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Strategic Finance and Analytics

Master's thesis

Momentum Anomaly and Performance of the Momentum Investment Strategy in Helsinki Stock Exchange

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ABSTRACT

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This thesis aims to examine momentum anomaly and momentum investment strategy in the Helsinki Stock Exchange. This thesis utilises a six-month momentum strategy and the investigation period is between 2009 and 2019. The purpose is to examine whether strategy based on investing in better-performing companies can achieve greater returns than worse performing companies and above the average market return. This study's methodology imitates Jegadeesh and Titman's (1993) study by sorting companies into quintiles according to their six-month performance. The causes of potential excess returns are examined in terms of risk using Sharpe's ratio, Jensen's alpha and Treynor's index. The red thread through this thesis is the question of market efficiency.

With the support of existing literature, this study finds momentum anomaly in the Finnish Stock Market. The portfolios with better-performing companies outperform the worse performing companies and the market almost without exception. During the entire period, the winner portfolio realises a compounded excess return of 9,22% per year on average, and the difference between the winner and the loser portfolios are approximately 15% per year. Besides, according to the research results, momentum returns cannot be explained by an increase in risk level. The risk-return ratio does not appear to be significantly strongly correlated.

TIIVISTELMÄ

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Tämän työn tarkoituksena on tutkia momentum anomalian esiintyvyyttä ja momentum strategian menestystä Helsingin pörssissä. Tutkimuksessa käytetään kuuden kuukauden momentum sijoitusstrategiaa vuosien 2009 ja 2019 välillä. Tarkoituksena on tutkia, voidaanko paremmin menestyviin yrityksiin sijoittamalla saada suurempaa tuottoa kuin huonosti menestyviin yrityksiin ja yli keskimääräisen markkinatuoton. Tutkimuksessa käytetty metodologia on jäljitelmä Jegadeeshin ja Titmanin (1993) tutkimuksesta. Yritykset jaotellaan kvintiileihin niiden kuuden kuukauden menestyksen mukaan. Mahdollisten ylituottojen syitä tarkastellaan riskin näkökulmasta hyödyntäen Sharpen lukua, Jensenin alfaa ja Treynorin indeksiä. Punaisena lankana läpi tämän Pro Gradu -tutkielman toimii kysymys markkinoiden tehokkuudesta.

Olemassa olevan kirjallisuuden tukemana, myös tämän tutkimuksen tulokset puoltavat momentum anomalian esiintymistä Suomen osakemarkkinoilla. Portfoliot, joissa on suorituskykyisempiä yrityksiä menestyy paremmin kuin heikosti suoriutuvien yritysten portfoliot ja markkinat lähes poikkeuksetta. Koko tutkimusjakson aikana voittajaportfolio saavuttaa keskimäärin 9,22% ylituottoa vuodessa sekä voittaja- ja häviäjäportfolio ero on noin 15% vuodessa. Lisäksi tutkimustulosten mukaan momentum tuottoja ei voi selittää riskitason kasvulla, riskin ja tuoton välillä ei ole yhtenevää korrelaatiota.

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On 26th of February 2021 in Helsinki,
Mustafa Sabir

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LIST OF ABBREVIATIONS

AMEX	American Stock Exchange
B/P	Book-to-Price Ratio
CF/P	Cash Flow-to-Price Ratio
D/P	Dividend-to-Price Ratio

EBITDA/EV	Earnings Before Interest, Taxes, Depreciation, and Amortization-to-Enterprise Value Ratio
E/P	Earnings-to-Price Ratio
ME/BE	Market Value of Equity-to-Book Value of Equity Ratio
NASDAQ	National Association of Securities Dealers Automated Quotations
NYSE	New York Stock Exchange
OMXH	OMX Helsinki Index
S/P	Sales-to-Price Ratio

1. INTRODUCTION

Risk and return. Two main factors of investing embodied in these terms. The fundamental hypothesis of the risk-return trade-off principle is that prospective returns improve with a rise in risk—the theory about the trade-off between risk and returns is exceptionally vital among finance academics. However, various researches show that the relationship is not as straightforward as the widely acknowledged financial theories have affirmed. Investors and academics have tried for a long time to develop numerous investment strategies that would allow us to make systematic risk-adjusted excess returns feasible. Various risk factors and market anomalies, thus deviations from market efficiency, have been utilised to achieve this. In practice, investment in risk factors has become an important term in the investment world, and its popularity has risen in recent years. (Cazalet & Roncalli, 2014)

The assumption of efficient markets, which applies to investors' inability to get higher returns than the market provides, has become a long-standing paradigm in the financial world (Fama, 1970). Nevertheless, by pursuing abnormal returns for varying investment techniques over time, investors have questioned this model. They seek to leverage such observable market inefficiencies - anomalies - to their benefit to achieve this target. Any successful exploitation would deem a violation of efficient markets. However, several anomaly-related experiments have shown evidence against it, causing efficient markets' functionality questionable.

Professional investors are often classified into two groups based on the type of investment strategy they follow: technical analysis or fundamental analysis. The security is analysed by examining its absolute value and the related economic, qualitative and quantitative factors. Those who follow technical analysis are often referred to as chartists, as their strategy is based on modelling the historical stock price development and predicting the future. So they do not think the market follows a random pattern. On the other hand, they believe that the market is information efficient, i.e. all information affecting shares, such as information on dividends or future performance, as reflected in the past price development of the share. Besides, in their view, prices move in trends, with successors, for example, continuing to succeed and losers disappearing. Such a trend and phenomenon is called the momentum anomaly.

The 1993 study by Narasimhan Jegadeesh and Sheridan Titman is considered a pathfinder in the momentum anomaly study. They made substantial returns by buying well-performing stocks and selling poorly-performing ones. Many studies that have followed this have replicated the way Jegadeesh and Titman studied. While searching for new markets where momentum could occur, efforts were made to identify the anomaly's cause. A unanimously accepted explanation has not yet been found, but the most substantial reason has been identified as investor behaviour. Behaviour mostly affects the strengthening of momentum. When investors notice a rise in the share price, they also want to join the peak and buy the stock, further strengthening the share price. The momentum anomaly as a phenomenon contradicts the above-mentioned efficient market hypothesis. Past information should not affect future share price developments, as such information has already affected the share price as soon as it was announced. However, in the momentum anomaly, the history of exchange rate developments influences its future direction.

Studies of anomalies have received much awareness because they expose the imperfections of existing theories and may show the path to a new perspective or even model. However, the existence of these "imperfections" in classic theories is understandable. The complex world requires simplifications, and narrow theories cannot account for everything in the real world. It has awakened researchers interest in behavioural finance, and they have paid some attention to explain momentum anomaly and find a reason for its occurrence.

When behavioural finance is involved, then finding the causation may become hard. The complexity arises from the problem of how to measure and model human behaviour. It is easy to obtain data from purely finance-related schemes such as stock or volatility movements, but explaining why humans do something and their motives are challenging. Moreover, models are always simplifications of reality. Barbara and Odean (2011) say it simply: "The investors who inhabit the real world and those who populate academic models are distant cousins".

1.1 Objectives and research questions

Firstly, the purpose of this thesis is to find out whether there is a momentum anomaly on the Helsinki Stock Exchange and, secondly, what kind of return it is possible to obtain concerning the market by utilising the momentum investment strategy. It is also intended to examine, in the event of a possible momentum, the period in which the anomaly occurs and when it is worth exploiting it. We can formulate the research questions of this thesis as follows:

1. Does momentum anomaly occur in the Helsinki Stock Exchange?

2. How has the momentum investment strategy performed in Helsinki Stock Exchange?

3. What kind of return has been possible to gain with the momentum investment strategy compared to the benchmark index?

These are the crucial questions in which we try to answer and find clarification in this study. By answering those research questions, we cover the anomaly's theoretical background, find empirical evidence for it in Finnish Stock Market, and finally make a practical approach when offering ways to put the momentum investment strategy into action.

If we present the previous research questions as objectives, the research aims to describe momentum anomaly and find possible reasons for its existence. Another primary object is to measure if the momentum anomaly can also be observed in the Helsinki Stock Exchange. Finally, the study's practical objective is to form a trading strategy that takes advantage of this anomaly.

1.2 Limitations of the study

Although most of the theoretical evidence presented in this study has been discovered in a wide range of markets, this study solely focuses on Finnish Stock Market. Moreover, the time is restricted to the ten years of stock price data to fit enough evidence for a six-month holding period. This delimitation is partly done because of the author's interest in learning more about

the Finnish Stock Market, but there are also more compelling reasons. By choosing this focus, we want to extend our awareness and maybe even supply new information in this context.

A great motive for market restriction is the lack of momentum anomaly academic research that examines Finnish markets. Leivo and Pätäri (2011) studied local markets, and some theses did too, but most academic research studies with another market in scope. This leads to a large amount of research focusing on U.S. markets – of course, and there are still essential studies from other market regions as the anomaly exists in numerous stock exchanges. In any case, to increase the amount of contrasting research, we will focus on the OMX Helsinki Stock Exchange.

Lastly, the assumption of zero-cost portfolios persists throughout this thesis. Especially trading within anomalies would face transaction costs, taxes and optional costs related to investment activity, altering the results.

1.3 Research structure

The structure of this thesis is the following. This thesis splits into two main parts. The first part is a qualitative overview that describes the theoretical background behind assumptions and methods employed in this thesis and goes through previous research related to momentum anomaly. The second part is a quantitative empirical study that describes the data and the methodology used in this research. Lastly, we go through the observed results from these two parts' foundation and conclude the paper.

2. THEORETICAL FRAMEWORK

In the world of economics, many market models have an assumption that there are no anomalies or, worse, no other "disruptive" factors to the model. However, models are derived from theories that the information on the market is complete and accessible to everyone, and that assumes that people always behave rationally. A great example of this is the perfect competition model in economics, which cannot describe an imperfect market and an efficient market model. Financial markets' efficiency implies that all available information has an immediate effect on the prices of securities on the market and is thus information efficient. However, this is only a hypothetical situation, as in the current market, the results of information reflect in securities prices with a lag. Also, people tend to behave unpredictably in the stock market and follow their personal preferences. These exceptions to market efficiency are called anomalies.

This theoretical chapter is divided into seven subsections. At the beginning of chapter 2.1., Fama's (1970) Efficient Market Hypothesis and Random Walk hypothesis, which is strongly linked to it, are presented in more detail. The purpose of this research is to test the efficient market hypothesis in the Helsinki Stock Exchange. For this reason, it has been chosen as the first topic to be presented in the theoretical chapter. This is followed by a presentation of Markowitz's (1952) modern portfolio theory, the essential academic contribution considered to benefit investors of diversifying investment targets. The ideas of modern portfolio theory are utilised in the empirical part of the research when modelling investment portfolios. In addition to these critical theories, the investment valuation model CAPM will be introduced, which key developers have been Sharpe (1964), Lintner (1965), and Black (1972) (Fama & French, 1992). This is followed by an introduction to the momentum anomaly phenomenon and behavioural finance. Finally, some other anomalies represented are related to momentum anomaly at least to some extent.

2.1 Efficient market and random walk hypothesis

According to Eugene Fama's (1970) definition, many rational investors in the stock market seek to maximise their profits. Individuals compete in the market against each other and try to predict stock prices' future price development. The market's efficiency and form can be determined by

imposing additional restrictions on the market and the available information condition. If all the requirements are met, the market can be said to be operating effectively.

According to information transmission, Fama (1970) divides market efficiency into the weak, semi, and strong form. These conditions can be used to assess the adequate level of the securities market.

1. Weak form: The securities prices include all historical information, such as the security's previous price information.

2. Semi-strong form: Securities prices include all historical information as well as all publicly available information.

3. Strong form: Securities prices contain all possible information, including private information.

Strong form always includes semi-strong and weak conditions. Correspondingly, semi-strong terms include weak terms. The momentum anomaly contradicts already with weak form hypothesis that stock prices already include all past information. Therefore, the future should only be the result of changes in the present. However, the momentum theory's core idea is that past price developments will imply similar future actions.

In a perfect market, investors act rationally, maximising their expected benefits. The competition in the market is ideal and has efficient market prices. Also, efficient market conditions include so-called inconsistency, i.e., there are no taxes or transaction costs in an efficient market. The information must be free and accessible to all. (Malkamäki & Martikainen, 1990)

In recent years, research has presented conflicting findings and criticisms of efficient market theory. However, Fama (1970) already points out in his study that a perfect market does not exist. However, market efficiency does not necessarily depend on the fulfilment of ideal market conditions.

In turn, according to Shleifer (2000), the definition of market efficiency can be summarised in three arguments that lead to increasingly weak conditions. According to Shleifer, these conditions are as follows:

1. Investors are rational, and they evaluate the price development of securities accordingly.

2. If not all investors are rational, their actions and decisions will be random. As a result, investment decisions cancel each other out, at least in part.

3. If some occasionally behaving investors act in the same way, rational investors take advantage of the arbitrage option, leaving the same securities price level.

According to Shleifer (2000), market efficiency theory assumes that investors' investment strategies are partially irrational and do not correlate with each other. As a result, they can at least partially cancel each other out so that there is no effect on the securities' price level. In this case, the share price remains close to the fundamental value despite the irrationality of investors. On the other hand, even if irrational investors' behaviour is correlated, rational investors can take advantage of the resulting pricing error through the possibility of arbitrage. After that, the prices will return to their right level.

Market efficiency conditions, such as investor rationality and transparent information, are never fully met in practice. This means that, on a practical level, excess returns can be achieved from the stock market, at least at certain times. Empirical research of the stock market has proved that there are standard exceptions, i.e. anomalies, in the price development of securities, the existence of which has not been explained by changes in the risk level of shares. These anomalies indicate that the market is not functioning effectively. (Malkamäki & Martikainen, 1990) On the other hand, however, Schwert (2003) notes that anomalies found in studies often weaken or disappear even after the publication of research results on their discovery.

The efficient market hypothesis has been challenged in numerous studies and has been widely criticised (Malkiel, 2003). According to Piotroski (2000), the market does not react strongly enough to financial statement reports. His research showed that in connection with quarterly

reports, one-sixth of the annual earnings per share come during the three days surrounding the quarterly report. However, investors do not react quickly enough to this changing information, and this phenomenon is robust in the case of small and poorly monitored companies. This phenomenon is called the small-cap phenomenon and is one of the factors explaining stock returns.

On the other hand, in his subsequent publication, Fama (1998) argued that the market is efficient despite long-term anomalies such as the momentum anomaly. According to him, market over- and under-reactions are about as standard, so their sum is zero. Thus, according to the researcher, anomalies are not relevant in the long run to fulfil an efficient market.

According to Chakrabart and Sen (2013), the efficient market hypothesis disseminates the knowledge that some markets can win all the time, and all markets can win at some time. However, it would be impossible to win all markets at all times. They argue that the momentum is that the market is at most moderate and that there is some long-term memory. Based on that definition, momentum infringes the occasional price movement associated with an efficient market.

The efficient market hypothesis is one of the cornerstones of financial theory, although it is rarely, if ever, fully realised. There are abnormalities in the market, at least occasionally, of which anomalies are a good example. As already stated, the momentum anomaly violates the efficient market conditions described above and contradicts the random walk theory. Past price developments have been found to have a statistical significance for future price developments, i.e. stocks have shown trend-like behaviour and positive autocorrelation at periods of at least less than a year. These studies will be delved into later.

One of the assumptions of the efficient market hypothesis is a random walk. This means that there is no connection between the future returns and the investment's historical returns, and the prospective return is thus unpredictable. According to the random walk theory, most investors in the market are rational and seek to maximise their profits. Investors compete actively with each other and seek to analyse future price developments in securities and markets. According to the theory, the market works efficiently, and information is available to

all market participants. (Fama, 1995) The share price thus reflects all the factors affecting the value of that share, and the costs change as soon as new information enters the market. The market thus discounts information changes to share prices.

The random walk assumes that the share price includes all the information available at that time. As soon as there is information in the market about, for example, the price of a share is underpriced, several investors buy the share and raise the price back to the right level through their actions. The basic assumption of random walk theory is that price changes occur randomly and are not predictable. (Bodie, Kane & Marcus, 2018) If stock prices are determined rationally, only new information will cause a change in the security cost. At each point in time, the price level is thus independent and does not depend on similar findings. According to Fama (1995), share price movements are separate, and past price development has no bearing on future price development. In other words, consecutive observations do not correlate with each other if the market follows the theory of random walk. This contradicts the findings of the momentum anomaly. According to efficient market theory, it is impossible to obtain regular abnormal investment returns, and a higher risk must be accepted by anyone seeking a higher return. Thus, the news of a given day affects only the exchange rate changes of that day so that fluctuations in exchange rates do not in any way correlate with the price changes of the previous day (Malkiel, 2003).

Efficient market and random walk hypotheses are essential when looking at the momentum anomaly and its causes. The idea of efficient markets is undeniably at least somewhat at odds with practice, and behavioural economics, for example, has become part of the mainstream of economics. Behavioural economics has challenged the efficient market hypothesis and its terms. For example, deviations from rationality have been observed in investor behaviour, affecting market efficiency (Shleifer, 2000).

2.2 Modern portfolio theory

This subsection introduces modern portfolio theory. The developer of this theory is considered Harry Markowitz (1952), who in the 1950s introduced methods for effective portfolio formation in his research. Investors choose the investment targets they want from all the available

investment targets (shares, bonds, commodities), which investors usually have more than one in their possession. These investments form a portfolio. (Knüpfer & Puttonen, 2014) Investing in many different assets is called diversification or allocation. When done correctly, its purpose is to invest in as few correlated investments as possible, such as stocks and bonds, for example (Markowitz, 1952).

It is not the most important thing for a prudent investor to choose the investments with the highest potential return, but those with the highest return concerning the risk involved. The investor should always compare the variations in the returns of individual investments relative to the portfolio as a whole and thus not be interested only in the characteristics of individual investments themselves. (Markowitz, 1952)

Central to portfolio theory is the ability to calculate the return and volatility of individual investments in a portfolio, i.e. the volatility of investment prices. Volatility is used as a measure of investment risk and describes the standard deviation of investment returns. One of the significant contributions of portfolio theory is the importance of decentralisation to reduce the risk. According to portfolio theory, an investor can achieve a lower level of risk for the entire portfolio without compromising the size of returns. This is accomplished with the right allocation of investment targets. (Knüpfer & Puttonen, 2014)

The portfolio theory, like many other theories in the background, affects many assumptions. Investors are thought to be rational and make all their decision on that basis. Portfolio theory assumes the following things about investor behaviour (Francis & Kim, 2013).

1. Investors consider all potential investments and treat them as sets of probabilities of returns over a given period.
2. Investors' risk predictions are proportional to the variability in the investments' returns (such as variance or equally standard deviation).

3. Investors are willing to base all their decisions solely on expected returns and risk.

4. Investors always strive to maximise returns and minimise the level of risk.

Therefore, the purpose of modern portfolio theory is to provide the tools to find the right relationships between investment allocations to achieve the highest possible return with the least potential risk. To achieve a higher return, the investor must stake a higher risk. Portfolio theory can find the most optimal relationship between return and risk, an efficient frontier.

The figure below shows the relationship between return and risk as defined by portfolio theory. The point market portfolio in the model is efficient; it has an optimal return-to-risk ratio. Better returns cannot be achieved without increasing the risk level, and risk cannot be reduced without a fall in return expectations. The effective point arises at the intersection of the capital market line and the efficient frontier.

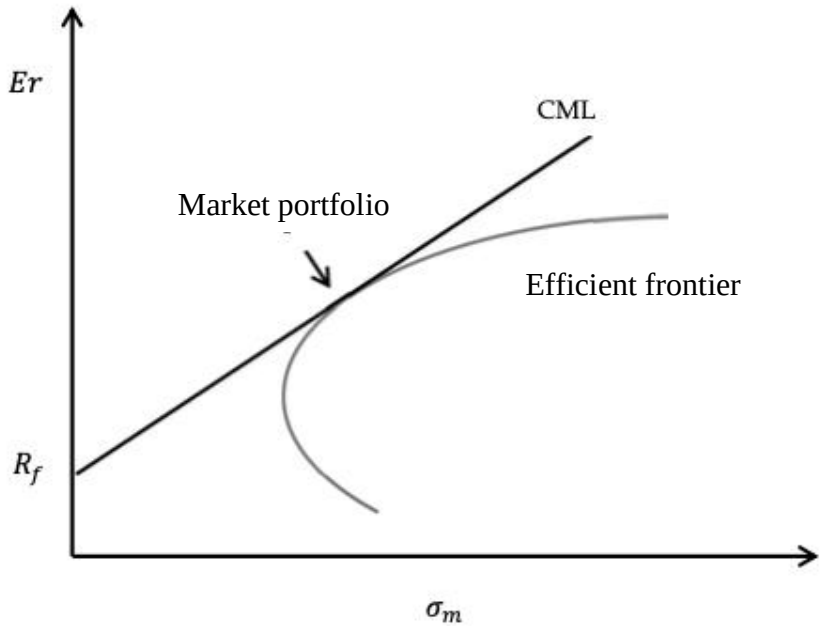

Figure 1. The efficient frontier and Capital Market Line. (Cuthbertson & Nitzhe, 2004)

All points below the efficient frontier front are ineffective, making it possible to obtain an increased return without an increase in risk or a correspondingly reduced risk without a decrease in return. Points above the efficiency front, in turn, are impossible in the current situation. Depending on the risk and return, the investor chooses the right combination for him. This, in turn, is affected by the investor's risk-fluctuation factor, how much the investor is willing to tolerate the risk. (Bodie, Kane & Marcus, 2018)

According to portfolio theory, it is essential to compare the relationship between the expected return of a portfolio and its risk. Mathematically, the expected return of a portfolio can be calculated using a formula:

$$E(r_p) = \Sigma_{i=1}^{n} w_i E(r_i) \quad (1)$$

Where $E(r_p)$ is expected to return on the portfolio, $E(r_i)$ is the expected return on the investment and w_i is the weight of the investment. (Cuthbertson & Nitzhe, 2004)

Portfolio risk, in turn, can be assessed by determining portfolio variance. Variance measures the volatility of a portfolio's value over time. The higher the variance of the portfolio, the more vulnerable its return to market shocks. The variance can be calculated from the formula:

$$\sigma_p^2 = \Sigma_{i=1}^{n} \Sigma_{j=1}^{n} w_i w_j Cov(r_i r_j) \quad (2)$$

Where σ_p^2 of the portfolio is calculated by determining the covariance of the individual stocks with each other stock with respect to their weights and adding these together. (Markowitz, 1952) Covariances are weighted by the correct weighting factor, for example, shares of capital invested in different stocks. Covariance describes the dependence between calculation objects.

2.4 Capital Asset Pricing Model

The concept of risk is divided into two parts in financial theory: systematic and unsystematic risk. Decentralisation can minimise unsystematic risk, but even decentralisation cannot eliminate risk. There is always a systematic risk associated with investing activities that affect the entire securities market at the same time in some way. Systematic risk consists of factors affecting the economy, such as inflation, exchange rates and interest rates. Systematic risk is described by a beta factor that reflects the effect of changes in an individual investment target on changes in the entire market portfolio. Market portfolio refers to a portfolio in which all investments are weighted in the portfolio according to their market value. (Knüpfer & Puttonen, 2014)

The figure below shows the relationship between portfolio variance and the number of investments in a portfolio. As the number of investments increases, the share of unsystematic risk in the portfolio decreases. In theory, it can even be minimised entirely in an optimal situation. (Knüpfer & Puttonen, 2014)

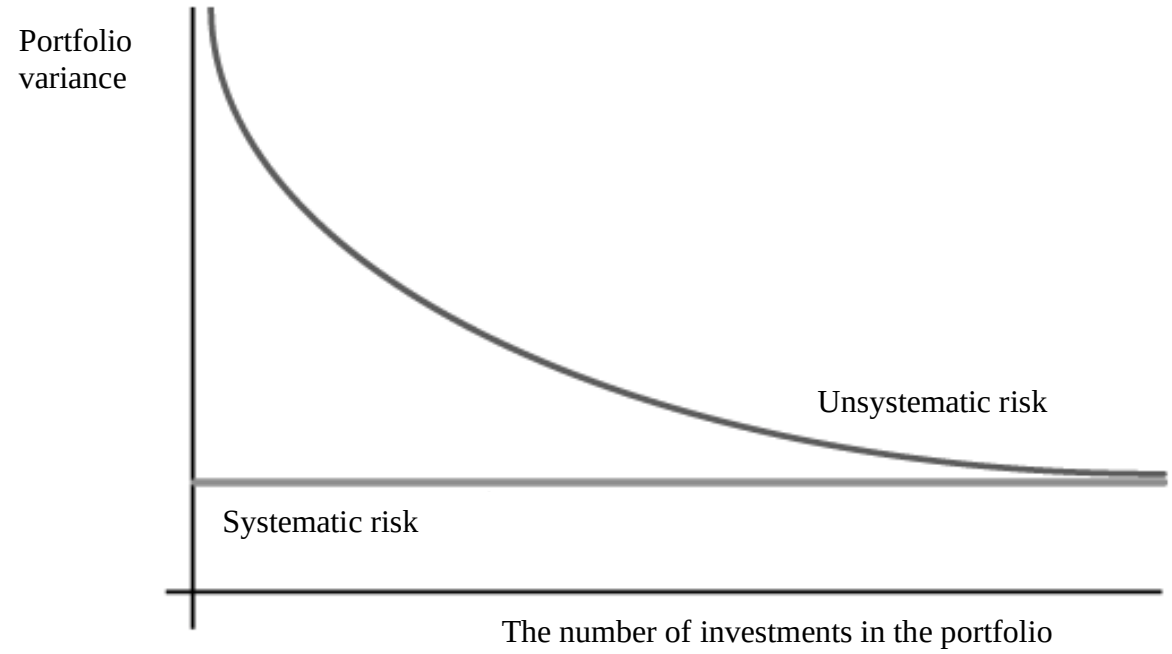

Figure 2. Systematic and unsystematic risk (Knüpfer & Puttonen, 2014)

Investors demand some compensation for the risk, so when unsystematic risk is minimised, the value of investments is determined solely based on return expectations based on systematic risk. This is the basis of the CAP model, whose key developers have been Sharpe (1964), Lintner (1965), and Black (1972) (Fama & French, 1992). According to Sharpe (1964), the expected return on investment is defined as follows:

$$E(r_i) = R_f + \beta_i * E(R_m - R_f) \quad (3)$$

Where $E(r_i)$ is expected return on a security, R_f = risk-free rate, β_i = beta of the security and R_m is market return expectation.

The beta factor indicates the sensitivity of the investment object to the average market return. When beta is equal to 1, the investment changes in the same proportion as the average return

on the market. Values of less than one beta multiplier represent less risky investment than the average market return because their value fluctuates less than the market average. For example, with a beta of 0,5, an investment's value increases by an average of 0,5 per cent, while the market rises by one percent and when the market is falling by one per cent, respectively, the value of investment decreases by an average of 0,5 per cent. More than one beta multiplier describes riskier investment than the market, whose process fluctuate more than the market average. The beta factor of a risk-free asset is 0 (Knüpfer & Puttonen, 2014). The expected return on investment is defined as follows:

$$\beta_i = \frac{Cov(R_i, R_m)}{Var(R_m)} \quad (4)$$

Where $Cov(R_i, R_m)$ is the covariance between the return on asset *i* and the return on the market portfolio and $Var(R_m)$ is the market variance. (Fama & French, 2004)

2.5 Momentum anomaly

If no stock pricing model can explain a particular stock's returns, that phenomenon can be called an anomaly. (Fama & French, 1996). Jegadeesh and Titman (1993) tested various strategies to buy stocks that experienced a price rise and sold stocks that had fallen in value. The study looked at several different periods, but the most attention was paid to the six-month time horizon, where well-performing stocks were bought over six months, and these stock were held in a portfolio for another six months. The equity incomes from the United States (NYSE & AMEX) were used as data. The strategy generated a significant excess return, 12,01% per year above the CAP model assumption. This has later come to be called the momentum strategy or anomaly. This strategy will also be used in the quantitative part of this dissertation.

Hwang and George (2004) examined the publicly known 52-week high and low-value figures using the momentum anomaly. These figures are published on several investment platforms and show the stock's highest and lowest value over the past year. According to them, a strategy that buys the shares with the highest matter of the closest 52 weeks and sells the stakes with the lowest value most immediate to 52 weeks short with a 6-month holding period will double the return 6/6-month strategy proposed by Jegadeesh and Titman. On the other hand, the t-values obtained were slightly higher in the work of Jegadeesh and Titman. However, both momentum

strategies yield statistically significant returns. This should not be possible under the efficient market hypothesis, especially when information on the 52-week high and lowest is freely available to all.

Jegadeesh and Titman (1999) review the momentum strategy returns in the late 1990s and state that the phenomenon has continued. Also, they were looking for an explanation for the anomaly. Efforts have been made to explain the momentum with risk-based explanations, and a behavioural scientific basis for the phenomenon has also been sought. In the risk-based description, returns are defined by the higher return expectation of momentum shares. In that case, future returns should be higher, and this would be only compensation for the risk.

The behavioural perspective, on the other hand, highlights investors' overreaction to the news. Jegadeesh and Titman (1999) investigated this by looking at momentum stocks' performance after 13-60 months of portfolio formation. If the return is due to a higher return expectation (and thus risk), the shares should continue to generate positive returns. If, on the other hand, the investors overreact, the return on well-performing shares should turn worse than the market if investors find the valuation to be high due to the overreaction. In that case, future returns should be higher, and this would only be compensated for the risk. Jegadeesh and Titman (1999) find support for behavioural theory as returns turn negative over a more extended period. However, they point out that the results should be treated with caution, as the return on returns will not take place until four years after the portfolios have been formed.

2.6 Momentum investing

Investors have always sought to develop a profitable investment strategy and achieve excess returns by winning the market. However, according to the efficient market hypothesis presented earlier, it should not be possible to attain excessive returns concerning risk with any strategy in the long run. Thus, a completely random investment strategy produces an efficient return in the long run in an efficient market like any other strategy. In practice, however, the market is rarely fully efficient, so the investor has a chance to win the market even in the long run.

In light of research, the momentum investment strategy has the potential to outperform the market returns. According to the investment strategy based on the momentum anomaly, those

shares should be purchased that have been successful based on the historical price development. Those shares whose growth has been the worst should be sold respectively. Barroso and Santa-Clara (2015) have recently investigated that momentum utilisation has provided the highest Sharpe ratio compared to market, value, or size factors.

According to Jegadeesh and Titman (1993), the momentum strategy increases the portfolio's beta value and, thus, the riskiness to some extent. Rouwenhorst (1998) came to a similar conclusion. However, both proved that the increase in risk is small and has little relevance to the momentum strategy's returns' statistical significance.

Indeed, most studies have concluded that the increase in momentum portfolios' risk has only a minor effect on the portfolio's return expectation growth. In other words, the rise in risk level does not seem to explain the increase in portfolio return, at least not thoroughly. However, it has also been suggested that the returns of momentum would be almost exclusively due to the rise in risk, and comparing the rate of return of momentum and market portfolio to the actual risk of portfolios, the correlation between returns and risk would be more or less similar (Asness, Moskowitz & Pedersen, 2013)

However, Asness, Frazzini, Israel, and Moskowitz (2014) concluded in their study that the momentum anomaly is not due to an increase in risk level. Furthermore, the momentum anomaly is not only effective in the case of small companies, as has been suspected in some studies, but the anomaly occurs equally when looking at small cap and large cap companies. Also, increased trading costs cannot eliminate the profitability of the momentum anomaly. According to the researchers, the momentum can only be explained at this stage utilising behavioural economics. The most common explanation is probably the overestimation of investors' information's effectiveness and the resulting overreaction to changed market information. Another general reason is, among other things, the herd behaviour suggested by Malkiel (2003). The possible causes of the momentum anomaly are discussed in the next chapter.

2.7 Behavioural finance

Behavioural finance takes into account the behavioural science perspective in its review of economics. Behavioural finance, for example, studies the role of psychology in investors investment decisions. Such a research trend is relatively new, but its popularity has been growing, especially since the millennium. (Shefrin, 2002)

There may also be behavioural causes behind the momentum anomaly, and, as a result, they are also addressed in this thesis. The behavioural irrationalities of investors may be fundamentally underlying the momentum anomaly. The field of behavioural finance theory is vast, and its presentation as a whole would require its thesis. However, this chapter is intended to highlight possible connections between momentum anomaly and behavioural theories.

In recent years, several studies have taken into account the behavioural perspective in economic phenomena. According to De Bondt and Thaler (1995), overconfidence is one of the most proven phenomena in decision-making. Thus, investors often rely too much on their abilities and make investment decision sensitively based on emotion rather than facts. In their article, they also provide an example of such a situation: "if people say they are 90% sure of an event, they may be right with only a 70% probability". With this, researchers want to show that people often overestimate their confidence. Behaviour like this has been suggested in some studies as a background factor for the momentum anomaly, as excessive investor confidence may lead to higher than justified exchange rate reactions, at least in the short run. This may, for example, cause the share price to rise significantly above its fundamental value momentarily. In the long run, the price tends to fall again towards its "true" value, but there will be an irrational rise in stock prices in the short run. This could explain Jegadeesh and Titman (1993) findings, in which an anomaly occurs in the short term, but the phenomenon disappears as the period lengthens. Their research is delved into in more detail in the next chapter.

De Bondt and Thaler (1995) also show in their research that investors often place more emphasis on losses than on gains. According to researchers, an investor's threshold of selling a losing share is usually much higher than the winning share. The loss is more remarkable for the investor than the profit, so the losses are not dared and unwilled to be realised. This is called

the "loss aversion", and this phenomenon has also been considered to have a possible effect on the occurrence of a momentum anomaly.

According to De Bondt and Thaler (1995), in addition to the previous phenomena, herd behaviour is also one of the most typical behavioural phenomena in the investment market. According to researchers, investors often make decisions as a group, making decision-making seem seemingly more effortless. The environment has a strong influence on human activities, opinions and decision-making. People also need to be accepted, so it's easier to agree with others than against the mainstream. For this reason, fashion phenomena in financial markets often drive investor decision-making as a group. In this case, however, the decisions may not be rational and fact-based, so anomalies or bubbles may arise in the market.

According to Malkiel (2003), the herd behaviour of investors can also lead to erroneous decision-making. According to him, investors quickly act inspired by the general atmosphere and thus cause different market trends without rational justification. The momentum phenomenon may be partly due to herd behaviour. A rise in stock prices may give rise to a self-sustaining prediction due to mass psychology, as many want to participate in a stock's rising price. On the other hand, according to the researcher, momentum may be related to unequal access to information. For example, as positive information progressively becomes available to more people, the stock price will rise slowly. This, according to Malkiel, may lead to an overreaction of prices, which would explain the short-term returns of momentum and the negative long-run correlation observed by Jegadeesh and Titman (1993) with a holding period of more than 12 months.

Another crucial psychological error to which investors are often exposed is naive extrapolation. Investors will find a formula or path in the share price trend that they believe will continue in the future. This is particularly important, as the momentum strategy is based on this type of ideology. As a result of this naive extrapolation, investor confidence intervals are skewed in the direction in which the market continues its possible trend. For example, during a downturn, investors believe significantly more in continuing a trend than in its reversal. (Shefrin, 2002)

As stated earlier, the momentum phenomenon is indisputably at odds with the efficient market hypothesis. However, behavioural finance more strongly questions the theory of an efficient market and assumes that markets may not be efficient due to behavioural-based phenomena.

This is an exciting refinement for the momentum anomaly and may explain the existence of the anomaly. There are many behavioural phenomena in economics, and only a few options have been presented above that have emerged in studies of the momentum anomaly.

2.8 Other anomalies

Many studies have found that the CAP model is not able to explain returns very well. Thus, many empirical results that differ statistically significantly from the theory have been found. The following chapters discuss these anomalies in more detail, the empirical study, and possible explanations. In summary, anomalies have been found and empirically valid; in the example, several different researchers have replicated many markets' results. However, researchers have had difficulty developing a unified theory that would explain the observed phenomena. The general view is that anomalies compensate for the risk that current models do not take into account, allowing investors to be rational maximisers of returns at the desired level of risk, without compromising the assumption of rationality or market efficiency. Besides, behavioural arguments based on the abandonment of investors' expectations of rationality have also been presented for the phenomena, at least in part. The following chapters discuss size effect and value anomalies, as they are perhaps the best known and most studies anomalies. These anomalies are presented for the perspective to our momentum anomaly research.

2.8.1 Size effect anomaly

Banz (1981) was perhaps the first to detect an anomaly related to firm size. He found that shares of companies with a smaller market capitalisation performed better, adjusted for risk, than those of larger ones. In practice, there seems to be a negative relationship between company size and returns. However, in the light of the CAP model, all risk should be priced by standard deviation, and company size should not affect returns. Thus, this result indicated that the CAP model did not consider all the factors affecting earnings per share. Later, Fama and French (1992) confirmed the same finding, finding a 0,74% premium for small firm returns, and the beta factor did not differ significantly between portfolios formed by firm size. This later contributed to the later development of the Fama and French factor model.

Van Dijk (2011) comprehensively reviews the size effect anomaly and previous research on it in his work. He compiles empirical studies on the subject, in which most of Banz's (1981) initial

findings have been able to be replicated in the US and international markets. However, according to the study, the validity of the global results is partly questionable, as, for example, the material used is, in some cases, incomplete. In all cases, the phenomenon has not been tested statistically using a pricing model. Besides, some more recent studies suggest that the phenomenon would have disappeared in the late 1980s. For example, in the United Kingdom, the "size premium" has been negative between 1989 and 1997 (Dimson & Marsh, 1999). However, van Dijk (2011) notes that the total premium was observed again from 2001 to 2010, with a high value averaging 11,3% per year. It may therefore be unnecessarily early to declare the whole anomaly dead.

The theoretical rationale for the size effect anomaly has also been sought. One explanation is provided by Berk (1995), who discusses the size-related anomaly in his work and provides a theoretical explanation of why the size effect anomaly reflects risk. The study presents a simple one-period model in which investors look for a suitable risk-return ratio. Assume that all companies are the same size, that is, that the value of cash flows for all companies' final period is the same. However, because the cash flows of different companies are exposed to risks in different ways in the example, the correlation of risk factors with cash flows varies between companies. The market value of companies may also differ between companies. Thus, riskier companies have lover market values. In this case, a negative correlation is formed between the market value and the returns. Finally, Berk (1995) formally leads an arrangement in which, even if risk and firm size were not related, there would still be a negative relationship between expected returns and market value. Thus, the market value seems to capture the effect of even unexplained risk factors. Indeed, the study concludes that the anomaly designation is misleading for the company size effect, as a negative relationship between company size and expected returns is theoretically justified.

In his research, van Dijk (2011) also repeats many possible explanations for the size effect anomaly. These have been sought from data mining, incomplete information, and the company's size as an explanator for other risk factors. Besides, explanations have also been presented in which the presumption of investor rationality has been lightened. Indeed, van Dijk (2011) states that further empirical research on firm size anomaly is needed. Due to time intervals, the anomaly does not appear to have lasted due to possible shortcomings in some international studies. On the other hand, the development of theory is needed at the same time. According to

him, efforts should be made to develop an approach explaining the anomaly, the validity of which can be tested empirically.

2.8.2 Value anomaly

One of the first research on value anomaly was possibly published by Nicholson (1960). In his study, Nicholson analysed the US stock market during and after the second world war. He found out that high E/P firms have generated higher returns than low E/P firms measured with raw returns. Basu (1977) agrees with Nicholson revealing similar results: substantial E/P ratio firms generated higher risk-adjusted returns than low E/P firms. Fama and French (1992) studied value premium in the US stock market with a broader field, including three American stock exchanges – NYSE, AMEX and NASDAQ – using decile portfolios in the assessments. Fama and French review stock returns from the United States from 1963–1990, explaining them using the ME/BE ratios in their work. They suggested that firms with high ME/BE ratios yielded higher returns than firms with low ratios.

The premium for ME/BE companies in the highest decile relative to the lowest decile was 1,53% monthly, almost double that of the company size effect (0,74%). The average slope for high ME/BE returns is 0,5 and is statistically significant. However, the company's size also remains statistically significant, and the work finds support for previous research on the size effect anomaly. A later study by Lakonishok, Shleifer and Vishny (1994) presented similar outcomes strengthening the proof of value premium in the US stock market. Fama and French (1998) applied their previous research to 13 separate stock markets, including E/P, B/P, D/P and CF/P ratios. Their studies have provided consistent outcomes favouring firms with high ratios relative to low ratios: The value portfolios exceeded average growth in 12 out of 13 markets. In a more recent study, Fama and French (2012) extended their preliminary analyses to the 21st century, examining the stock markets of the US, Europe, Asia and the Pacific region during 1989-2011. These results did not vary from those of the previous, suggesting perseverance of the premium value.

The evidence of the value anomaly in the Finnish Stock Market has been exhibited by Pätäri and Leivo (2009). They added two individual valuation ratios to Fama's and French's used ones, EBITDA/EV and S/P. Also, eight separate composite valuation measures were adopted to increase the returns of single ratio portfolios. Their portfolio tests' success has shown that the

value premium's presence is apparent between 1993-2008. Many value portfolios outperformed both the index and equivalent growth portfolios, suggesting clear evidence favouring value stocks. When assessed with risk-adjusted metrics, the composite value measure portfolios demonstrated improved results to a certain degree. (Pätäri & Leivo, 2009) Later the same year, Leivo and Pätäri (2009) prior research has been expanded, with an extended holding period of up to 5 years. The authors illustrated the impact of efficiency changes with longer holding periods on some of the portfolios.

3. PREVIOUS RESEARCH

The momentum strategy has been studied extensively worldwide, in many different markets, and with many different methods. The study *Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency* by Jegadeesh and Titman (1993) serves as a model for almost all studies dealing with the momentum phenomenon. In this study, Jegadeesh and Titman find that the momentum strategy works effectively in the medium term, i.e., hold periods of three, six, and 12 months. Subsequently, the methods used in the study have been successfully replicated in articles by other researchers. In a more recent study, Jegadeesh and Titman (2001) confirm that the phenomenon was still present in the 1990s.

3.1 Jegadeesh and Titman

In 1993, Narasimhan Jegadeesh and Sheridan Titman published their article mentioned above. This article is central to any study dealing with the momentum effect and is therefore imperative to go through in more detail in this thesis. The purpose of this section is to outline in more detail the starting point and basis for the study of price momentum.

The study by Jegadeesh and Titman (1993) is unique in that until the early 1990s, little price momentum was studied. The central belief was that investors overreacted to information. De Bondt and Thaler (1987) showed that stock prices also overreacted to the news by suggesting that contrarian strategies with a holding period of 3–5 years may allow for overpricing. However, according to Jegadeesh and Titman (1993), this study's results are questionable. The excess return may be explained by the systematic risk of contrarian portfolios and the phenomenon of company size. However, they also note that the contrarian strategy has been found to allow excess returns in the shorter term, using the previous week or month's losers when forming portfolios. They believe this is due to short-term price pressures or a lack of liquidity in the market.

Levy's (1967) study is one of the earliest studies on market efficiency in which past winners are bought and past losers are sold. However, Jegadeesh and Titman (1993) found that Levy's (1967) study suffers from sampling bias. After this article, academic research focused firmly

and even favoured contrarian strategy. Jegadeesh and Titman (1993) wonder in their paper that while most early 90s study deals with contrarian strategy, investors and funds still take advantage of price momentum when choosing stocks for their portfolios. They present two different perspectives on excess earnings, the first of which suggests that extra profits are not additional earnings or those excess earnings are not related to investors' tendency to select past winners in their portfolios. On the other hand, another perspective suggests that academic research's investment horizons and practical investors differ significantly. They show that studies favouring a contrarian strategy use a brief period of one week or one month or a very long period, three to five years, as their investment horizon. However, investors who make practical use of price momentum model their portfolios by examining stocks' behaviour over the past 3-12 months.

Jegadeesh and Titman's (1993) immense contribution to the study of price momentum is related to the observation and holding period's choice. They understood that the past medium-term performance of equities is a strong indicator of future medium-term success. Their study shows that a strategy based on price momentum is profitable, using NYSE and AMEX shares from 1965-1989 as their data.

In their study, Jegadeesh and Titman (1993) show that the momentum strategy returns are not systematic, i.e. company-specific, risk. Besides, they found that the lead-lag effect could not explain returns due to the delayed response of stocks to information. However, the data are consistent because company-specific information affects the delayed reaction of an individual share price.

One of the main observations made by Jegadeesh and Titman (1993) was that momentum returns are not permanent. After a twelve-month holding period, the winning portfolios begin to generate negative abnormal returns, i.e. negative excess returns. This trend will continue until the 31st month of portfolio formation. They found that the formed based on the previous half-year portfolio's success yielded 9,5% over the next 12 months, but more than half of the portfolio lost profits during the 24 months.

In their study, Jegadeesh and Titman (1993) also observe the significance of earnings announcements for momentum returns. Past winners consistently realised higher returns than losers in the earnings announcement within the next seven months of portfolio formation. However, in the next thirteen months, the losers realised higher returns than the winners, with earnings announcements.

Jegadeesh and Titman (1993) found that the most profitable momentum strategy is achieved with a 12-month observation period and a three-month holding period. The return on this strategy was 1,49% monthly. This strategy was implemented without a time delay between portfolio formation and creation.

Jegadeesh and Titman (1993) selected a 6-month ranking period and a 6-month holding period for their review to identify the excess return causes. They formed a three-factor model, two of which explain systematic risk and one company-specific returns. The third factor is strongly related to examining market efficiency because if company-specific revenues constitute surplus, it violates the efficient market hypothesis. The first factor describes the dispersion of cut-off expected returns - realised returns include a component of due returns. Hence, shares whose prices rise during a given period are also likely to grow in the following period. Another factor in the model is the time component. If there is a positive autocorrelation in the portfolio's returns, the momentum strategy is exposed to select stocks with a high beta when the portfolio's expected return is high.

Jegadeesh and Titman (1993) found that the beta coefficients of momentum portfolios made up of extreme losers and extreme winners are higher than the average beta coefficient for the entire sample. Also, they found that the winner and loser portfolios contained smaller than average equities. Based on these observations, they concluded that the first component of the model does not generate price momentum returns. They also found that autocorrelation is hardly a factor in earnings, as they saw the six-month weighted index autocorrelation to be negative. Finally, they found that the price-momentum strategy's most apparent cause is related to the market's under-reaction to company-specific information.

From a practical perspective, Jegadeesh and Titman (1993) found that the momentum strategy can also be implemented in the real world. They took into account 0,5% one-way transaction costs, after which the strategy appeared to generate 9,29% year-on-year. The same is true for risk-adjusted returns.

In their study, Jegadeesh and Titman (1993) also examined the momentum strategy's seasonal nature. They also observed the January phenomenon: the strategy loses an average of 7% each January but achieves positive abnormal returns every other month. They found that the average return in months other than January is 1,66%. These findings were consistent with other studies that deal with the January phenomenon. Jegadeesh and Titman (1993) found that the last two months of the year, November and December, were advantageous for the momentum strategy. They speculated that this was due to portfolio managers' need to sell loss-making shares for tax purposes.

In 1927-1940, Jegadeesh and Titman (1993) also discovered the possibility of utilising the momentum strategy. However, this period's volatility was significantly higher than in the original period considered, which resulted in lower returns, but still statistically significant ones. As another explanation, they observed a shift of the market towards its average during this period.

Finally, Jegadeesh and Titman (1993) tested the significance of earnings announcements for the previous winning and losing stocks between 1980 and 1989. They found that with a positive earnings announcement, winning shares returned 0,7% better on average six months after the earnings announcement. In line with their previous observations, they found that, especially 11 to 18 months after the negative earnings announcement, winning shares returned 0,7% less than losing shares.

In their conclusions, Jegadeesh and Titman (1993) state that the momentum strategy returns do not consist of their systematic risk, so that the explanation can be found in the market's inefficiency. They are convinced that market underreaction is too simplistic an explanation for abnormal returns. A more sensible reason could be that the market underreacts to short-term information but overreacts to the long-term outlook.

3.2 Momentum strategy research after Jegadeesh & Titman

Rouwenhorst (1998) studied the momentum effect on the European Stock Market from 1980 to 1995. He found that an internationally diversified portfolio of past winners outperformed a portfolio of past losers by about 1 per cent per month. The result is very similar to the study by Jegadeesh and Titman (2001). Demir, Muthuswamy and Walter (2004) examined the momentum strategy in the Australian Stock Market. They watched, measured by returns, even more robust evidence of momentum than the previously studied European and US stock markets, using the winners of the previous 30, 60, 90 and 180 days. Liu, Strong and Xu (1999) showed that the momentum phenomenon is also found in the UK Stock Market.

The momentum strategy's effectiveness in the Japanese Stock Market has been vigorously debated: however, Asness (2011) argues in his article that the method is also useful in Japan. Fama and French (2012) observed momentum in their extensive study of the North American, European, and Asian Stock Markets but could not detect it in Japan. Wang, Huang H. and Huang C. (2012) study momentum in the Taiwanese Stock Market. However, they failed to obtain statistically significant evidence of the existence of momentum.

Emerging markets have also been actively studied, but the momentum phenomenon has been observed with varying degrees of success. For example, Cakici, Fabozzi and Tan (2013) could not detect momentum anomaly in Eastern Europe. Research in emerging markets has often had problems due to, among other things, large stock fluctuations.

In previous studies, a relatively large number of shares have been included in the portfolios of winners and losers. Siganos (2007) studied the momentum strategy, taking only the extreme winners and the extreme losers on the London Stock Exchange. This strategy can achieve even double returns compared to the more extensive portfolios used in previous studies. According to the study, the results remained statistically significant even when trading costs were taken into account.

The results of research conducted in recent years suggest that the returns generated by the momentum strategy are sensitive to market changes. Indeed, Asem and Tian (2010) find in their

study that the momentum strategy returns are higher when the market remains stable compared to a situation where the upturn turns to the downturn or vice versa. Current research strongly suggests that the momentum strategy cannot achieve returns in a declining market. In their article, Cooper, Roberto and Allaudeen examine the impact of ups and downs on momentum strategy and concludes with the same conclusion.

However, Daniel and Moskowitz (2016) point out that strategy leads to considerable losses at times. According to them, momentum works well when the market is close to a long-term growth trajectory. In this case, the momentum strategy's use achieves excessive returns concerning the level of risk. However, according to the study, the situation in the declining market may be completely reversed. In the so-called bear market, the momentum may, according to researchers, act quite the opposite, i.e. the losers of the past will rise in the future more than average. Similarly, past successes in the downtrend market will lose their value in the future. A similar observation was made by Grundy and Martin (2001), who found that the beta of the momentum portfolio is often negative during a downturn. On the other hand, Barroso and Santa-Clara (2015) state in their study that such anomalies in the operation of the momentum anomaly are often predictable. Therefore, the investor can avoid them.

Eakins and Stansell (2004) examined the momentum strategy in the S&P 500, dividing its portfolio by different industries (e.g., energy, healthcare, information technology). They found that the internet sector had the most significant impact on the returns of the momentum strategy. They also found that most momentum strategies were more effective than their benchmark, as measured by Sharpe's ratio. Ahmed and Mohammad (2020), on the other hand, found in the US Stock Market that high-tech stocks generate greater momentum returns than low-tech stocks.

Leivo & Petäri (2011) studied the effect of various key figures, including E/P and B/P, on the Helsinki Stock Exchange's momentum strategy in 1993–2008. They prove that by selecting stocks that have been successful in light of the momentum strategy's key figures, higher returns can be achieved. However, they point out that the level of risk measured by volatility increased somewhat when using the momentum strategy. Moreover, the increase in the level of risk did not fully explain the increased average returns. Thus, the researchers used Finnish data to reach

similar conclusions as many other researchers with data from different countries. According to Leivo and Pätäri, the momentum strategy's use increased the average annual return by approximately 2,8%, which was explained by the increase in risk level.

In their article, Avramov, Chordia, Jostova and Philipov (2007) examine the impact of a credit rating on momentum strategy. They found that the strategy's profitability is best and statistically significant among the lower-rated companies but utterly non-existent with the best-rated companies. According to the study, the differences cannot be explained by company size, company age, analyst estimates, indebtedness, return or cash flow volatility.

Asness, Moskowitz and Pedersen (2013) observed value and momentum premiums in government bonds, commodities and currencies, in addition to equities. Their study's most immense contribution was the observation that these value and momentum strategies go hand in hand, i.e., correlate, across both market boundaries and security classes. They also found that the value and momentum factors were negatively correlated both within and between different markets. The observations suggest that there are common global risk factors that affect the momentum phenomenon. They formed a three-factor model in which the value and momentum factors are separated from each other, as the effect of each is significant but negatively correlated with each other. When the correlation of the factors is negative, and the expected return of both is strongly positive, the portfolio created by these strategies will reach a more efficient front than the strategy alone.

Israel and Moskowitz (2013) investigated the impact of short selling on momentum strategy returns. They note that because short positions are, on average, more expensive to maintain than long positions, and because some investors cannot take a short position (e.g. mutual funds and institutional investors), the net effect of trading costs may be significantly lower and many investors strategy. Israel and Moskowitz (2013) state that short selling does not considerably impact momentum returns. However, they found that the importance of short selling increases in the momentum strategy when there are large-cap companies in the portfolio.

Moskowitz and Grinblatt (1999) studied the importance of industry in a momentum strategy. They state that the 'industry momentum' is much stronger than the momentum produced by

individual shares. They argue that the momentum caused by individual shares is statistically insignificant when industry factors are taken into account. Moskowitz and Grinlatt (1999) found that industry momentum is strongest in the short-run (on a one-month horizon). Like the momentum of individual stocks, the industry momentum evaporates after 12 months, eventually reversing in the longer term. They also found that the momentum caused by the industry momentum and the momentum generated by individual shares are parallel in the medium and long term. In a short time, less than a one-month horizon, the industry momentum is positive, negative to individual shares.

Moskowitz and Grinblatt (1999) found that momentum investors' diversification may be very weak because industries play a significant role in momentum returns. They also state that, unlike the momentum of individual shares, the industry momentum returns are also strong among the largest, most traded shares. Finally, they note that explanations based on behavioural sciences may cause this phenomenon: Investors may have overconfidence about specific sectors or industries or be slow to change their views on new sectors (cf. the internet sector). This explanation is consistent with Hong and Stein (1999).

Leippold and Lohre (2012) studied the effect of companies' earnings momentum on share price momentum. Here, earnings momentum refers to the companies' continuing ability to make better results. They suggest that the price momentum is only an estimate of the earnings momentum or a factor. They also found that price momentum is most vital when there is a great deal of uncertainty in the market. The more difficult it is to interpret companies' fundamental values, the slower that information is passed on to prices. They also made an important observation regarding the risk levels of companies. The higher the volatility of a share, the greater its significance for momentum returns. As a result, the momentum phenomenon is still prevalent: the cost of arbitrage to exploit the anomaly is too high to eliminate the market's anomaly.

Hwang and Rubesam (2013) state that the momentum premium changes over time. They found extended periods when momentum strategies do not allow for either positive or negative returns. They note that the sensitivity of the strategy to risk factors changes from period to period. In their study, they argue that the momentum phenomenon has completely disappeared

in the 21st century. According to them, after the tech bubble of the late '90s, arbitrage opportunities have removed the momentum premium. This is an exciting research result, as the observation period of this thesis falls in the period when, according to Hwang and Rubesam (2013), the momentum phenomenon is no longer exploitable.

Novy-Marx (2012) ponders in his article whether: *Is momentum really momentum?* He notes that the definition of momentum in finance is that rising prices continue to grow, and falling prices fall. However, he found that recent historical prices are a poor forecast for future prices, precisely in line with the definition of momentum. He discovered that 7-12-month-old stock prices are significantly more reliable estimates of future prices. He states that this medium-term momentum strategy has been profitable for the last 40 years.

3.4 The cause of the Momentum phenomenon?

The Momentum phenomenon has been observed in several different markets, in several different review periods. Thus, it can be reliably argued that momentum is not due to research data or data mining. Theories of investor behaviour have been studied extensively about the momentum phenomenon. Among others, Liu, Strong and Xu (1999) observe a medium-term momentum in their research, in which investor behaviour differs significantly from rational behaviour.

One reason for the momentum phenomenon has been considered to be the hypothesis that adverse information in particular rarely spreads among all investors. Hong, Lim and Stein (2000) confirm this in their study, finding that the momentum strategy works better with stocks that analysts follow less. They also found that analysts track past losers more closely than past winners. Therefore, they concluded that the momentum phenomenon is more potent in companies whose information is slowly entering the market. In their study, Barberis, Shleifer and Vishny (1998) state that investors pay too much attention to the weight of available information and do not quote the statistical significance. Indeed, they suggest that the stock market overreacts to ongoing excellent or bad news. The ability of analysts to predict stock prices has been extensively studied. In his study, Womack (1996) states strong evidence that analysts' forecasts affect stock prices.

In its study, Hong and Stein (1999) divide the market into two groups: "News viewers" and "Momentum investors". Every news viewer can get some private information in the same hands but cannot distinguish information from other news viewers from stock prices. When word spreads slowly to all investors, prices underreact in the short term. This means that momentum investors can "chase the trend". If they can pursue a momentum strategy, their arbitrage attempt should lead to overreaction in the long run. Badrinath and Wahal (2002) found that institutions act as momentum investors when entering the market and act as contrarian investors when they exit the market. They came to similar conclusions with Hong & Stein (1999).

De Long, Shleifer, Summers and Waldmann (1990), in their study, address "noise traders" and "positive feedback traders". Noise traders are a group of investors who, as a herd, accelerate and maintain stock trends. Positive feedback traders react to the purchases of others. Rational investors who expect noise traders to buy in the future may buy today. In this case, positive feedback traders may become more enthusiastic and force prices further away from the fundamentals. Noise traders may well be one factor that explains the existence of the momentum phenomenon.

Hameed and Kusnadi (2002) suggest that certain unidentified risk factors may affect the momentum phenomenon, varying from market to market. Suppose the momentum is due to an underreaction in the US Stock Market to the prices' information. In that case, they could not find a similar phenomenon in the Asian Stock Market. Conrad and Kaul (1993), on the other hand, argued that methodology and the calculation style of returns affect momentum detection.

Asness, Moskowitz and Pedersen (2013) argue that liquidity risk in the financing may be strongly related to momentum returns. Momentum appears to be increasing liquidity risk. Therefore, they suggest that momentum represents the most popular stock trades of all, as investors chase shares whose prices have risen most recently. When a liquidity shock strikes due to the need for cash or risk management, investors put pressure on the most popular trading venues. The prices of these stocks are under increasing pressure, causing a positive momentum trend.

Chui, Titman and Wei (2010) explain why the momentum phenomenon is concentrated in certain parts of the world stock market. They suggest that cultural differences between different countries have the potential to have an impact on behavioural biases that are reflected in the momentum phenomenon. Chui et al. (2010) state that the absence of the momentum phenomenon in Japan can explain factors related to individualism. Japanese culture is very non-individualistic, i.e. investors give considerable weight to their views. Thus, they do not behave with overconfidence, and therefore, as a herd, do not push prices further than their fundamental values.

4. DATA AND METHODOLOGY

4.1 Data

Raw share price data was retrieved from Datastream, and it covers the period of 2009-2019. The data was needed from 1/2009 to calculate the first ranking period. Data contains weekly closing prices of all public companies listed in NASDAQ OMX Helsinki during almost the 10 years of 1.1.2009 – 1.1.2019, hence providing close to 600 observation points if the company has existed in exchange for the whole time. Data includes extinct companies to avoid the survivorship bias, but also for the sake of more data points. Otherwise, the data would have been pretty thin as OMX Helsinki currently holds approximately 135 companies, and only a portion of these have consistently existed for the ten years. To measure returns correctly, adjustments for dividends and splits are made appropriately using the stocks' total return index, which takes dividends and stock splits into account. Dividends and stock splits are reinvested in shares of the same company without transaction costs or tax penalties.

The number of companies is highest in 6/2018 at 152 and the lowest in 1/2013 at 121– the average being 131, e.g. 26 companies in each quintile. Larger company count is a substantial difference to Baker and Haugen (2012) as their data from OMX Helsinki includes only an average of 69 companies.

The development of the top, 2nd, 3rd, 4th and the bottom portfolio returns are compared with each other. The aim is to determine whether there are differences in the development and whether past price developments correlate with the future. Portfolio returns are also compared to the index. Besides, the calculation of Sharpe's figures, for example, must take into account the so-called risk-free interest rate. The one-month Euribor rate was chosen as the measure of the risk-free interest rate. Data describing the development of the Euribor interest rate have been retrieved from Datastream as well.

During the research period, 121 to 152 companies were selected for the six-month research material on the Helsinki Stock Exchange based on the previously mentioned restrictions. In this study, these companies describe the market. Figure 3 below shows market returns for ten years. The annual average standard deviation of the market is just over 11 per cent. Over ten years,

revenues have been relatively evenly distributed. The clearest peaks are in July 2011, when the dip is almost -14 per cent, and in October 2011, when the return is just over 10 per cent.

Figure 3. Weekly market return over ten years.

As shown in Figure 4 below, the index has risen more than 10,000 index points in ten years. The cumulative return of the index over five years is over 130%, and the average annual cumulative return is just under 9%.

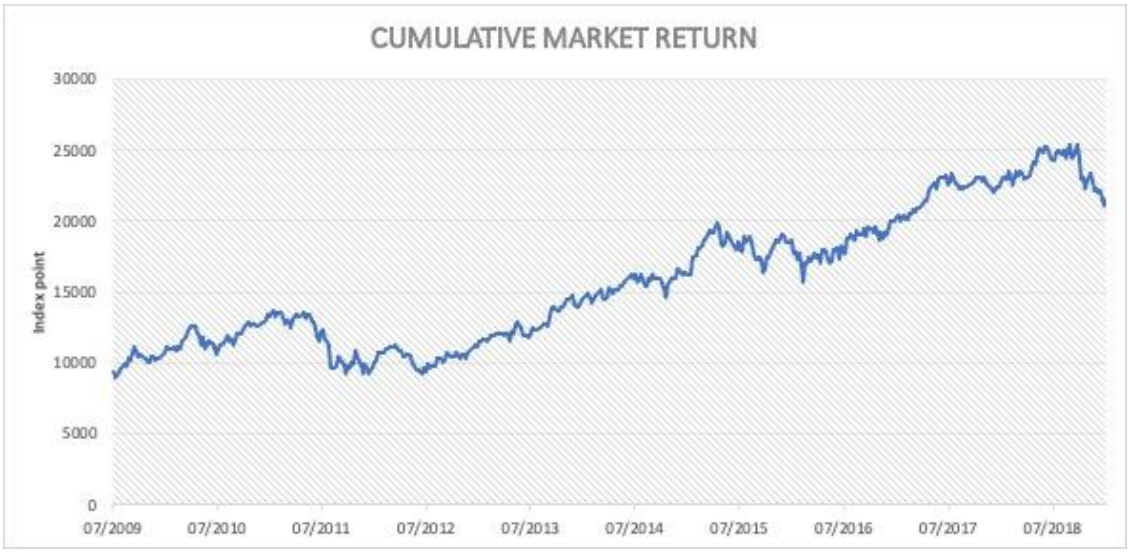

Figure 4. OMX Helsinki index development from 7/2009 to 1/2019.

By investing in the OMX Helsinki index, it has been possible to get a better return than by investing in the 4th or bottom portfolio. More on that in the next chapter.

4.2 Methodology

The empirical part of the study examines the success of a momentum investment strategy through quantitative portfolio analysis. Portfolio analysis is performed in an Excel spreadsheet. The methods used to build the portfolios and study success are described as accurately and clearly as possible in the following sections.

The methodology used in this study is an adaption of momentum anomaly study committed by Jegadeesh and Titman (2001) in the US Stock Market between 1965-1997. Other researchers have also executed studies with closely similar methodology. The researchers used six-month ranking and holding periods to calculate average returns for every stock and then sort the results into ten deciles. The length of the ranking period was six months throughout the study, but the holding period was changed as their study progressed. Thus, the study kept the six-month ranking period the same but gradually extended the holding period's length. However, according to Jegadeesh and Titman, the momentum portfolio's cumulative return was negative with a holding period more than a year, meaning that the winning portfolio of previous winners then performed less than the losing portfolio of previous losers. Momentum returns thus turned negative.

The methodology is near the same in this work, but the length of the ranking and holding period is kept at six months throughout the study. Besides, the portfolios are sorted into quintiles because of the lack of observations. Doubling the portfolio size also makes this study more reliable.

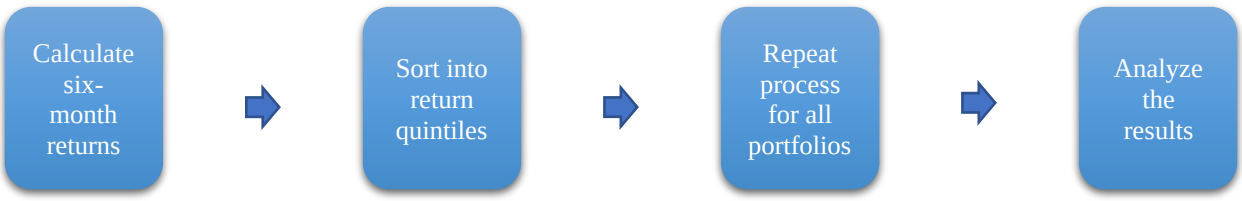

Figure 5. Principles of methodology.

To form portfolios, companies' weekly return index is calculated for each week from the previous week's value. Six-month income is calculated as the average value of weekly gain for the corresponding period. Based on the returns for the first six months, the companies are arranged in order of size, from which the 20% that produced the most for one portfolio and the 20% that made the least for the other portfolio have been selected. All the shares have equal weights. The companies between these top and bottom quintiles are also evaluated for getting better insight from the market. These companies' returns have been reviewed over the next six months to detect a possible parallel return trend and momentum anomaly. Creating portfolios is to look at the previous period's top and bottom companies and examine how they have performed in the next period.

Table 1. Creation of six-month ranking and holding -period illustrated.

PERIODS	**1.1.2009-1.7.2009**	**1.7.2009-1.1.2010**	**1.1.2010-1.7.2010**	**…**	**1.7.2018-1.1.2019**
1	RANKING				
2		HOLDING RANKING			
3			HOLDING RANKING		
…				…	
19					HOLDING

The researchers' primary method was to find out the possible difference in return between the different portfolios. For example, the difference between winner and loser portfolios was

closely monitored. Thus, the study was not intended to compare the winning portfolio's returns to the index, as an investor seeking an optimal strategy would do. Instead, the researchers aimed to determine whether past price developments correlated with future ones, i.e., whether the efficient market hypothesis is rebutted.

In addition to examining portfolio returns, the purpose is to analyse the period during which the momentum strategy available on the market is profitable. It is also interesting to determine whether there is an apparent coincidence in the portfolios' returns when the returns turn negative. The returns of momentum portfolios are to be compared to the returns of the market. In addition to looking at cumulative returns, portfolios and markets are compared using different success metrics.

Looking at returns alone is not a very reliable way to compare different investments. The returns achieved do not in any way take into account the type of risk required to obtain the returns. The return of a portfolio can be related to its risk using various success indicators. Success indicators are used to compare different time points in the same portfolio and compare different portfolios (Jobson & Korkie, 1981). This allows other portfolios or dates to be ranked.

The best-known portfolio metrics that consider risk and its magnitude are the Sharpe ratio, Jensen’s alpha an the Treynor index. The key figures are used to compare the portfolios' returns with the risk they contain and determine the portfolios' performance more reliably and comparably. The following sections take a closer look at the success indicators used in the study.

4.2.1 Sharpe ratio

One of the most well-known portfolio performance metrics is the Sharpe ratio. In 1966, William Sharpe developed a measure to measure the risk-adjusted return on investment. The Sharpe ratio, or the reward to volatility ratio, measures the return on investment against its total risk, i.e., the investment return's standard deviation. (Sharpe, 1966) Higher values of the key figure indicate good investment success. The higher the Sharpe ratio, the better the investment can yield in the long run. The values above one suggest that the investment produces relatively high

returns with relatively low volatility. (Dugan, 2005) The formula for the Sharpe ratio can be written as follows:

$$Sharpe\ ratio = \frac{r_i - r_f}{\sigma_i} \quad (4)$$

Where r_i is an average return of the asset, r_f is the risk-free rate and σ_i is the standard deviation of the asset. (Sharpe, 1966)

Its popularity stems from its simplicity, giving an intuitive approach to any investment strategy's essential aspects – risk and return (Sharpe, 1994). It is considered one of the best performance measures due to its simplicity and solid theoretical framework (Eling, 2008).

However, the traditional indicator used to compare portfolios has its weaknesses. Many researchers, including William Sharpe himself, have criticised Sharpe's key figure, stating that past development is a poor future growth prediction. (Dugan, 2005) Hodges, Taylor & Yoder (1997) found that Sharpe's number cannot be used alone on the planned investment horizon. The Sharpe number varies significantly depending on the holding time. This is because the standard deviation of returns increases faster than the average of returns over time, leading to declining Sharpe figures. The results are in line with Levy (1972).

The Sharpe ratio assumes that the distribution is mean-centred, and therefore, it works best in situations where the portfolio returns are normally distributed (Lo, 2002; Eling & Schumacher, 2007). In other words, if there are, for example, high spikes, tails, or other abnormalities in returns, the standard deviation used in Sharpe is not at its most effective in measuring risk. In this case, the key figure can give completely wrong values and lead the investor to compare portfolios with the skewed ratios. On the other hand, all metrics have their weaknesses. Revenues can be made more normally distributed by calculating them logarithmically. However, for simplicity and more straightforward illustration, raw return rates have been used in this thesis. However, despite possible distortions, the Sharpe figure is used due to its notoriety and clarity.

4.2.2 Jensen alpha

Jensen's alpha is also a success measure named after its developer Michael Jensen. The key figure is based on the CAPM model and can look at how the portfolio has performed relative to the CAPM model's forecast. The calculation formula also takes risk into account, so the key figure is risk-adjusted. If the alpha is positive, the portfolio has performed better than the forecast in the CAPM model. Correspondingly, a negative value indicates lower performance. The usual "buy and hold" strategy can be expected to give zero value (Jensen, 1967). Jensen's alpha is calculated using the following formula:

$$r_i - r_f = \alpha_i + \beta_i(r_m - r_f) \tag{5}$$

Formula 5 can also be modified to the following better representative form of alpha:

$$\alpha_i = (r_i - r_f) - \beta_i(r_m - r_f) \tag{6}$$

Where in formulas 5 and 6 r_i means portfolio return and r_f means risk-free return, respectively. The systematic risk of the portfolio is described by β_i. The market return as a benchmark is defined by r_m. The alpha, which describes the performance relative to the CAPM model, is represented by the α symbol.

Jensen’s alpha can be used to compare portfolios that are managed in similar ways and have comparable risk levels. Jensen's alpha considers only the systematic risk of a β-factor, and the risk is always proportional to the chosen benchmark index or portfolio. (Amenc & Le Sourd, 2003)

4.2.3 Treynor index

The reward to variability ratio known as the Treynor index is a portfolio success measure developed by Jack Treynor. At the time of its release in 1965, Treynor was one of the first people to establish a measure of success that depended on the risk-return ratio. (Treynor, 1965) The Treynor index measures the return of an investment object above its risk-free level to the

β-factor of the investment object, i.e. its systematic risk according to the CAP model. The Treynor index can be written in the following format (Amenc & Le Sourd, 2003)

$$T_i = \frac{r_i - r_f}{\beta_i} \quad (7)$$

Where $r_i - r_f$ is excessive return an β_i is beta for an asset.

In formula 7, the Treynor index is obtained by subtracting the risk-free interest rate from the portfolio return and dividing the value obtained by the portfolio's β-factor. The β-factor can be calculated, as shown in formula 4. Like Jensen's alpha, Treynor's figure also depends on the market index chosen and its success.

The Treynor index is particularly well-suited to measure the success of well-diversified portfolios. It only considers systemic risk, i.e. the part of the risk that cannot be eliminated by diversification. The Treynor index is also the most appropriate measure to measure portfolios that are only a portion of an investor's investments. (Amenc & Le Sourd, 2003) However, the Treynor index has its weaknesses. Because it is an index, it is susceptible to the denominator's inaccuracies, or beta, giving poor results to market-neutral funds. (Hübner, 2005)

5. RESULTS

This section presents and analyses the results of the study. The purpose is to answer the research question, i.e. how the investment strategy based on the momentum has been successful on the Helsinki Stock Exchange during the research period. In this section, the results are examined by comparing the formed top, 2nd, 3rd, 4th and bottom portfolios. The market portfolio uses its returns and the success indicators presented in the previous chapter. In interpreting the results, it should be noted that for simplicity, transaction costs, data acquisition costs, commission costs, administrative costs, and taxation have not been taken into account in this study. These costs would have a real impact, leading to a deterioration in results.

5.1 Momentum strategy returns

Let us begin analysing the results by looking at the portfolio returns graph summarized in Figure 6. The figure consists of the combined cumulative returns of the nineteen top, 2nd, 3rd, 4th, bottom portfolios and OMX Helsinki index, which serves as a comparative market portfolio. In the graph, the portfolios are indexed to the starting point of 1000, after which the cumulative returns of the portfolios are aggregated. The cumulative returns of individual portfolios are in Appendix 1.

The cumulative returns of all portfolios have similar patterns with a different momentum, shown in Figure 6. By far, the best portfolio has been the top portfolio, which has returned almost 400% cumulatively in ten years. The portfolios 2nd & 3rd and 4th & bottom both pairs have been progressed nearly hand in hand throughout the whole ten year period. The 2nd portfolio has returned around 177 per cent and the 3rd 185 per cent in ten years. The progress between these two portfolios was almost identical until 2015, when the 2nd portfolio began to take ahead from the 3rd portfolio but finished somewhat similar returns. Simultaneously, the 4th and bottom portfolios have been progressing very identically, both having yielded a return of almost 100 per cent in ten years. The OMX Helsinki market portfolio has outperformed the pairs mentioned above with a difference of nearly 30 per cent. All of the portfolios have at least practically doubled in size in the ten year study period. The average portfolio returns are in Appendix 2.

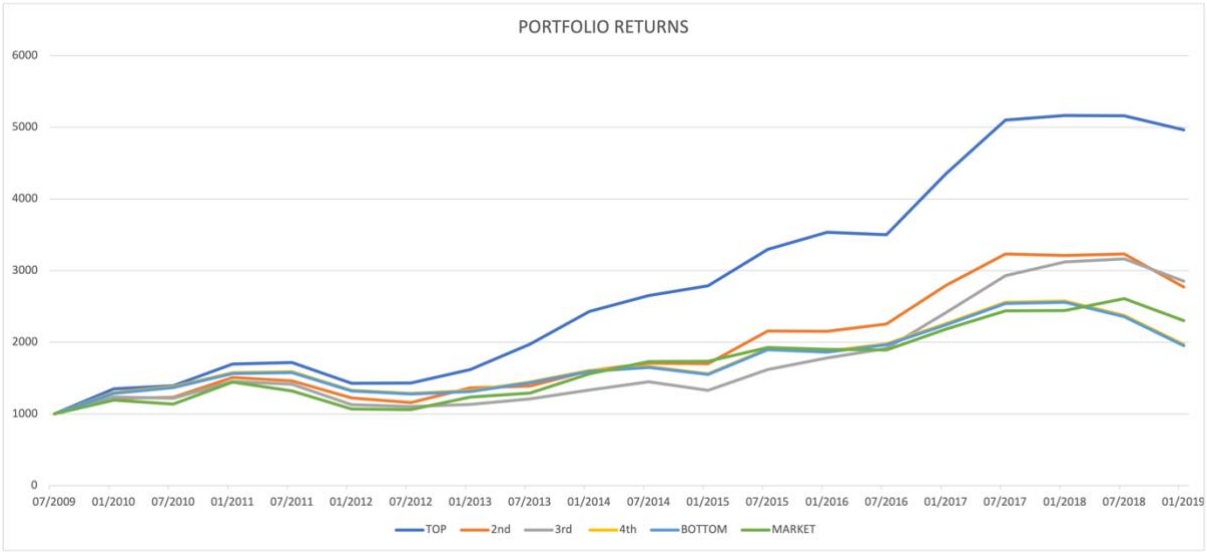

Figure 6. Portfolio cumulative returns.

When investigating the individual portfolio returns (Appendix 3), we can notice many quite compelling cases. There are these two six month periods between 1.7.2011-1.1.2012 and 1.7.2018-1.1.2019 when all of the portfolios have yielded negative returns. The first one of these two periods' negative returns was black Monday in August 2011 when US and global stock markets crashed. This was attributed to fears about the expansion of the European sovereign debt crisis to Spain and Italy and concerns about the new French AAA rating concerns about the weak economic development of the United States, and the downgrading of its credit ranking. Extreme stock price index volatility continued for the remainder of the year. While the year 2018 was the worst year for stock markets since the financial crisis in 2008. Since October, when the stock market, which witnessed the longest bull run in history, took a turn for the worse, the vast majority of losses have come.

The other quite fascinating observation is that the bottom portfolio has performed better than the top portfolio two times in six months in the last ten years. The first time in 2015 and the second time in 2016. In 2015, the bottom portfolio returned to almost ten per cent more than the top portfolio formed by the best-performing companies based on returns. The same size difference occurred once again in 2016. This evidence is quite the opposite of what the momentum anomaly suggests.

On the other hand, until the end of 2012, the top and bottom portfolios have had almost identical returns. From 2012 until the end of the investigation period, the top portfolio has had the highest returns, which is a good sign for the momentum strategy's success. Simultaneously, when looking at the bottom portfolio, it is observed that its performance has lagged far behind all other portfolios, except the 4th portfolio. From the momentum anomaly point of view, the weak relative development of the bottom portfolio, in particular, suggests the occurrence of the anomaly and the fact that poorly performing companies do indeed perform worse than the market later on.

5.2 Performance with key figures

Returns alone are not enough to explain the success of portfolios. Therefore, different indicators are needed to observe the success of portfolios concerning their risk. In this section, portfolios are examined from both the whole study period and individual periods. Particular attention will be paid to periods where there have been anomalies in portfolio returns.

5.2.1 Sharpe ratio

The processing of key figures begins with the Sharpe ratios. Sharpe’s ratio differs from other metrics in that it is not dependent on the chosen market index, but is based on portfolio volatility, i.e., portfolio standard deviation. In other words, the Sharpe figure takes into account the overall risk of the investment. We can see that Sharpe's ratio is positive for all portfolios from Table 2. Examining the portfolios of the entire investment period, it can be seen that the top portfolio has performed the best and the bottom portfolio the worst with the value of 0,97 and 0,28, respectively. However, what is interesting is the worse success of the bottom portfolio than the market portfolio on this metric. Although the bottom portfolio's return has been decent, its high volatility makes it very risky, lowering the Sharpe’s ratio. The better success of the market portfolio can again be concluded due to low volatility. It is also engrossing to see that Sharpe’s ratios do not decrease when moving in the direction of less successful portfolios. The reason is that the 3rd portfolio has generated more income with less risk than the 2nd portfolio. The market portfolio has a Sharpe ratio of 0,52, which is just under the average of other portfolios.

The portfolios' riskiness has been somewhat the same during the ten years except for the bottom portfolio. The volatility has been around 16 to 18 percentages. So it is safe to say that the differences between the portfolios' returns are the reason for the differing Sharpe ratios.

Table 2. The annualized portfolio Sharpe ratios.

	TOP	2nd	3rd	4th	BOTTOM	MARKET
Average return	17,38 %	10,74 %	11,05 %	7,00 %	6,93 %	8,71 %
Risk-free rate	0,15 %	0,15 %	0,15 %	0,15 %	0,15 %	0,15 %
Volatility	17,85 %	17,85 %	17,62 %	16,97 %	24,28 %	16,46 %
Sharpe ratio	**0,965**	**0,593**	**0,619**	**0,404**	**0,279**	**0,520**

Looking at the Sharpe ratios for individual portfolios (Appendix 6), negative Sharpe figures for two different 6-month periods are seen during the study period for all portfolios, which are naturally due to negative returns. These were the before-mentioned two periods when stock markets plummeted due to different macro-economic reasons.

Comparing the Sharpe ratios of the top portfolio with the Sharpe ratio of the market portfolio, it is observed that almost without exception, the Sharpe figure of the top portfolio is high when the Sharpe figure of the market is high (Appendix 4). This reinforces the already strong view of the impact of the market situation on the momentum strategy returns. When comparing the bottom portfolio, no similar relationship can be found with the market.

5.2.2 Jensen alpha

Next, the portfolios are compared with each other with Jensen’s alpha. Table 3 summarizes Jensen alphas for all portfolios covering the entire study period. The risk-free return for this period is calculated as the one-month Euribor average for the whole of the investigation period. Looking at Jensen’s alphas, it is observed that the top portfolio has been by far the best in this field. Its annualized Jensen alpha is 9.22 per cent, meaning the portfolio has produced more than 9 per cent more than the CAP model return in ten years with a β-factor of 0,94. The market has outperformed the bottom portfolio with Jensen’s alpha metric, with its annual alpha at -1,57% and a β-factor of 0,98. That means that the bottom portfolio's return has been achieved

with a higher risk than the top portfolio's return shown from their β-factors. The market β is, of course, 1, and thus, Jensen's alpha value is 0. The 3rd portfolio performs better than the 2nd yet again when reviewing Sharpe's ratio due to lower correlation with the market. The 4th portfolio has the lowest beta yet eminent alpha because of a considerably low return.

Table 3. The annualized portfolio Jensen alphas.

	TOP	2nd	3rd	4th	BOTTOM
Average return	17,38 %	10,74 %	11,05 %	7,00 %	6,93 %
Risk-free rate	0,15 %	0,15 %	0,15 %	0,15 %	0,15 %
Beta	0,94	0,94	0,81	0,73	0,98
Market return	8,71 %	8,71 %	8,71 %	8,71 %	8,71 %
Jensen alpha	**9,22 %**	**2,52 %**	**3,94 %**	**0,58 %**	**-1,57 %**

Examining the Jensen alphas of individual portfolios (Appendix 5), it is seen that the alphas of top portfolios are positive throughout most of the study and have been mostly at their strongest when market returns have been strong, excluding the market crisis in 2011 and 2018. When analyzing the bottom portfolio's alphas, it is observed that the strong negative results of the market crisis periods also have a significant impact on the alpha of the entire research period. The bottom portfolio's alphas are high; their β-factors are also generally high, which means that returns are achieved with high systematic risk. (Appendix 5)

The top portfolio's excellent success in looking at Jensen's alphas is good news for the momentum strategy's success. It has been able to beat market returns and its CAP model returns, suggesting that the momentum strategy would have been successful in the Helsinki Stock Exchange.

5.2.3 Treynor index

When looking at Treynor's indexes, it should be remembered that the success measure does not take into account unsystematic risk. This means that it is assumed that the decentralization has been done so well that no non-systematic risk matters. However, this study aims not to evaluate

the benefits of decentralization but to examine the momentum strategy's effectiveness. The Treynor index is a good measure but not optimal in this context. Thus, we can simply look at only the excessive return ratio to beta.

Looking at the Treynor indexes, a similar development is observed throughout the study period when looking at the Jensen alpha. The top portfolio has been the most successful, and the bottom portfolio even worse than the market portfolio. The bottom portfolio has the highest β-factor, which is an indicator of riskiness. However, it has not profited from the point of view of the momentum strategy. The Treynor index of the top portfolio is almost three times better than in the bottom portfolio and more than double the market portfolio. However, the Treynor index of the market portfolio only shows its return over the risk-free return and has been added to Table 4 for comparison.

Table 4. The annualized portfolio Treynor indexes.

	TOP	2nd	3rd	4th	BOTTOM	MARKET
Average return	17,38 %	10,74 %	11,05 %	7,00 %	6,93 %	8,71 %
Risk-free rate	0,15 %	0,15 %	0,15 %	0,15 %	0,15 %	0,15 %
Beta	0,94	0,94	0,81	0,73	0,98	1,00
Treynor index	**0,184**	**0,112**	**0,134**	**0,094**	**0,069**	**0,086**

When analyzing the Treynor indexes for individual portfolios (Appendix 6), we notice a trend in which the top portfolio's index moves in the opposite direction when the market portfolio is doing well. This is exciting, as macroeconomic factors do not appear to impact the momentum strategy's success during the study period.

5.3 Summary

This section summarizes the results above and compares portfolio returns and calculated key figures to see how the moment strategy has been successful overall. The results show that the difference in returns between the winner and loser portfolios was significant with the six-month momentum strategy. An annual difference in return of more than 14% is a sign of the moment strategy's success. Adding further success from a metrics perspective further reinforces the vision. This would suggest that past share price developments will also have an impact on future

price developments. The momentum strategy would therefore seem to work in the Helsinki Stock Exchange as well.

When looking at portfolios from different key figures' perspective, the relative order of rankings of the portfolios is the same. The top portfolios have received the highest values, and the bottom portfolios the lowest. However, the 3rd portfolio has been more successful than the 2nd portfolio. The results show that the top portfolio has been able to beat the market portfolio and the bottom portfolio by all metrics.

In this review, the anomaly would seem to occur over all periods, but its intensity may vary. Thus, at least without further investigation, it is impossible to determine whether an anomaly necessarily exists in all market situations. Based on the observations, it would most likely appear that the anomaly is strongest with high market volatility. With Sharpe's ratio, the level of risk would seem to explain some, but not all, of the returns on the winning portfolio. Based on Sharpe ratios, it is clear that there is no matching correlation between risk and return. For example, the return of the loser portfolio has been weak despite the high risk.

It was expectable that the momentum anomaly could be found on the Helsinki Stock Exchange, as Leivo and Pätäri (2011) had already detected it in their research at different times. Previous studies have also found that an increase in risk level can only describe the anomaly at most in part. Previous studies have also found that an increase in risk level can only explain the anomaly at most partly.

6. CONCLUSIONS

This thesis examines the momentum phenomenon and momentum strategy on the Helsinki Stock Exchange over the 2009 and 2019 period. The anomaly was studied using a six-month momentum strategy. The purpose was to examine whether strategy based on investing better-performing companies can achieve greater returns compared to worse performing companies and above the average market return. The causes of potential excess returns were examined in terms of risk using Sharpe's ratio, Jensen's alpha and Treynor's index. The theoretical part and previous studies serve as the basis for the empirical part in which the actual research is presented. According to previous studies, momentum investing has achieved excess returns compared to market revenues. Excess returns have also not been compensated for higher risk-taking. The red thread through this thesis is the question of market efficiency.

Research on the Finnish Stock Market has been somewhat limited in momentum anomalies, so selecting and studying this topic presumably yielded some new information. The most crucial research question can be answered reliably based on the research results. The momentum anomaly has occurred in the Helsinki Stock Exchange during the research period. This observation is consistent with the study conducted by Leivo & Pätäri (2009), in which they observed the momentum phenomenon in the Finnish Stock Market. The results show that the strategy has been profitable over the medium term and ranking and holding periods. A clear difference in portfolio returns and past share price developments would appear to have a strong correlation with future price developments. From 2009 to 2019, the winner portfolio was significantly more successful in performance indicators and cumulative returns than the bottom portfolio and market portfolios. During the entire period, the winner portfolio realizes a compounded excess return of 9,22% per year on average, and the difference between the winner and the loser stocks is approximately 15% per year.

According to the research results, momentum returns cannot be explained by an increase in risk level. Here, the level of risk was measured by the standard deviation. The risk ratio was compared to returns using the Sharpe ratio. According to Sharpe ratios, the risk-return ratio does not appear to be significantly strongly correlated. The finding is consistent with many previous studies of the momentum anomaly. The Treynor index also indicated that the

macroeconomic factors do not appear to impact the momentum strategy's success during the study period.

The momentum strategy's profitability also confirms the momentum phenomenon's observation, which has not disappeared from the Finnish Stock Market. Continuing trends in share prices were observed, and it was possible to utilise them in an investment sense. This result is in stark contrast to a study by Hwang & Rubesam (2013) in which they claim the momentum phenomenon disappeared entirely in the 21st century.

All in all, it can be said that Fama's (1970) efficient market hypothesis has been partially refuted for the Helsinki Stock Exchange concerning recent research data. In practice, this means that even today, with all research data readily available to all, there appear to be anomalies in the market that lead to excess returns. As long as people operate in the financial markets, various inefficiencies can be expected to occur. It may be that in the future, the market will become even more efficient as automation increases. This speeds up the response to new data and can potentially reduce inefficiencies in this regard.

The thesis had certain limitations, such as the location of the Helsinki Stock Exchange in the periphery. Therefore, the results obtained are not generalizable in all geographical areas. The 10-year review period used in this thesis may not be long enough to get reliable research results. Most studies in this discipline have used longer review periods to minimize the randomness of results. Further studies could use a broader period to achieve more reliable research results. Besides, since the momentum phenomenon was examined only with six-month ranking and holding periods in this study, it would be interesting to study still slightly different length periods. Based on this study, a six-month strategy is useful, but it is possible that regulating the length of periods could make the momentum strategy even more productive. As an extension to this study, the effects of taxes and transaction costs now excluded could be considered. From a behavioural science perspective, it would be useful to look at what types of investors use a momentum investment strategy and whether they have some common characteristics in common.

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APPENDICES

Appendix 1. The cumulative returns of individual portfolios.

	TOP	2nd	3rd	4th	BOTTOM	MARKET
1.7.2009	1000	1000	1000	1000	1000	1000
1.1.2010	1351,45726	1220,64151	1236,61234	1297,7424	1288,56313	1191,56232
1.7.2010	1394,6715	1232,37295	1218,90847	1379,71954	1369,96041	1139,40301
1.1.2011	1696,02604	1510,19748	1452,63674	1576,06887	1564,92092	1444,82876
1.7.2011	1715,69444	1460,30731	1413,14919	1590,1683	1578,92062	1320,13694
1.1.2012	1427,02404	1222,17563	1129,76181	1329,53744	1320,13327	1070,0521
1.7.2012	1430,85723	1160,86403	1101,51873	1288,08778	1278,97679	1058,70237
1.1.2013	1621,55616	1361,65887	1131,63058	1323,63385	1314,27144	1236,56836
1.7.2013	1974,44863	1391,18574	1209,51744	1446,17315	1435,94399	1289,81853
1.1.2014	2432,06028	1603,39357	1334,45576	1605,27447	1593,91993	1560,66732
1.7.2014	2653,22179	1711,18427	1448,11326	1661,84481	1650,09015	1731,21198
1.1.2015	2789,44378	1700,78237	1328,09612	1560,55661	1549,51838	1736,6085
1.7.2015	3298,34397	2157,62091	1621,24269	1911,40227	1897,88241	1926,31346
1.1.2016	3533,26076	2152,04163	1780,05601	1877,12561	1863,8482	1903,08087
1.7.2016	3500,38066	2253,52198	1913,83011	1980,1419	1966,13583	1891,17554
1.1.2017	4348,58997	2791,20427	2414,01543	2259,09707	2243,11788	2180,87952
1.7.2017	5100,09938	3231,98498	2928,49458	2557,9708	2539,8776	2439,06183
1.1.2018	5166,72485	3211,60038	3121,2617	2574,87236	2556,6596	2444,30742
1.7.2018	5159,56564	3234,46919	3164,37522	2376,25203	2359,44417	2607,69024
1.1.2019	4965,77133	2772,81319	2853,44356	1967,63173	1953,71415	2304,31455

Appendix 2. The average portfolio returns.

	TOP	2nd	3rd	4th	BOTTOM	MARKET	TOP-BOTTOM
10 years	396,58 %	177,28 %	185,34 %	96,76 %	95,37 %	130,43 %	301,21 %
1 year	17,38 %	10,74 %	11,05 %	7,00 %	6,93 %	8,71 %	14,90 %
1 month	1,34 %	0,85 %	0,88 %	0,57 %	0,56 %	0,70 %	1,16 %

Appendix 3. The individual portfolio returns.

	TOP	2nd	3rd	4th	BOTTOM	MARKET
1.7.2009-1.1.2010	35,15 %	22,06 %	23,66 %	29,77 %	28,86 %	19,16 %
1.1.2010-1.7.2010	3,20 %	0,96 %	-1,43 %	6,32 %	1,59 %	-4,38 %
1.7.2010-1.1.2011	21,61 %	22,54 %	19,18 %	14,23 %	16,87 %	26,81 %
1.1.2011-1.7.2011	1,16 %	-3,30 %	-2,72 %	0,89 %	-9,65 %	-8,63 %
1.7.2011-1.1.2012	-16,83 %	-16,31 %	-20,05 %	-16,39 %	-25,81 %	-18,94 %
1.1.2012-1.7.2012	0,27 %	-5,02 %	-2,50 %	-3,12 %	-5,22 %	-1,06 %
1.7.2012-1.1.2013	13,33 %	17,30 %	2,73 %	2,76 %	7,33 %	16,80 %
1.1.2013-1.7.2013	21,76 %	2,17 %	6,88 %	9,26 %	-5,33 %	4,31 %
1.7.2013-1.1.2014	23,18 %	12,81 %	10,33 %	11,00 %	-3,81 %	21,00 %
1.1.2014-1.7.2014	9,09 %	6,72 %	8,52 %	3,52 %	4,23 %	10,93 %
1.7.2014-1.1.2015	5,13 %	-0,61 %	-8,29 %	-6,09 %	-24,61 %	0,31 %
1.1.2015-1.7.2015	18,24 %	26,86 %	22,07 %	22,48 %	28,18 %	10,92 %
1.7.2015-1.1-2016	7,12 %	-0,26 %	9,80 %	-1,79 %	-8,49 %	-1,21 %
1.1.2016-1.7.2016	-0,93 %	4,72 %	7,52 %	5,49 %	9,20 %	-0,63 %
1.7.2016-1.1.2017	24,23 %	23,86 %	26,14 %	14,09 %	20,67 %	15,32 %
1.1.2017-1.7.2017	17,28 %	15,79 %	21,31 %	13,23 %	8,51 %	11,84 %
1.7.2017-1.1.2018	1,31 %	-0,63 %	6,58 %	0,66 %	-6,64 %	0,22 %
1.1.2018-1.7.2018	-0,14 %	0,71 %	1,38 %	-7,71 %	-11,27 %	6,68 %
1.7.2018-1.1.2019	-3,76 %	-14,27 %	-9,83 %	-17,20 %	-32,61 %	-11,63 %

Appendix 4. The individual portfolio Sharpe ratios.

	TOP	2nd	3rd	4th	BOTTOM	MARKET
1.7.2009-1.1.2010	1,734	1,563	1,231	2,514	0,954	11,081
1.1.2010-1.7.2010	0,177	0,071	-0,146	0,430	0,095	-2,086
1.7.2010-1.1.2011	1,452	1,386	1,230	0,932	0,773	21,022
1.1.2011-1.7.2011	0,027	-0,312	-0,321	0,011	-0,660	-5,068
1.7.2011-1.1.2012	-1,038	-1,207	-1,525	-1,182	-2,005	-4,856
1.1.2012-1.7.2012	0,007	-0,385	-0,204	-0,190	-0,212	-0,622
1.7.2012-1.1.2013	1,182	1,810	0,122	0,240	0,306	10,314
1.1.2013-1.7.2013	0,780	0,153	0,411	0,805	-0,192	2,633
1.7.2013-1.1.2014	0,829	0,724	0,806	0,596	-0,175	18,312
1.1.2014-1.7.2014	0,671	0,627	0,845	0,285	0,179	9,594
1.7.2014-1.1.2015	0,265	-0,038	-0,478	-0,421	-1,754	0,173
1.1.2015-1.7.2015	1,586	1,309	1,170	1,678	1,228	6,837
1.7.2015-1.1-2016	0,365	-0,012	0,489	-0,120	-0,473	-0,591
1.1.2016-1.7.2016	-0,050	0,247	0,667	0,402	0,470	-0,173
1.7.2016-1.1.2017	1,032	1,131	1,393	0,907	0,472	10,651
1.1.2017-1.7.2017	0,898	1,178	1,660	1,236	0,413	13,320
1.7.2017-1.1.2018	0,077	-0,042	0,617	0,071	-0,406	0,550
1.1.2018-1.7.2018	0,004	0,073	0,163	-0,572	-0,600	6,126
1.7.2018-1.1.2019	-0,167	-1,282	-0,601	-1,065	-1,365	-6,598

Appendix 5. The individual portfolio Jensen alphas.

	TOP	Beta	2nd	Beta	3rd	Beta	4th	Beta	BOTTOM	Beta
1.7.2009-1.1.2010	0,192	0,828	0,089	0,682	0,137	0,509	0,175	0,632	0,183	0,542
1.1.2010-1.7.2010	0,023	-0,096	-0,004	-0,188	-0,027	-0,172	0,051	-0,156	0,007	-0,088
1.7.2010-1.1.2011	0,258	-0,178	0,224	-0,010	0,209	-0,083	0,188	-0,193	0,154	0,040
1.1.2011-1.7.2011	-0,020	-0,273	-0,045	-0,076	-0,040	-0,087	-0,001	-0,057	-0,101	-0,002
1.7.2011-1.1.2012	-0,092	0,404	-0,097	0,355	-0,136	0,345	-0,201	-0,164	-0,314	-0,258
1.1.2012-1.7.2012	-0,001	0,022	-0,054	0,021	-0,030	-0,033	-0,037	-0,112	-0,061	-0,271
1.7.2012-1.1.2013	0,129	0,000	0,162	0,040	0,029	-0,036	0,024	-0,004	0,047	0,132
1.1.2013-1.7.2013	0,214	-0,011	0,017	-0,002	0,067	-0,060	0,094	-0,147	-0,051	-0,165
1.7.2013-1.1.2014	0,313	-0,412	0,192	-0,327	0,111	-0,059	0,175	-0,335	0,026	-0,330
1.1.2014-1.7.2014	0,068	0,168	0,061	0,018	0,078	0,026	0,024	0,058	0,014	0,220
1.7.2014-1.1.2015	0,047	0,028	-0,011	0,009	-0,087	-0,049	-0,065	-0,093	-0,251	-0,012
1.1.2015-1.7.2015	0,182	-0,038	0,270	-0,052	0,220	-0,031	0,212	0,079	0,268	0,086
1.7.2015-1.1-2016	0,064	-0,318	-0,008	-0,105	0,092	-0,130	-0,024	-0,169	-0,090	-0,079
1.1.2016-1.7.2016	-0,013	0,196	0,044	0,528	0,072	0,478	0,051	0,424	0,089	0,509
1.7.2016-1.1.2017	0,253	-0,096	0,134	0,639	0,242	0,093	0,106	0,195	0,147	0,354
1.1.2017-1.7.2017	0,207	-0,318	0,179	-0,205	0,251	-0,348	0,146	-0,145	0,070	0,085
1.7.2017-1.1.2018	0,010	-0,238	-0,010	-0,096	0,062	-0,070	0,003	-0,176	-0,069	-0,290
1.1.2018-1.7.2018	-0,009	0,044	-0,007	0,133	0,013	-0,059	-0,078	-0,047	-0,105	-0,171
1.7.2018-1.1.2019	0,041	0,740	-0,082	0,583	-0,039	0,570	-0,101	0,669	-0,215	1,027

Appendix 6. The individual portfolio Treynor indexes.

	TOP	Beta	2nd	Beta	3rd	Beta	4th	Beta	BOTTOM	Beta	MARKET
1.7.2009-1.1.2010	0,419	0,828	0,317	0,682	0,456	0,509	0,464	0,632	0,524	0,542	0,187
1.1.2010-1.7.2010	-0,281	-0,096	-0,024	-0,188	0,112	-0,172	-0,372	-0,156	-0,123	-0,088	-0,049
1.7.2010-1.1.2011	-1,170	-0,178	-20,777	-0,010	-2,209	-0,083	-0,697	-0,193	4,056	0,040	0,260
1.1.2011-1.7.2011	0,008	-0,273	0,614	-0,076	0,471	-0,087	0,083	-0,057	54,067	-0,002	-0,100
1.7.2011-1.1.2012	-0,440	0,404	-0,486	0,355	-0,609	0,345	1,058	-0,164	1,037	-0,258	-0,199
1.1.2012-1.7.2012	-0,042	0,022	-2,549	0,021	0,870	-0,033	0,311	-0,112	0,206	-0,271	-0,014
1.7.2012-1.1.2013	595,290	0,000	4,251	0,040	-0,729	-0,036	-7,264	-0,004	0,547	0,132	0,167
1.1.2013-1.7.2013	-20,316	-0,011	-10,146	-0,002	-1,136	-0,060	-0,621	-0,147	0,330	-0,165	0,042
1.7.2013-1.1.2014	-0,557	-0,412	-0,385	-0,327	-1,729	-0,059	-0,322	-0,335	0,122	-0,330	0,208
1.1.2014-1.7.2014	0,536	0,168	3,728	0,018	3,203	0,026	0,586	0,058	0,188	0,220	0,108
1.7.2014-1.1.2015	1,801	0,028	-0,727	0,009	1,702	-0,049	0,660	-0,093	21,081	-0,012	0,003
1.1.2015-1.7.2015	-4,857	-0,038	-5,143	-0,052	-7,042	-0,031	2,869	0,079	3,278	0,086	0,110
1.7.2015-1.1-2016	-0,231	-0,318	0,004	-0,105	-0,768	-0,130	0,093	-0,169	1,051	-0,079	-0,010
1.1.2016-1.7.2016	-0,029	0,196	0,096	0,528	0,165	0,478	0,138	0,424	0,188	0,509	-0,003
1.7.2016-1.1.2017	-2,553	-0,096	0,379	0,639	2,863	0,093	0,740	0,195	0,594	0,354	0,157
1.1.2017-1.7.2017	-0,554	-0,318	-0,787	-0,205	-0,622	-0,348	-0,939	-0,145	1,044	0,085	0,122
1.7.2017-1.1.2018	-0,070	-0,238	0,027	-0,096	-0,989	-0,070	-0,059	-0,176	0,216	-0,290	0,006
1.1.2018-1.7.2018	0,053	0,044	0,081	0,133	-0,297	-0,059	1,575	-0,047	0,639	-0,171	0,071