Momentum Strategy on the Swedish Large-Cap Market.

An Empirical Study of
the Momentum Strategy on OMXS30

Erik Ellborg Hansson
Oskar Hektor

Stockholm Business School
Bachelor's Degree Thesis 15 HE Credits
Subject: Business Administration
Spring Semester 2018
Supervisor: Dexiang Wu

Stockholm Business School

Stockholm University

Abstract

This year (2018), it is 25 years since the Momentum Strategy was first scientifically described. Despite this, the cause of the effect has not surely been concluded although it has been empirically studied in several previous studies. It has been shown to be valid for different kinds of assets.

Since the authors of this thesis are based in Stockholm they thought it would be interesting and relevant to study if the strategy is valid on the Swedish market. The stock data comes from the stocks which has been part of the OMXS30 at least once during the period of 2010-2018. This study has also utilised two different ways on how to quantitate the return of the different portfolios. The effect of the holding period has in this report been attempted to address. The holding period is the length of the period which assets should be enclosed in the portfolio.

One of the quantitation methods compared the portfolios' development each month. The other method was more like a window analysis, to evaluate a portfolio's return if one decides to invest in that theory until all the invested funds has been turned over.

The study finds that the Momentum Strategy with holding periods of 2, 3 and 4 months significantly outperforms the market. With a higher significance level (10%) Momentum Strategy portfolios with holding periods of 2-6 and 11-14 months are outperforming the market. With a larger sample size, it is possible that the results would have been more conclusive.

Table of Content

Chapter 1: Introduction

Background and previous research

The holy grail for an investor, if one might say so, is to find a strategy that can outperform the market. The goal of active investment is to outperform the market, or at least achieve a similar return, which seen by those with a strong belief in the Efficient Market Hypothesis is a more realistic target. The authors of this study however do not subscribe to the belief of a perfectly efficient market and hence wanted to find a strategy that could outperform the market and put it to test on the Swedish market. The authors have looked at several such strategies but chose the Momentum Strategy with its momentum effect which they found intriguing, seeming both fully logical and counterintuitive at the same time. Logical in the sense of it seeming quite reasonable that well performing stock would continue to perform, more counterintuitive that they would do so in such a manner that it wasn't picked up by the market and therefore could be exploited for designing a strategy to outperform the market. The authors were also very impressed with the results yielded from different markets, with different assets during different time periods. Further on they were intrigued by a strategy which could be implemented automatically and working on stock prices alone, not being dependent on insider knowledge, close examination of financial records or deep analysis of the future of products or industries. Therefore, in this thesis, the authors have chosen to examine the Momentum Strategy in the Swedish market.

The name of the Momentum Strategy comes from Newton's first law of motion which states that an object in motion stays in motion. Of course, Newton's law does not predict economic assets price-time behaviour, but the observed natural scientific phenomena have given inspiration to the naming of an economic term. The basic premise is that stocks that have performed well will continue to do so in the intermediate term and stocks that have performed badly will continue to do so. The strategy is therefore to buy past winners and sell past losers.

Since the Momentum Strategy was first put forward in 1993 by Jegadeesh and Titman it has been partly accepted with mixed reviews. (Asness, et al., 2014) Even if several studies have given empirical evidence for the strategy the cause

of the phenomena not been indisputably determined. Some have also argued that this means that there is no evidence for the success of the strategy but rather that there are other factors behind the seemingly overperforming returns. These include hidden risks as well as the other two factors of the *"The Fama and French three factor model"*, size and market to book ratio. Despite this the strategy may still be a useful tool for a portfolio analyst since it has been showed to work on most markets historically.

Previously the Momentum Strategy has been shown to work for several different markets and types of assets during both long and different time periods. There are exceptions of course, Japan being the obvious example, but it has also been shown that the effect materializes in different ways in the Chinese market. Although it has also been investigated in a Swedish setting in a bachelor thesis about 10 years ago, the authors argue that the research, and therefore the evidence, on how the Momentum Strategy performs on the Swedish market is if not insubstantial at least in need of complementing research. This study aims to do just that and gain some renewed empirical validity for the Momentum Strategy in the Swedish market.

Knowledge gap

On the international stage, mainly in the US, studies of the occurrence of momentum effect and the success of Momentum Strategy have already been conducted on a scale this study are unable of surpassing, so the study has instead been designed on a market which has not seen this type of study for quite some years. The authors are interested to see if it is possible to replicate the results on our chosen market or if it differs from most and others, and in that case, in which way.

By studying if the Momentum Strategy significantly outperforms the market during 2010-2017 one may conclude if the Momentum Strategy works on the Swedish market.

In order for the thesis to be at a suitable workload and difficulty for a bachelor thesis the compared assets in this study have been selected from those stocks which make up the Stockholm OMX30 index. The study aims to make a

theoretical portfolio where it buys previous winners. These will be determined by the top 10th percentile. For the same reason this will be a strictly quantitative study which will just examine the performance of the Momentum Strategy on the Swedish market rather than trying to figure out why it works or doesn't work. The study will examine large cap companies only to be able to disregard the effect of size, i.e. that small companies outperform larger ones, on our studied stocks.

Research question:

"Can the Momentum Strategy be successful on the Swedish market and if so, for what holding periods is it successful?"

Chapter 2: Literature Review

Scientific Appearance

The empirical evidence to the Momentum Strategy was first given in 1993 when proposed. The study puts forward the framework for the strategy, to buy winners and sell losers. The winners are defined by the bottom 10^{th} percentile of the distribution of return of assets for an evaluation period. The losers are then the top 10^{th} percentile. The study finds that in every month (except Januaries) does the past winners outperform the market-mean for holding periods of 3 to 12 months. The study is unable to answer the cause of the phenomena which allows the strategy but suggests that it may have something to do with investor behaviour. (Jegadeesh & Titman , 1993)

With the strategy turning 20 years old in 2014 an article was published regarding the Momentum Strategy. The authors discussed, explained and debunked myths and misconceptions about the effect that the investing community might have against the theory. The argumentation is both based on empirical evidence as well as review of references on the topic. (Asness, et al., 2014)

The article Value and Momentum Everywhere, recognises there are methods which more accurately may predict the returns of a specific asset class, but if Momentum Strategy may be used across asset classes would the method have an increased usefulness compared to if not. The study provide evidence for the momentum strategies globally across asset classes. It also provides strong correlation across asset classes which according to the authors may not be fully reconciled with at the time existing behavioural theories which further gives the Momentum Strategy theory validity. (Asness, et al., 2013)

The authors of the first study on the Momentum Strategy returned with a new article trying to shed some light on the causes of why the Momentum Strategy works. This study gives similar empirical evidence as their first article. The empirical evidence shows a positive return for up to 12 months. After that the return becomes negative or non-significant. The authors argues with empirical evidence for rejection of the hypothesis proposed by Conrad and Kaul (Conrad &

Kaul , 1998) in which they oppose the presence of momentum in favour of price reversal (Jegadeesh & Titman , 2001).

Theoretical framework

Efficient Market Hypothesis

Benoît Mandelbrot claims that the Efficient Market Hypothesis (EMH) was first proposed as early as 1900 by the French mathematician Louis Bachelier (Hadas & Authers, 2010). The more modern version of it was developed by Eugene Fama and presented in *Efficient Capital Markets: A Review of Theory and Empirical Work* (Fama, 1970). The hypothesis state that stock price reflects all information available and because of this always trade at their fair value. Hence, if the market works efficiently there would be no opportunity for investors to take advantage of incorrectly priced stocks and gain profit by selling or buying them. In other words, it isn't possible to outperform the overall market.

To test the hypothesis Fama designed three versions of Efficient Market Hypothesis tests which differed by the type of information the price would be built on. These three categorizations of information led to the weak, semi strong and the strong form of Efficient Market Theory. The weak form consists of historical prices and returns. The semi strong form consists of the information included in the weak form as well as publicly available information. The strong form consists of both earlier categories as well as monopolistically accessible information. In other words, the strong form of EMH claims that even though an investor has insider information they would not be able to outperform the market. (Fama, 1970)

Fama finds evidence of the weak form and the semi strong form of EMH but concludes that the strong form model is a bit too extreme to be "an exact description of the world". However, he argues that the only groups that are documented to have monopolistic access to information are corporate insiders and specialists and for most investors the EMH is a working approximation of reality. (Fama, 1970)

Fama French Model

The Fama French Three Factor Model, from here on abbreviated as FFM, is expanded upon CAPM and is a model for valuing assets. It was presented by Fama & French in 1993, built on a paper from the year before. The three factors included in the model, market risk, size of company and book to market ratio (i.e. the ratio between the accounting value of the company and the market value of the company-shares), is often used to explain why a strategy or an investor may outperform the market. (Fama & French, 1993) Advocates of the Momentum Strategy, as shown later in this chapter, have tried to prove that the Momentum Strategy cannot be explained by these factors alone. This is necessary in order to prove that a momentum effect exists.

Momentum Strategy

The thinking behind Momentum Strategy and why it would work is that it is more likely that well performing stocks, or other assets, will continue to perform well in the future and that those that previously have performed badly will continue to do so. This was observed by Jegadeesh & Titman. This knowledge, or observation, led to two basic strategies. The first is to simply take the factor of momentum into account when assessing stock prices and thereby being able to find good value. The second is to build portfolios by going long on those assets that have performed well and short on those that have performed badly. For this strategy to be successful 'all' that it takes is for previous winners to outperform the losers. Or for the opposite, the losers have to outperform the winners. It is a way to diversify in order not to be relying on the overall performance or trend of the market, it removes the market risk, only leaving firm specific risk. (Jegadeesh & Titman , 1993)

Gamblers fallacy

One psychological theory which could correspond to the success of the Momentum Strategy is that of the gamblers fallacy. It is the observed behaviour of gamblers betting against streaks in situations where previous results have no impact of coming results such as in roulette or dice games. Even if a dice has been cast ten times, all resulting in sixes, the chance of the dice being a six the eleventh time is still one in six but a cognitive bias has been observed (Tversky

& Kahneman, 1972) where people believe that a small sample size should behave like a large population. This might be a reason for investors instinctively going against momentum, thinking that the trend soon must shift. If this occurred to a sufficiently large extent it could shift the market from an efficient one to one where it is profitable to go against this behaviour or in other words implementing Momentum Strategy.

Momentum Effect contrasting EMH & FFM

Momentum Strategy stands in contrast to EMH since if EMH were true no strategy can outperform the market over time. The success of Momentum Strategies is therefore theoretically an argument against EMH although it may not be enough to reject it. Momentum Strategies and FFM can also be said to be incompatible, although this might point to FFM not being perfect rather than incorrect. To prove that a momentum effect exists outside the explanatory variables of the FFM Louis K. C. Chan, Narasimhan Jegadeesh and Josef Lakonishok (Chan, et al., 1996) check firstly only large cap companies and thereby removing the size factor. Secondly, they check the book to market ratio but although the portfolio of winners loads marginally negatively on the ratio and the portfolio of losers does the opposite. This cannot explain the momentum effect either. The authors argue that since the effect drops off after about a year it can't be explained by higher risk since then its performance even after the one-year mark should continue in order to justify it. If not, it means that the risk of the stock would only be high in the time period correlating with good performances from the Momentum Strategy i.e. 6-12 months. Carhart (Carhart, 1997) accepted that the FFM wasn't perfect and couldn't explain the momentum effect, therefore choosing to add momentum as a factor in his own Carhart's Four Factor Model.

Previous Empirical Research

Performance of the Momentum Strategy in the US market

Grinblatt, Titman, and Wermers (Grinblatt, et al., 1995) studied mutual fund behaviour in the US. They first adjust for herd behaviour, i.e. those that exhibited real Momentum Strategy behaviour and not just those that followed the trend of

other funds. With the adjustment they then found a clear correlation between those funds who exhibited Momentum Strategy behaviour and above average performance.

George and Hwang (George & Hwang, 2004) uses the Momentum Strategy as a comparison when evaluating the 52-Week High strategy. Their findings suggest that the 52-week high strategy yields about twice compared to other strategies. Thus, George and Hwang have used the larger percentiles (30th) than proposed by Jegadeesh when determining the winners and losers. Therefore, the proposed comparative yield may be exaggerated compared to the true comparative yield between 52-Week high yield strategy and momentum theory. On the other hand, Jegadeesh (Jegadeesh & Titman , 1993) suggesting that the Momentum Strategy yields large returns, just significant.

Performance of the Momentum Strategy in other Assets and Markets.

Early research on Momentum Strategy focused largely on the US market. Rouwenhorst in 1998 researched the Momentum Strategy on an international scale by examining returns on sample stocks from twelve different countries between 1978 and 1995. The author found the strategy to work much the same way that earlier research had showed it to work in the US which he argues not only validates the strategy on those markets but also validates its success on the US market. (Rouwenhorst , 1998)

This research however focused on markets with a strong correlation to the US market. Kang, Liu and Xiaoyan Ni examined one which did not, the Chinese market. With differing settings and factors, mainly the lack of reliable and publicly available information, it contradicts the EMH. They found the Momentum Strategy work although differing in which holding time periods it was the most successful. (Kang, et al., 2002)

The clearest exception to the “rule”, i.e. that Momentum Strategy works, has been Japan. Asness argues that although the results of the strategy have not been positive historically on the market this does not mean that it cannot be successful there. Asness uses four geographically divided areas, UK, non-UK Europe, US & Japan, as well as a combination of all of them to compare large caps for the

period 1981-2010. He looks at the Sharpe ratios and run simulations and find the failure of the Momentum Strategy to be not that impressive statistically and that the bad results historically may just be a case of bad luck. Using a version of the Fama-French three-factor model they find that Momentum Strategy is not in fact a failure but an empirical success. (Asness, 2011)

Theories of underlying factors for the success of the Momentum Strategy

Chan, Jegadeesh and Lakonishok try to examine why the Momentum Strategy works, why it produces a seemingly disproportionate high return in relation to its risk, it is after all based on publicly available information. In this article the authors look at both the prior stock return, which later will be focused on in this thesis, and recent earnings surprise, i.e. when the reported profits of a company differ from those analysts were expecting. Their conclusion is that the investors and the analysts who predict earnings, react slowly or underreact since in the cases where they are surprised by the presented earnings they are on average surprised by it in the same direction, higher or lower, at least for two following announcements. The market shows sign of reacting in a similar way, probably helped, or hindered if you will, by this. However, since the market reacts to more information than that of analysts it is not the sole reason for the momentum effects, rather it acts, like the analysts, gradually on the information of stock return and surprise earnings. (Chan, et al., 1996)

Moskowitz and Grinblatt argues that the momentum effect exists more in industries than in specific stocks/companies. In this article the authors find that if you look at specific stocks and compare them to industries, even though the Momentum Strategy performs differently during different periods in the intermediate scope i.e. 6-12 months, the performance over that entire period is almost identical. For individual stocks the performance is bad during the first month, picking up after that while it works almost the opposite way for industries. They argue that the momentum industry strategies are superior to individual stock Momentum Strategies since an adjustment for momentum within industries removes almost all profit from individual stocks Momentum Strategy. (Moskowitz & Grinblatt , 1999)

Chen and De Bondt showed that the style momentum is distinct different compared to price and industry momentum. At the end of the decade 1990 where different kinds of momentum defined. (Chen & de Bondt, 2004) The one as first suggested by Jegadeesh was categorised as price momentum since it only considers the price of the asset. By complying portfolios of styles of assets may one use momentum strategy to determine which portfolio to buy and which to sell. In such way, the Style momentum strategy is determined. By doing as the Style Momentum Strategy but with a style being defined as industries do one obtain the Industry Momentum Strategy (Chen & de Bondt, 2004) In a similar way as Asness 2014 shows is the momentum theory a fair way of predicting different kinds of assets, i.e. gives the possibility of price, style and industry momentum (Asness, et al., 2014).

Chapter 3: Research Design

The study has been separated into two different parts. Both parts still have the aim to provide evidence to evaluate if the Momentum Strategy is valid on the Swedish large cap market. The financial data were collected through the Stockholm stock exchange operator Nasdaq Nordic public historic financial information (Nasdaq OMX Nordic, 2018).

The prices of the stocks were decided to be the closing price on the first day of trading in every month. For every month the three top performers of the last six months were calculated. The holding time is the length of the time in-between when the stock is purchased to when it is sold again. For this study it varied from 1 to 18 months, i.e. the time for when the stock is part of the portfolio. The weights of the stocks in the portfolio are such that the invested share is the same value in the stocks for each time of purchase (form here on referred to as decision time). The weights may also be described as:

$$w_{j_n} = \frac{1}{3H} \qquad j_n = 1; 2; 3 \tag{1}$$

Where n describes the decision time. H is the holding time and j_n corresponds to the order of performance last six months at decision time n.

The formulated hypothesises are:

H_0: The Momentum Strategy does not give a better yield than the market mean

H_1: The Momentum Strategy gives a better yield than the market mean.

The Sample stocks – OMXS30

The stocks which has been a part of the index fund OMXS30, which consists of the stocks on the Stockholm stock exchange, has the thirty largest trading turnovers (Nasdaq Stockholm AB, 2016). During the time between January 2010 and February 2018 has there been 33 different company stocks in the OMXS30.

The Scania stock was listed on the stock exchange until MAN bought the company in 2014.

From the 3rd quarter 2018 has Essity been part of the index following a fission in the company SCA. During that time OMXS30 consisted of 31 companies.

Modifications to dataset

For the case of this study has the stock value of the Essity and SCA been compounded.

For the case of this analysis has the rate of return from the Scania stock been set to zero starting in 3rd quarter of 2014.

Evaluating the Momentum Strategy with a portfolio with given holding time.

One way to evaluate the Momentum Strategy is to create one portfolio for each evaluated holding period length. In this case that would make up 18 different portfolios. Each of the portfolio becomes a sample for the test of each holding period time. The values of the portfolios are evaluated monthly. Those values are then compared to the market mean rate, the comparisons are then put through a statistics analysis. The statistics analysis analyses the standard errors, t-tests, p-tests, and confidence intervals. Finally, the Sharpe-ratio is estimated. Hopefully conclusions may then be drawn.

Evaluating the Momentum Strategy using a moving window.

The Momentum Strategy may also be tested in another way, with an evaluation with a moving window. Practically it is evaluating what the yield of the portfolio is after one complete turnover of the portfolio. Firstly, the algorithm purchases w_{jn} of the 3 stocks with the best record. One month later the algorithm will purchase w_{jn} of the 3 stocks with the best record at that time. This is repeated until the holding time has passed since the decision time. Then, in addition to new stocks being purchased, the 3 firstly acquired stocks will be sold. This is repeated until all the stocks have been sold. When all stocks have been sold off one window is fulfilled. For each window, the total return is recorded for each decision time (the opening time for the window, i.e. the time of the first purchase in the portfolio). The data then describes what the yield would be if a broker would start the Momentum Strategy every month of the sample period. The evaluated time periods then become:

$$N_w = (T + 1 - 2 \cdot H) \cdot H \quad (2)$$

Where N_w is number of evaluated moths, T is the number of months in the sample, H is the holding time given in months.

Each of these values of the yields of each decision time is compared to the corresponding market return for the same window. That data is then analysed by the means of the standard errors, t-tests, p-tests and confidence intervals. Hopefully conclusions may then be drawn.

The way that the window approach is defined by

$$r_{w(t)} = \sum_{k=t}^{t+H-1} \sum_{n=1}^{3} w_{j_n} \frac{C_{j_n(k)}(k+H)}{C_{j_n(k)}(k)} = \sum_{k=t}^{t+H-1} \sum_{n=1}^{3} \frac{C_{j_n(k)}(k+H)}{3HC_{j_n(k)}(k)} \quad (3)$$

Where:

$C_{j_n(k)}(t)$ is the value of the $j_n(k)$ asset at time t,
$j_n(k)$ is the asset with the *n*:th best historic performance for the period *k-6* to *k*,
k is referred as the decision time, the time of the choice the purchases of the assets are determined.

The parallel approach is different since it only estimates the monthly return of a momentum portfolio.

The way that the parallel approach is defined by

$$r_p\,(t) = \sum_{k=t-H+1}^{t} \sum_{n=1}^{3} w_{j_n} \frac{C_{j_n(k)}(t+1)}{C_{j_n(k)}(t)} = \sum_{k=t-H+1}^{t} \sum_{n=1}^{3} \frac{C_{j_n(k)}(t+1)}{3HC_{j_n(k)}(t)} \quad (4)$$

Where:

$C_{j_n(k)}(t)$ is the value of the $j_n(k)$ asset at time t,
$j_n(k)$ is the asset with the n:th best historic performance for the period k-6 to k,

k is referred as the decision time, the time of the choice the purchases of the assets are determined.

Sharpe ratio

The Ex Post Sharpe Ratio

Sharpe derives the Ex Post Sharpe Ratio by letting R_{Ft} be the return of the fund in period t. R_{Bt} is the return of the benchmark portfolio (suggestively a market portfolio) or security in period *t*. D_t is the differential return in period t: (Sharpe, 1994)

$$D_t \equiv R_{Ft} - R_{Bt} \tag{5}$$

$\overline{D}$ is the average value of D_t over the period from *t=1* through *T*: (Sharpe, 1994)

$$\overline{D} \equiv \frac{1}{T}\sum_{t=1}^{T} D_t \tag{6}$$

And σ_D is the standard deviation over the period: (Sharpe, 1994)

$$\sigma_D \equiv \sqrt{\frac{\sum_{t=1}^{T}(D_t - \overline{D})^2}{T-1}} \tag{7}$$

Sharpe then defines the Ex Post Sharpe Ratio (S_h), also called historic Sharpe Ratio as: (Sharpe, 1994)

$$S_h = \frac{\overline{D}}{\sigma_D} \tag{8}$$

Sharpe recognises that the Sharpe ratio has a time dependence. (Sharpe, 1994). Since the term D_t is the differentiated return it is easy, if assuming linear regression relations, to obtain.

$$\overline{D}_T = T \cdot \overline{D}_1 \tag{9}$$

$$\sigma_{\overline{D}_T}{}^2 = T \cdot \sigma_{\overline{D}_1}{}^2 \tag{10}$$

Leading to that the Sharpe ratio has the time dependence of:

$$S_T{}^2 = \sqrt{T} S_1 \tag{11}$$

Tuning the Sharpe Ratio

Since the Sharpe ratio is not time independent and the second part of this study is done with a moving time window, it is important to rescale the variables to be able to compare the Sharpe ratios between both of the tests. Sharpe makes the following assumptions of the time dependence of the differentiated returns (*d*) in the Sharpe ratio (Sharpe, 1994):

$$\bar{d}_T = \left(\frac{T}{t}\right) \bar{d}_t \tag{12}$$

$$\sigma_{d_t}{}^2 = \left(\frac{T}{t}\right) \sigma_{d_t}{}^2 \tag{13}$$

$$S_T = \sqrt{\left(\frac{T}{t}\right)} S_t \tag{14}$$

In the case of the time window application is t substituted for H (holding period)

It is also well known that the standard error has the following relationship:

$$\hat{\sigma}_{\mathrm{n}} = \frac{\sigma}{\sqrt{n}} \tag{15}$$

Equation 15 describes how the sample standard deviation varies with the sample size. Since the window approach are using overlapping data, the Standard deviation will be underestimated, while the Sharpe ratio is overrated. The overestimation of the standard deviation is assumed to be proportional to the rate between the number of periods in this study and the number of evaluated periods of the overlapping window. Therefore, the Sharpe ratio will be "normalized" by multiplying the inverse of the overestimation.

$$s_{\mathrm{w}} = s_{\mathrm{N_w}} \sqrt{\frac{\mathrm{N_w}}{T}} \tag{16}$$

With equation 14 and 16 may the results be normalised to allow some comparison between the different test setups.

Chapter 4: Analysis & Findings

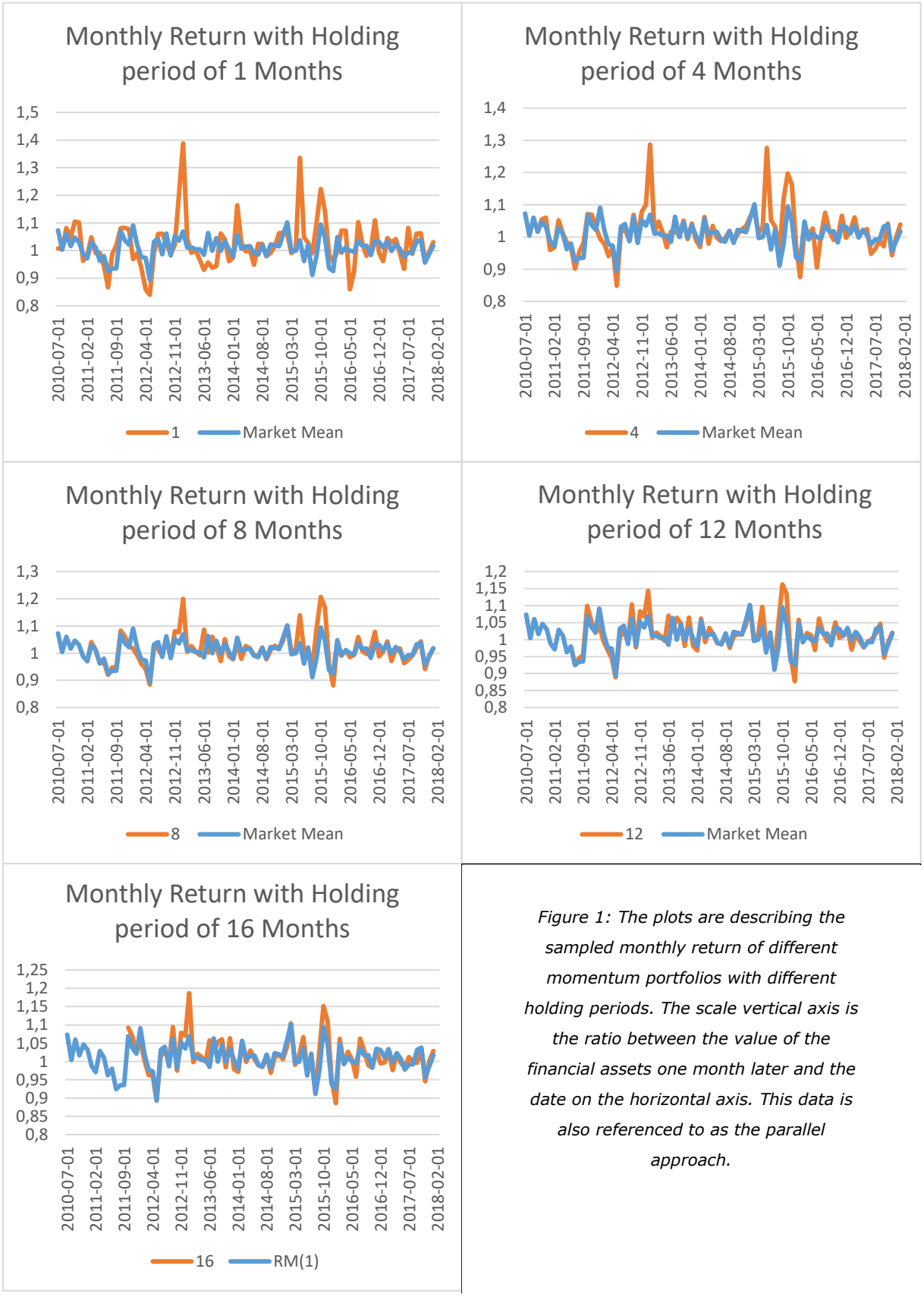

Figure 1: The plots are describing the sampled monthly return of different momentum portfolios with different holding periods. The scale vertical axis is the ratio between the value of the financial assets one month later and the date on the horizontal axis. This data is also referenced to as the parallel approach.

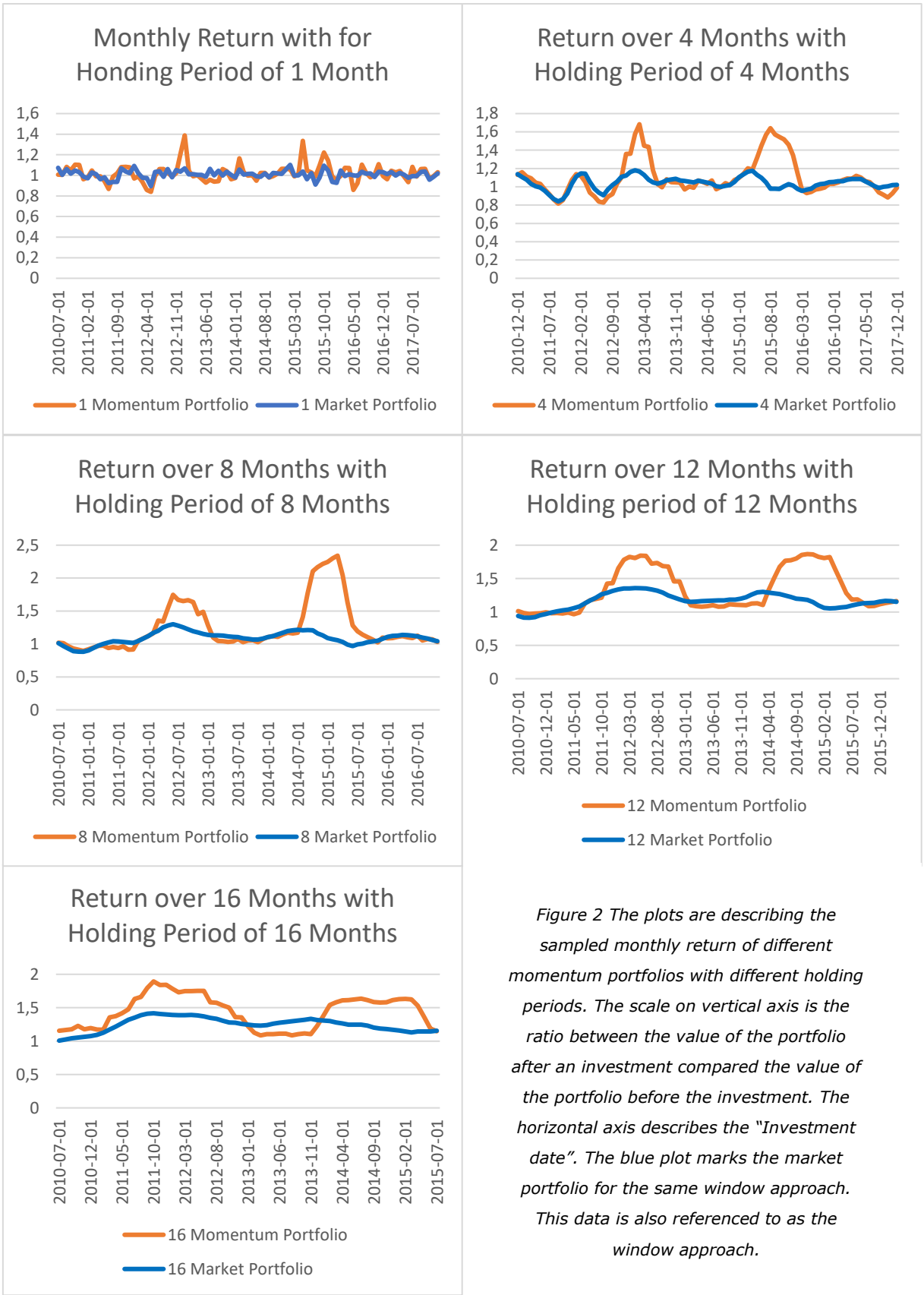

Figure 2 The plots are describing the sampled monthly return of different momentum portfolios with different holding periods. The scale on vertical axis is the ratio between the value of the portfolio after an investment compared the value of the portfolio before the investment. The horizontal axis describes the "Investment date". The blue plot marks the market portfolio for the same window approach. This data is also referenced to as the window approach.

Sharpe rate

This section covers different Sharpe rate measures of the different portfolios studied in this thesis.

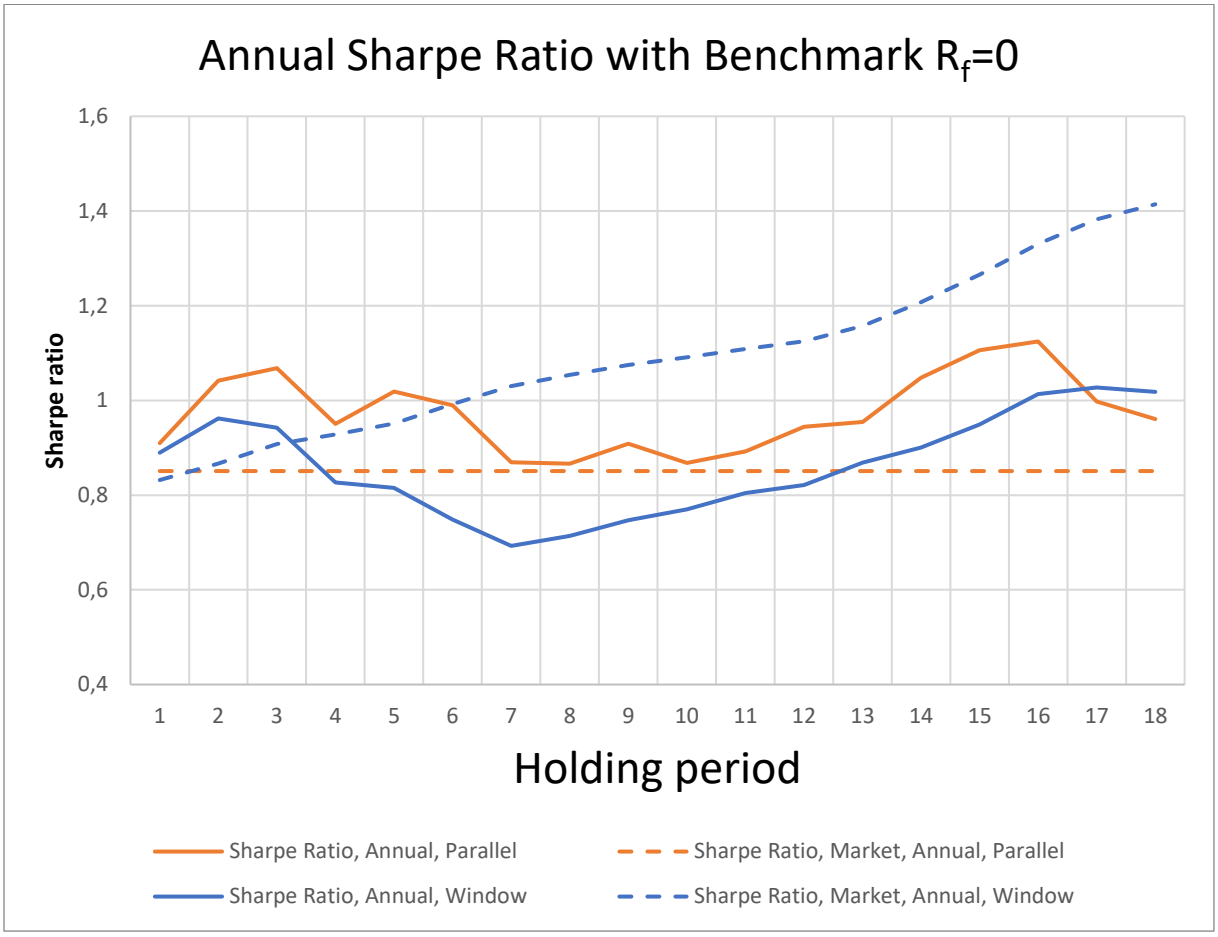

Figure 3 Describes how the Sharpe ratio varies with the holding period for the different evaluation methods.

In figure 3 it is possible to see how the Sharpe ratio for the parallel approach with the momentum is greater than the market mean. But for the window approach the Sharpe ratio is greater than the momentum portfolio for holding periods one, two and three months, but not for longer holding periods. The Sharpe ratios for the window approach are in figure 3 normalized according to equation (16). That normalization has not changed for which holding periods which yields a higher Sharpe ratio for the momentum portfolio compared to its corresponding market Sharpe ratio.

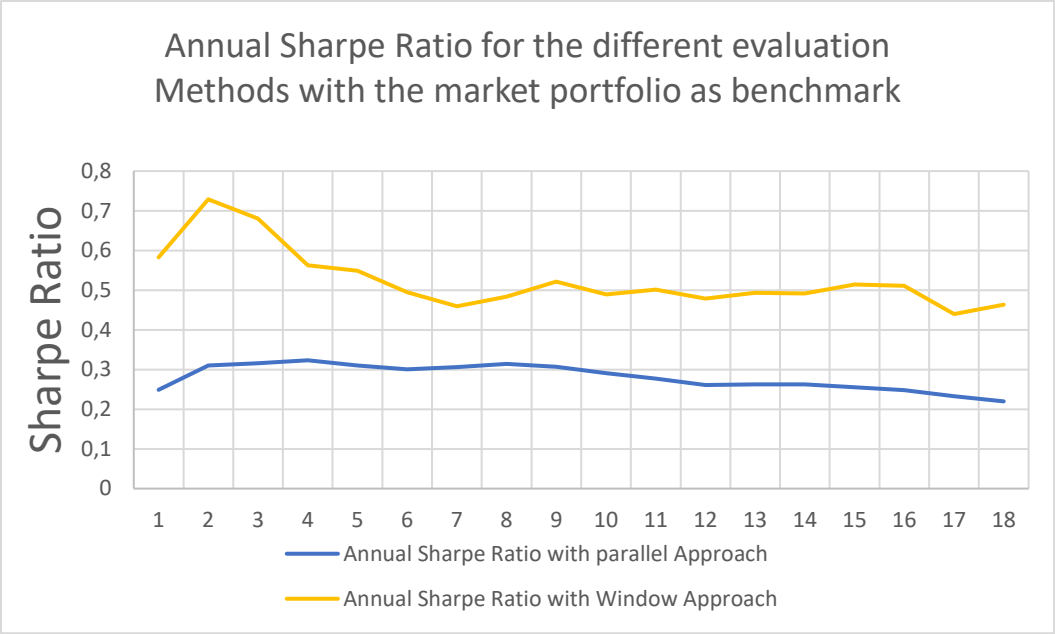

Figure 4 Shows the Sharpe ratio, with the market portfolio as benchmark. The Sharpe ratio has been reduced as to equation (16) prescribes.

In figure 4 it is possible to see how the Sharpe ratio has a relatively small variation with different holding periods. One may observe that the Sharpe ratio is greater with shorter holding periods, which yields that the risk normalized return is greater for shorter holding periods compared to longer holding periods.

Statistics and hypothesis evaluation

This section will show the statistical results given by the statistical analysis. In this study a significance level of 5% has been used. The analyses will then be the basis for the hypothesis testing.

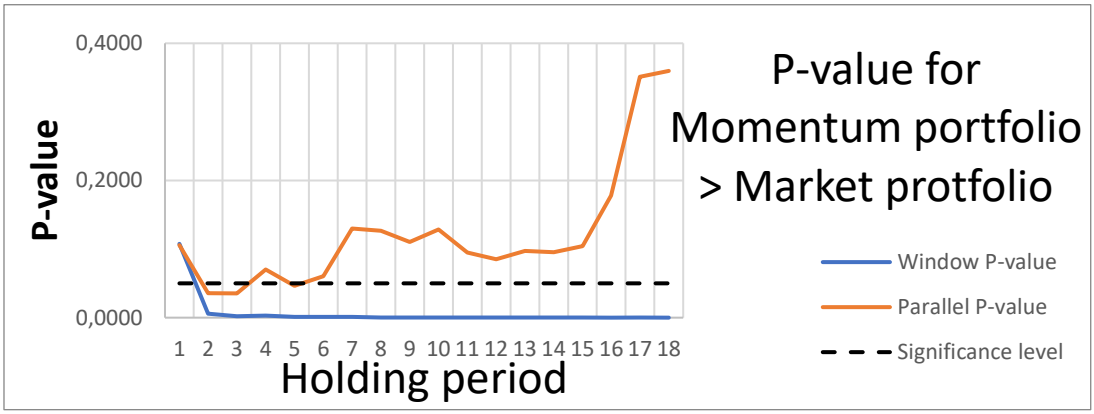

Figure 5 Shows how the P value varies for the different approaches. The Significance level is 5%.

Figure 5 shows how the p-value varies for different holding periods. It is observable for the window approach that the p-value is less than the significance

level for holding periods greater than 1 month. For the parallel approach the p-value is only lower than the significance level for holding periods of 2, 3 and 4 months. Thus, if relaxing the significance level to 10%, the parallel approach will give p-values lower than the significance level for holding periods of 2-6, 11-14 months.

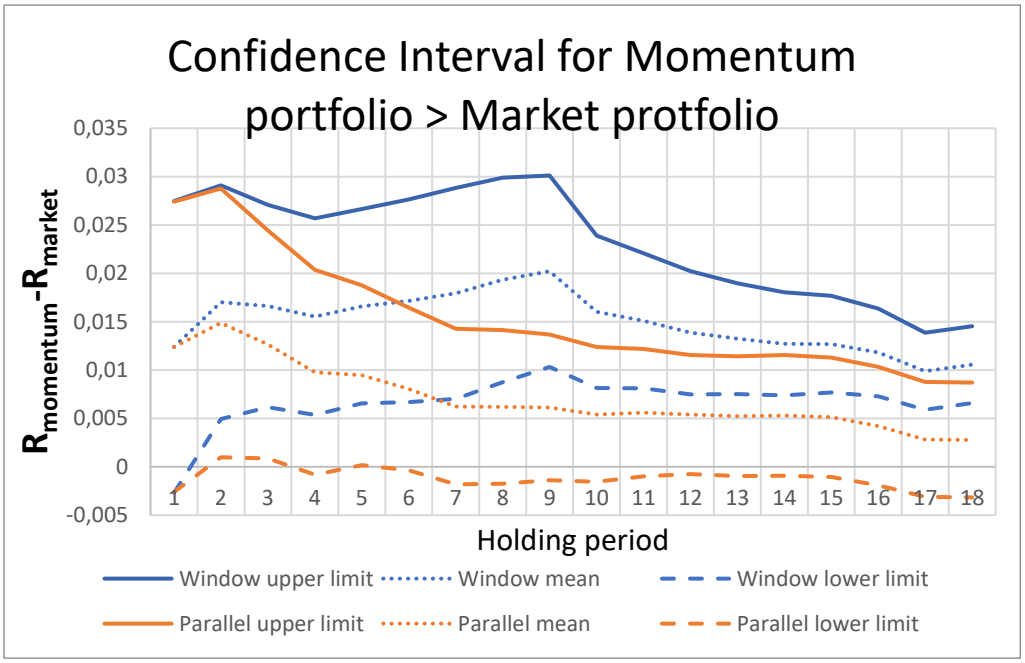

Figure 6 Shows that the confidence interval of the rate of the momentum portfolio is greater than the market portfolio. A significance level of 5% has been used.

Figure 6 shows how the confidence interval narrows as the holding period increases. One may then see how the window approach gives a steady return for the momentum return which is 1-1.5%-units greater than the market performance. The parallel approach yields a positive return, but its confidence intervals yields zero, i.e. the null hypothesis may not be rejected for that holding period.

With the data described in figure 5 and figure 6 may one see how the $\mathbf{H_0}$ could be rejected for holding periods of 2, 3 and 4 months at a significance level of 5%. For those holding periods are both the confidence interval nonzero, and the p-value is less than the significance level, for both the parallel and window approach.

$\mathbf{H_0}$ could be rejected for holding periods of 2-6, 11-14 months at significance level of 10%, shown in figure 6. It is shown that the p-value is less than 10% for both the window and parallel approach.

Chapter 5: Discussion & Critical Reflection

Our critical learnings, and the answer to our research question, is that yes, the Momentum Strategy can be successful on the Swedish market. The analysis has found success for the strategy for holding periods of 2, 3 and 4 months. With a relaxation of the significance level could one say 2-6 and 11-14 months. That estimation is on the other hand conservative since that conclusion is mainly based on the parallel approach, which is more trivial. If one analyses the samples with the window approach, the conclusion is that the momentum theory is significantly larger than the corresponding market mean. It is under the condition that the window approach is an allowed method of quantitation. Thus, this interpolation is underestimating the deviation of these samples, which is giving an offset to the financial measurements used, e.g. the Sharpe ratio.

Our findings align with the theories behind the Momentum Strategy but therefore also contradicts the EMH. It has been showed that the above-market-mean performance of the strategy is not because of two of the factors of the FFM, those being the factors of size and of risk, but have not been able to check for the market to cap ratio for all our stocks in all our time periods and as such this study cannot reject the FFM. Our findings do not alter the momentum theories as much as it reinforces them and expands them into a partly new market in a new time. Likewise, they question how perfect the EMH is rather than disproving it. It should though be stated that any number of smaller examinations have found results contradicting the EMH but still not disproven it. The hypothesis finds it strongest support with large populations over long time periods rather than being perfect always.

As a theory based on empirical evidence, theory and analytical results are connected closely from the birth of the Momentum Strategy. It was not deductively theorized first and later tested in practise, rather it is a theory based on observation. Therefore, analyses are mainly focused on more closely deciding how it is utilized best and what are the more precise bounders in specific cases in

terms of practical use. This can most clearly be seen in our study in our choice to study relatively many different holding periods. More theoretical analyses focus on the causes behind the momentum effect existing and although it has been taken these into consideration when constructing the study. This study does not dig into the causes of the effect but rather studies its existence. It has however been our target to try and disprove that our results are dependent on factors such as size and increased or undervalued risk and rather that they occur because of an actual existing momentum effect, thereby making our results meaningful to someone deciding if implementing Momentum Strategy may be a valid choice.

Our findings give some statistical validity to the answer that the Momentum Strategy works on Swedish large cap market. Thus, it is recognised that many aspects have been foreseen in this study. There are several suggestions for further studies. Firstly, how the sampling frequency affects both the acquired data and forecasting accuracy. With this knowledge it might be possible to extrapolate data and, in such ways, make the forecasts and measures more accurate and fair. These topics addresses issues of the long time series data which is needed for the Momentum Strategy analysis. With a suitable extrapolation technique could the required sample be smaller or more accurate.

This thesis might still have some source of errors. Foremost has 33 stocks been investigated. For half of the studied time period has only 32 stocks been a tradeable asset. Since three stocks were aquired every month does it mean that instead of evaluating the interval 90^{th} to 100^{th} percentile the study has evaluated the interval 91^{st} to 100^{th} percentiles. It should not make a great difference, but it could make the market portfolio more stable which would mean a volatile return would be damped and thereby possibly have less return than the momentum portfolio.

Also, the asset Fingerprint Cards has been one of our studied stocks. But since it has been ruled in court the stock has been exposed to price manipulation (Ekobrottsmyndigheten, 2018). It is highly probable that it has affected our statistical results.

For the window approach, when studying figure 2 one may see a few remarkably high returns which propagates through the samples such that the viewed behaviour and characteristics of the holding time of 1 and 16 varies much.

By the effort put in by the authors they have grown fond of the Momentum Strategy. It is in its design uncomplicated and its effect has been validated in several previous studies, as well as this study, if at least small validity. We know that the cause of why the Momentum Strategy works is disputed. We have two theories of our own on why it works. Our first theory is that it in a way is a simple evolutionary cause. It is evolutionary in its design since it will be composed of more of the assets which has historically shown a persistent higher return. The portfolio will namely weigh heavily on stocks that has performed well during a very long time and weigh lighter if not, not at all on stocks which has not performed well. If one assumes that the historical prices could be used to estimate future returns i.e. the rate of change of the return is constant, that means one could see the Momentum Strategy as a dynamic approach to pan for the best assets. If there is little change of which assets in the market that performs well, the Momentum Strategy should outperform the market, especially for longer holding periods. But if there are a lot of shifts between winners and losers on the market, the momentum portfolio for longer holding periods should be more like the market portfolio. Then the length of the holding period should be so short that the Momentum portfolio has the time to adjust its content faster than the market has had the time to turn the winners to losers.

The other theory we have explaining why the Momentum Strategy works is connected to the stock market dynamics. All the models we have learned in our bachelor program has been static. If one assumes that the market uses these static models, which are designed with static conditions, the market will fail to forecast the dynamics of a portfolio. The failure of the market to accurately forecast the dynamics of the assets would create an arbitrage for someone that may use a dynamical modelling for its portfolio design. We consider the Momentum Strategy to be a dynamic strategy. The failure to accurately forecast the future price of asset price dynamics will make the market price lag the fair price. This phase lag would then be the arbitrage one may claim using Momentum Strategy. If the market is behaving statically, then there is no dynamical arbitrage which

could be profited by the Momentum Strategy. Since Japanese companies many times are consortium, which give them a steadier behaviour that decreases or dissolves the effect of the Momentum Strategy, as shown empirically for the Japanese stock market by Asness 2011.

We value the contribution of our study as a part among many others which examine the Momentum Strategy in different ways, with regards to different factors in different time periods on different markets. However, we also value it as a study of the Swedish stock market with regards to certain aspects of how it functions, specifically in terms of momentum effect as well as a study of which theories and strategies that may be applicable on it. On an international scale, i.e. as a part of the strength of the momentum theory, our study may not have a large contribution. The validity of the Momentum Strategy might have gained something, but how much is perhaps for others to decide. On a Swedish scale, as an examination of the market and what strategies may be successful, the authors are hoping it might contribute as it is not the most well examined market in the world. Here our study may also have value in a more practical sense, being more unique as well as being up to date, at least when this thesis is written. Hopefully it may be of use in shaping strategies which will be implemented on the market and used as a basis for trading. Our study might also be of use to those that choose to further explore and study Momentum Strategy and effect both on the Swedish market and perhaps elsewhere.

Chapter 6: Conclusion

The Momentum Strategy on the contemporary Swedish market has been examined. It consisted of a study of the relative statistics between the momentum theory and the market, but also verifying the return is not just a result of undervalued risk. In order to, from our findings, formulate a successful strategy, examine which holding periods yielded the best results. From this, the research question formulated as:

"Can the Momentum Strategy be successful on the Swedish market and if so, for what holding periods is it successful?"

Firstly, the study is defining two different ways one may calculate return of the portfolio with the momentum theory. Secondly, the conclusion drawn is that the Momentum Strategy significantly outperforms the market for the holding periods of 2, 3 and 4 months. It is also concluded there are tendencies for it for holding periods up to 15 months. At a significance level of 10% the holding periods 2-6 and 11-14 months are yielding a greater return than for the market mean.

We were not, however, able to completely dismiss all explanations put forward during the last 25 years to disprove the success of the momentum theory and this could be further studied onwards. Our theories are that it works due to the fact that the Momentum Strategy is dynamic, just as a market is. Our results are clear that an effect of our proposed strategy is seen in some holding periods and this should not be dismissed. However, this study cannot rule out with absolute confidence that this is the result of other factors than momentum effect and if our results are depending on other factors instead of a momentum effect it would be perilous to build a strategy on momentum, assuming the correlation between these factors and the perceived momentum effect is not constant. Therefore, the authors advise caution before basing a strategy where money is at stake on our results and would like to make clear that historical results do not equal future results. Much more could be studied; thus, the authors conclude that it is a suitable topic to use as an arena for learning future techniques of describing and characterizing asset price behaviour.

Chapter 7: Limitations of Research

It was a deliberate design choice to only include large cap stocks in the study. Because of this behaviours of small cap company stocks are not analysed within this thesis. This means the conclusions may not be representative for the entire Swedish stock market. There is also a limitation in only having 33 stocks in the sampled market. The winners picked from these 33 are of course still stocks that are performing well, and better than all other in our sample, however it is uncertain if the demonstrated behaviour of the stocks are due to individual stock performance or a systematic superior return of the Momentum Strategy. However, the distinction of winners and losers still hold and is not in conflict with momentum strategy.

During the time for which the data was acquired the financial markets have been stable. The study does not provide data of how the strategy performs in a recession. Therefore, the conclusions from this study may not be applicable in a recession, financial crash or depression.

Although this study has managed to exclude size and risk as explanatory variables for the success of the strategy with certain holding periods, it has not been able to exclude all possible explanatory causes previously presented for it.

Bibliography

Asness, C., 2011. Momentum in Japan: The Exception That Proves the Rule. *The Journal Of Portfolio Management*, Summer.pp. 67-75.

Asness, C., Frazzini, A., Israel, R. & Moskowitz, T., 2014. Fact, Fiction, and Momentum Investing. *The Journal of Portfolio Management Special 40th Anniversary Issue 2014*, 40(5), pp. 75-92.

Asness, C. S., Moskowitz, T. J. & Heje Pedersen, L., 2013. Value and Momentum Everywhere. *The Journal of Finance*, June, 68(3), pp. 929-985.

Barroso, P. & Santa-Clara, P., 2015. Momentum has its moments. *Journal of Financial Economics*, Volume 116, pp. 111-120.

Carhart, M. M., 1997. On Persistence in Mutual Fund Performance. *The Journal of Finance*, March, 52(1), pp. 57-82.

Chan, L. K. C., Jegadeesh, N. & Lakonishok , J., 1999. The Profitability of Momentum Strategies. *Financial Analysts Journal*, Nov-Dec, 55(6), pp. 80-90.

Chan, L. K. C., Jegadeesh, N. & Lakonishok, J., 1996. Momentum Strategies. *The Journal of Finance*, December, 51(5), pp. 1681-1713.

Chen, H.-L. & de Bondt, W., 2004. Style momentum within the S&P-500 index. *Journal of Empirical Finance*, Volume 11, pp. 483-507.

Chui, A. C., Titman, S. & Wei, K. J., 2010. Individualism and Momentum around the World. *The Journal of Finance*, February, 65(1), pp. 361-392.

Conrad , J. & Kaul , G., 1998. An Anatomy of Trading Strategies. *The Review of Financial Studies*, Fall, 11(3), pp. 489-519.

Cooper, M. J., Gutierrez Jr, R. C. & Allaudeen, H., 2004. Market States and Momentum. *The Journal of Finance*, June, 59(3), pp. 1345-1366.

de Haan, L. & Kakes, J., 2011. Momentum or contrarian investment strategies: Evidence from Dutch institutional investors. *Journal of Banking & Finance*, Volume 35, pp. 2245-2251.

Ekobrottsmyndigheten, 2018. *Ekobrottsmyndigheten - Swedish Economic Crime Authority*. [Online] Available at: https://www.ekobrottsmyndigheten.se/press/nyheter/2018/1/fallande-dom-for-grov-otillborlig-marknadspaverkan-i-fingerprint-aktien/ [Accessed 28 May 2018].

Fama, E. F., 1970. Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance*, May, 25(2), pp. 383-417.

Fama, E. F. & French, K. R., 1992. The Cross-Section of Expected Stock Returns. *The Journal of Finance*, June, 47(2), pp. 427-465.

Fama, E. F. & French, K. R., 1993. Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, February, 33(1), pp. 3-56.

George, T. J. & Hwang, C.-Y., 2004. The 52-Week High and Momentum Investing. *The Journal of Finance*, October, 59(5), pp. 2145-2176.

Griffin, J. M., Ji, X. & Martin, J. S., 2003. Momentum Investing and Business Cycle Risk: Evidence from Pole to Pole. *The Journal of Finance*, December, 58(6), pp. 2515-2547.

Grinblatt, M., Titman, S. & Wermers, R., 1995. Momentum Investment Strategies, Portfolio Performance, and Herding: A Study of Mutual Fund Behavior. December, 85(5), pp. 1088-1105.

Grundy, B. D. & Martin , J. S., 2001. Understanding the Nature of the Risks and the Source of the Rewards to Momentum Investing. *The Review of Financial Studies*, Spring, 14(1), pp. 29-78.

Hadas, E. & Authers, J., 2010. *Lex live: Inefficient markets and Mandelbrot*, London: s.n.

Jegadeesh, N. & Titman , S., 1993. Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *The Jounal of Finance*, March, 48(1), pp. 65-91.

Jegadeesh, N. & Titman , S., 2001. Profitability of Momentum Strategies: An Evaluation of Alternative Explanations. *The Journal of Finance*, April, 56(2), pp. 699-720.

Kang, J., Liu, M.-H. & Ni, S. X., 2002. Contrarianandmomentumstrategiesinthe China stockmarket:1993–2000. *Pacific-Basin Finance Journal*, Volume 10, pp. 243-265.

Loughran, T. & Ritter, J. R., 1995. The New Issues Puzzle. *The Journal of Finance*, March, 50(1), pp. 23-51.

Moskowitz, T. J. & Grinblatt , M., 1999. Do Industries Explain Momentum?. *The Journal of Finance*, August, 54(4), pp. 1249-1290.

Moskowitz, T. J., Heje Pedersen, L. & Hua Ooi , Y., 2012. Time series momentum. *Journal of Financial Economics*, Volume 104, pp. 22-250.

Nasdaq OMX Nordic, 2018. *Nasdaq OMX Nordic Historiska Kurser - Aktier.* [Online] Available at: http://www.nasdaqomxnordic.com/aktier/historiskakurser

Nasdaq Stockholm AB, 2016. *Rules for the Construction and Maintenance of the OMX STOCKHOLM 30 INDEX VERSION 1.6 / November 2016 ,* Stockholm: Nasdaq Stockholm AB.

Ramiah, V. et al., 2011. Contrarian investment strategies work better for dually-traded stocks: Evidence from Hong Kong. *Pacific-Basin Finance Journal*, Volume 19, pp. 140-156.

Rouwenhorst , K. G., 1998. International Momentum Strategies. *The Journal of Finance*, February, 53(1), pp. 267-284.

Sharpe, W., 1994. The Sharpe ratio.. *Journal of Portfolio Management*, Fall, 21(1), pp. 49-58.

Siganos, A. & Chelley-Steeley, P., 2006. Momentum profits following bull and bear markets. *Journal of Asset Management*, January, 6(5), pp. 381-388.

Tversky, A. & Kahneman, D., 1972. Belief in the law of small numbers. *Psychological Bulletin*, 76(2), pp. 105-110.

Appendix – Tables

In this Appendix is the tables which could provide more details to the data of which the plots in Chapter 4 are based upon.

HOLDING PERIOD	STANDARD ERROR	MEAN	T-VALUE	P-VALUE	WINDOW UPPER LIMIT	WINDOW LOWER LIMIT	NORMALIZED STANDARD ERROR	T-VALUE	P-VALUE_NORM
1	0,0077	0,0124	1,6090	0,1076	0,0275	-0,0027	0,0077	1,6002	0,1096
2	0,0123	0,0340	2,7607	0,0058	0,0582	0,0099	0,0125	2,7291	0,0063
3	0,0160	0,0499	3,1161	0,0018	0,0812	0,0185	0,0163	3,0606	0,0022
4	0,0208	0,0621	2,9930	0,0028	0,1028	0,0214	0,0213	2,9191	0,0035
5	0,0256	0,0829	3,2364	0,0012	0,1332	0,0327	0,0265	3,1323	0,0017
6	0,0321	0,1029	3,2094	0,0013	0,1658	0,0401	0,0334	3,0801	0,0021
7	0,0389	0,1255	3,2254	0,0013	0,2018	0,0492	0,0409	3,0668	0,0022
8	0,0432	0,1546	3,5824	0,0003	0,2392	0,0700	0,0459	3,3714	0,0007
9	0,0454	0,1820	4,0056	0,0001	0,2710	0,0929	0,0488	3,7268	0,0002
10	0,0402	0,1603	3,9901	0,0001	0,2390	0,0816	0,0437	3,6651	0,0002
11	0,0392	0,1661	4,2409	0,0000	0,2429	0,0894	0,0433	3,8396	0,0001
12	0,0390	0,1663	4,2658	0,0000	0,2427	0,0899	0,0438	3,7989	0,0001
13	0,0380	0,1722	4,5265	0,0000	0,2468	0,0976	0,0435	3,9555	0,0001
14	0,0380	0,1780	4,6784	0,0000	0,2526	0,1034	0,0445	3,9993	0,0001
15	0,0382	0,1902	4,9737	0,0000	0,2652	0,1152	0,0459	4,1431	0,0000
16	0,0369	0,1891	5,1186	0,0000	0,2615	0,1167	0,0457	4,1336	0,0000
17	0,0345	0,1681	4,8748	0,0000	0,2357	0,1005	0,0443	3,7906	0,0002
18	0,0364	0,1901	5,2203	0,0000	0,2615	0,1187	0,0491	3,8715	0,0001

Table 1 is the data from the statistics from the window approach.

HOLDING PERIOD	STANDARD ERROR	MEAN	T-VALUE	P-VALUE	+1,96 INTERVAL	-1,96 INTERVAL
1	0,0077	0,0124	1,6180	0,1057	0,0274	-0,0026
2	0,0071	0,0149	2,0990	0,0358	0,0288	0,0010
3	0,0060	0,0127	2,1045	0,0353	0,0244	0,0009
4	0,0054	0,0098	1,8097	0,0703	0,0204	-0,0008
5	0,0048	0,0095	1,9936	0,0462	0,0188	0,0002
6	0,0043	0,0081	1,8766	0,0606	0,0165	-0,0004
7	0,0041	0,0062	1,5151	0,1297	0,0143	-0,0018
8	0,0041	0,0062	1,5280	0,1265	0,0141	-0,0018
9	0,0038	0,0061	1,5958	0,1105	0,0137	-0,0014
10	0,0036	0,0054	1,5206	0,1284	0,0124	-0,0016
11	0,0034	0,0056	1,6705	0,0948	0,0122	-0,0010
12	0,0031	0,0054	1,7214	0,0852	0,0115	-0,0007
13	0,0032	0,0052	1,6573	0,0975	0,0114	-0,0010
14	0,0032	0,0053	1,6677	0,0954	0,0115	-0,0009
15	0,0032	0,0051	1,6246	0,1042	0,0113	-0,0011
16	0,0031	0,0042	1,3474	0,1779	0,0103	-0,0019
17	0,0030	0,0028	0,9327	0,3510	0,0088	-0,0031
18	0,0030	0,0028	0,9159	0,3597	0,0087	-0,0032

Table 2 is the Statistics is obtained with the Parallel approach.

The Stocks

Alfa Laval AB	Nordea Bank AB
ASSA ABLOY AB ser. B	Sandvik AB
AstraZeneca PLC	SCANIA AB ser. B
Atlas Copco AB ser. A	Securitas AB ser. B
Atlas Copco AB ser. B	Skandinaviska Enskilda Banken ser. A
Autoliv Inc. SDB	Skanska AB ser. B
Boliden AB	SKF, AB ser. B
Electrolux, AB ser. B	SSAB AB ser. A
Ericsson, Telefonab. L M ser. B	Swedbank AB ser A
Fingerprint Cards AB ser. B	Swedish Match AB
Getinge AB ser. B	Svenska Cellulosa AB SCA ser. B
Hennes & Mauritz AB, H & M ser. B	Essity AB ser. B [1]
Investor AB ser. B	Svenska Handelsbanken ser. A
Kinnevik AB ser. B	Tele2 AB ser. B
Lundin Petroleum AB	TeliaSonera AB
Modern Times Group MTG AB ser. B	Volvo, AB ser. B

Table 3 is Presenting stock which were included in the study. They have all of them at least been a part of OMXS30 once since 2010

[1] *At SCA's AGM in April 2017 was a decision made to practically fission SCA to SCA and Essity.*

Stockholm Business School
Stockholm University
SE-106 91 Stockholm
Tel: 08 – 16 20 00
www.sbs.su.se

Stockholm University