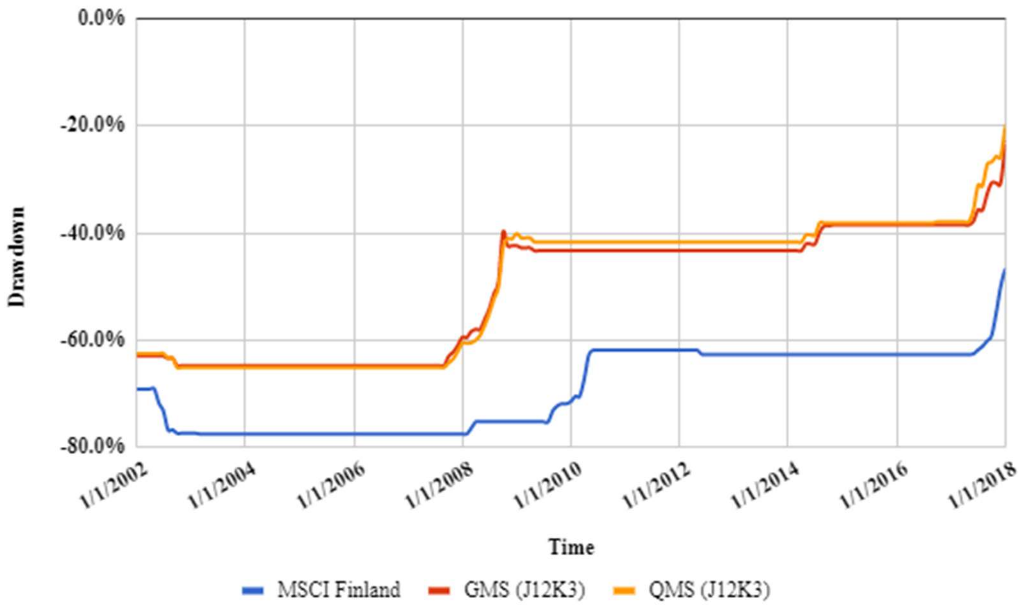
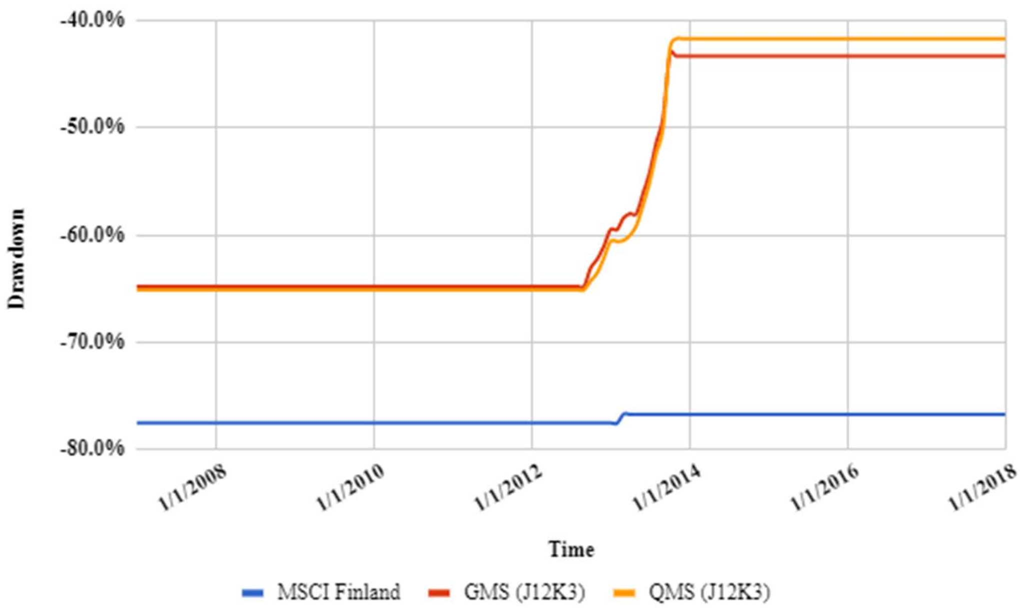


Figure A6-0-8 Ten-Year Rolling Max Net Drawdown (Finland)



APPENDIX 7 - REGRESSION RESULTS

Table A7-0-1 Asset Pricing Coefficient Estimates for the Quantitative Momentum Strategy (J12K3) - 29 December 1996 to 29 December 2017

	Annual Alpha	MKTRF	SMB	HML	WML	N	R-squared	Adj R-Squared
Panel A: Norway, QMS(J12K3)								
CAPM	12.7%	0.71				252	45.9%	45.7%
	(3.44)	**(13.25)**						
FF3	14.3%	0.78	0.22	0.09		252	49.9%	49.3%
	(3.87)	**(12.13)**	**(2.72)**	**(-2.04)**				
Carhart	12.9%	0.96	0.41	-0.08	0.27	252	53.2%	52.5%
	(3.66)	**(11.66)**	**(4.21)**	(-0.96)	**(3.89)**			
Panel B: Sweden, QMS(J12K3) sub1								
CAPM	10.7%	0.61				252	47.8%	47.6%
	(3.23)	**(12.82)**						
FF3	10.3%	0.71	0.40	0.08		252	53.4%	52.9%
	(3.23)	**(12.32)**	**(4.87)**	(1.48)				
Carhart	9.3%	0.78	0.49	0.17	0.20	252	58.2%	57.5%
	(2.91)	**(13.76)**	**(5.15)**	**(2.25)**	**(2.81)**			
Panel C: Denmark, QMS(J12K3) sub3								
CAPM	13.2%	0.61				252	36.5%	36.3%
	(4.11)	**(10.63)**						
FF3	14.0%	0.72	0.28	0.07		252	38.4%	37.6%
	(4.32)	**(10.72)**	**(2.46)**	(0.34)				
Carhart	10.1%	0.75	0.28	0.09	0.23	252	41.4%	40.5%
	(3.00)	**(11.22)**	**(2.80)**	(1.30)	**(3.32)**			
Panel D: Finland, QMS(J12K3)								
CAPM	7.2%	0.41				252	33.4%	33.1%
	(1.86)	**(7.92)**						
FF3	6.2%	0.67	0.44	0.09		252	38.3%	37.5%
	(1.69)	**(9.38)**	**(3.11)**	**(3.67)**				
Carhart	1.2%	0.64	0.33	0.27	0.36	252	46.4%	45.6%
	(0.34)	**(9.30)**	**(2.36)**	**(3.52)**	**(5.04)**			

APPENDIX 8 - ANNUALIZED ALPHA ROLLING WINDOWS

Figure A8-0-1 Five-Year Rolling Annualized Alpha (Norway)

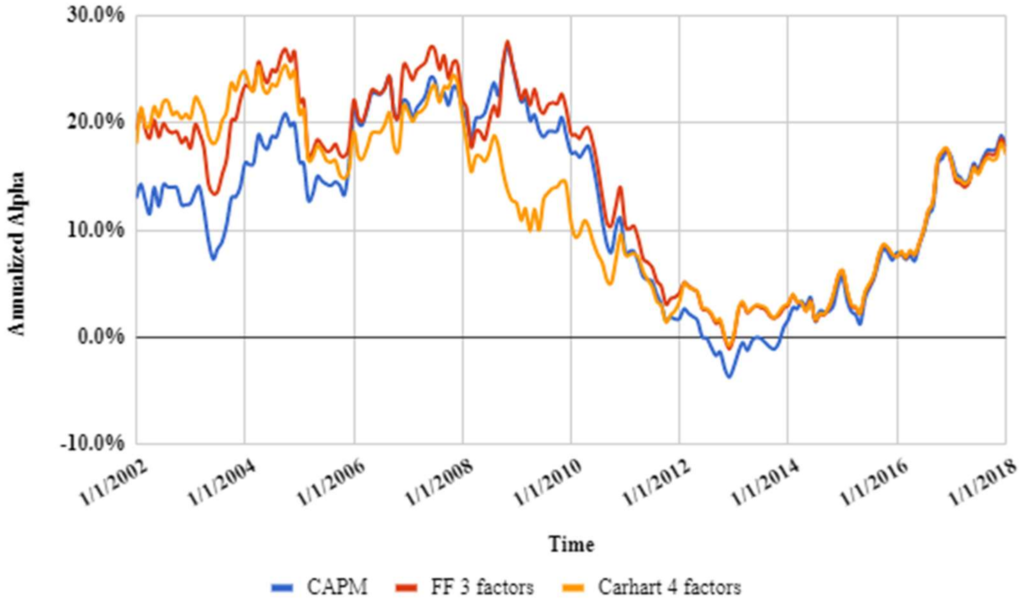


Figure A8-0-2 Ten-Year Rolling Annualized Alpha (Norway)

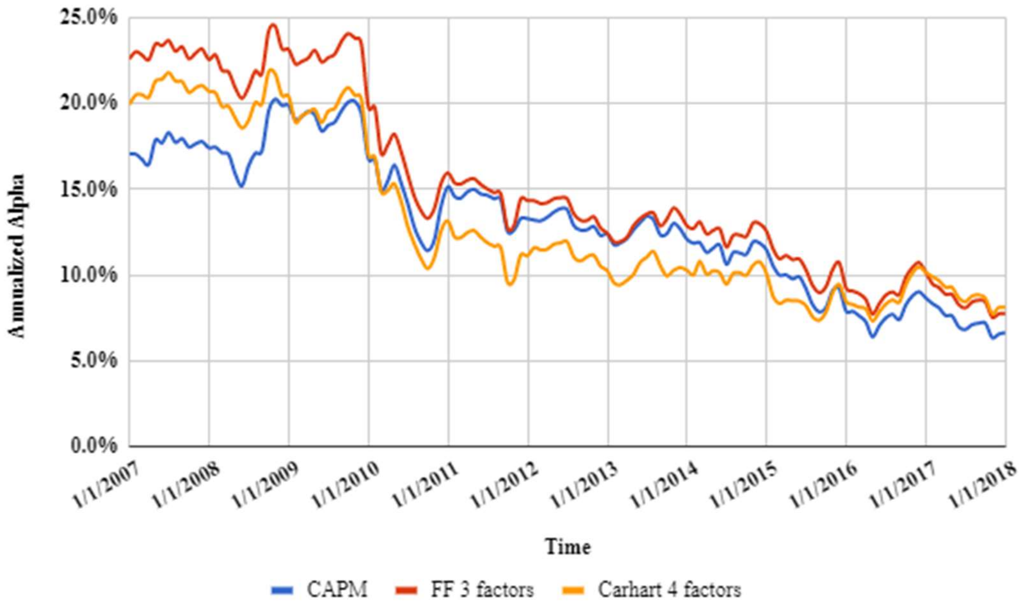


Figure A8-0-3 Five-Year Rolling Annualized Alpha (Sweden)

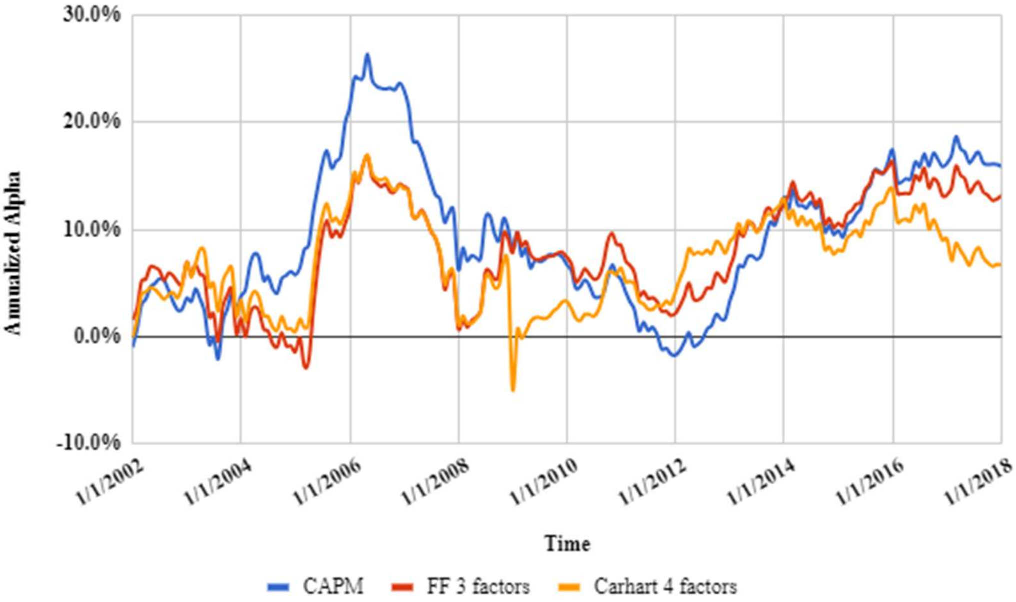


Figure A8-0-4 Ten-Year Rolling Annualized Alpha (Sweden)

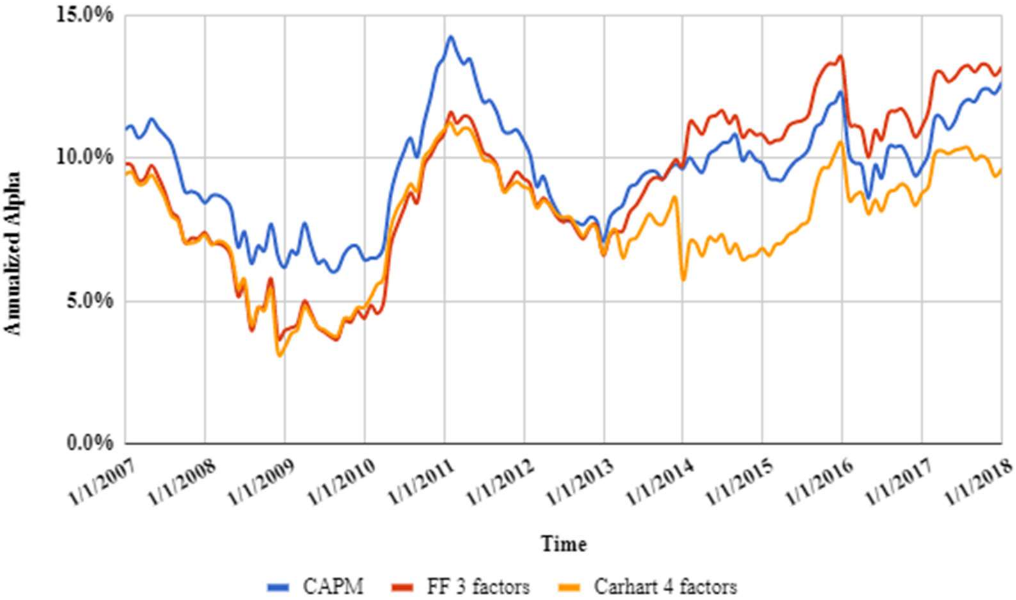


Figure A8-0-5 Five-Year Rolling Annualized Alpha (Denmark)

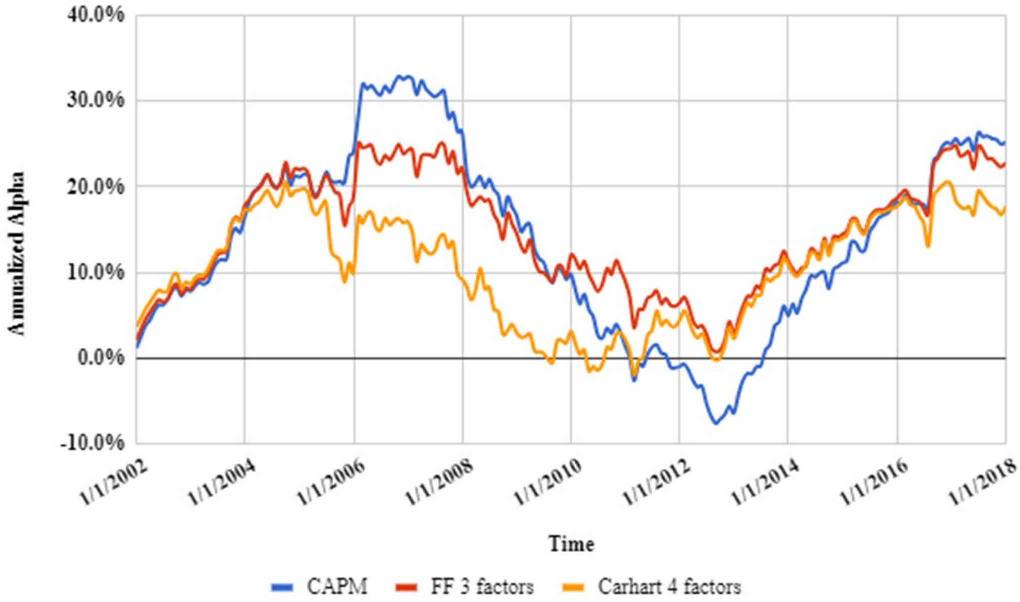


Figure A8-0-6 Ten-Year Rolling Annualized Alpha (Denmark)

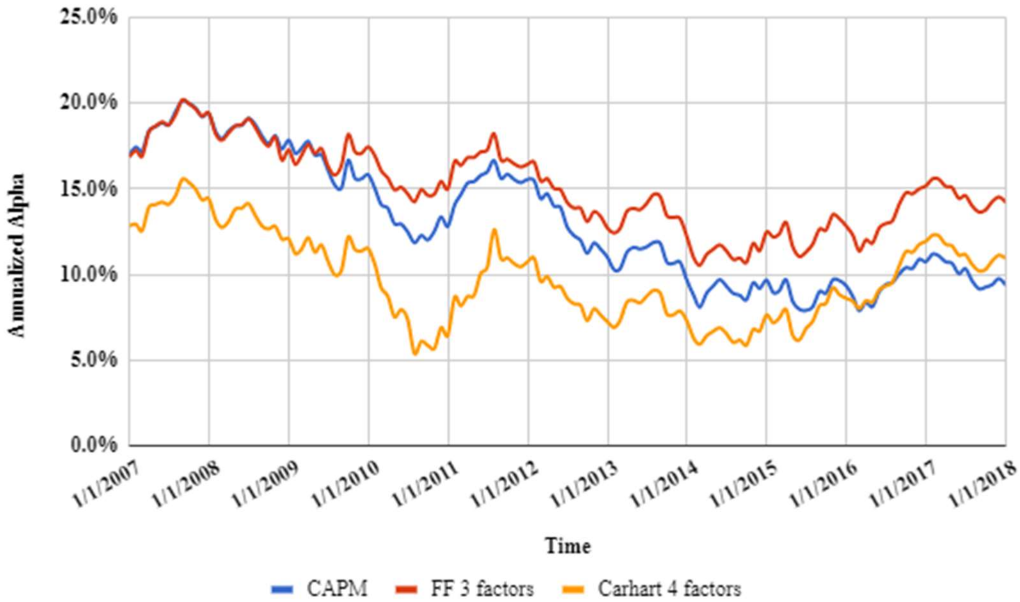


Figure A8-0-7 Five-Year Rolling Annualized Alpha (Finland)

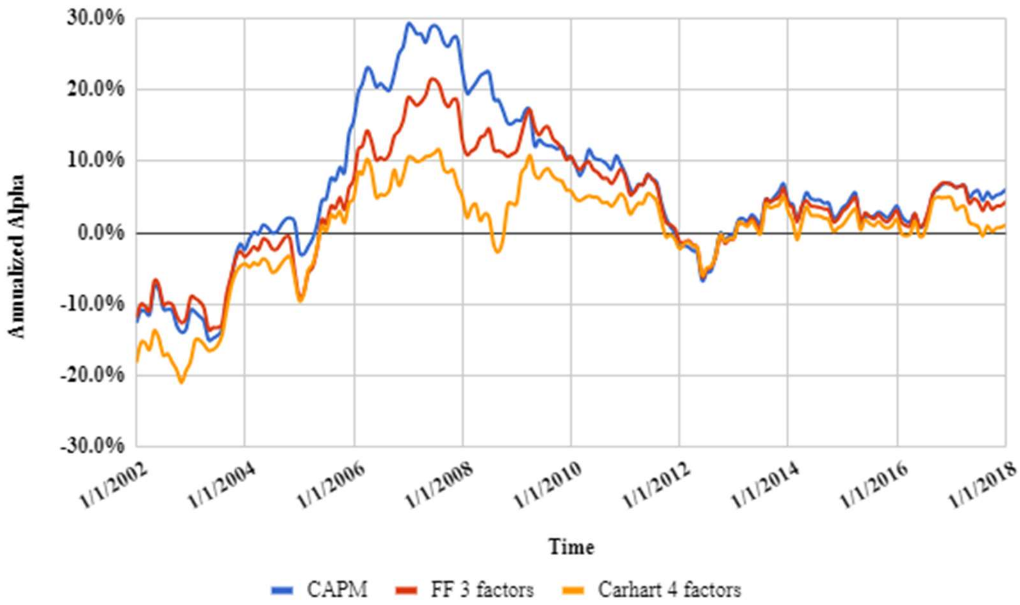


Figure A8-0-8 Ten-Year Rolling Annualized Alpha (Finland)