UNIVERSITY OF VAASA

SCHOOL OF BUSINESS

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COMBINING VALUE AND MOMENTUM: NORDIC EVIDENCE

Master´s Thesis in

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ABSTRACT:

This Master´s thesis examines whether value and momentum strategies have been profitable in the Nordic stock markets from 1993 to 2017 and if combining the value and momentum can improve the pure-play strategies. Additionally, and most importantly, it is researched whether combining value and momentum into a more sophisticated combination portfolio can improve the results even further.

By using Nordic data and a new time period, additional contribution is added to the existing research. Additionally, the combination of momentum and value is studied in a more detailed portfolio implementation manner than in Asness et al. (2013). Similar portfolio creation methods are used as in Fisher et al. (2016) but additionally long-short portfolios are examined.

The results indicate that value and momentum anomalies existed in the Nordic stock markets during the time period, although value is driven mostly by the smaller stocks. Simple 50/50 allocation improves portfolio performance significantly which is further improved by combining value and momentum into a more sophisticated combination portfolio.

KEY WORDS: value, momentum, portfolio implementation

1. INTRODUCTION

1.1. Background

The chase for higher returns on investments is one of the most discussed and debated topics in the field of finance. Finance theory tells us that it is not possible to get higher returns without taking a higher risk. The correlation between risk and return is described with the capital asset pricing model, known as CAPM. (Bodie et al. 2011a: 280). The topic has been in the keen interest of practitioners as well as academics.

In 1992, Fama and French researched that firm size has a negative relation to average return and book-to-market ratio has a positive correlation to average return. This is not explained by CAPM where nothing but market beta should affect average returns. These findings were already discovered earlier, size by Banz in 1981 and value anomaly has been present since the 1930s when Graham and Dodd introduced it (Banz 1981, Graham & Dodd, 1934). The anomalies are known as size and value premium. Based on their findings, Fama and French developed a new model where they added three proxies for risk: firm size, book-to-market ratio and market return. The model is widely recognized in the field of finance and it is known as the Fama-French three-factor model. (Fama & French 1992).

In the academic field of finance, markets are considered efficient. Stock prices move randomly and this is called random walk, therefore there are no possibilities for greater returns without greater risk. If we could predict stock prices it would be an absolute gold mine. (Bodie et al. 2011a: 343-348). Yet there are several anomalies that should not exist according to the efficient market theory. Market capitalization, book-to-market ratio or prior stock market

movements should have zero effect on average returns. One explanation for these overly large average returns is solely higher risk, the other one is mispricing.

In the 21st century, value investing has become increasingly popular. There are mutual funds, ETFs and hedge funds that fixate merely on value investing. The principle behind this fixation is the value premium. Many financial companies have also funds concentrated on the momentum effect. There are even funds that try to combine both premiums into one product, such as AQR´s International multi style fund (https://funds.aqr.com/). It is easy to see why such funds have gained huge popularity among financial companies. Value stocks have outperformed growth stocks in the past, further winner stocks have beaten loser stocks and it can be seen as an attractive story to sell to possible investors. Then again, some might argue that the reason behind the popularity of growth stocks is their possibilities of huge returns and chances of getting on board with the new Microsoft or Apple on the ground floor. These kinds of stories attract investors, even though it has been clear that value stocks outperform growth stocks in the long run, although there are some studies claiming that value no longer works.

1.2. Purpose of the study

The purpose of this thesis is to analyze value and momentum premiums on the basis of prior studies and research the best possible ways to combine the two styles. The main idea is to find out if simple separate value or momentum strategies can be beaten by the 50/50 approach, where half of the portfolio is allocated to value investing and other half to momentum strategy, or by combining the two measures into one strategy. The research will attempt to find ideal portfolio implementation techniques that will enhance the sole value or momentum strategies. It is also researched which of the strategies generates the highest risk-adjusted returns as well as raw returns.

This thesis will also present some of the most popular stock pricing models and discuss whether they can price risk properly. One possible explanation for the anomalies is that current pricing models are incapable of pricing risk, and value and momentum just work as proxies for the risk. Another explanation is that these value stocks and momentum phenomena are merely mispriced because of the errors in investor behaviour and stock pricing models.

There are a number of studies that have examined value and momentum anomalies separately but only some of them have concentrated on their correlation and even fewer have been focusing on combining the two measures. There is controversial debate on the value premium's ability to capture risk. Some see it as a proxy for risk, while others feel it is based on market inefficiencies, such as mispricing. A third view is that the phenomenon rises because of random occurrences, e.g. data mining issues. Same applies to the momentum anomaly. There are some studies where the concentration has been on the combination of the anomalies. This paper will concentrate on a few of them. Most of the studies have been made with U.S. data, which leaves demand for further examination with international data to which this thesis will contribute.

Using a liquid set of Nordic stocks provides significant contribution that supports previous academic research. Additionally, focusing on finding the best way to combine value and momentum anomalies adds to the existing research and contributes to practitioners in portfolio management. To my knowledge this the first time when the optimal combination of value and momentum is researched in the Nordic stock market setting.

1.3. Previous studies

Previous studies have suggested that value and momentum strategies earn abnormal risk-adjusted returns (Stattman 1980, Jegadeesh & Titman 1993). There

have been also studies that show negative correlation between the two strategies (Asness et al. 2013, Cakici et al. 2013). This paper studies the value and momentum anomalies and whether higher risk adjusted returns are achievable by combining value and momentum strategies. This is an interesting and current topic as investors all around the world seek a more favourable risk/reward ratio. There is also a lack of consensus on the subject of what causes these premiums: this is a massive motivator for this study.

Most of the prior studies have concentrated on showing the existence of value and momentum anomalies separately. The anomalies are well recorded in many markets with different time periods, but yet not many have studied the anomalies combined. Asness et al. (2013) study these anomalies jointly and find negative correlation within asset classes. The presence of negative correlation in two high-yielding strategies is exhilarating and they record substantially improved Sharpe ratios with a 50/50 portfolio in comparison to simple value or momentum strategy.

Fisher et al. (2016) take an approach similar to this paper when studying the combination of value and momentum strategies. They compare the simple 50/50 strategy to more complex combination strategies with U.S. stocks with long-only strategies. After accounting for transaction costs combination is discovered as a better strategy than the simple 50/50 approach. Both strategies beat value and momentum-only strategies. In this study, the aforementioned approach is broadened by including also long-short strategies in a new market setting. Also examining long-short strategies and discussing issues around them in a smaller but liquid market contributes to the research as well as to the practice of portfolio management.

The emphasis of the study will be in finding the best way to combine the two strategies into one portfolio. The emphasis will be on risk-adjusted returns, but raw returns are also presented. It is noteworthy that some of the diversification benefits that derive from negative correlation of value and momentum may be lost when combining them into one portfolio rather than using the 50/50 approach. Double screening and ranking methods may end up behaving in a manner very similar to momentum portfolio. Using Nordic stock market data adds to the prior studies and the results contribute to both portfolio management as well as academic research. Researching Nordic markets adds to current research by widening the scope to a liquid and low risk environment. It is noteworthy that the previous studies may have had sample-specific results and some of the previous studies have used value-weighted returns when researching Nordic markets as part of their study. Value-weighted returns are not a viable measure in the Nordic stock market setting due to the fact that it leads to few or even one stock dominating the returns. This issue is further discussed in this thesis.

1.4. Research question and hypothesis

This paper studies whether momentum and value anomalies exist in the Nordic stock markets and if it is possible to earn higher risk adjusted returns. Additionally, and most importantly, it is studied whether combining the two measures can improve the risk-adjusted returns and portfolio performance. The hypotheses are as follows:

H0: There is no correlation between P/B ratios and future stock returns

H1: There is no correlation between past stock returns and future stock returns

Assuming H0 or H1 are proven false, the study will be extended to researching the best ways to combine the two phenomena.

> H2: 50/50 allocation between momentum and value portfolio will not increase risk-adjusted returns.
>
> H3: Combining value and momentum anomalies into one combination portfolio will not increase risk-adjusted returns.
>
> H4: Combining value and momentum anomalies into one combination portfolio will not increase risk-adjusted returns of 50/50 allocation between momentum and value.

1.5. Structure of the study

This thesis gets acquainted with value and momentum anomalies and the factors behind these phenomena. A literature review will present the value and momentum anomalies and the explanations regarding what causes them, further previous studies on combining value and momentum are presented. Both risk-based and mispricing-oriented views are presented and analyzed based on prior academic research. In addition, stock pricing models and portfolio performance measures are presented.

The second chapter will go on to introduce efficient market theory, and thereafter Nordic stock markets will be discussed in the third chapter. Stock pricing models will be presented in the fourth chapter. In the fifth chapter, portfolio performance measures are presented and discussed. The sixth chapter will discuss the anomalies, and prior studies regarding the combination of value and momentum strategies are presented and analysed. Seventh chapter will present the data and methodology used in this paper, followed by empirical results that are reported in the eighth chapter. Lastly, the final chapter covers the conclusions of the study.

2. MARKET EFFICIENCY

The primary role of the capital market is the allocation of the financial resources. Investors are able to make higher returns by lending money for investments, and companies are able to finance their production investments and make their businesses grow. Markets are also seen as an efficient environment where free lunches do not exist. Yet there are a huge number of actively managed funds in spite of their higher cost and the fact that money managers should not be able to find higher profit opportunities based on mispricing. (Bodie et al. 2011a, 2, 5-6, 9-11.) Without properly functioning capital markets, our standard of living would not have reached such a high level as companies and individuals would not have the capital to invest in profitable endeavours (Smith 1776). Therefore, it is important to understand the factors that affect financial markets, and the theories behind them. Efficient markets are the corner stone of any financial theory.

Markets also reflect information by prices. A market that completely reflects all the information all the time is referred as efficient. This is known as the efficient market hypothesis (EMH). There are three levels of efficiency, and it is tested firstly with weak form tests; secondly, with semi-strong form tests and lastly, with strong form tests. Weak form tests contain merely discussion of the historical prices. Semi-strong form tests take into consideration whether prices adjust efficiently to information that is publicly available, such as stock splits and announcements of the quarterly earnings. Strong form tests concern whether some investors have access to information that is relevant to price formation and that others do not have access to (Fama 1970.) Fama views that the efficient markets hold up well, aside from few expectations.

The three forms of the efficient market hypothesis are presented below in Figure 1. It shows that strong forms include semi-strong and weak forms plus all private

information. Semi-strong forms include all public information plus weak forms, and weak forms include only past prices.

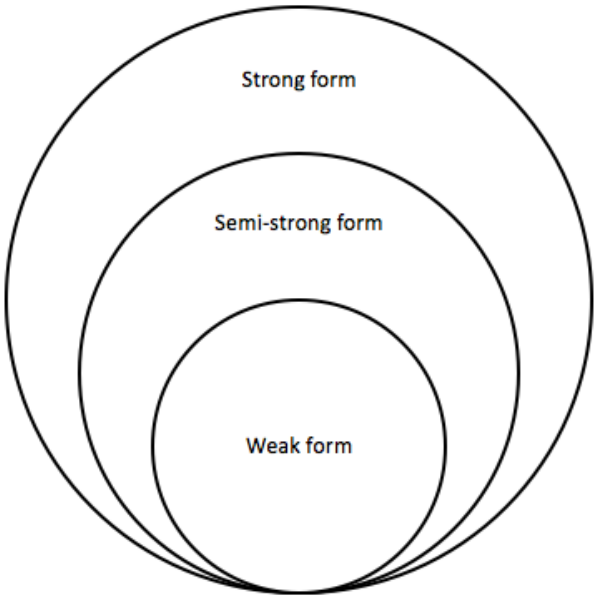

Figure 1. Three forms of the EMH

Nowadays, there is a strong belief among some academics that the behavior of investors may not be rational all the time. Due to our human nature we tend to make errors and irrational decisions. This school of thought is known as behavioral finance. Behavioral finance tries to explain market inefficiencies, such as anomalies, through investor psychology. It has been discovered that overreaction, anchoring and mental accounting, to name few, affect the investors' decision making. This view offers opposite explanations for anomalies to market efficiency. (Bodie et al. 2011a, 382-385.)

There is some evidence supporting the view that EMH is not completely accurate. Lakonishok & Lee (2001) find that insider trading has the capability to anticipate market movements. On average, insiders are contrarian investors but they do a better job at predicting market movements than simple contrarian strategies. They also perform better in predicting movements of small companies than large

companies. Lakonishok et al. (2001) suggest that larger companies are priced more efficiently, thus the biggest potential benefits of exploiting insider trading can be achieved in the smaller companies. They also believe that market ignores the valuable information of insider trading. "There is very little action around the time when insiders trade" (Lakonishok et al. 2001.) When comparing stocks that investors buy extensively to those that they sell extensively, the bought stocks outperform the sold ones by 7,8% during the first year and by 2,3% in the second year. In third year there is no noticeable difference in returns. It is very unlikely that this is caused by higher risk, because of the pattern that the gap in returns disappears over time.

Insiders buy and sell different types of stocks on average. They tend to buy value stocks that are cheap by book-to-market measures and have had weak past performance, whereas insiders tend to sell "glamor" stocks that have had a good run in the past. In addition, investors prefer buying small-cap stocks. It is also discovered that only insiders' purchases are valuable information, because insiders selling stocks do not associate with low returns. This may be due to the fact that insiders have a variety of motives in selling stocks, and the main reason in buying them is to make money. (Lakonishok et al. 2001.)

3. NORDIC STOCK MARKETS

Nordic stock markets are relatively new yet developed stock markets. The market consists of five countries: Denmark, Finland, Iceland, Norway and Sweden. Out of these markets, Iceland is extremely small and often not included as part of the Nordics as is done in this study. (www.nasdaqomxnordic.com) Foreign ownership of the Nordic stock markets has risen significantly from the early 90´s as the economies have developed and stock markets have become more active in pure number of stocks and trading volume as well.

These markets are sometimes even referred to as periphery markets. Periphery market refers to a stock market that is on the outskirt of the investment horizon. Oftentimes these periphery markets are volatile as in times of distress investors pull their money away from these markets first. This is the other side of the flight to safety. Today, Nordic countries are often considered part of the European "core", although the shift in foreign ownership during crises implies that they still experience some peripheral qualities.

Nordic stock markets started to develop rapidly in the 90´s when the economies started growing at a fast pace. As a young but liquid stock market and a low risk environment, the Nordic stock market offers an interesting opportunity to broaden equity market studies outside of the traditional U.S. scope. The trading volumes are lower than in the U.S., but the markets are stable and the countries have a stable political environment with low risk profiles. For example, the bond yields of Nordic countries have been very close to U.S. bond yields which is not the case with many periphery or developing markets. The development of Nordic and U.S. credit rating is presented in Figure 2. It is clear that Nordic markets are seen somewhat riskier than the U.S. one but they are far from the risk levels of emerging markets. The ratings are S&P local currency long term credit

ratings and are gathered from Bloomberg. In addition to the Nordic and U.S. credit ratings, BRIC-countriey ratings are presented to give a visible evidence on the differences on risk levels.

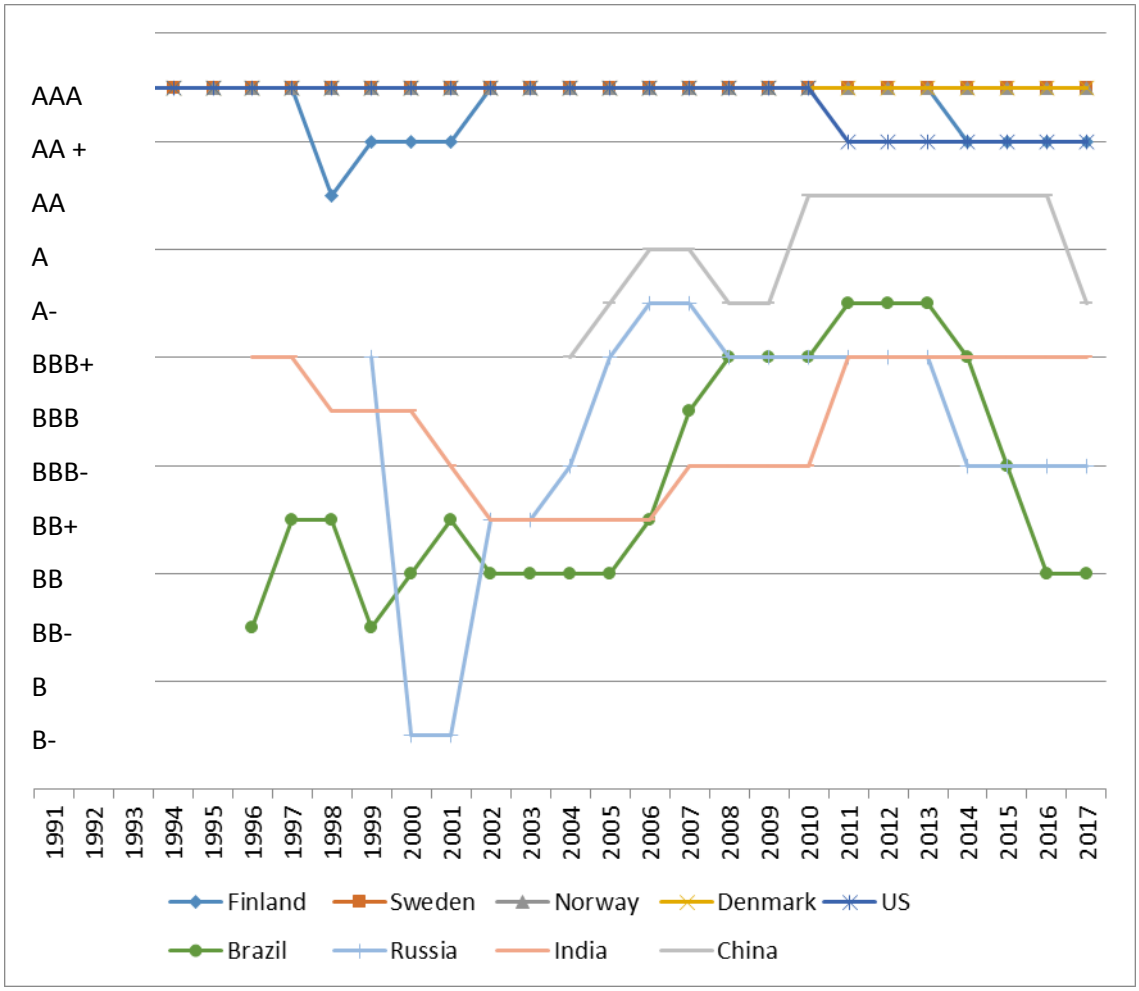

Figure 2. Nordic and U.S. credit rating development from 1993 to 2018

Nordic countries have held constantly a triple-A credit rating with the exception of Finland which is currently rated at the same level as the U.S. Some might even argue that the Nordic stock markets are less risky from this standpoint than the U.S. one, hence the U.S. has also been downgraded to the double-A while Denmark, Norway and Sweden hold triple-A rating. The Nordic countries are also low in corruption and the stock markets have a healthy level of liquidity.

In previous research, there has not been a lot of focus on the Nordic stock markets, and some of the studies that have researched a wide range of international markets have used market-weighted returns which is not viable in a smaller market setting with few very large stocks. In addition, a rapidly growing stock market with a lot of new stocks emerging, increasing liquidity, high level of exporting products and services of GDP, but low risk levels offer a fertile ground to study stock market anomalies. Furthermore, it should be noted that many funds tend to have home market bias and it is as valuable to create alpha in any market.

4. STOCK PRICING MODELS

In financial markets, there is ongoing process to find and exploit mispriced securities. Even minor mispricing gives investors opportunities to beat the market and earn excess returns. This is why there is an army of analysts, money managers and individual investors searching for even the smallest error between the company's "true" value and its market value. In order to determine the "true" value of a company and uncover mispricing securities, analysts and investors use different valuation models. (Bodie et al. 2011b: 763.) This chapter presents a few of the most commonly used valuation methods and provides the basis for later critique.

4.1. Capital asset pricing model

The capital asset pricing model, usually referred to as the CAPM, is a centerpiece of modern financial economics. The model provides us with a decisive prediction of the relationship between the risk and expected return of an asset. The model was developed simultaneously but independently by William Sharpe (1964), John Lintner (1965) and Jan Mossin (1966). Their work was laid on the foundations of Harry Markovic who developed the modern portfolio management in 1952. The formula for CAPM presents as follows (Bodie et al. 2011b: 308, 321):

(1) $$E(R_i) = R_f + \beta_i[E(R_m) - R_f]$$

where $E(R_i)$ = expected return of portfolio i

R_f = risk-free return

β_i = the beta coefficient of the portfolio i

$E(R_m)$ = expected return of market portfolio

There is a number of simplifying assumptions that lead to the basic version of the CAPM. These assumptions are unrealistic but they provide us with a platform from where we can pursue the goal of completely understanding risk-return relationship. The assumptions are as follows (Bodie et al. 2011b: 308-309):

1. There are numerous investors whose wealth is small compared to the total endowment of all investors. Therefore, investors are price-takers whose actions do not affect the prices. Thus perfect competition prevails.
2. All investors have the same holding period.
3. Investments are limited to publicly traded financial assets, such as bonds and stocks, and to risk-free lending and borrowing. Investors can lend or borrow any amount at risk-free rate.
4. Investors pay no transaction cost or taxes.
5. All investors are rational mean-variance optimizers, thus using Markowitz´s portfolio selection model.
6. All investors have homogenous expectations and beliefs.

The correlation between expected return and beta is expressed below graphically. The line, which contains every possible scenario between beta and expected return, is known as security market line (SML). It can be viewed from the graph that return of a security contains two parts: risk-free return (R_f) and risk premium. In this graph, the expected return of the investment ($E(R_i)$) is higher than expected market return ($E(R_m)$) because of its greater beta. The slope of the security market line is the markets risk premium. "Correctly" priced stock lies in

the SML, however there may occur mispricing and therefore stock may not be on the SML. If stock is above the SML it is considered to be under-priced and conversely over-priced stock lies below the security market line. (Bodie et al. 2011b:317-320.)

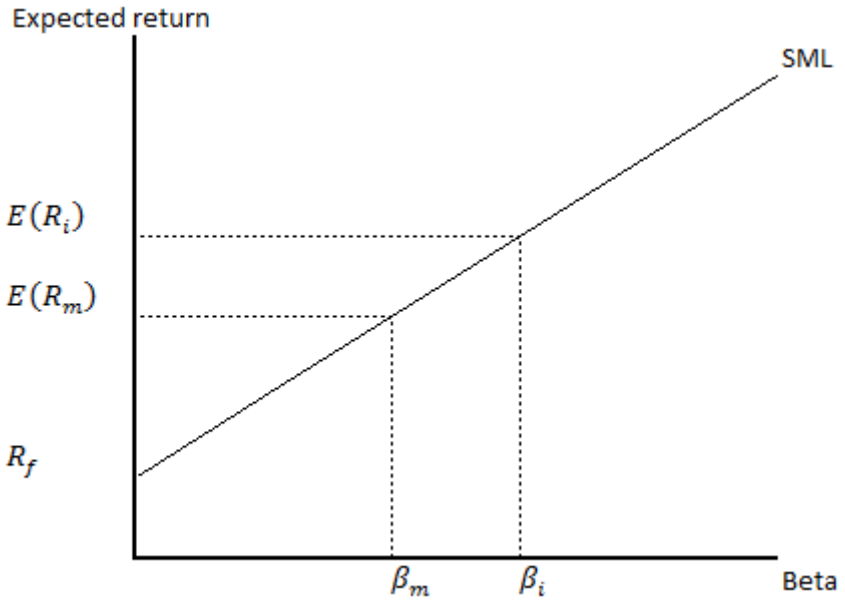

Figure 3. The Security market line (Bodie et al. 2011b: 319)

4.2. Three-factor model

In order to capture risk premiums better than with CAPM Fama and French developed the three-factor model. The variables are based on prior evidence and predict well average returns. There are two easily measured variables in addition to the beta, Small Minus Big and High Minus Low. Small Minus Big, often referred to as SMB, is a factor that tries to capture the size premium and, according to Fama and French, it works as a proxy for risk. High Minus Low, otherwise known as HML, is a proxy for risk that value stocks carry. The smaller the company and the greater its book-to-market ratio, the riskier it is. Thus small companies with high book-to-market ratios should earn higher returns than the

market on average. (Fama & French, 1992, 1996). The Fama-French three-factor model is dominating industry applications and empirical research. The formula of the three-factor model is presented as follows (Bodie et al. 2011b: 363):

The expected excess return on portfolio i is:

(2) $$E(R_i) - R_f = b_i\left[E(R_m) - R_f\right] + s_i E(SMB) + h_i E(HML)$$

where: $E(R_i) - R_f$ = expected market return premium

E(SMB) = expected size premium

E(HML) = expected premium on high book-to-market stocks

b_i = factor loading market return premium

s_i = factor loading on size premium

h_i = factor loading on high book-to-market stocks

4.3. Carhart four-factor model

In 1997, Carhart studied the performance of mutual fund managers and found that their performance does not represent superior stock-picking skills, but rather it is based on few common factors that current stock pricing models do not take into account. Based on the findings, the Carhart four-factor model was developed to better capture the risk-adjusted returns. In addition to Fama and French's three-factor, Carhart (1997) suggests adding the momentum spread as a fourth risk factor. The fourth factor is called winners-minus-losers (WML) and captures the risk-related to momentum anomaly.

The expected excess return on portfolio i is:

(3) $$E(R_i) - R_f = b_i\left[E(R_m) - R_f\right] + s_i E(SMB) + h_i E(HML) + m_i E(WML)$$

where: $E(R_i) - R_f$ = expected market return premium

E(SMB) = expected size premium

E(HML) = expected premium on high book-to-market stocks

E(WML) = expected premium on momentum stocks

b_i = factor loading market return premium

s_i = factor loading on size premium

h_i = factor loading on high book-to-market stocks

m_i = factor loading on momentum stocks

4.4. Fama and French five-factor model

In a more recent paper, Fama and French (2015) proposed a five-factor model. It better captures higher excess returns related to anomalies when adjusting for risk compared to previous models. It adds two factors, profitability (RMW) and investment (CMA), to their previous three-factor model. Profitability is the difference of returns between high and low profitability companies and investment is the difference between low and high investment firms. CMA is described as conservative minus aggressive and RMW is described robust minus weak. They find that "positive exposures to RMW and CMA capture the high average returns associated with low market β, share repurchases, and low stock return volatility". (Fama & French 2015, 2016)

The expected excess return on portfolio i is:

(4) $E(R_i) - R_f = b_i\left[E(R_m) - R_f\right] + s_i E(SMB) + h_i E(HML) + r_i E(RMW) + c_i E(CFA)$

where: $E(R_i) - R_f$ = expected market return premium

E(SMB) = expected size premium

E(HML) = expected premium on high book-to-market stocks

b_i = factor loading market return premium

s_i = factor loading on size premium

h_i = factor loading on high book-to-market stocks

r_i = factor loading on high profitability stocks

c_i = factor loading on low investment stocks

4.5. Dividend discount model

Dividend discount model (DDM) is a stock valuation model created to uncover the stocks' intrinsic value. The model is based on the company's future dividends. The intrinsic value of the share is its dividend's present value into perpetuity. The idea was first presented by John Burr Williams in 1938. It is important to notice that the variables used to calculate intrinsic value are estimated dividends. If we predict the forecast of the growth in dividends wrong it has a major impact to the result, because majority of the intrinsic value is driven by future dividends. The formula for dividend discount model or DDM goes as follows: (Bodie et al. 2011b: 767-768; Berk et al. 2015: 226-237.)

(5) $$P_0 = \frac{D_1}{1+k} + \frac{D_2}{(1+k)^2} + \cdots + \frac{D_t}{(1+k)^t}$$

where: P_0 = current share price

D_t = dividend at time t

k = required rate of return

The model presented above is not very practical because it treats all future dividends as separate. Based on the previous model, a constant-growth DDM, or the Gordon model, named after Myron J. Gordon, was developed. Constant-growth DDM simplifies the valuation process because we do not need dividend forecast for every year into the indefinite future. Instead, an estimate for the dividend growth is used. The formula for constant-growth DDM presents as follows (Bodie et al. 2011b: 768-771; Gordon & Shapiro 1956):

(6) $$P_0 = \frac{D_1}{k-g}$$

where g = estimated growth rate of dividends

From the formula, it can be seen that the growth rate of dividends (g) must be smaller than the required rate of return (k), otherwise the current value of the share would be infinite. The stock's valuation will be higher the higher the growth rate (g) is, the lower the required rate of return (k) is and the higher the first year's dividend is. (Bodie et al. 2011b: 768-771; Gordon & Shapiro 1956.) It can be viewed from the formula that getting the expected growth rate wrong has substantial impacts to the valuation. DDM and Gordon model assume no

differences on expected return due to P/B ratio, past price movements or firm profitability.

4.6. Free cash flow model

An alternative approach to dividend-based models is using the firm's free cash flow to determine its intrinsic value. This approach is valuable when estimating the value of a firm that does not pay dividends, for which using DDM is not possible. With this model, the firm's valuation is based on the current value of the firm's free cash into perpetuity. (Bodie et al. 2011b: 789-792.) The free cash flow is discounted using weighted average cost of capital (WACC). The formula for WACC is presented below in equation 6. (Allen et al. 2014: 221)

(7) $$FCF = EBIT(1 - t_c) + Depreciation - Capital\ expenditures - Increases\ in\ NWC$$

where FCF = free cash flow

EBIT = earnings before interest and taxes

t_c = the corporate tax rate

NWC = net working capital

(8) $$WACC = r_D(1 - t_c)\frac{D}{D+E} + r_E\frac{E}{D+E}$$

where r_D = cost of debt

r_E = cost of equity

D = market value of debt

E = market value of equity

After calculating free cash flows and WACC, we may evaluate the present value of a company. Formula 7 shows how one may calculate a stock's present value using year by year forecasts. In formula 8 it is shown how it is possible to calculate the present value using estimated growth rate for free cash flow. This eases the valuation process for analysts and investors. (Bodie et al. 2011b: 789-792; Allen et al. 2014: 486-487.)

(9) $$P_0 = \frac{FCF_1}{1+WACC} + \frac{FCF_2}{(1+WACC)^2} + \cdots + \frac{FCF_t}{(1+WACC)^t}$$

(10) $$P_0 = \frac{FCF_1}{(WACC-g)^t}$$

where P_0 = present value of the company

FCF_t = free cash at time t

WACC = weighted average cost of capital

g = growth rate of the cash flows

It is worthy to acknowledge that even minor changes in assumptions change the value considerably. Therefore, it is vital not to become mesmerized by numbers and just complete the valuation just mechanically, while also addressing a

strategic view. (Allen et al. 2014: 486-487.) It is possible that investors make errors in valuing companies because they estimate future earnings and growth rates wrong. DCF-model is probably the most used valuation model with investors, analysts and fund managers. It is noteworthy that it does not consider whether a company has a low book ratio or if it has been gaining in share price recently, but rather assumes that investors are able to estimate future cash flows accurately and account for risk via WACC.

5. PORTFOLIO PERFORMANCE MEASURES

In this chapter, the most well-known portfolio performance measures are discussed. These measures are widely used in and/or academic research as in the field of portfolio management.

5.1. Sharpe ratio

In 1966, William Sharpe created a measure to compare the performance of different investment portfolios and revised the measure in 1994. Today, it is widely used in academic studies as well as in practice. For example, most of the mutual funds report their Sharpe ratios as indicators of past performance. As performance Sharpe ratio uses excess return and divides it with standard deviation to adjust for risk. The formula goes as follows (Sharpe 1966, 1994):

$$(11) \qquad S_\alpha = \frac{E(R_\alpha) - R_f}{\sigma_\alpha}$$

Where: S_α = Sharpe ratio

$E(R_\alpha) - R_f$ = excess return over risk-free rate

σ_α = standard deviation of the excess return

5.2. Sortino ratio

Sharpe ratio has been criticized because it penalizes assets for high returns due to the fact that rising asset prices increase standard deviation. From this stand point Sortino developed a measure in 1994 that would account only for the

downside risk. This measure is called the Sortino ratio whose formula is presented below (Sortino 1994):

$$(12) \qquad S = \frac{E(R_\alpha) - R_f}{\sigma_n}$$

Where: S = Sortino ratio

$E(R_\alpha) - R_f$ = excess return over risk-free rate

σ_n = standard deviation of the negative returns

5.3. Jensen´s alpha

In 1968, Michael Jensen developed a model to measure portfolio performance. The model is based on the CAPM-model and it expects riskier assets to earn higher returns than low risk assets. The risk is measured by beta as in the CAPM-model. The formula for Jensen´s alpha is as follows (Jensen 1968):

$$(13) \qquad \alpha = R_i - [R_f + \beta_i * (R_m - R_f)]$$

Where: α = Jensen´s alpha

R_i = return of portfolio i

β_i = beta of portfolio i

R_m = return of market portfolio

R_f = risk-free return

If the portfolio is able to create alpha it creates excess returns that are not captured by CAPM. This may be due to CAPM ineptitude or actual excess returns generated by portfolio manager.

6. ANOMALIES

Based on the theory of efficient markets, it should not be possible to earn higher returns by using publicly available data, such as book-to-market ratio, market capitalization or past prices. Yet smaller firms have had higher returns than bigger firms and higher book-to-market companies have exceeded the returns of low book-to-market firms and previous share price development has had positive correlation to future returns. These excess returns cannot be explained by CAPM which is the most commonly used model in measuring risk-reward ratio. Therefore, these phenomena are called anomalies. (Bodie et al. 2011a, 360.)

There are several explanations for size, momentum and value anomalies, the most common ones being risk-based explanations that argue small value stocks being riskier than larger growth stocks, and mispricing arguments that concentrate on the irrational acts of investors, and behavioral finance. There is not a clear consensus on whether size, momentum and value premiums are based merely on greater risk or irrational acts of investors, such as anchoring, herd behaviour and overconfidence. (Bodie et al. 2011a, 360-361.)

One explanation for anomalies is mispricing. This would mean that the market systematically misprices stocks according to the book-to-market ratio. Another possible explanation is that high book-to-market companies carry more risk than low book-to-market firms and therefore have higher returns. (Bodie et al. 2011a, 361.) The size, value and momentum anomalies as well as previous studies in value and momentum combinations are presented hereafter.

6.1. Firm size anomaly

Banz (1981) discovered that small firms have higher risk-adjusted returns than large firms. This phenomenon is widely known as the size effect or small firm effect. In his study, Banz (1981) used NYSE common stocks that were listed for at least five years between 1926 and 1975. After forming different portfolios and comparing their risk-adjusted returns, he found out that there was a significant negative relationship between a firm's market value and average return. The stocks of the firms with smaller market values had greater returns than the stocks of the larger companies with equal betas. This is evidence for the misspecification of the capital asset pricing model because the size effect has existed for at least four decades. In 1983, Basu discovered similar findings and also came to the conclusion that CAPM is misspecified.

Fama & French (1992) also discovered that small firms have higher returns that CAPM could not explain. They came to the conclusion that size is proxy for risk, which CAPM could not explain. Therefore Fama & French created the three-factor model where size is one of the factors that proxy for risk. They did not see size anomaly as a result of mispricing. Berk (1995) argues that size is not an anomaly at all. He detects that firm size only measures risk and does not have the characteristics of an anomaly.

In line with the distress explanation, Chan and Chen (1991) present that small firms are riskier investments, because they are so called marginal firms. Marginal firms are companies that have become small because of their weak past performance and are likely to experience cash flow problems and high financial leverage. They suggest that smaller firms are less efficiently run and are also less efficient in their production. These factors may also result in worse accessibility to external finance.

More recently there has been research claiming that size effect has diminished or even vanished. There is empirical evidence that the size effect has disappeared in the early 80s in the U.S. (Hirshleifer 2001, Amihud 2002). Contrarily, van Dijk (2011) argues that size is not dead even though there have been studies claiming so in the past years. He found that size effect has been large and positive during the last years in the U.S. stock markets. Additionally, he points out that further empirical research is needed in both U.S. and international market settings.

In this study, the smallest companies are excluded from the sample in order to avoid creating a bias towards size anomaly. There are a lot of very small stocks in the Nordic stock markets, some even below 10 million euros in market capitalization. The procedure to eliminate size bias is discussed in chapter 7.

6.2. Value anomaly

The basic idea behind value investing has been around for decades. Its roots go as far as the 1930s when Benjamin Graham and David Dodd introduced the strategy to the wider audience. Value investors aim to buy cheap companies that are priced for one reason or another below their intrinsic value. Graham and Dodd suggest that investors in general overestimate the growth rates of growth companies leading to overpricing them and underpricing value companies. (Graham & Dodd, 1934).

Book-to-market anomaly has attracted investors and academics ever since it was first discovered by Stattman (1980) who found out that stocks with higher book value to market price outperform stocks with low book value to market price ratio. Similar findings were made in 1985 by Rosenberg, Reid and Lanstein. Rosenberg et al. (1985) suggest that because there is such inefficiency at the market there are still larger potential profits to be achieved.

Value premium is particularly interesting because common sense dictates that growth options are riskier than assets already in place. Contrary to the conventional wisdom, Zhang (2005) points out that growth options are actually less risky than assets in place, especially during economic turmoil the price risk is high for the assets in place. Firm value can be easily melted by unproductive capital and cutting capital is more expensive than expanding it. He sees the value premium as "a proxy for a state variable associated with relative financial distress".

Contrarily to Zhang (2005), Griffin and Lemmon (2002) find that distress risk does not explain value anomaly. They discovered that among the firms with the highest risk of distress high book-to-market companies had twice as large returns compared to low book-to-market companies. This large difference cannot be explained by the three-factor model. Same results were detected by using both O-score and Z-score as proxies for distress risk. The most striking finding is the extremely low stock returns of the low book-to-market firms in the highest O-score group. This group's size-adjusted return is 6,36 on average, which is even slightly lower than the risk-free rate of return over the sample period. The research was done with U.S. data from 1965 to 1996.

In a more recent paper, Avramov et al. (2012) found that most of the profits from value strategies derive from stocks that carry high credit risk but bypass the distressed situation. The study was done with all U.S. listed firms from 1985 to 2008. They also found that many other anomalies can be explained by distress risk, accruals anomaly being an exception.

The most well-known research examining the book-to-market anomaly is Fama and French's (1992) report "The Cross-Section of Expected Stock Returns". In their study, Fama & French propose that two easily measured variables, book-to-

market and size, provide a powerful and simple explanation of the cross-section of average stock returns for the 1963-1990 period. Because of the higher returns on high book-to-market and small companies, Fama & French suggest that book-to-market and size are proxies for risk. However, they admit that overreaction could be a possible explanation for the value premium. They assert that their findings have practical implications for portfolio formation and performance evaluation for long-term investors. Fama & French carried out their initial study with U.S. data, but the value premium exists also internationally. (Fama & French 1998.)

Again, Fama & French (1992) grant the possibility that value premium is just regression towards mean. This would mean that markets are irrational about pricing the prospects of companies. The fact that value stocks have outperformed growth stocks could arise from the fact that investors and analysts overestimate the growth potential and are overly cautious about the prospects of value companies. If this is the case, book-to-market anomaly is not based purely on higher risk but rather on mispricing.

Lakonishok, Shleifer and Vishny (1994) argue that value stocks outperform growth stocks because investors consistently overestimate the growth rate of "glamour stocks". They state that value stocks have been under-priced relative to their risk and therefore investing in such stocks have earned excess returns. Despite the fact that value strategies have outperformed growth strategies investors tend to favor glamorous growth strategies. This springs from a variety of reasons. Firstly, investors extrapolate past growth rates of glamour stocks like Amazon, even though such high growth rates are highly unlikely to persist in the future. Conversely, investors are excessively pessimistic about the future performance of the firms that have performed poorly in the past.

Secondly, investors like to invest in good and well-run companies regardless of the price. This might lead to investors equating well-run firms with good investments. They also claim that institutional investors prefer investing in glamour stocks because they appear as "prudent" investments and are therefore easy to justify to sponsors. Lakonishok et al. (1994) also claim that many investors have shorter time horizons than what is required for value strategies, which is another reason for preferring glamour strategies over value stocks.

There are also studies on profitability increasing value performance which makes it even harder to explain the anomaly with risk-based explanations. In 2013, Novy-Marx discovered that gross profitability improves value portfolios' performance and that value is not driven by unprofitable stocks. He also discovered that value and profitability anomalies are negatively correlated. The study was done with U.S. data from 1963 to 2010.

Although the majority of the studies have been conducted with U.S. stock market data, there is also clear evidence supporting the value anomaly in Nordic stock markets, yet most of the studies have been done with individual stock market rather than combination of the markets. Leivo and Pätäri (2009) find that value anomaly persists in the Finnish stock market. Davydov, Tikkanen and Äijö (2016) find similar results.

Cakici and Tan (2014) find significant HML factors in Denmark, Finland, Norway and Sweden for small capitalization stocks, although only Denmark and Finland persisted when only the large stocks are included in the sample. Kim (2012) found significant value premiums in 18 out of 23 developed countries as well as in 10 out of 13 emerging countries. The time period was from 1990 to 2010 and earnings to price (E/P) was used as the value metric. Out of the Nordic countries only Norway had significant value premium. The poor results from the Nordic

markets may be at least partially explained by value-weighting the returns. In the Nordic markets, there have been cases where one stock has had a massive portion of the market capitalization of the total stock market, e.g. Nokia which was more than half of the Finnish stock market during the tech bubble. This issue is discussed in chapter 7.

Yet the reason behind the anomaly is still unclear as others support behavioral explanations and others risk-based ones. This paper does not try to explain the reasons behind the anomaly but to study whether it is possible to improve the risk adjusted returns of the value portfolios by combining it with momentum metrics.

6.3. Momentum anomaly

The basic idea of momentum is to benefit from the stocks that are experiencing a positive trend, i.e. momentum. This trend is based on historical share prices and the strategy is often referred to as buying winners and selling losers. Based on the weak forms of efficiency, past prices should not indicate the future movements of the stock prices, even though it is a well-recorded phenomena that past winners tend to beat the past losers. This phenomenon is called momentum anomaly. The anomaly is well documented and studied and has been proven to earn excess returns in many markets. It has existed even to date and have persisted even after they have been discovered and researched many times over. (Bodie 2011b, 386)

In 1993, Jegadeesh and Titman showed the momentum anomaly in the U.S. stock market between 1965 and 1989, and it is one of the most well-known momentum anomaly studies. They studied the performance of selling past losers and buying past winners and uncovered significant positive returns for 3 to 12 months holding periods. Their evidence claims that the performance of the momentum

strategies is not due to their systemic risk. Short-term positive momentum followed by long-term negative returns on winners suggest that common explanations of return reversals as evidence of overreaction and return persistence as evidence of underreaction are most likely oversimplified.

Jegadeesh and Titman (2001) revisited their study later and discovered that momentum anomaly has existed also after their initial time period and pointed out that the results were not a product of data mining. They also evaluated alternative explanations for the performance of momentum strategies and found evidence supporting behavioural explanations, although they note that this evidence "should be tempered with caution."

There are also studies that link the higher returns achieved with momentum strategies to higher risk. Avramov et al. (2007) uncovered a robust link between credit ratings and momentum returns. They provide evidence that momentum strategies are profitable and significant only among low-grade firms and non-existent among high-grade ones.

Pastor & Stambaugh (2003) discovered that illiquid stocks exceed liquid stocks returns by 7.5 percent annually even after adjusting for momentum, value and size. They also found that half of the momentum returns are related to liquidity risk factor during their 34-year period from 1966 to 1999.

Similarly, Sadka (2006) finds positive correlation between "variable (informational) component of liquidity risk when studying individual U.S. stocks". Momentum portfolios generally outperform during positive liquidity shocks and consequently underperform during negative ones. Sadka suggests that "this supports the hypothesis that the empirically observed premia for bearing liquidity risk or information-asymmetry risk is associated with investors' preferences with respect to risk in different states of the world".

Brunnermeier & Pedersen (2009) separate market liquidity from funding liquidity. They document that "under certain conditions, margins are destabilizing and market liquidity and funding liquidity are mutually reinforcing, leading to liquidity spirals". This implies that traders can be drivers of risk premiums and market liquidity.

Momentum crashes are perhaps one reason investors may feel uncomfortable investing with momentum strategy. There are several periods where momentum strategies have generated very high losses during a short time period. Barroso & Santa-Clara (2015) note that momentum has had the worst crashes out of the most common factors (size, value and momentum) and this may cause investors who dislike kurtosis and negative skewness to avoid investing with momentum strategy. Additionally, they claim that momentum crashes can be predicted with a risk management model that doubles the Sharpe compared to regular momentum.

Similarly, results were found by Daniel & Moskowitz (2016), who researched momentum crashes also with international equity markets in addition to Barroso & Santa-Clara´s (2015) paper. They state that momentum crashes "occur in panic states, following market declines and when market volatility is high, and are contemporaneous with market rebounds." Also, they find that momentum crashes can be hedged increasing Sharpe ratios and alphas significantly. This thesis does not account for any risk-managed momentum strategies but rather focuses on the most common momentum and value strategies and their combinations.

Momentum life cycle (MLC) was introduced in 2000 by Lee and Swaminathan. They suggest that stocks experience different "cycles" during their lifetime as

investors "favour and neglect" them from time to time. They find that trading volume backs the hypothesis. The MLC is presented in Figure 4.

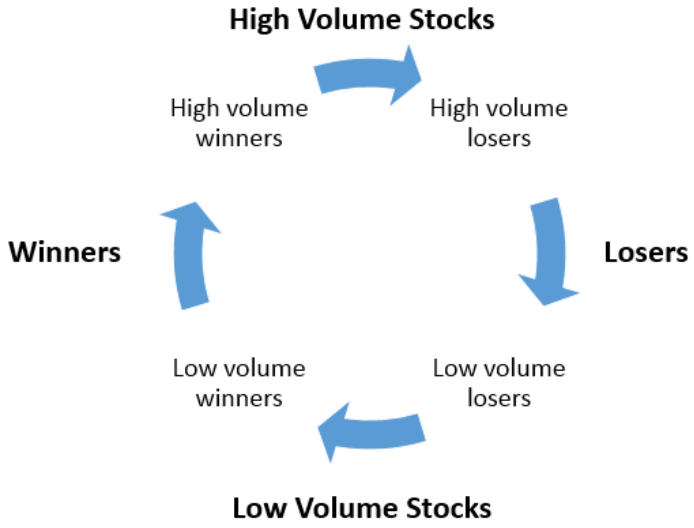

Figure 4. Momentum life cycle (Lee & Swaminathan, 2000)

In momentum anomaly, the most commonly used portfolio creation measure is 12 months' return excluding the last month. There are also studies that show momentum working with different time horizons such as one-month and three-month momentum. (Jegadeesh & Titman 1993, Chan 2003, Blitz & Viet 2009). The anomaly has been present in many markets although majority of the studies have focused on U.S. equity markets, although there has been a wide range of studies on different regions. (Rouvenhorst 1997, 1999, Asness et al. 2013). This paper studies the 12-1 month momentum strategy, hence it is the most widely used in the Nordic equity markets.

Although the majority of the studies have been done in the U.S. stock market setting, there is previous research proving the existence of momentum also in the Nordic stock markets. Cakici et al. (2014) found a significant WML factor in all

Nordic markets except for Sweden, although in Sweden there was a significant HML factor with the small capitalization stocks. The study was conducted from 1991 to 2012.

Yet the reason behind the anomaly is still unclear as others support behavioral explanations and others risk-based ones. This thesis does not try to explain the reasons behind the anomaly but to study whether it is possible to improve the risk adjusted returns of the momentum portfolios by combining it with value metrics.

6.4. Previous studies in value and momentum combination

Already in 1997, Asness discovered negative correlation between value and momentum. Value was strongest among loser stocks that had experienced low momentum, and momentum was strongest in expensive growth stocks that were low in value. Similar findings were uncovered by Daniel and Titman (1999). Negative correlation among two high-yielding anomalies possibly offers an exceptional opportunity to earn high returns with a very stable portfolio with little volatility.

Perhaps the most well-known study when it comes to combining value and momentum is Asness et al. (2013) where they studied the correlation and performance of value and momentum anomalies as well as the performance of combo strategy across eight asset classes and markets. They found significant negative correlation between value and momentum, value and momentum earning excess returns in all the markets and asset classes except momentum in Japan, and especially improved performance of the combined portfolio. They note that the negative performance of the momentum in Japan should not be viewed in solitude but in the context of value and momentum combination. In

the selected time period, value performed exceptionally well in Japan. The study used extensive time series from 70s to the 2010s.

In 2013, Cakici et al. studied the size, value and momentum in 18 emerging markets and found strong evidence for value in all the markets and for momentum in all the markets excluding Eastern Europe. They also find that value and momentum are negatively correlated which is in line with previous studies. Their time period started from January 1990 and ended in December 2011 covering regions from Asia, Latin America and Eastern Europe.

Fisher et al. (2016) studied the portfolio implementation of momentum and value anomalies. They studied long-only portfolios in U.S. stock market from 1975 to 2013 and used several approaches to combine the anomalies to long-only portfolios. All of the approaches increased Sharpe ratios in comparison to the market both in small and large stocks. Accounting for transaction costs supported portfolios which had greater exposure to value than momentum due to the slower moving signal and therefore lower turnover. More sophisticated combination portfolios outperformed simple 50/50 combination.

Few of the previous studies have focused on the Nordic stock markets. Leivo (2012) found that enhancing value with momentum improves most of the traditional value-only portfolios. However, Leivo found that including momentum metric into the portfolios increases the asymmetry of return distribution in an undesirable manner for investors. The study was done with Finnish stock market data from 1993 to 2009.

In 2004, Bird & Whitaker studied value and momentum anomalies in the major European markets. They discovered that value anomaly can be significantly improved with a combination of momentum strategy and that adding dispersion to the strategy improves the returns even further, implying that these stocks may

be at a turnaround point as some of the analyst have discounted it to the estimates while others have not. They also flagged the very poor performance of growth and loser stocks. They reason that the findings affirm that many stocks go through a cycle similarly as Lee & Swaminathan (2000) suggest. The time period was from 1990 to 2002 and the study covered German, French, Italian, Dutch, Spanish, Swiss and British stock markets.

Further in 2007, Bird & Casavecchia studied whether value strategies could be enhanced using momentum indicators to time the stock purchases. The study was done from 1989 to 2004 with European data but now also smaller countries such as Nordic countries were involved, increasing the total number of countries to 15. They discovered that value strategies could be enhanced and suggested that "due to the difficult nature of forecasting the turnaround of a stock it might be just best to react to the sentiment swings." They also added that analysts are more reactive than predictive in their forecasts.

7. DATA AND METHODOLOGY

In this section, the data and methodologies used in this study are examined. The purpose of this chapter is to explain the selected data and methodologies, possible caveats and why the data and methodologies have been used.

7.1. Data

The data is compiled with OMXH, OMXSPI, OSEBX and OMXC main listed companies' historical returns and financials from January 1991 to December 2017. E.g. all stocks that are traded in First North or in other non-main list market places are excluded from the sample. Icelandic stock exchange is excluded due to the very low amount of stocks, trading volume and especially the size of those companies. This presents the vast majority of the Nordic stock markets but all of the stocks cannot be described very liquid, hence many of the stocks are very small. The period that portfolios are held starts from January 1993 and ends at December 2017. This 25-year period presents the vast majority of the time horizon when Nordic stock markets have been large and active enough for large overseas investors.

If a stock is delisted it will be sold at the closing price of its last trading day. If a stock has gone bankrupt the return on it will be minus 100 percent. The dividends are reinvested to the same stock, eliminating biases arriving from different dividend yields between stocks. The total number of stocks in the sample is high, over 2000, due to the fact that all of the stocks that have been traded in the period are included. This procedure eliminates the survivor bias which would tilt the results to be a lot more favorable, especially in a smaller market setting.

This unique set of stocks from several countries collected into one basket offers a liquid set of securities that can actually be traded. Using Nordic data offers valuable contribution to existing academic research. Returns are measured in euros and stock returns and market caps from Swedish, Danish and Norwegian companies are converted to euros using month-end exchange rates that are derived from Bloomberg. This approach gives actual returns that investor would have been able to generate, although some of the returns may be driven by currency rate changes. Yet, Swedish and Norwegian crowns have been relatively stable, and the Danish crown is even tied to euro. This is visible in the Figure 5 below.

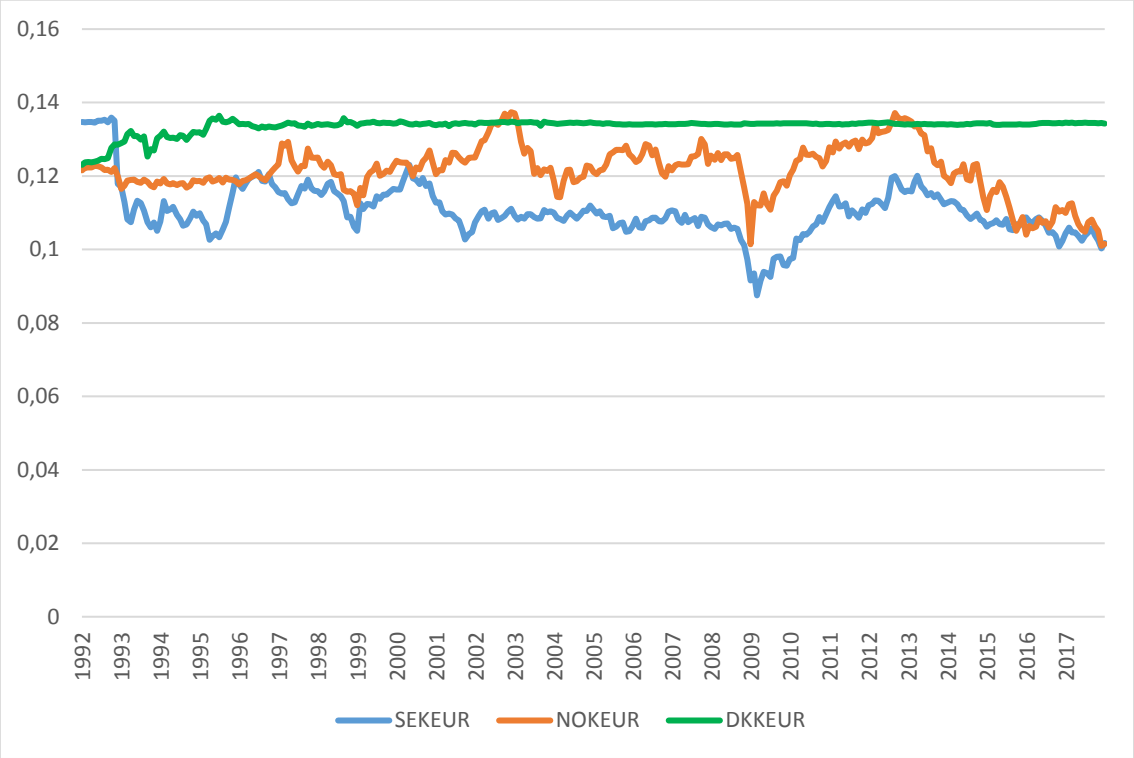

Figure 5. Development of foreign exchange rates

Financial companies and stocks that are not primary listed in the Nordic exchanges are excluded from the sample, for example if they have primary listing in London but have dual listing in Oslo. Table 1 presents descriptive statistics of the sample. The lowest number of companies in the sample was 543 and highest 1052. On average, there were 844 stocks in the sample. The large variance in the number of companies is explained by the low number of stocks in the early 1990s and the rapid development of Nordic stock markets. Sweden is the largest market as it accounts for almost half of the average number of companies as well as the total market values. Hence Sweden´s part of the results is very significant. The total number of stocks and total value are slightly lower after excluding financial companies from the sample.

Table 1. Descriptive statistics of companies in the sample

	Denmark	Finland	Norway	Sweden	Total
Max number of stocks	214	150	236	493	1052
Min number of stocks	133	100	95	164	543
Number of stocks of average	178	126	181	359	844
Average market value in total M€	140 000	137 000	116 000	307 000	700 000

The value portfolios are based on their P/B ratios and the momentum portfolios are based on their past 52 weeks' total shareholder return excluding the last month. Using total shareholder return instead of simple share price performance avoids unnecessary trading created from large dividend payments creating false signals as share price should drop the amount of dividend paid. This should not have a major impact on the momentum signals but it will avoid repelling stocks with high dividend yields.

As a risk-free rate 6-month interbank offered rate is used. As a risk-free rate an average of 6-month Euribor, Stibor, Nibor and Cibor is used. For the periods prior Euribor 6-month Helibor is used as a risk-free rate of the Finnish market. This method gives the best proxy for a risk-free rate to investor who invest into the Nordic stock market. Especially in the early 90s, the markets had higher interest rates and therefore higher risk profiles than e.g. U.S. market. Due to this, the country average of 6-month interbank offered rate is preferred to U.S. T-Bill that has been used in some country basket studies in previous academic research. Additionally, a 6-month rate is used instead of a 3-month rate in order to avoid months with negative risk-free rates. Using the 6-month rate gives also a slightly higher average risk-free rate than using the 3-month rate.

In Figure 6, it is visible that the Nordic IBOR-rates have been higher compared to the U.S. T-Bill, with the exception of the most recent years and the years coming to the financial crisis. It is also noteworthy that the Nordic rates are highly positively correlated with the exception of Norway which has its own special circumstances due to the impact of oil price, although it does not differ from the other rates significantly. From these IBOR-rates, an average is formed which is used as a risk-free rate in this study.

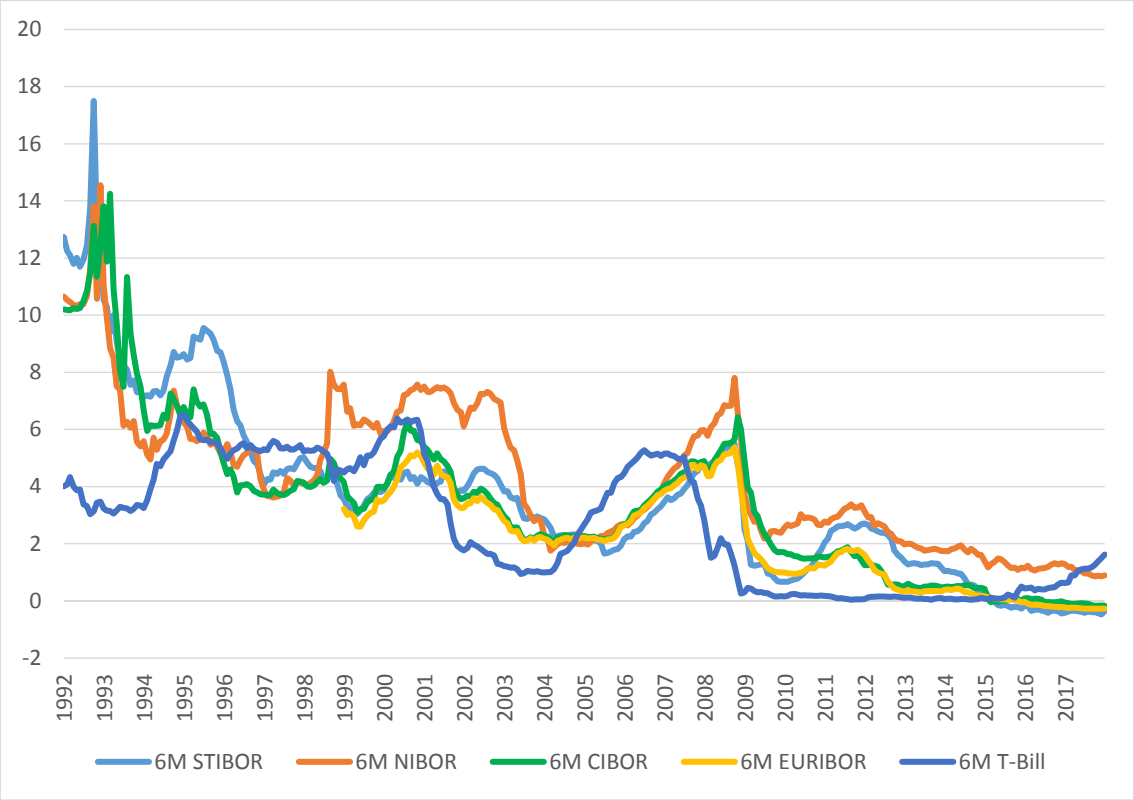

Figure 6. Nordic IBOR-rate and U.S. T-Bill development

Price-to-book ratios are calculated as the latest share price divided by the last year's actual reported book value per share. The book values are considered to be from last year on the first of July in order to avoid ahead look bias. Share price data, risk-free rates, stock index returns, foreign exchange rates, market caps and price-to-book ratios are derived from Bloomberg database.

The investment horizon is from 1993 to 2017, lasting 25 years. This time period includes several market cycles and sentiments offering a comprehensive dataset for research. During the period, the Nordic stock markets have evolved and grown in size as well as experienced turmoil from the tech bubble in the turn of the century to the financial crisis in the late 2000s, as well as countries having endured their own banking crises.

In the final data sample from which the combination portfolios are created the portfolios hold only the top third of the largest stocks by market capitalization. This leads to a dataset where the smallest stock in the sample is 65 M€ in market capitalization and on average all companies are above 175 M€ in market capitalization. This leads to a liquid set of securities, although there may be some short sales constraints in medium-sized stocks. This matter is being discussed throughout this and next chapter where results are presented.

7.2. Methodology

When creating portfolios, the aforementioned parameters are used in creating the value and momentum portfolios. Top and bottom thirds are used as limits for value and growth as well as winners and losers -portfolios. The portfolios are then adjusted monthly to hold the winners and losers at all times. The same procedure is applied to value portfolios as well, although in many previous studies these portfolios are not adjusted as often. This procedure is used in order to have better comparability between all the portfolios when moving into creating combination portfolios and comparing them with each other, as well as with the pure play value and momentum portfolios.

In a similar manner to risk-free rates, a combined market index is created using all-share indexes from OMX Helsinki, Stockholm, Oslo and Copenhagen. The returns are total shareholder returns where dividends have been reinvested in a similar manner as in portfolios created in this study. The returns of individual country indexes are additionally value-weighted to avoid bias from having a too high portion of the returns from smaller countries. It is important to note that the index will have returns also from the smaller stocks, hence creating larger returns compared to an index compiled from only the largest stocks in the market. This

conservative method creates a larger hurdle to surpass for the portfolios created in this study.

Portfolio performance is measured with Sharpe ratio and Sortino ratio. Also, absolute returns are presented and compared as well as risk-adjusted returns measured by Capital Asset Pricing Model. The performance of the formed value and momentum combination portfolios are compared to the combined index as well as simple separate value and momentum portfolios form the same time period.

In addition to pure play value and momentum portfolios, several types of value and momentum combination portfolios are created:

(1) 50/50: half of the portfolio on momentum and other half on value strategy
(2) Double screening: stocks that indicate both value and momentum signals (in the top 50% in both for long and bottom 50% for both for short)
(3) Ranking scheme: rank stocks based on value and momentum and take the average of the scores (long for top third and short for lowest third)

Every portfolio will be constructed with long-only and long-short approach, so the number of portfolios will be treble to the strategies presented above plus the pure-play value and momentum portfolios. Long-only is studied conservatively due to the fact that some of the stocks are relatively small in size and can have some restrictions to short selling.

In order to account for size bias, portfolios are also created with stocks that are in the top third of the sample measured by market capitalization in euros. The large cap tiers are also adjusted monthly so if a stock has been in the portfolio but the share price declines, it may be sold if the drop-in share price causes the stock to fall below the top third in market capitalization. This procedure offers an even

more liquid set of securities reducing short-sales constraints and transaction costs compared to small cap stocks. Additionally, returns are then value-weighted creating an extremely liquid set of returns and leaving very little room for short sales constraints, high trading costs or non-viable trades. Value-weighting supports additionally momentum and diminishes value. Value-weighted returns are not presented due to very large stocks causing massive bias.

Instead, equal-weighted returns are presented due to the fact that in the Nordic stock markets there are not that many very large companies and their returns will dominate the value weighted returns. For example, in the early 2000s, Nokia´s market cap was more than 25% of the total market value of all stocks in the Nordic stock market. This creates several situations where one stock's weight is more than half of the portfolio, i.e. that the portfolio's performance would be almost solely driven by one stock. Hence the primary focus is in the equal-weighted returns because it provides the best picture of the returns that could have been actually achieved. Similarly, equal-weighted returns have been used in other Nordic stock market research (Äijö et al. 2016, Leivo et al. 2009, 2012).

When moving into comparing the best combination strategies, only larger stocks are included in the universe. In pure-play value and momentum portfolios also smaller stocks are included to show the effect that size has to value and momentum strategies. The conservative approach of using only the large stock is then applied when studying the best-in-class value and momentum combinations.

To adjust for possible autocorrelation and heteroscedasticity, Newey-west covariance estimator is used. The t-statistics are presented along with monthly returns and monthly alphas of the portfolios in the next chapter. Also Sharpe and Sortino ratios are presented, as well as portfolio betas and standard deviations.

8. RESULTS

Firstly, it is expected that value and momentum anomalies exist like they have in several studies before. Secondly, it is expected that the combination of the two strategies outperform value-only and momentum-only strategies. Yet it is unclear which of the strategies to combine the anomalies will produce the highest risk-adjusted returns. All of the portfolios are also expected to beat the market measured by combination of country indexes.

In this section results of the momentum, value and combination portfolios are represented. The pure-play value and momentum portfolios are represented in both, including all stocks and having only the top third of the largest stocks. The combination portfolios are presented only from the data that includes the top third largest stocks. This eliminates size bias and describes that there are significant differences in returns if small stocks are included compared to a more realistic situation where small stocks are not included in the sample.

Figures presented in this chapter describe portfolio returns over risk-free returns. Monthly returns in tables are raw returns, i.e. risk-free returns are not deducted from the returns. T-statistics are presented in parenthesis in the tables.

8.1. Pure-play momentum

Momentum anomaly offered significant excess returns in the Nordic stock market during the period. Although momentum performed well, the strategy suffered some crashes during the period, as has been identified by the previous research. (Barroso et al. 2015, Daniel et al. 2016) Part of the returns diminish after accounting for size but momentum remains to deliver significant excess returns even when using only the largest and most liquid stocks.

Excluding financial companies from the sample reduces returns slightly as well but has no significant effect to the results as momentum strategy offers excess returns with or without investing in financials. Financial companies are excluded from the sample due to the fact that then returns are more comparable to different value and value momentum combination strategies. Returns of momentum strategies including financial stocks are not presented in the paper but it is noteworthy that excluding them does not have a material effect on the returns.

Winners minus losers -portfolios offer highly significant results with high t-statistics in both all-stocks and large stocks. The results are significant at 5% level in all-stocks portfolio and have even higher significance levels at large-cap portfolio. The very high returns in all-stocks portfolios are somewhat diminished by extremely high standard deviations. Sharpe ratio even increases in large-stock portfolios compared to all-stocks, although it delivers lower alpha and Sortino ratio. This is due to the very high volatility of the all-stocks momentum portfolio. Hence Sortino ratio does not account for the upside risk so it does not increase moving into large-stocks only portfolio.

Table 2. Results of momentum strategy

All stocks equally weighted			
	Winners	Losers	Winners minus losers
Monthly return	2,47 % (3,56)	0,75 % (1,54)	1,72 % (2,93)
Monthly alpha	1,74 % (2,54)	-0,28 % (-1,11)	2,01 % (2,99)
STDEV	38,5 %	21,7 %	37,5 %
Sharpe ratio	0,77	0,27	0,61
Sortino ratio	12,42	1,67	8,89
Portfolio beta	0,63	0,88	-0,25

Top third equally weighted			
	Winners	Losers	Winners minus losers
Monthly return	1,95 % (4,61)	1,10 % (2,61)	0,86 % (3,57)
Monthly alpha	0,92 % (4,46)	-0,01 % (-0,06)	0,93 % (4,21)
STDEV	19,0 %	20,2 %	13,3 %
Sharpe ratio	1,16	0,51	0,81
Sortino ratio	7,34	3,02	4,72
Portfolio beta	0,89	0,95	-0,06

Momentum strategy is tilted towards growth as on average the P/B ratio of the winners-portfolio is 7,2 and for the losers-portfolio it is only 3,7 in the top third portfolio. In the all-stocks portfolio the difference is even larger as the winners-portfolio has over triple the P/B ratios of the losers-portfolio, although now the ratios are a lot lower, winners having 2,1 and losers having 0,7 on average.

8.2. Pure-play value

Value anomaly offered excess returns from the 1990s to 2017 in the Nordic stock market when small stocks were a part of the portfolio but after accounting for size the returns were significantly lower. In the whole sample value anomaly yielded impressive returns but it suffered long periods of low returns that can be one of the reasons why investors avoid value strategies. (Lakonishok et al. 1994) Value anomaly seems to be driven partially by small stocks as equally weighted returns of the whole sample offer significantly higher returns compared to the universe of stocks that are in the top third by market capitalization. Large value stocks experienced poor performance coming to the tech bubble but since that have delivered excess returns.

Value minus growth portfolios created significant excess returns in both all- and large-stocks portfolios. The Sharpe ratio declines significantly from 1,11 to 0,44 when only the largest stocks are included, indicating that small value stocks are driving the anomaly at least to some extent but are not the sole reason. Both results are statistically significant at 5 % level.

Table 3. Results of value strategy

All stocks equally weighted			
	Value	Growth	Value minus growth
Monthly return	2,05 % (4,30)	0,80 % (1,71)	1,25 % (4,12)
Monthly alpha	1,16 % (4,02)	-0,23 % (-0,99)	1,39 % (4,95)
STDEV	20,9 %	19,5 %	14,5 %
Sharpe ratio	1,12	0,33	1,11
Sortino ratio	9,17	1,85	9,87
Portfolio beta	0,76	0,88	-0,12

Top third equally weighted			
	Value	Growth	Value minus growth
Monthly return	1,50 % (3,69)	1,06 % (2,28)	0,44 % (1,50)
Monthly alpha	0,49% (2,05)	-0,08 % (-0,41)	0,58 % (2,08)
STDEV	18,5 %	20,3 %	12,2 %
Sharpe ratio	0,85	0,48	0,44
Sortino ratio	5,11	2,70	2,49
Portfolio beta	0,86	0,98	-0,12

8.3. 50/50 value and momentum portfolio

The value-growth and winners-losers portfolios of the top third largest companies are very highly negatively correlated. This is consistent with previous studies and offers clear diversification benefits between value and momentum. Negative correlation prevents large crashes in the portfolio that pure-play momentum experiences from time to time. Both are also negatively correlated to index, value providing larger negative correlation. Correlation matrix is presented in Table 4.

Table 4. Correlation matrix of value and momentum portfolios and index

	Value	*Growth*	*Winners*	*Losers*	*Value - growth*	*Winners - losers*	*Index*
Value	1,000						
Growth	0,807	1,000					
Winners	0,829	0,938	1,000				
Losers	0,927	0,846	0,771	1,000			
Value-growth	0,175	-0,441	-0,303	-0,002	1,000		
Winners - losers	-0,220	0,057	0,260	-0,415	**-0,430**	1,000	
Index	0,852	0,885	0,858	0,863	**-0,181**	**-0,083**	1,000

Using a very simple 50/50 allocation between the aforementioned value and momentum increases Sharpe ratios significantly as negative correlation between the strategies reduces standard deviation. The results are in line with previous studies (Assnes et. al 2013). In Figure 7, it visible how a simple 50/50 combination improves the portfolio as the development of the portfolio is an almost straight diagonal line to northeast while momentum experiences significant downturns and value suffers from long periods with extremely low or even negative returns.

The 50/50 combination clearly adds value as Sharpe and Sortino ratios improve significantly compared to pure-play strategies that are presented in Table 5. The

improvement of Sharpe ratios gives strong additional evidence that the combination of value and momentum creates pervasive and significant excess returns while reducing risk compared to individual value or momentum strategies. The weak returns of value strategy should not be looked in solitude but rather in combination with momentum. The weak value returns are more than compensated with high momentum returns. The results are similar to Assnes et al. (2013) in Japanese stock market though the roles between the hero and zero are reversed.

Table 5. Results of value, momentum and 50/50 portfolios

All stocks equally weighted			
	Value minus growth	Winners minus losers	50/50
Monthly return	1,25 % (4,12)	1,72 % (2,93)	1,48 % (4,79)
Monthly alpha	1,39 % (4,95)	2,01 % (2,99)	1,70 % (4,73)
STDEV	14,5 %	37,5 %	19,3 %
Sharpe ratio	1,11	0,61	1,00
Sortino ratio	9,87	8,89	23,82
Portfolio beta	-0,12	-0,25	-0,18

Top third equally weighted			
	Value minus growth	Winners minus losers	50/50
Monthly return	0,44 % (1,50)	0,86 % (3,57)	0,65 % (4,94)
Monthly alpha	0,58 % (2,08)	0,93 % (4,21)	0,75 % (4,78)
STDEV	12,2 %	13,3 %	6,8 %
Sharpe ratio	0,44	0,81	1,18
Sortino ratio	2,49	4,72	9,35
Portfolio beta	-0,12	-0,06	-0,09

The results of 50/50 portfolios are statistically significant at 1% level. The t-statistics are higher than in either value or momentum portfolios. Especially compared to value portfolio the t-statistics are well above. The very low standard deviation of 50/50 portfolio increases Sharpe ratios significantly even though the raw returns are below momentum portfolio´s returns.

For the period after tech bubble at the turn of the century the roles of the value and momentum performance have changed. Value reports higher returns than momentum due to the performance after the bubble burst. The 50/50 combo continues to increase Sharpe ratio. Once again the 50/50 portfolio is an almost straight diagonal line to northeast. The portfolio performances from the turn of the century are presented in Figure 8.

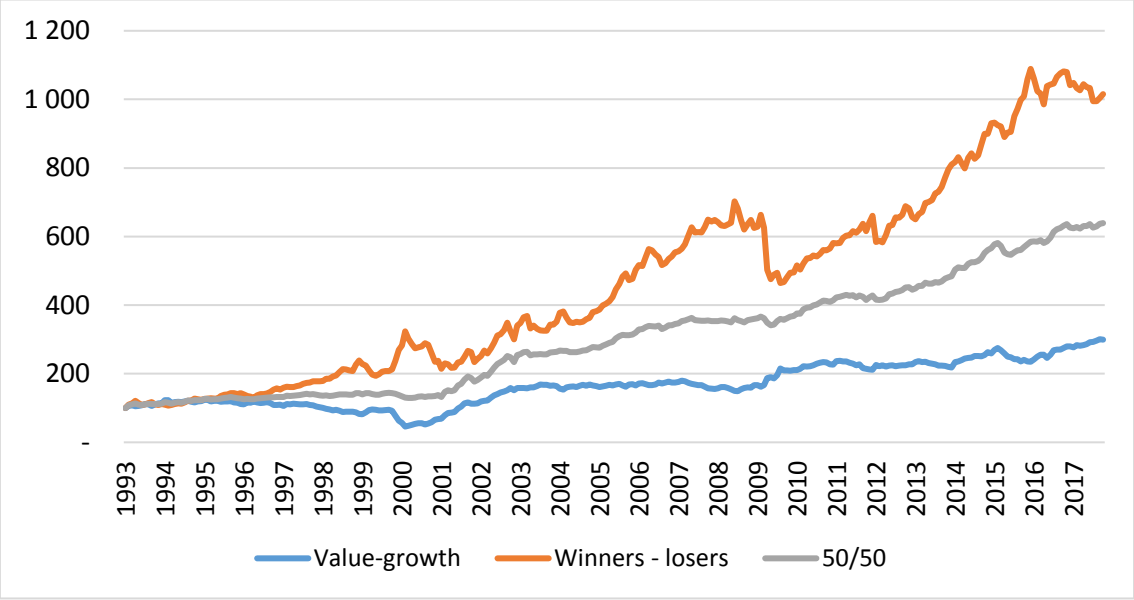

Figure 7. Value, momentum and 50/50 portfolios (top third equal weighted)

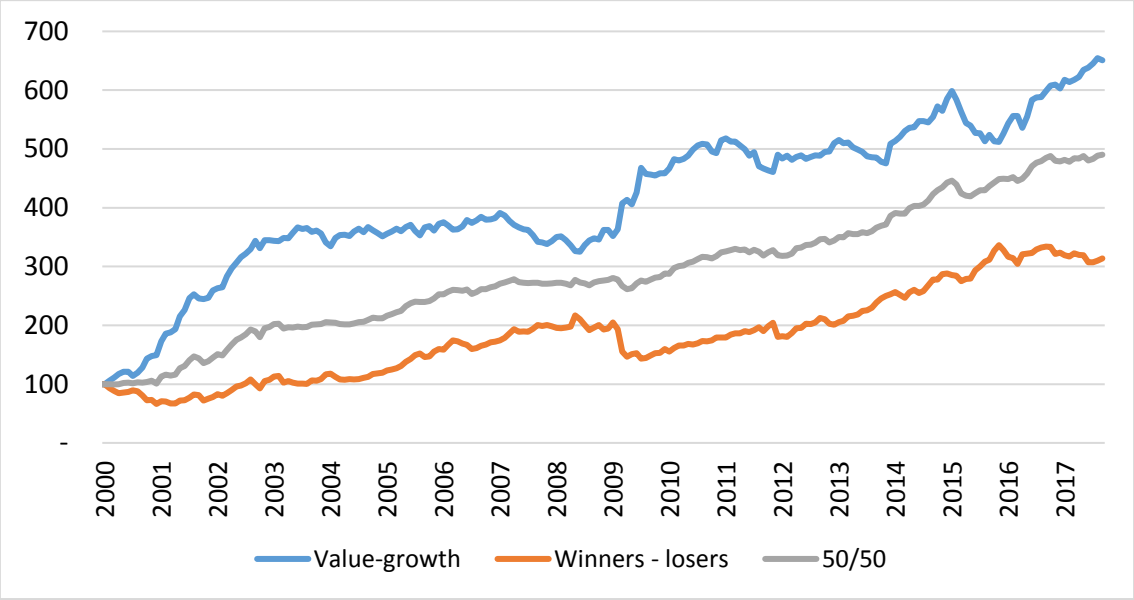

Figure 8. Value, momentum and 50/50 portfolios post tech bubble (top third equal weighted)

8.4. Double screening for value and momentum

Now only the top third of the market capitalization is used in order to exclude too small stocks that are not liquid enough or might have short sales constraints. Now the value and momentum limits are set to 50% in order to have enough stocks in the portfolios at all times as stocks must have both value and momentum signals to be included to the portfolio, i.e. stocks are sorted based on momentum and value in the whole sample, not firstly sorted based on value and then in momentum within the value stocks.

Lowering the limits somewhat increases the returns but additionally increases standard deviations. The results of the 50%-limits portfolios are presented in Table 6. and 33%-limits portfolios are presented in Table 7. In further comparisons the 50%-limits portfolio is used due to the aforementioned issues.

Combining value and momentum metrics into one portfolio increases returns significantly. Value and winner portfolio creates extremely high average returns, although with high standard deviation implying that some of the diversification benefits from negative correlation between pure play value and momentum are lost. Surprisingly, growth and winners create even higher returns, although very slightly, implying that momentum is the driver of excess returns. Even more unexpectedly the returns of the two aforementioned portfolios are very highly correlated throughout the period, although growth and winners experience slightly higher volatility leading value and winners to be the best performing portfolio with highest Sharpe ratio. This is visible in Figure 9. and presented in Table 6.

Value and losers -portfolio creates also excess returns but not as significant that value and winners -portfolio. This is constant with the results from previous studies that adding momentum to value metrics can enhance returns (Leivo 2012).

The most significant finding is the extremely poor performance of growth and losers -portfolio. It yields even lower returns than the risk-free rate in the period. This offers great short sales opportunity and the possibility to create zero cost portfolios. As only the largest stocks are used, execution of the strategy is viable. The finding is consistent with Lee & Swaminathan (2000) who suggest that momentum experiences different cycles. Similar results were also found by Bird & Whitaker in 2004 in major European stock markets from 1990 to 2002. On the contrary to this study, they found that the most prolific long play would have been value and losers rather than value and winners.

Thus a long–short portfolio is a portfolio that is long in value and winners and short on the opposite side, i.e. growth and losers. If there were short sales constraints it would lower the returns.

Table 6. Results of long-only combination portfolios (50% limits)

Top third equal weighted				
	Value and winners	Value and losers	Growth and winners	Growth and losers
Monthly return	1,66 % (3,95)	1,22 % (2,97)	1,68 % (3,69)	0,25 % (0,56)
Monthly alpha	0,72 % (2,56)	0,18 % (0,89)	0,61 % (2,98)	-0,88 % (-4,18)
STDEV	18,2 %	19,2 %	19,7 %	20,6 %
Sharpe ratio	0,99	0,62	0,92	-0,01
Sortino ratio	5,80	3,79	5,74	-0,07
Portfolio beta	0,81	0,89	0,92	0,97

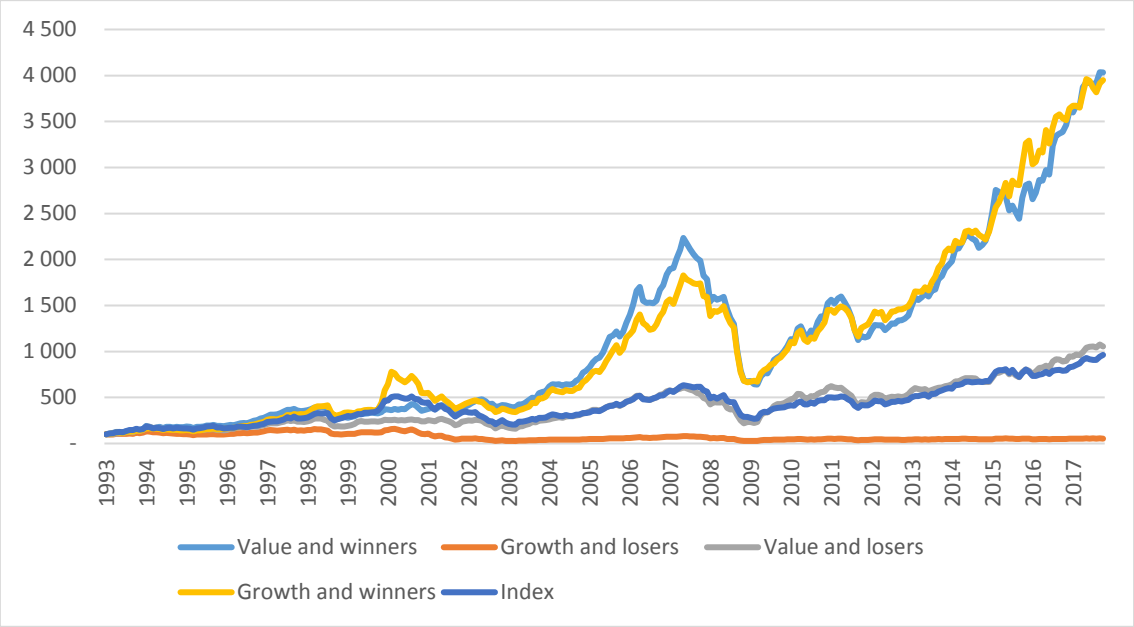

Figure 9. Cumulative returns of combination portfolios and market equal weighted

The best-performing value and winners -portfolio offers statistically significant returns and alpha at 1% significance level. Value and losers seems to be highly correlated with the market, so it fails to create significant alpha. Growth and winners delivers significant alpha and returns, as well, but it has higher volatility compared to value and winners, so it delivers lower Sharpe ratio and slightly lower Sortino ratio. Growth and losers creates statistically highly significant very negative alpha.

Table 7. Results of long-only combination portfolios (33% limits)

Top third equal weighted				
	Value and winners	Value and losers	Growth and winners	Growth and losers
Monthly return	1,83 % (3,72)	1,29 % (2,93)	1,97 % (3,87)	-0,13 % (-0,28)
Monthly alpha	0,84 % (2,38)	1,12 % (2,55)	1,72 % (3,56)	-0,40 % (-0,89)
STDEV	20,9 %	21,3 %	21,9 %	23,2 %
Sharpe ratio	0,97	0,61	1,02	-0,21
Sortino ratio	5,90	3,86	6,51	-1,08
Portfolio beta	0,85	0,15	0,22	0,24

When using 33% limits, the trends are similar as in 50% limits, although now growth and winners delivers the highest Sharpe ratio. Growth and losers creates now even negative returns, although the results are not statistically significant. These portfolios are more volatile; hence they hold less securities than the portfolios constructed with 50% limits. This is presented in Table 8 below. When using 33% limits, portfolios end up holding very few stocks at worst. Value and winners -portfolio even has periods when zero stocks are held. On average using 50% limits at least doubles the number of stocks in portfolios compared to using 33% limits.

Table 8. Number of stocks in portfolio

	Value and winners	Value and losers	Growth and winners	Growth and losers
Average 33 %	17	31	33	20
Max 33 %	37	55	57	40
Min 33 %	0	9	8	2
Average 50 %	47	65	64	48
Max 50 %	74	102	106	78
Min 50 %	13	20	20	14

Based on these results investors who are eager to invest in growth companies should include momentum metrics in their investment criteria as it increases the returns of growth stocks dramatically. The poor performance of the growth stocks seems to be at least partly explained by the extremely weak performance of loser stocks. Investing into growth and loser stocks should be avoided.

8.5. Average ranking method

Average ranking method ranks stocks from 1 to 0 based on their ranking in price to book and 12-1M returns compared to the other stocks. Lowest price to book ratio (highest value) gets 1 and highest (lowest value) gets 0 and the stock in the middle gets 0,5 as ranking score. Similarly, highest 12-1M return gets the score of 1 and lowest gets 0. Then these to ranks are added together and based on that score the top third of the companies creates a long portfolio (high rank) and lowest third creates a short portfolio (low rank).

This procedure allows stocks to be part of the portfolio even if they do not have both signals but are high in another. It may also include stocks that are neither value nor momentum but are almost in both. This is a similar procedure as in Fisher et al. (2016) with the exception that also a short portfolio is created. This has some benefits compared to double screening as it lowers the portfolio turnover, hence it is not solely driven by momentum. Additionally, it allows a stock to be part of the portfolio even if it fails to be high in both momentum and value if it is very strong in the other.

Average ranking value and momentum signals yields significant excess returns. After accounting for size by using only the top third largest stocks it offers extremely high returns and Sharpe ratios. The exceptionally high returns from an equally weighted high–low portfolio may not be as high in real life with trading cost and especially if there are short sales restrictions, as significant portion of returns is driven by the very weak performance of a low-rank portfolio. The average monthly return of the low-rank portfolio is even lower than the risk-free return in the period. If there are many stocks that cannot be sold short the returns would decrease significantly, although a long-short portfolio of a high-rank market would have also produced significant returns, so the excellent performance of the ranking scheme cannot be explained by short sales constraints as the long part of the portfolio offered very high returns.

Table 9. Results of ranking method portfolios

Top third equally weighted			
	High rank	Low rank	High - low
Monthly return	1,85 % (4,84)	0,25 % (0,56)	1,60 % (7,01)
Monthly alpha	0,90 % (4,12)	-0,88 % (-4,18)	1,79 % (6,87)
STDEV	17,4 %	20,6 %	11,6 %
Sharpe ratio	1,18	-0,02	1,81
Sortino ratio	7,35	-0,08	16,44
Portfolio beta	0,81	0,97	-0,17

High-rank portfolio creates extremely high raw returns and alpha, both being significant at 1% level. Same applies to the long-short portfolio which creates even higher alpha as well as Sharpe and Sortino ratio. Partially this is driven by the weak performance of low-rank portfolio which creates very negative alpha with 1% significance level. It should be noted that even if there would be some short sales constraints it would not diminish returns hence the long portfolio creates very high returns. Additionally, growth stocks are on average larger in size than value stocks, and including only the largest third of the stocks in the portfolio decreases the probability of constraints significantly. This is visible in Figure 10.

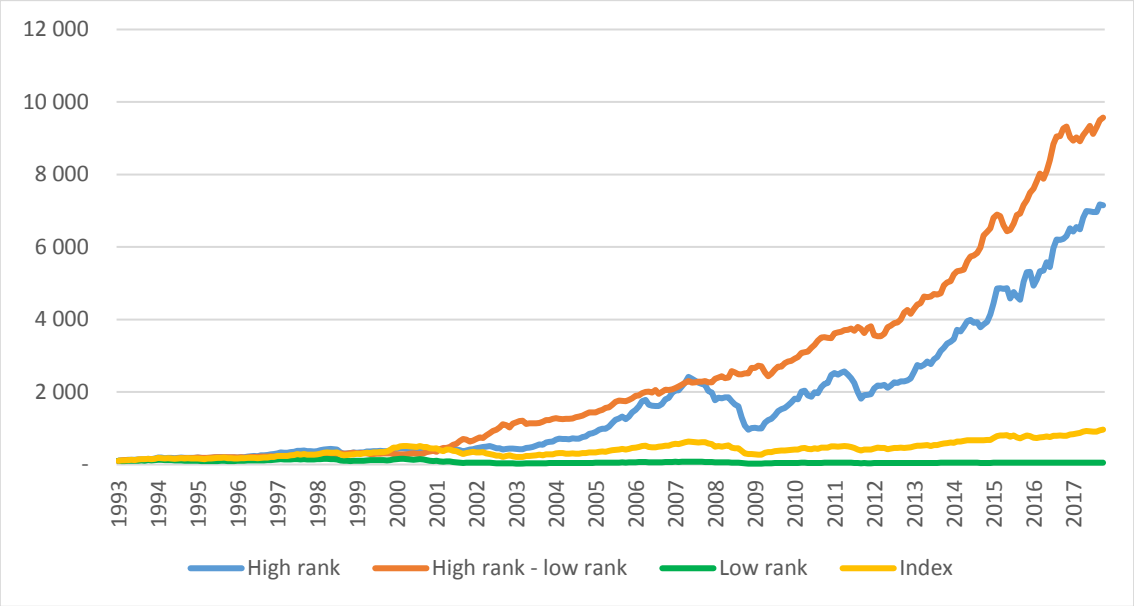

Figure 10. Returns of ranking scheme portfolios

Fisher et al. (2016) also found that the average ranking method decreases portfolio turnover compared to momentum portfolio and therefore trading costs significantly, although it has a higher turnover compared to the 50/50 portfolio that benefits from the very low turnover of a value portfolio. Using thresholds in trading as done by Fisher et al. (2016) would decrease the portfolio turnover even more.

8.6. Comparing the best-in-class value and momentum long-short portfolios

Value and winners minus growth and losers would be the natural long-short portfolio which combines value and momentum. It also generates higher raw returns compared to the 50/50 portfolio and increases partially driven by the Sharpe ratio even if it has a higher standard deviation implying that some of the diversification benefits from the negative correlation between value and momentum are lost.

Same story applies to ranking a scheme-based portfolio. The ranking scheme -based portfolio created extremely high raw returns and Sharpe ratios compared to any other portfolio in this study, although some of these returns may not have been achievable if there had been significant short sales restrictions in medium-sized stocks. Compared to value and winners minus growth and losers -portfolio, there is even reduction in standard deviation as well as higher raw returns leading to significant improvement in Sharpe ratio. The results are presented in Table 10. as well as visually demonstrated in Figure 11.

Table 10. Results of best-in-class value and momentum portfolios

Top third equal weighted			
	Value and winners – growth and losers	High rank – low rank	50/50
Monthly return	1,41 % (5,35)	1,60 % (7,01)	0,65 % (4,94)
Monthly alpha	1,60 % (5,11)	1,79 % (6,87)	0,75 % (4,78)
STDEV	12,5 %	11,6 %	8,0 %
Sharpe ratio	1,48	1,81	1,18
Sortino ratio	11,69	16,44	9,37
Portfolio beta	-0,16	-0,17	-0,09

Considering transaction costs would decrease the returns of portfolios with higher exposure to momentum more than the portfolios with higher exposure to slow moving value. Fisher et al. (2016) found that ranking scheme -based portfolios have a slightly higher turnover than the 50/50 portfolio and naturally momentum portfolios had the highest turnover and value portfolios had the lowest turnover. Value and winners minus growth and losers should have the

highest turnover of the aforementioned combo portfolios as it is a momentum portfolio even though it also sorted on a value metric. The stock can be bought only if both signals are positive but will be sold even if the other turns negative in the portfolio. This supports additionally the 50/50 portfolio and somewhat the ranking scheme -based portfolio.

All in all, the ranking scheme -based long–short portfolio seems to be superior. It creates very high raw returns, alpha, Sharpe and Sortino ratio while having fairly low standard deviation and negative beta. The results have also the highest t-statistics of the portfolios, being significant at 1% level.

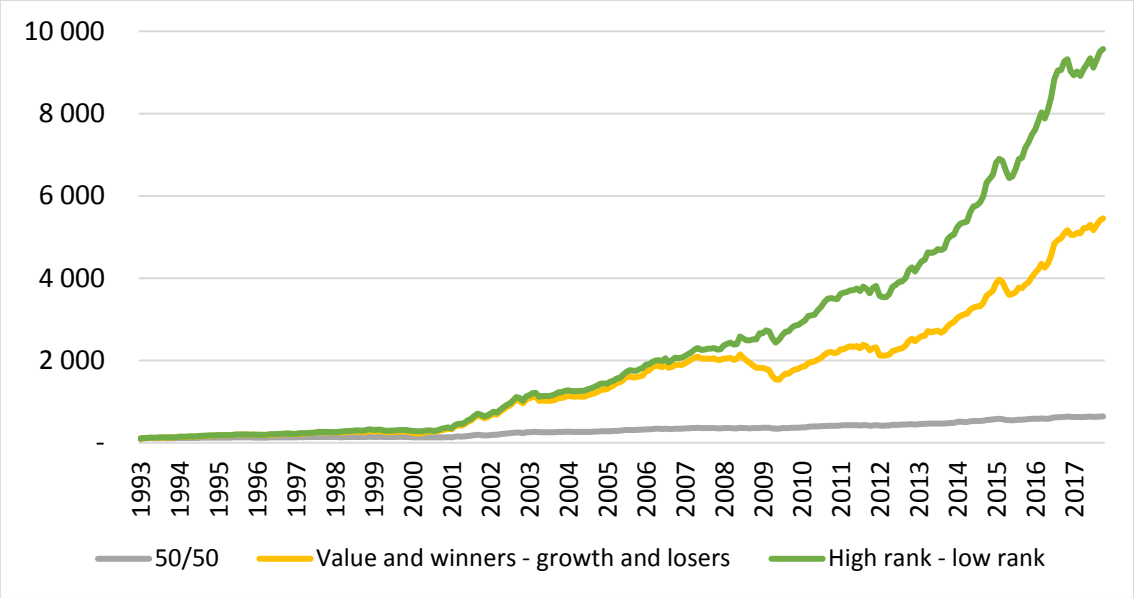

Figure 11. Cumulative returns of equal weighted top third portfolios

Table 11. Correlation matrix of best-in-class combination portfolios and index

	High rank - low rank	*50/50*	*Value and winners - growth and losers*	*Index*
High rank - low rank	1,00			
50/50	0,90	1,00		
Value and winners - growth and losers	0,94	0,89	1,00	
Index	-0,26	-0,24	-0,24	1,00

In Table 10, correlations of the portfolios' returns over risk-free rates are presented. All of the portfolios are negatively correlated to the index but are highly positively correlated with each other.

8.7. Comparing the best-in-class value and momentum long-only portfolios

If there are significant short sales constraints or costs in the market, the best performing combination portfolios might not offer such outstanding returns, hence a large portion of their performance is driven by the short sale side. To offer a view of the possible effect of the restrictions, long-only returns are presented in Table 11 and Figure 12.

Table 12. Results of best-in-class long-only value and momentum portfolios

Top third equal weighted					
	Value and winners	High rank	Winners	50/50	Market
Monthly return	1,66 % (3,95)	1,85 % (4,84)	1,95 % (4,61)	1,72 % (4,33)	1,17 % (3,18)
Monthly alpha	0,72 % (2,56)	0,90 % (4,12)	0,92 % (4,46)	0,71 % (3,53)	
STDEV	18,2 %	17,4 %	19,0 %	18,0 %	18,3 %
Sharpe ratio	0,99	1,18	1,16	1,05	0,62
Sortino ratio	5,80	7,35	7,34	6,38	5,86
Portfolio beta	0,81	0,81	0,89	0,87	1,00

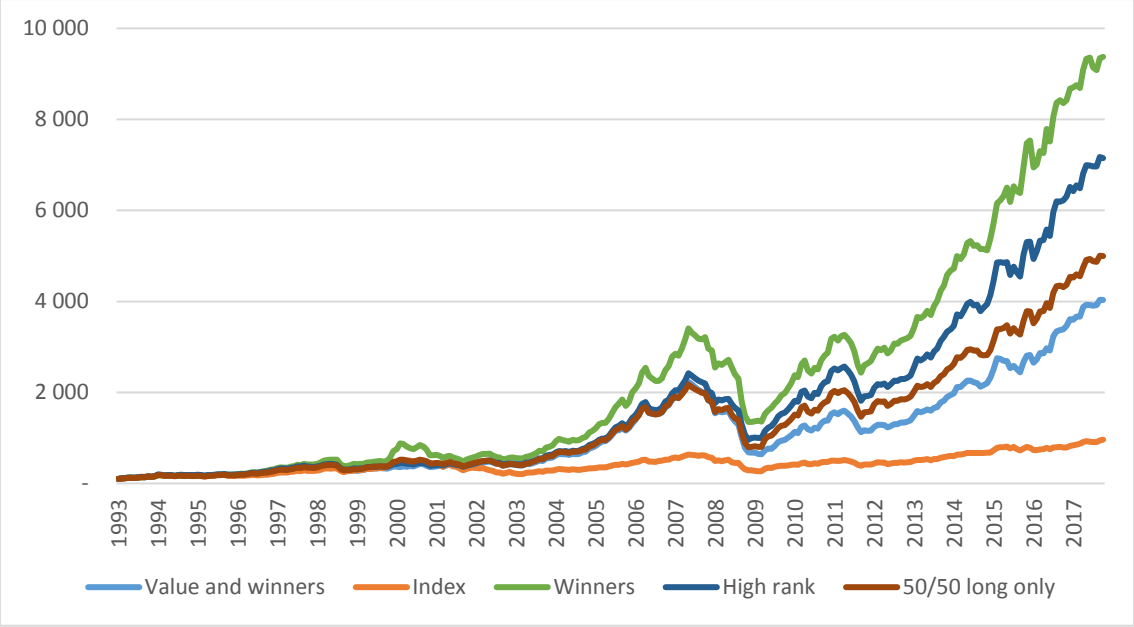

Figure 12. Cumulative returns of long-only equal weighted top third portfolios

All of the portfolios created statistically significant returns and alphas at 1% significance level except for value and winners -portfolio whose alpha was at 5% significance level.

Now high rank increases the Sharpe ratio of a momentum portfolio only slightly, although it is noteworthy that accounting for transaction costs would lower the winners -portfolios' returns significantly more compared to the high rank and 50/50 portfolio. Hence, ranking scheme still holds as the best-performing value and momentum metric. All of the portfolios beat the index clearly. The turnovers of different value and momentum portfolios by Fisher et al. (2016) are presented in Table 12. All of the portfolios beat the market clearly in both raw returns and Sharpe ratios. All of the portfolios also created significant alpha.

Table 13. Turnovers of value and momentum and combination portfolios (Fisher et al. 2016)

Strategy	Buy	Sell	Turnover (small cap)	Turnover (large cap)
Value	90	70	31 %	**26 %**
Value	95	65	25 %	**20 %**
Momentum	90	70	118 %	**157 %**
Momentum	95	65	104 %	**133 %**
0.5V + 0.5M	90	70	75 %	**91 %**
0.5V + 0.5M	95	65	64 %	**76 %**
Avg. V/M	90	70	89 %	**103 %**
Avg. V/M	95	65	62 %	**75 %**

Momentum clearly has the highest turnover with both buy and sell thresholds and value the lowest which is in line with the common belief that value is a fast-moving signal and momentum a slow-moving one. The 50/50 combo has significantly lower turnover than momentum and average ranking scheme -based portfolio has higher turnover than the 50/50 combo. Increasing the

thresholds lowers portfolio turnover and decreases average-ranking portfolios' turnover below the 50/50 combo. These sort of thresholds are not used in this paper as it is assumed that an average-ranking portfolio has a slightly higher turnover than the 50/50 combo and that momentum has clearly the highest. It is also important to note that these are long-only turnovers but the relationship between different strategies can still be compared.

9. CONCLUSIONS

Momentum strategy yields significant excess returns in the Nordic stock market that cannot be explained by size. The yields of the value strategy offer significant excess returns but after accounting for size those returns decrease, implying that value premium is partly but not fully driven by size effect in the Nordic stock market.

Combining value and momentum increases Sharpe ratios and offers investors significant diversification benefits in the Nordic stock markets which is in line with previous studies (Asness et al. 2013, Fisher et al. 2016). All of the combination portfolios improved Sharpe ratios of pure-play momentum and pure-play value. The combination of value and momentum into a single portfolio can improve a simple 50/50 combination significantly. The ranking scheme -based portfolio offered the best performance. All of the combination portfolios also had higher raw returns than pure play value and momentum except for 50/50 portfolio, though it had higher than pure play Sharpe ratios due to very low volatility.

The smaller stocks investors can buy and sell short, the more it supports value portfolios, hence value is largely driven by small stocks. Almost all of the portfolios that have more exposure to value have higher risk-adjusted returns than when small stocks are included. These returns may not be viable for state pension funds or a several-billion-dollar U.S. based hedge fund but could be viable to achieve for medium sized Nordic mutual funds.

This paper studied several different metrics to combine value and momentum in a long-short portfolio. The best risk-adjusted returns were achieved with the ranking scheme approach. All of the combination portfolios were able to increase

the very high Sharpe ratio of simple value and momentum portfolio. The increase in Sharpe ratio was clearly driven by the very low standard deviation caused by negative correlation between value and momentum in the case of the 50/50 portfolio. Other value and momentum combination portfolios seemed to somewhat lack the ability to decrease volatility compared to the 50/50 portfolio, even though all of them had lower standard deviations than a simple momentum portfolio. The increase of Sharpe ratios with a ranking scheme -based portfolio and a double-sorted portfolio that were compared to the 50/50 portfolio were solely driven by higher raw returns.

Only simple combination methods and the most common value and momentum measures were used in order to avoid data mining. These are far from the only possible ways to combine value and momentum. Further research could be done with additional momentum metrics, such as 3-month and 1-month, additional value metrics, such as PE or EV/EBIT ratios, or even more exotic ways to combine the metrics. Additionally, analyst forecasts, profitability or asset growth could be analysed to better understand the anomalies.

This paper does not consider trading costs but rather focuses on the highest gross returns within liquid set of securities, although it is noted based on previous research that momentum experiences higher transaction costs than value. Additional research could be done with estimating trading costs for the portfolios, e.g. based on the actual spreads for each specific stock at the given date. This might support portfolios with higher exposure to value metric, hence it is a lot slower-moving signal compared to momentum. Also, the scope of the research could be broadened to other markets and time periods.

Neither does this paper account for the fact that some sophisticated momentum strategies, such as risk-managed momentum, could increase Sharpe ratios of

simple momentum strategies by avoiding momentum crashes. Same applies for value as no other than the traditional P/B anomaly is researched. Additional research could be done by researching whether risk-adjusted momentum and best-in class value strategies could be combined in a way that increases the Sharpe ratio of the aforementioned strategies. Additionally, trading volume could be used to identify better trading strategies when combining value and momentum.

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