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Performance Comparison of Behavioral Finance -based Investment Strategies in the Finnish Stock Market 1996-2010

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ABSTRACT

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In this thesis traditional investment strategies (value and growth) are compared to modern investment strategies (momentum, contrarian and GARP) in terms of risk, performance and cumulative returns. Strategies are compared during time period reaching from 1996 to 2010 in the Finnish stock market. Used data includes all listed main list stocks, dividends and is adjusted in case of splits, and mergers and acquisitions.

Strategies are tested using different holding periods (6, 12 and 36 months) and data is divided into tercile portfolios based on different ranking criteria. Contrarian and growth strategies are the only strategies with improved cumulative returns when longer holding periods are used. Momentum (52-week high price[1]) and GARP strategies based on short holding period have the best performance and contrarian and growth strategies the worst. Momentum strategies (52-week high price) along with short holding period contrarian strategies (52-week low price[2]) have the lowest risk. Strategies with the highest risk are both growth strategies and two momentum strategies (52-week low price).

The empirical results support the efficiency of momentum, GARP and value strategies. The least efficient strategies are contrarian and growth strategies in terms of risk, performance and cumulative returns. Most strategies outperform the market portfolio in all three measures.

[1] Stock ranking criterion (current price/52-week highest price)
[2] Stock ranking criterion (current price/52-week lowest price)

TIIVISTELMÄ

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Tässä tutkielmassa perinteisiä sijoitusstrategioita (arvo ja kasvu) vertaillaan moderneihin sijoitusstrategioihin (momentum, contrarian ja GARP) riskin, suoriutumisen ja kumulatiivisen tuoton mittareilla. Strategioita vertaillaan Suomen osakemarkkinoilla aikavälillä 1996-2010. Käytetty aineisto sisältää kaikki päälistalle listatut yhtiöt ja maksetut osingot, ja sitä on muokattu splittien, fuusioiden ja yritysostojen tapauksessa.

Strategioita testataan eri pitoajoilla (6, 12 ja 36 kuukautta) ja aineisto jaetaan testeissä tertiiliportfolioihin eri jaottelukriteereihin perustuen. Kumulatiivisilla tuotoilla mitattuna contrarian- ja kasvustrategiat ovat ainoita, joiden tulokset ovat parempia pidempiä pitoaikoja käytettäessä. Momentum- (52 viikon korkein hinta[3]) ja GARP-strategiat perustuen lyhyeen pitoaikaan suoriutuvat parhaiten, contrarian- ja kasvustrategiat huonoiten. Momentum-strategiat (52 viikon korkein hinta) yhdessä lyhyen pitoajan contrarian-strategioiden (52 viikon alin hinta[4]) kanssa ovat vähäriskisimpiä. Suurimman riskin omaavia strategioita ovat molemmat kasvustrategiat ja kaksi momentum-strategiaa (52 viikon alin hinta).

Empiiriset tulokset puoltavat momentum-, GARP- ja arvostrategioiden tehokkuutta. Tehottomimpia strategioita ovat contrarian- ja kasvustrategiat riskillä, suoristumisella ja kumulatiivisilla tuotoilla mitattuna. Suurin osa strategioista päihittää markkinaportfolion kaikilla kolmella mittarilla mitattuna.

[3] Osakkeiden jaottelukriteeri (nykyinen hinta/vuoden ylin hinta)
[4] Osakkeiden jaottelukriteeri (nykyinen hinta/vuoden alin hinta)

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1 INTRODUCTION

1.1 Background

Fundamentals of traditional finance are based on variety of different models which are used to predict market movements and different phenomena of the economy. Assumption is that everything can be modeled with these mathematical equations. Most famous of these models is capital asset pricing model which was first introduced to finance community in 1960's. This model was result of several researchers' individual work including Treynor, Sharpe, Lintner and Mossin. It has been one of the most important things in finance theory ever since.

For almost twenty years capital asset pricing model was perceived as an undisputed fact. Just before the turn of 1980's it was seriously questioned for the first time by Roll (1977). Later on De Bondt and Thaler (1985) were also questioning the model and decided to exploit earlier results of psychology research in finance research. They found out that psychology can be used in predicting investors' movements in markets. They claimed that investing decisions aren't always based on rationality and that numerous decisions are made purely for psychological reasons. Many studies have proven their findings right afterwards. As a result of these studies traditional capital asset pricing model has been questioned by many. Last ten years in stock markets have also made many to question validity of the CAPM model especially during events like financial crisis and Dot-com bubble.

Even though there have been doubts about CAPM models validity there have also been defenders of this traditional model. In 1993 Black responded on the appeared criticism against the model. He claimed that results which were not supporting the model were a result of data mining. By this he meant that these results conflicting with the CAPM model are got by using various combinations of explanatory factors, various periods and various models and eventually representing only the results that support determined hypothesis.

Traditional investment strategies are based mostly on inspecting stock fundamentals and the goal is to find stocks with strong fundamentals which are undervalued. They can also be based on great future expectations which don’t yet show in company’s fundamentals at the time of the investment. Such strategies are value and growth strategy for example. Newer strategies such as momentum and contrarian strategy concentrate on predicting market movements by employing psychology as a part of investment decision process. The purpose of these strategies is always to find trends which can be beneficial for investors. There are multiple variations of these strategies and it seems that effectiveness of these variations depends on market which they are used in and also partly on the market cycle they are used in. However in general these strategies have been used successfully to create excess returns.

1.2 Objectives of the study

The primary purpose of this study is to research if different involved investment strategies can be used to create excess returns in Finnish stock markets with risk taken into account. The secondary purpose is to find out whether newcomer strategies (momentum, contrarian and growth at a reasonable price) are more efficient than so called traditional investment strategies (value and growth investing) in Finnish stock market.

Many different variations of these strategies are examined and compared with each other. All portfolios are compared with each other in terms of risk and performance measures.

1.3 Structure and limitations

The study has theoretical and empirical part. Theoretical part includes section 2 and 3. Section 2 introduces all the investment strategies used in this study and includes also review of most important studies previously made related to these strategies. In section 3 different used ratios, measures and related concepts are introduced. Section 4 includes description of data and methodologies used in this work.

The empirical part of the study is based on historical stock market data from OMX Helsinki. Monthly stock data is used to measure effectiveness of different strategies. Used data is described in detail in section 4. Section 5 discusses about the final results.

The momentum strategy is researched in this thesis in the same way as George and Hwang (2004) did. They were the first ones to use ratio calculated from the past 52-week highest price and current stock price to form portfolios. They also used two different variations of the momentum strategy beside this 52-week high price[5]. One of them was the traditional way suggested by Jegadeesh and Titman (1993) in which the portfolios are built based on the past return performance of individual stocks. In this variation investment portfolios are rebuilt every sixth month based on stock prices at the rebuilding date compared to price six months before. The method used in this work was chosen to be the one introduced by George and Hwang because it's less examined than other older variations. Other variation which is used is 52-week low price[6]. It works in the same way as 52-week high price but the used ratio is calculated by dividing current stock price with stocks 52-week lowest price. Holding period is from 6 months to 36 months.

[5] Stock ranking criterion (current price/52-week highest price)
[6] Stock ranking criterion (current price/52-week lowest price)

In growth at a reasonable price (GARP) strategy growth is measured using yearly price per earnings growth ratio which is a more sophisticated measurement of growth for a company than traditional price per earnings ratio. This is because it takes into account company's real growth in terms of earnings growth. Holding periods in this strategy are one and three years and evaluation of stocks is based on earnings growth in one year.

Company evaluation in value strategy is based on the P/E ratios of companies. Stocks of companies with low P/E ratios are preferred and those with high ratios avoided. In growth strategy the evaluation is completely opposite and high P/E ratios are favored in cost of low P/E ratios. Holding periods in these strategies are one and three years.

Transaction costs like taxes and trading costs aren't taken into account. Transaction costs would make the comparison of the strategies difficult.

2 INVESTMENT STRATEGIES

2.1 Introduction of compared strategies

Momentum and contrarian investment strategies are based on the assumption that investors tend to overreact on new information about companies. This is assumed to be true in the case of both positive and negative news. Earlier research in experimental psychology indicated that this seems to be the way that humans react to new information.

The first ones to research if this assumption affects stock prices were De Bondt and Thaler (1985). In their research they found out proof that this kind of human behavior affects also determination of stock prices and that investors tend to overreact to news. They found out long-term overreaction in stock returns. According to their study stocks that had performed poorly in past three to five years were more likely to perform well in the next three to five years.

2.1.1 Momentum Strategy

The idea of this strategy is to buy stocks that have performed well and short sell stocks that have performed badly in the past. On a short term prices tend to go up or down too much depending on whether the news are positive or negative. This strategy is often implemented by choosing a constant time period to determine when to reform the stock portfolio (which stocks to buy and which to short sell). The reformation can happen, for example, every sixth month based on the past performance of the stocks. Portfolio formation criterion can also be chosen from multiple options.

Momentum strategy is fairly new investment strategy. Jegadeesh and Titman (1993) were one of the first to conduct research on this subject. Their research was made using stocks from United States and they found out that it's possible to make abnormal returns with this strategy on short term (3-12 months) but after 12 months the abnormal returns created during the first year start to decline. Later in 1998 Rouwenhorst got similar results in his research. He also showed that momentum strategy can be successfully used outside United States as well to gain abnormal returns. Later on there have been many research papers which support the efficiency of momentum strategy but also some with counterarguments.

Many alternative explanations have been given to gain of these abnormal returns. Some have argued that these returns are just due to risk compensation meaning that chosen stocks have been riskier than the market in general. Many researchers have been trying to explain success of this strategy with several different risk types. So far undisputed risk based explanation hasn't been given and some have even added more questions to this puzzle.

Momentum researches have also been criticized for data mining. This means choosing of data that supports the results. Later on Jegadeesh N. et al. (2001) made a new research paper to prove that the results of their first paper in 1993 weren't result of data mining. This time they used data which included nine more years of observations and also confirmed their previous findings that abnormal returns can be created in first 12 months and returns start to decline after that.

George and Hwang (2004) used three methods in their study. Two of these were previously studied in other papers and third method was developed by them. The previously examined ones were related to momentum of individual stocks and momentum related to industries. The third method which they developed was momentum based on the ratio between past 52-week high stock prices and current stock prices. In their study they found out that this third variation of the momentum strategies was the most profitable.

Their explanation for the efficiency of this strategy was that traders use 52-week high stock prices as a reference point against which they evaluate the potential impact of the news. When good news comes out and the stock price closes the 52-week high price the traders are first unwilling to bid over this price. Eventually the impact of the new information prevails and stock prices moves above this 52-week high. The impact of news is the same when bad news comes out and stock price comes to same level as its 52-week low. Traders are unwilling to sell these stocks at first but eventually the bad news push stock price below the reference level and they are forced to sell. This kind of predictability is not possible with stocks that have their 52-week low and high prices close to current stock price. These are stocks that are not chosen to investment portfolios in this variation of the strategy.

2.1.2 Contrarian investment strategy

This is a strategy which works completely contrariwise to momentum strategy. The idea for this strategy is also to utilize overreaction of other investors but in a totally opposite way. Based on past company stock price performance badly performed companies stocks are bought and well performed are short sold. This strategy requires more time to work so usually the holding period of stocks is longer than with momentum strategy.

First ones to research if abnormal returns are possible to make with this strategy were De Bondt and Thaler (1985). They divided stocks to “winners” and “losers” and found out that this strategy is efficient and can be used to make excess profits. “Winners” were stocks which had performed well in the past and “losers” stocks which had performed badly. They found out that “loser” stocks had earned 25 % more than “winner” stocks during 36-month holding period. They also made an observation that especially “loser” portfolio earned significant excess returns every January.

As soon as De Bondt and Thaler had published their first research paper about investor overreaction many other researchers published their own explanations about these findings. in 1987 De Bondt and Thaler published a new research paper with further proof about their theory about investor overreaction. In this paper they prove that excess returns can’t be explained solely by the firm size effect or higher risk level measured with betas which were given as alternative explanations to their original findings.

Effectiveness of contrarian strategy has been explained with mean reversion –theory. It suggests that prices and returns eventually move back towards the mean or average. For example if company’s stock price is unusually low the contrarian strategy would advice on investor to buy certain stock and mean reverse –theory would explain the increase of the stock price.

One explanation for this strategy’s efficiency has been higher risk level of investments made. First one to research risk level of stocks in this strategy was Chan (1988). He was convinced that so called abnormal returns were a result of higher risk level of picked stocks. He used beta level of companies as a measurement of risk and based on his research claimed that users of contrarian strategy tend to buy loser stocks with high risk level and these so called abnormal returns are just normal risk compensation for the riskier investments.

Conrad and Kaul (1993) argued that previous studies showing that long term contrarian strategies can be utilized to produce excess returns are biased. Results from previous studies were got by cumulating single-period (monthly) returns over long periods and their argument was that this leads only to appearance of upward bias instead of true excess returns. They argued that this upward bias was a result of measurement errors (for example, due to bid-ask effect). Their final conclusion was that the abnormal performances of previous long-term contrarian strategies were due to combination of biased performance measure and "January effect". In other words true abnormal returns were only created by "January effect".

Conrad's and Kaul's research was followed by a similar paper of Ball et. al. (1995). Their explanation for appearance of excess returns was that contrarian strategies always invest in extremely low priced "loser" stocks. They found out that on average "loser" stocks are so low-priced that 1/8 $ increase in their stock price reduces five year buy-and-hold return by 25%. The equal increase in lowest-price quartile stock prices decreases five year return by 86%.

2.1.3 Value investment strategy

This strategy is based on past performances of companies. Stock portfolio is built by comparing company's financial fundamentals to its current stock price. These fundamentals can be earnings, dividends, book value and cash flow for example. Investor using this strategy looks far into the company's history. They do this by looking its financial statements in the past. Eventually the buying decision is made if the company's current stock value is lower than it should be based on these company fundamentals. One of the most used ratios in this strategy is the P/E ratio. Lower the ratio more attractive the stock.

This strategy has long traditions and it has been used successfully by many investors and academics. First ones to research value investing were Columbia University finance professors Graham and Dodd in 1934. They found out that there are companies whose stocks are temporarily undervalued compared to information found from their financial statements. They also found out that these stocks can be used to create excess returns with relatively lower risk level.

Later on Basu (1977) researched the relation between P/E ratio and stock returns. In his research paper he found out that in the time period from 1957-1971 low P/E portfolios earned higher absolute and risk-adjusted rate of returns than did the high P/E portfolios. He formed several different portfolios with similar risk level. One portfolio included stocks with low P/E ratio and others included randomly selected stocks. Compared portfolios had the same overall risk level. The idea of this was to test if efficient market hypothesis was valid. Eventually he stated that abnormal returns can be created because all publicly available information doesn’t instantly reflect to stock prices.

Similar kind of proof of the efficiency of this strategy was presented in 1985 by Rosenberg et al. In their paper they found out that P/E ratio isn’t the only ratio which can be used to create excess returns. In their work they used B/P ratio and were also able to proof that this variation of the strategy can be implemented efficiently. Numerous other variations of this strategy have been also used successfully. Just to name a few CF/P ratio was used by Chan et al. (1991) and D/P ratios by Blume (1980), Litzenberger and Ramsawamy (1982), and Rozeff (1984).

Jaffe et. al. (1989) made further findings from the same topic as Basu before over a decade ago. They conducted a research by using two different explanatory items. They tried to find out how much small company effect can explain the success of value strategy and how much of it is explained by small P/E ratio itself. Before this study many had argued that the strategy emphasizes small companies as investment objects and that it's not only the P/E ratio of a company but also the size of a company that explains excess returns gained with value strategy.

They also conducted the research on a longer time period reaching from 1951 to 1986 to make it even more comprehensive than the research employed by Basu (1977). They omitted survival bias from their data but included firms with negative returns which had been omitted from the previous studies. They found out that the results are significant for both firm size effect and P/E ratio. However, outside January the only significant one is P/E ratio. They also found that firms of all size with negative earnings provide high returns in the future.

2.1.4 Growth investment strategy

Growth investing strategy is based on future expectations of companies. Current or historical financial numbers of a company don't matter in the same way in this strategy as they matter in value investing. For example company's P/E ratio can be very high at the moment of investment decision. This is because earnings are based on current situation and growth strategy user expects them to grow rapidly in the future which would make P/E number eventually lower.

This strategy was very common before the burst of dot com bubble. Investors had huge expectations of information technology companies and made investment decisions mostly based on these expectations. Obviously these expectations were too high and eventually stock markets collapsed all over the world after many years of stock market boom.

Growth estimation is the most vital thing in this strategy. Results can be catastrophic if the estimation fails. Vice versa, profits can be significant if estimation goes right or if the growth is even better than estimated.

2.1.5 Growth at a Reasonable Price

Growth at a reasonable price is an investments strategy where investors are trying to find stocks with growth potential which are not overpriced. This strategy tries to combine the good features of both traditional value and growth investment strategies and it places somewhere between these two strategies. Perhaps the most important thing with this strategy is correct estimation of growth potential. Investor using this strategy may end up paying overprice if the growth is lower than estimated at the moment of investment decision.

There are many ways to build portfolio in this strategy. The first thing to decide is which indicator of growth to use. Perhaps the simplest way to measure growth is by looking earnings growth in the past and forecast them to future. This is usually done by looking annual earnings per share ratio. The simplest way to measure a company’s stock value level is by looking its price per earnings ratio. If one wants to combine these two ratios the result is price per earning growth ratio. This ratio is explained in more detail in the next section of this thesis.

3 Basic concepts related to involved strategies

3.1 Efficient Market Hypothesis

In 1965 Fama made a paper which introduced a new hypothesis called random walk hypothesis. This was also the paper which introduced the concept of efficient markets. Random walk hypothesis itself states that stock prices are impossible to be forecasted with knowledge from the past. It also states that if a forecast of stock price is correct it's only a result of luck. Fama continued the development of efficient market hypothesis and eventually named three possible market efficiency levels.

Weak-form efficiency states that stock prices reflect fully and instantly all information of the past prices. This implies that the future stock prices can't be predicted using the past stock prices. Semi-strong efficiency states that stock prices reflect all publicly available information and also react instantly to any new information which makes it impossible to make excess profits using lag in stock prices. Strong-form efficiency states that stock prices reflect all publicly available information and also all non-public information. The existence of this last form of efficiency would make it impossible for anyone to make excess profits using any information because all information would be known and utilized by all the investors. (Fama, 1970)

Efficient market hypothesis and random walk were assumed to be true among majority of academics until the late 1980's when behavioral finance came apart of finance research. Ever since Fama's assumptions have been a matter of constant dispute. Before that there had been doubts about the validity of the hypothesis but these doubts weren't based on investor behavior but financial fundaments. Weak-form and semi-strong efficiency have got evidence for and against but strong-efficiency is widely rejected.

3.2 Ratios

Ratios are used in all strategies included in this thesis. Wide variety of different variations of strategies can be made by just simply changing used ratio. Stocks are ranked into portfolios based on their ratios. Here are brief explanations of most common ratios used and others less known are introduced along with used strategies.

3.2.1 P/E ratio

This ratio is perhaps the most well known and used ratio. In this ratio company's stock price is divided by its earnings per share. Stock price means stock's market price and earnings per share means net income or profit earned by the company per share. The simplest way to calculate earnings per share is to take net income of a company for last 12 months and divide it by the number of shares outstanding. Formula for this ratio is:

$$\frac{P}{E}\ ratio = \frac{Price\ per\ Share}{Annual\ Earnings\ per\ Share} \quad (1)$$

The higher the P/E ratio the more investors are paying for each unit of net income. Another interpretation for this could be that stocks which have a higher P/E ratio are more expensive for investors to buy. Simply said this ratio tells investors how many years would it take for the firm to pay back their investment without taking account the time value of money.

Different investment strategies are based to this ratio. Value investors would most likely leave a stock with high P/E ratio away from their portfolio while this wouldn't be necessarily the case for investor using growth investment strategy. Growth investors seek stocks with future potential and this can mean that P/E ratio for such a company could be high. This is because stock price can be loaded with great future expectations. In fact, most stocks chosen by growth investors have relatively high P/E ratio.

3.2.2 PEG ratio

PEG ratio is P/E ratio added with growth factor. Like mentioned before stocks with high growth expectations tend to have high P/E ratio and value investors classify them as overvalued. This might be the right classification for some of these stocks but at the same time many stocks with great profit making opportunities are rejected. PEG ratio makes it possible to compare companies with different growth rates. Growth rate is measured with the growth of earnings per share and the ratio is:

$$PEG\ ratio = \frac{Price/Earnings}{Annual\ EPS\ Growth} \tag{2}$$

A lower ratio is better and a part of assumingly cheap stocks characteristics. Two ways are used when calculating annual earnings per share growth. Some use past earnings per share figures and some forecasted figures for earnings per share. Good thing with historical values is that they are based on numbers which can be used by anyone. Bad thing is that they don't necessarily give any information about the company's growth rate in the future. If forecasted numbers are used the used numbers are no longer objective and available for everybody. Forecasted numbers are based on estimator's individual view of the company's future and differences between forecasts can't be avoided. Forecasts are also highly sensitive to changes in the situation of the company which makes calculations vulnerable. Wrong estimations of future growth can be costly.

3.3 Risk Measures

There are two types of risk. First one is systematic and second one unsystematic risk. Unsystematic risk can be lowered by diversifying portfolio by buying more stocks. Valid performance comparison of investment strategies requires that risk is taken into account. Otherwise differences in returns of different strategies could be explained simply with different risk level of investments made. The simplest ways to estimate risk are comparisons of beta or volatility of portfolios. Other more sophisticated measures of risk, among many other variants, are value at risk (Var) and skewness- and kurtosis-adjusted deviation (SKAD). SKAD is explained later on with Skewness- and kurtosis-adjusted Sharpe ratio.

3.3.1 Annual Volatility

Annual volatility is a risk measure which describes, for example, how volatile a certain stocks return is in general. In order to find out stock’s volatility the first thing to do is to find out stock’s standard deviation which can be calculated as follows:

$$\sigma = \sqrt{\sum \frac{(x - \overline{x})^2}{n}} \tag{3}$$

Where:
x = single periods stock return
$\overline{x}$ = mean of stock returns
n = number of return observations

Annual volatility can be calculated from monthly data with monthly observations when we know standard deviation and the formula for that is:

$$Annual\ volatility = \sqrt{12} * \sigma \tag{4}$$

3.3.2 Beta

Beta value reveals stocks relation to market movements. If a stock's beta is less than 1 it means that the stock's return is expected to change less than stock market in average and vice versa if it's above 1 stock's return is expected to change more than stock market in average. In both cases its irrelevant whether market's value increases or decreases because market's movement is simply multiplied with stock's beta value. If stock's beta is 1 it means that its expected return changes are exactly equal to return changes, of stock market in average.

Beta is a measurement of systematic risk which can't be lowered by diversifying portfolio. Systematic risk is sometimes also called market risk. Beta can be measured by running regression analysis between market return and return of an individual stock or portfolio of stocks as follows:

$$\beta_i = \frac{Cov(r_i, r_m)}{Var\ (r_m)} \tag{5}$$

Where:
$Cov\ (r_i, r_m)$ = covariance between market index and individual stock returns
$Var\ (r_m)$ = variance of market index returns.

Many studies have been done related to beta ratio. Capital asset pricing model states that higher beta predicts higher expected return for a stock.

Validity of this statement has been researched by many. In 1972 Black presented proof of validity of this statement. He found out that there is a simple positive relation between average stock returns and β during the pre-1969 period. However, perhaps the most famous and disputed research was made by Fama and French in 1992. They wanted to find out how well beta can be used to explain stock returns in time period reaching from 1963 to 1990. They divided stocks to ten groups depending on firm size. All groups had one common characteristic which was negative relation between high beta and stock returns on a short term. This relation was strongest with large companies. However this relation turned to slightly positive on a longer term (1941-1990). Before their study Reinganum (1981) and Lakonishok and Shapiro (1986) had got similar results from post-1963 period implying that there is no systematic relation between β and average return.

Shortly after Fama's and French's study Black (1993) released his paper which was counterstrike to Fama's and French's study. He accused them for data mining meaning that they published only the results of their study which supported their hypothesis. Black also stated that finding of anomalies could also be result of data mining. Kothari et al. (1995) examined beta and its explanatory power with similar data than Fama and French did few years before. The difference with their study was that they used annualized returns to estimate beta and got results which supported capital asset pricing model better. They also accused Fama's and French's study for including survivorship bias which they eliminated from their own study.

3.3.3 Value at risk

Value at risk is used to estimate the maximum loss over certain period of time at a chosen probability level. This estimate applies only in normal market conditions. Value at risk for a portfolio can be calculated with the formula represented below. Usage of the following formula requires that the used data is normally distributed.

$$VaR_{95\%\ confidence} = P - 1{,}645\ \times\ \sigma \qquad (6)$$

Where:
P = Mean return of the portfolio
σ = The portfolio's standard deviation

Since it's highly likely that the stock market data isn't normally distributed it's better to use percentile function to calculate value at risk. Percentile function gives reasonably accurate value for value at risk with a given probability level even if the data isn't normally distributed. This is done by interpolating.

Value at risk is a very commonly used measurement of investment risk because by nature it's simple and easy to understand. However, there are many different ways to calculate value at risk which may give wide range of different results. This is noted by Beder (1995), who compared results of eight different variations of value at risk with three different portfolios. By doing this she found out that the different methods with differed assumptions aren't comparable with each other and can give surprisingly different results. Beden also states that it's important to understand that risks like regulatory risk, liquidity risk, political risk etc. can't be captured by quantitative techniques.

3.4 Performance Measures

3.4.1 Jensen's Alpha

Jensen's alpha is a risk adjusted performance measure. Typically it's used measuring portfolios instead of single securities. It can be calculated using the formula below.

$$\alpha_p = \bar{r}_p - \left[r_f + \beta_p\left(\bar{r}_m - r_f\right)\right] \quad (7)$$

Where:

$\bar{r}_p$ = Total portfolio return

r_f = Risk free rate

β_p = Beta of the portfolio

$\bar{r}_m$ = Market return

With a given beta for a portfolio Jensen's alpha tells how much over the return suggested by capital asset pricing model the portfolio is expected to yield.

This measure was first introduced by Jensen (1968). A few papers measuring mutual fund performances had been published before this. However, Jensen's paper was the first one where portfolio performance was measured using relative measure of performance instead of more or less absolute measure of performance. The introduction of this new risk measure made comparison of different portfolios easier.

3.4.2 Sharpe Ratio

Sharpe ratio was first introduced by Sharpe (1968) who first named the ratio as reward-to-variability ratio but during the following years other authors used different names of this ratio like the Sharpe Index and the Sharpe measure. In 1994 Sharpe made a new paper which was published to standardize the name and usage of the ratio. The ratio measures portfolio performance taking risk into account at the same time. Basically this ratio's idea is to compare excess return to the risk which is used to create it, in other words it measures how much excess return the portfolio has managed to generate per one percent of standard deviation. The Sharpe ratio can be calculated as follows:

$$S = \frac{r_p - r_f}{\sigma} \tag{8}$$

Where:

r_p = Portfolio return

r_f = Risk free return

σ = Portfolio's excess returns standard deviation

Even though standard Sharpe ratio is the most used one and has been around for decades it has also been criticized during these years ever since its introduction. One of the biggest problems of the standard ratio is that it relies deeply on normal distribution which isn't always the case with return distributions. If the return distributions being analyzed are right-skewed the use of standard deviation as a risk measure penalizes for the upside potential which would in fact be desirable for investors. (Pätäri et al., 2010)

3.4.3 Skewness- and Kurtosis-Adjusted Sharpe Ratio (SKASR)

This is a modified Sharpe's ratio introduced by Pätäri (2011). This ratio's function is to modify the original Sharpe ratio so it could be better utilized for other than normally distributed return distributions. This kind of modification is needed because many previous studies have shown that standard Sharpe ratio isn't always the best performance measure for investors e.g., see (Biglova et al., 2004; Eling and Schuhmacher, 2007; Pätäri, 2008).

First step to calculate SKASR is to modify normal distributions critical value Z. Modification is done so that non-normality of return distribution can also be taken into account. There are various ways to do the modification but in this thesis the so-called fourth order Cornish-Fisher (CF) expansion is used to create approximation of the true distribution using standard normal distribution and sample moments (Cornish and Fisher, 1938). Adjusted Z value can be calculated with formula:

$$Z_{CF} = Z_c + \frac{1}{6}(Z_c^2 - 1)S + \frac{1}{24}(Z_c^3 - 3Z_c)K - \frac{1}{36}(2Z_c^3 - 5Z_c)S^2 \qquad (9)$$

Where:

Z_c = Probability's critical value based on standard normal distribution

S = Skewness

K = Kurtosis

Formulas for skewness and kurtosis are:

$$S = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{r_{it} - \bar{r}_i}{\sigma}\right)^3 \qquad (10)$$

$$K = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{r_{it} - \overline{r}_i}{\sigma}\right)^4 - 3 \qquad (11)$$

Where,
N = number of outcomes
$\overline{r}_i$ = average return

Next step before calculating SKASR is the calculation of skewness- and kurtosis-adjusted deviation (SKAD). This is done by multiplying the standard deviation by the ratio of Z_{CF}/Z_c. SKASR can be calculated as follows:

$$SKASR = \frac{r_p - r_f}{SKAD_p^{(ER/|ER|)}} \qquad (12)$$

Where:
$SKAD_p$ = skewness- and kurtosis-adjusted deviation of monthly excess returns of a portfolio p
ER = average excess return returns of a portfolio p

SKASR takes into account all distributional asymmetries which are revealed by measures of skewness and kurtosis. The formula is parallel to that of the standard Sharpe ratio and SKAD can be compared to standard deviation of a portfolio. Interpretation is that if SKAD is lower than standard deviation it means that distributional deviations from normality are beneficial for investors and if the result is other way around the deviations from normality are unwanted for them. If the return distribution is exactly normally distributed then SKAD and standard deviation are equal. Comparing standard Sharpe ratio with SKASR also reveals how much of the useful information is lost by ignoring the impact of higher moments in performance measurement. (Pätäri, 2011)

4 DATA AND METHODOLOGY

The empirical part of this thesis focuses on Finland's stock market. Data used in this thesis is monthly data and reaches from 1996 to 2010 and includes all stocks listed in Helsinki Stock Exchange´s main list. This time period is chosen to ensure that the time frame of data would be long enough.

Data is total return meaning that it includes dividend-adjustments. Splits, and mergers and acquisitions are also taken into account in adjusting the data. All stocks have the same weight when portfolio performance is measured:

$$R_p = \frac{\sum_{i=0}^{n} R_i}{n} \tag{13}$$

Where:
R_i = Stock i's return
n = number of stocks in portfolio

During this time period many firms have left the Helsinki Stock Exchange. Every time this happens portfolios are modified by adding the exited stocks value to its portfolio's value on the month following the exit. In practice this would mean that the money received from the exited stock would be re-invested in other stocks of its portfolio. This modification is necessary to keep portfolios comparable with each other.

Since stocks are divided into tercile portfolios the amount of stocks in each portfolio isn't always even. To solve this problem stocks are divided into tercile portfolios so that depending on total stock amount portfolios 1 and 3 have one more stock than portfolio 2 or other way around that portfolio 2 has one more stock than portfolios 1 and 3.

4.1 Momentum and Contrarian strategies

Momentum and contrarian strategies are tested with two separate criteria. First criterion is 52-week high price meaning that stocks are ranked based on the ratio which is calculated by dividing stocks current price with its 52-week highest price. Second criterion is 52-week low price meaning that stocks are ranked based on the ratio which is calculated by dividing stocks current price with its 52-week lowest price. With both criteria stocks are ranked into tercile portfolios.

With 52-week high price criterion stocks with highest ratio form momentum portfolio and stocks with lowest ratio contrarian portfolio. With 52-week low price criterion stocks with highest ratio also form momentum portfolio and stocks with lowest ratio contrarian portfolio. Stocks found in the middle portfolio have characteristics of both strategies.

Tested holding periods for momentum and contrarian strategy are six months, one year and three years. These holding periods are chosen based on previous studies which have shown that momentum strategy works better on short holding periods and contrarian on longer periods. Both strategies were tested with all holding periods to make the results more comparable.

4.2 Value and Growth strategies

For these strategies data is also divided into tercile potfolios using historical data. Portfolios are ranked based on price per earnings ratio and then divided into portfolios. Stocks with highest P/E ratios form growth portfolio and stocks with lowest P/E ratios form value portfolio. Problem with P/E ratio is that if its values are negative the order of stocks in portfolios can get wrong. For that reason ratio P/E is modified to earnings yield as follows:

$$Earnings\ Yield\ ratio = 1/\frac{Price\ per\ share}{Annual\ earnigns\ per\ share} \qquad (14)$$

Usage of earnings yield makes it easier to arrange stocks to portfolios since stocks with high absolute value in P/E end up in the same portfolio. Stock with negative P/E can be thought as extreme growth stock which is favored by investors for its future growth potential rather than current earnings.

Investment period for these strategies were one and three years. Previous studies have shown that longer holding period works better with these strategies.

4.3 Growth at a Reasonable Price (GARP)

In this strategy companies are put in order by their earnings growth potential compared to current price. This is done with PEG ratio. Same three-portfolio approach is used with this strategy as well. PEG ratio is modified by dividing one by it and stocks are ranked using this modified ratio. This modification makes the order of stocks to be the best for testing efficiency of this strategy. Portfolio 1 with highest 1/PEG ratios contained companies which had mostly positive P/E and the fastest growth rate in terms of earnings growth. Earnings growth was measured by comparing previous year's EPS to current year's EPS.

Two holding periods are used with this strategy. They are one year and three years. Companies which have both negative P/E and earnings growth are omitted from the data. When PEG ratio is calculated for these companies the ratio gets positive value. However, these companies have negative future growth expectations and their earnings are already negative meaning that these are not desirable stocks to be picked up to portfolio formed with GARP strategy.

4.4 Portfolio performance comparison

Portfolios are compared in terms of Sharpe ratio and SKASR. The first ones to make a research paper about performance difference comparison based on the Sharpe ratio were Jobson and Korkie (1981). In this thesis comparison is done with the same method refined by Memmel (2003), according to whom the test statistic for performance difference between portfolios can be calculated as follows:

$$z_{JK} = \frac{Sh_i - Sh_j}{\sqrt{V}} \tag{15}$$

Where *V* can be calculated as follows:

$$V = \frac{1}{T}\left[2 - 2\rho_{ij} + \frac{1}{2}\left(Sh_i^2 + Sh_j^2 - 2Sh_i Sh_j \rho_{ij}^2\right)\right] \tag{16}$$

Where:

T= number of return observations for each portfolio

$\rho_{ij=}\frac{\sigma_{ij}}{\sigma_i \sigma_j}$

5 RESULTS

5.1 Descriptive statistics

Table 1.

Descriptive statistics for portfolio return distributions

This table reports descriptive statistics for all strategies and their variations used in this work. The sample includes portfolio returns from May 1996 to May 2010 (168 observations). The statistics are based on the monthly returns of the portfolios.

Portfolio	Time	Max.	Min.	Mean	Std. Dev.	Kurt.	Skew.
Momentum (H)	12,6	20,48%	-18,51%	1,62%	0,049	2,581	-0,340
Momentum (H)	12,12	28,38%	-18,51%	1,46%	0,053	4,516	0,212
Momentum (H)	12,36	28,38%	-15,89%	1,17%	0,054	3,505	0,283
Momentum (L)	12,6	28,77%	-22,09%	1,50%	0,064	2,331	-0,088
Momentum (L)	12,12	32,77%	-22,09%	1,51%	0,066	3,065	0,062
Contrarian (H)	12,6	26,13%	-18,33%	0,75%	0,074	1,428	0,405
Contrarian (H)	12,12	26,03%	-18,33%	0,93%	0,070	1,305	0,275
Contrarian (H)	12,36	26,03%	-19,72%	1,36%	0,065	1,634	0,196
Contrarian (L)	12,6	23,10%	-16,32%	0,88%	0,055	1,882	0,053
Contrarian (L)	12,12	18,14%	-16,32%	0,89%	0,052	1,345	-0,286
GARP	12	15,10%	-17,51%	1,43%	0,051	1,676	-0,628
GARP	36	15,10%	-20,24%	1,32%	0,052	2,054	-0,645
Value	12	15,64%	-16,89%	1,35%	0,049	2,459	-0,736
Value	36	15,64%	-21,74%	1,32%	0,053	2,551	-0,794
Growth	12	32,46%	-23,83%	0,99%	0,072	2,349	0,254
Growth	36	32,46%	-23,73%	1,18%	0,070	2,654	0,242

Portfolio return distributions (Table 1) are based on monthly return data of portfolios. In portfolio column contrarian and momentum strategies have (H) and (L) attached to them which refer to formation criteria of the portfolios in these strategies. First one (H) means 52-week high stock price and second one (L) 52-week low price compared to formation months stock price. In time column the first number is the length of selection period of the portfolio and second number is the holding period until the reformation of the portfolio. GARP, value and growth strategies have no formation periods so only holding periods are reported for them.

Mean return ranges from 0,75 % to 1,62 % per month meaning that the best portfolio is over twice as profitable as the worst one. The standard deviation column shows that growth and contrarian (H) strategies have the largest volatility in their monthly returns. Normal distribution has kurtosis value of 0 (Excel) meaning that all portfolios are leptokurtic because their kurtosis value is above 0. Portfolios get skewness values from both sides of zero. If the value is below zero it means that portfolios return distribution has a longer left tail and vice versa. Minimum and maximum monthly returns show that some months have significant impact to portfolio’s total performance.

5.2 Momentum and Contrarian

Three different holding periods are used with momentum and contrarian strategies. It is necessary to include a longer holding period in addition to two short ones since previous studies have shown that contrarian strategy works better on long term. There are also two different forming criterions which are 52-week high price and 52-week low price. The first ones to be reported are short holding periods with both portfolio formation criterion and the last table (no. 6) reports both strategies tested on a long holding period with 52-week high formation criterion.

Table 2.

Performance comparison of 3-quantile (12,6) momentum and contrarian portfolios

This table contains performance comparison of 3-quantile portfolios with selection period of 12 months and holding period of 6 months. Portfolio 1 represents momentum strategy and portfolio 3 contrarian strategy. Portfolio formation criterion is 52-week high price.

Time Period	**12 month formation 6 month hold**			
3-quantile portfolio	P1	P2	P3	M
Annual return	19,55%	14,63%	5,96%	11,10%
Annual volatility	17,04%	18,03%	25,47%	24,06%
SKAD	20,08%	22,61%	24,12%	24,29%
VaR 95 %	-6,69%	-7,85%	-11,94%	-9,81%
Beta	0,574	0,616	0,883	-
Alpha (sign.)	10,44% (0,000)	5,96% (0,039)	-3,20% (0,384)	-
SR	0,277	0,197	0,067	0,124
SKASR	0,236	0,158	0,071	0,123
Perf. Diff. Pi vs. Pm	P1 vs. Pm	P2 vs. Pm	P3 vs. Pm	-
SR diff. Z (sign.)	3,110 (0,002)	1,551 (0,121)	1,267 (0,205)	-
SKASR diff. Z (sign.)	2,315 (0,021)	0,738 (0,461)	1,160 (0,246)	-
Perf. diff. Pi vs. Pj	P1 vs. P3	P1 vs. P2	P2 vs. P3	-
SR diff. Z (sign.)	3,534 (0,000)	1,850 (0,064)	2,587 (0,010)	-
SKASR diff. Z (sign.)	2,799 (0,005)	1,824 (0,068)	1,737 (0,082)	-

The average annual return is remarkably better with P1 (momentum) portfolio. This portfolio is able to produce 19,55 % average annual return while P3 (contrarian) portfolio is only able to produce 5,96 %. This is an excellent result on itself and when annual volatilities are examined it makes performance of the momentum portfolio look even better. Based on value at risk measure the order of the portfolios remains the same. P3 is again the riskiest one with value of -11,94 % and market portfolio almost as risky with value of -9,81 %. The amount of maximum loss at 95 % probability level decreases to almost half for P1 when compared to P3.

The comparison of tercile portfolios' alphas shows that portfolios 1 and 2 beat the market in terms of abnormal return but portfolio 3 has underperformed against it. However, alphas are only statistically significant for portfolio 1 at 1

% level and portfolio 2 at 5 % level. Betas show that portfolio 3 has followed the market portfolio movements more closely than two other tercile portfolios. All portfolios have beta under 1 which means that their value changes typically less than the market portfolios.

The highest Sharpe ratio (0,277) is reported for momentum portfolio and it is also the only portfolio that has significantly outperformed the market portfolio on the basis of the same performance metrics. SKAD value is higher than annual volatility for P1, P2 and market portfolio, meaning that return distributions for these portfolios are not normally distributed and it’s better to use skewness- and kurtosis adjusted Sharpe ratio (SKASR). However, P1 has outperformed market portfolio significantly at 1 % level also based on the SKASR difference test.

P1 has beaten P3 in both Sharpe and SKASR comparisons at 1 % level and also P2 at 10 % level. P2 outperformed P3 in Sharpe comparison at 1 % level and SKASR comparison at 10 % level.

Table 3.

Performance comparison of 3-quantile (12,12) momentum and contrarian portfolios

This table contains performance comparison of 3-quantile portfolios with selection period of 12 months and holding period of 12 months. Portfolio 1 represents momentum strategy and portfolio 3 contrarian strategy. Portfolio formation criterion is 52- week high price.

Time Period	**12 month formation 12 month hold**			
3-quantile portfolio	P1	P2	P3	M
Annual return	17,10%	15,41%	8,58%	11,10%
Annual volatility	18,26%	17,32%	24,13%	24,06%
SKAD	20,56%	22,16%	23,66%	24,29%
VaR 95 %	-7,18%	-7,43%	-10,22%	-9,81%
Beta	0,635	0,583	0,822	-
Alpha (sign.)	7,91% (0,001)	6,86% (0,014)	-0,43% (0,905)	-
SR	0,228	0,214	0,096	0,124
SKASR	0,204	0,168	0,099	0,123
Perf. Diff. Pi vs. Pm	P1 vs. Pm	P2 vs. Pm	P3 vs. Pm	-
SR diff. Z (sign.)	2,306 (0,021)	1,861 (0,063)	0,592 (0,554)	-
SKASR diff. Z (sign.)	1,786 (0,074)	0,738 (0,461)	0,525 (0,600)	-
Perf. diff. Pi vs. Pj	P1 vs. P3	P1 vs. P2	P2 vs. P3	-
SR diff. Z (sign.)	2,571 (0,026)	0,793 (0,428)	2,226 (0,010)	-
SKASR diff. Z (sign.)	2,053 (0,040)	0,774 (0,439)	1,316 (0,188)	-

In 12-month holding period differences between portfolios' annual returns are lower than in 6-month holding period. Despite of smaller differences in annual returns the performance order of portfolios remains the same. P1's volatility is higher and it's no longer the lowest of the four portfolios. This time portfolio 2 has the lowest annual volatility. However, based on Value at risk, P1 is still the portfolio with the lowest risk of all four portfolios. The order of all four portfolios remains the same in VaR comparisons but VaR of P3 has decreased by almost 2 percentage units compared to the results from the shorter holding period.

In this holding period P1 gets the highest and portfolio P3 the lowest alpha. P1's alpha is statistically significant at 1 % level and P2's at 5 % level. P3's Alpha isn't statistically significant. Beta's are similarly below one as they were also on 6-month holding period comparison. The only difference is that this time P2’s beta is the lowest of three tercile portfolios.

The Sharpe ratio difference is significant for P1 at 5 % level and for P2 at 10 % level when compared to market. SKAD is higher than annual volatility for P1 and P2. P3’s SKAD is close to its volatility which means that distributional deviations from the normality are marginal.

Three results are statistically significant for Sharpe and SKASR difference comparison. P1 outperforms P3 significantly at 5 % level based on both Sharpe ratio and SKASR comparison. Third significant difference is the outperformance of P2 versus P3 based on the Sharpe ratio comparison. All other comparisons are far from being significant.

Momentum portfolio is the best performing portfolio with 52-week low price criterion when measured in terms of annual return. However, order of the portfolios has changed when ranked with volatility and the momentum portfolio has the highest volatility of tercile portfolios for the first time. Even though volatility is the highest the annual return is the lowest when compared to previously reported momentum portfolios. Despite of these changes in results it still has the highest annual return among the tercile portfolios. For the first time Var value is the lowest for other than momentum portfolio. P2’s VaR (-6,95 %) is the lowest. All three other portfolios have VaR values close to each other.

Table 4.

Performance comparison of 3-quantile (12,6) momentum and contrarian low price portfolios

This table contains performance comparison of 3-quantile portfolios with selection period of 12 months and holding period of 6 months. Portfolio 1 represents momentum strategy and portfolio 3 contrarian strategy. Portfolio formation criterion is 52-week low price.

Time Period	**12 month formation 6 month hold**			
3-quantile portfolio	P1	P2	P3	M
Annual return	16,69%	14,70%	9,11%	11,10%
Annual volatility	22,12%	17,92%	19,05%	24,06%
SKAD	24,67%	21,12%	20,27%	24,29%
VaR 95 %	-9,17%	-6,95%	-8,84%	-9,81%
Beta	0,803	0,612	0,646	-
Alpha (sign.)	6,61% (0,015)	6,02% (0,027)	0,82% (0,782)	-
SR	0,194	0,198	0,113	0,124
SKASR	0,175	0,169	0,107	0,123
Perf. Diff. Pi vs. Pm	P1 vs. Pm	P2 vs. Pm	P3 vs. Pm	-
SR diff. Z (sign.)	1,774 (0,076)	1,586 (0,113)	0,225 (0,822)	-
SKASR diff. Z (sign.)	1,308 (0,191)	0,738 (0,461)	0,341 (0,733)	-
Perf. diff. Pi vs. Pj	P1 vs. P3	P1 vs. P2	P2 vs. P3	-
SR diff. Z (sign.)	1,669 (0,095)	0,070 (0,945)	1,971 (0,049)	-
SKASR diff. Z (sign.)	1,402 (0,161)	0,149 (0,881)	1,203 (0,229)	-

Alphas are close to each other for P1 and P2 they are also both significant. Again betas for all portfolios' are below one but this time P1's beta is closest to unity and P2's and P3's betas are lower and close to each other.

The only significant Sharpe ratio difference is reported for P1 at 10 % level. SKAD values are higher than annual volatility for all portfolios. This implies that SKASR is a better measure of performance for this strategy and formation criterion but none of the tercile portfolios have significant SKASR difference compared to market.

Performance difference comparison shows that P1 has beaten P3 significantly (10 % level) only in Sharpe comparison and P2 has done the same at 5 % level. SKASR comparisons are all far from being significant.

Longer holding period seems to lower and even up annual returns between the portfolios with this forming criterion. At the same time volatility ranking stays the same and P1's volatility gets even higher closing up to market volatility. The difference between the values of these two portfolios is only 1,26 percentage points while it was 7,02 percentage points based on formation criterion of 52-week high and short holding period. For the first time P1 has the highest VaR value of all portfolios. This indicates that P1 would be the portfolio with the highest risk even though annual volatility doesn't support this argument.

Table 5.

Performance comparison of 3-quantile (12,12) momentum and contrarian low price portfolios

This table contains performance comparison of 3-quantile portfolios with selection period of 12 months and holding period of 12 months. Portfolio 1 represents momentum strategy and portfolio 3 contrarian strategy. Portfolio formation criterion is 52- week low price.

Time Period	**12 month formation 12 month hold**			
3-quantile portfolio	P1	P2	P3	M
Annual return	16,67%	14,95%	9,51%	11,10%
Annual volatility	22,80%	17,76%	17,94%	24,06%
SKAD	25,28%	20,93%	20,08%	24,29%
VaR 95 %	-10,16%	-7,39%	-8,84%	-9,81%
Beta	0,828	0,621	0,584	-
Alpha (sign.)	6,47% (0,028)	6,12% (0,012)	1,64% (0,586)	-
SR	0,190	0,203	0,123	0,124
SKASR	0,172	0,173	0,111	0,123
Perf. Diff. Pi vs. Pm	P1 vs. Pm	P2 vs. Pm	P3 vs. Pm	-
SR diff. Z (sign.)	1,670 (0,094)	1,779 (0,075)	0,016 (0,987)	-
SKASR diff. Z (sign.)	1,238 (0,216)	0,738 (0,461)	0,246 (0,806)	-
Perf. diff. Pi vs. Pj	P1 vs. P3	P1 vs. P2	P2 vs. P3	-
SR diff. Z (sign.)	1,349 (0,178)	0,176 (0,86)	1,827 (0,068)	-
SKASR diff. Z (sign.)	1,243 (0,214)	0,031 (0,975)	1,176 (0,240)	-

Change in the length of holding period didn't affect much P1 and P2 alphas which remain statistically significant at 5 % level. Even though P3's value for

Alpha double it remains statistically insignificant. P1’s and P2’s Beta values rose slightly closer to 1 but P3’s value is lower than with the short holding period.

P2 got the highest Sharpe ratio 0,203 which is also closest to significant outperformance compared to market. SKAD values are higher than annual volatilities for all portfolios including the market portfolio meaning that the return distributions are not normally distributed and again SKASR is more reliable performance metrics. Performance comparisons of Sharpe and SKASR between the tercile portfolios do not indicate significant differences.

Best annual return is given by the middle portfolio P2. This portfolio can be thought as combination of both strategies momentum and contrarian. It includes stocks which have ratio of formation moments stock price relative to 52-week high price placed between stocks of portfolios P1 and P3. P2 also has the lowest annual volatility of 17,91 %. In terms of annual return it seems that contrarian strategy is working better on this longer holding period as also shown by previous studies. Lengthening of the holding period lowers P1’s VaR but makes it higher for P2 and P3. Again P2’s VaR is the lowest but this time P3’s is the highest of three tercile portfolios.

Table 6.

Performance comparison of 3-quantile (12,36) momentum and contrarian portfolios

This table contains performance comparison of 3-quantile portfolios with selection period of 12 months and holding period of 36 months. Portfolio 1 represents momentum strategy and portfolio 3 contrarian strategy. Portfolio formation criterion is 52- week high price.

Time Period	**12 month formation 36 month hold**			
3-quantile portfolio	P1	P2	P3	M
Annual return	13,03%	15,84%	14,80%	11,10%
Annual volatility	18,81%	17,91%	22,38%	24,06%
SKAD	20,07%	24,35%	22,71%	24,29%
VaR 95 %	-8,91%	-7,56%	-9,25%	-9,81%
Beta	0,673	0,599	0,765	-
Alpha (sign.)	4,03% (0,078)	7,21% (0,012)	5,37% (0,114)	-
SR	0,168	0,215	0,171	0,124
SKASR	0,158	0,159	0,169	0,123
Perf. Diff. Pi vs. Pm	P1 vs. Pm	P2 vs. Pm	P3 vs. Pm	-
SR diff. Z (sign.)	1,070 (0,285)	1,855 (0,064)	1,012 (0,311)	-
SKASR diff. Z (sign.)	0,852 (0,394)	0,738 (0,461)	0,988 (0,323)	-
Perf. diff. Pi vs. Pj	P1 vs. P3	P1 vs. P2	P2 vs. P3	-
SR diff. Z (sign.)	0,057 (0,525)	0,715 (0,475)	0,635 (0,955)	-
SKASR diff. Z (sign.)	0,214 (0,831)	0,016 (0,987)	0,286 (0,775)	-

Alphas are strongly positive for all portfolios but significant only for P1 at 10 % level and P2 at 5 % level. In shorter holding periods contrarian portfolio has been clearly insignificant but this time it’s not far from being significant.

The Sharpe ratio is the highest for P2 and it’s also the only portfolio that significantly outperforms the stock market average. P1 and P3 aren’t even close from being statistically significant. SKAD values are higher than comparable volatilities for all portfolios meaning that none of them are normally distributed.

5.2.1 Momentum and Contrarian strategy conclusions

Figure 1 includes all momentum and contrarian strategy variations used in this work. It can be seen that both short term (6 and 12 month) momentum strategies have the highest SKASR values and at the same time their SKAD values are among the lowest. Also 36-month momentum strategy gets close to them in terms of SKAD but its SKASR value isn't as high.

Four of five contrarian strategies have worse SKASR than that of market portfolio but on the other hand, all have lower risk level in terms of SKAD. Momentum strategies where stocks are put into order with 52-week low price have decent SKASR values but their risk levels are the highest.

In general, it can be said that 52-week high momentum strategy outperforms contrarian strategy in all holding periods. Portfolios which combine characteristics of both strategies (P2's) give also surprisingly good results.

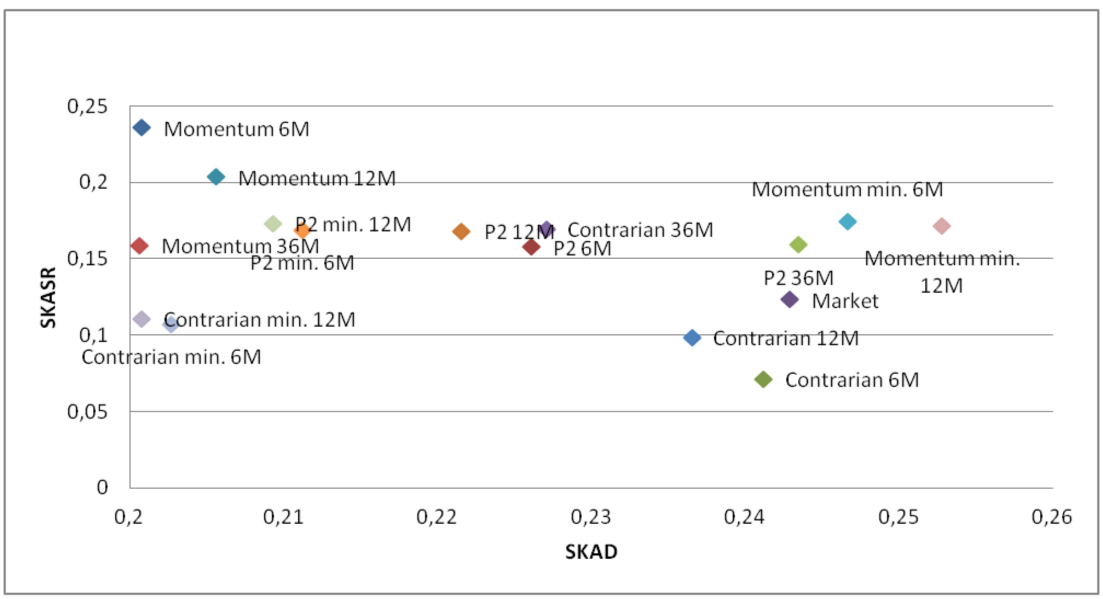

Figure 1. Momentum and Contrarian risk and performance

5.3 Growth at a Reasonable Price

Two holding periods are used with this strategy to make its performance more comparable with other strategies. However previous studies have shown that longer holding period works better with this strategy. A portfolio formation criterion is annual price per earnings growth. This is calculated by dividing price per earnings with annual earnings per share growth.

Some companies had negative values for both ratios P/E and EPS growth. These companies are omitted from final test data. This is because they got positive PEG values even though their earnings were declining instead of growing which is the strategy’s main driver.

Table 7.

Performance comparison of 3-quantile (12,12) growth at a reasonable price portfolios

This table contains performance comparison of 3-quantile portfolios with selection period of 12 months and holding period of 12 months. Portfolio 1 represents Growth at a Reasonable Price strategy other portfolios are benchmark portfolios. Portfolio formation criterion is yearly measured price per earnings growth ratio.

Time Period	**12 month formation 12 month hold**			
3-quantile portfolio	P1	P2	P3	M
Annual return	16,74%	14,30%	13,37%	11,10%
Annual volatility	17,55%	19,62%	19,69%	24,06%
SKAD	20,92%	22,44%	20,84%	24,29%
VaR 95 %	-7,23%	-8,27%	-8,62%	9,81%
Beta	0,612	0,714	0,698	-
Alpha (sign.)	7,75% (0,003)	4,93% (0,035)	4,25% (0,124)	-
SR	0,231	0,181	0,168	0,124
SKASR	0,195	0,159	0,159	0,123
Perf. Diff. Pi vs. Pm	P1 vs. Pm	P2 vs. Pm	P3 vs. Pm	-
SR diff. Z (sign.)	2,377 (0,018)	1,444 (0,149)	1,029 (0,304)	-
SKASR diff. Z (sign.)	1,598 (0,110)	0,738 (0,460)	0,846 (0,397)	-
Perf. diff. Pi vs. Pj	P1 vs. P3	P1 vs. P2	P2 vs. P3	-
SR diff. Z (sign.)	1,643 (0,100)	1,017 (0,309)	0,820 (0,412)	-
SKASR diff. Z (sign.)	0,927 (0,354)	0,954 (0,340)	0,042 (0,967)	-

P1 has the best annual return 16,74 %. Its annual return is significantly better than that of two other benchmark portfolios (14,30 % and 13,37 %). At the same time P1's annual volatility is the lowest. For this holding period, the order of portfolios seems to be favorable for GARP when measured with these two measures. This applies also for VaR of P1 and it's clearly the lowest of all portfolios. All portfolios are less risky than the market portfolio in terms of annual volatility and Value at Risk.

Alpha is also the best for P1. Alphas are statistically significant for both P1 and P2 portfolios. P1's alpha is significant at 1 % level and P2's at 5%, respectively. P1 has the lowest beta value of 0,612 so its correlation with market movement is the lowest of these three portfolios.

The only portfolio with significant Sharpe ratio difference is P1 (at 5 % level). Benchmark portfolios (P2 and P3) are far from being significant. All portfolios have higher SKAD value than their volatility meaning that none of them are normally distributed. However, market portfolios SKAD is extremely close to its annual volatility so it can be said that its return distribution is not far from normal distribution.

In performance difference comparisons the only significant result is reported on the basis of the Sharpe ratio between P1 and P3 portfolios (significant at 10 % level).

This longer holding period improves portfolio returns in general but makes the order of the portfolios different in terms of annual return. In this holding period P2 has the highest return of 18,09 %. P1's annual return is the only one which decline compared to short holding period. Despite this change P1's volatility stays the lowest. Annual volatilities for all three portfolios are higher than with 12 month holding period. The same holds also for P2's and P3's

VaRs. They have both increased but in the meanwhile P1's VaR has decreased. Even though P2 has the highest annual return it is also the one with the highest risk in terms of either volatility or VaR.

Table 8.

Performance comparison of 3-quantile (12,36) growth at a reasonable price portfolios

This table contains performance comparison of 3-quantile portfolios with selection period of 12 months and holding period of 36 months. Portfolio 1 represents Growth at a Reasonable Price strategy other portfolios are benchmark portfolios. Portfolio formation criterion is yearly measured price per earnings growth ratio.

Time Period	**12 month formation 36 month hold**			
3-quantile portfolio	P1	P2	P3	M
Annual return	15,14%	18,09%	14,19%	11,10%
Annual volatility	17,94%	20,94%	20,23%	24,06%
SKAD	21,67%	24,16%	24,18%	24,29%
VaR 95 %	-6,67%	-9,89%	-8,61%	-9,81%
Beta	0,609	0,760	0,709	-
Alpha (sign.)	6,46% (0,020)	8,03% (0,002)	5,02% (0,101)	-
SR	0,205	0,219	0,176	0,124
SKASR	0,170	0,190	0,148	0,123
Perf. Diff. Pi vs. Pm	P1 vs. Pm	P2 vs. Pm	P3 vs. Pm	-
SR diff. Z (sign.)	1,690 (0,091)	2,379 (0,017)	1,178 (0,239)	-
SKASR diff. Z (sign.)	0,989 (0,323)	0,738 (0,461)	0,558 (0,577)	-
Perf. diff. Pi vs. Pj	P1 vs. P3	P1 vs. P2	P2 vs. P3	-
SR diff. Z (sign.)	0,720 (0,472)	0,250 (0,803)	0,593 (0,553)	-
SKASR diff. Z (sign.)	0,564 (0,573)	0,470 (0,638)	0,284 (0,777)	-

Again, P1's and P2's alphas are both statistically significant. This time P2's alpha is significant at 1 % level and P1's at 5 % level. Order of betas stays the same and for this longer holding period, P1 remains the one with lowest correlation with the market. Longer holding period makes only minor changes to betas.

Two tercile portfolios have significantly outperformed the market portfolio on the basis of Sharpe ratios (i.e., P1 at 10 % level and P2 at 5 % level). SKAD values for all portfolios remain above annual volatility meaning that it's better to use SKASR in performance comparison in this longer hording period as well.

5.3.1 Growth at a Reasonable Price Conclusions

All portfolios created by using PEG ratio as determinant outperform the market portfolio. GARP strategy works best when holding period is 12 months but the performance is also good with 36-month holding period. P2 with 36-month holding period gets almost as high SKASR value as GARP with 12 months holding period but its risk level is remarkably higher.

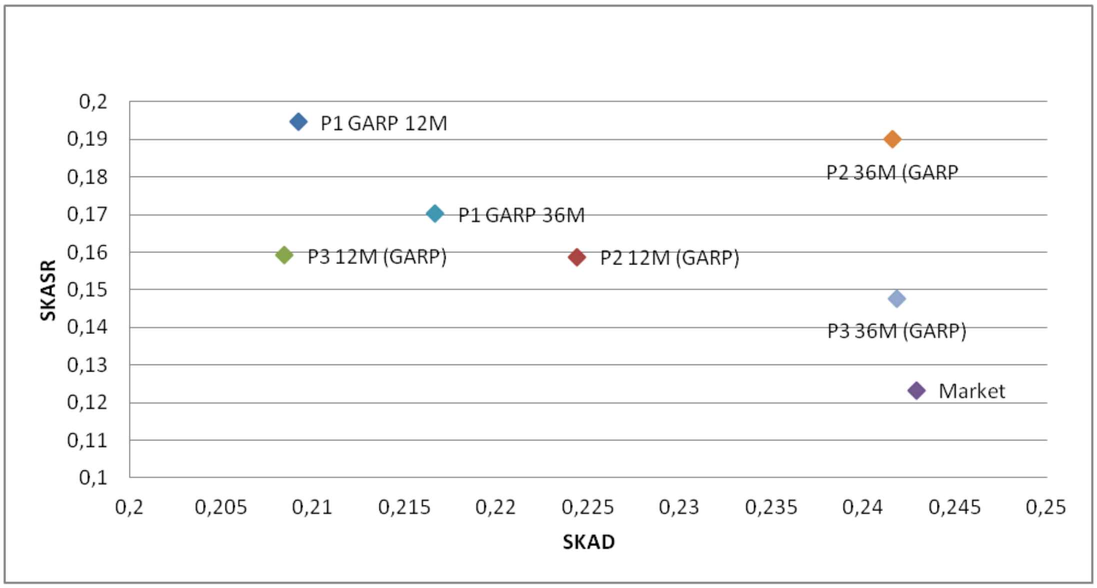

Figure 2. GARP risk and performance

5.4 Value and Growth

The highest annual return is reported for P2. P1's return is close to P2 losing only 0,32 percentage points on annual basis. P2's value is 16,07 % while P3's value is only 9,17 %. P2's volatility is 17,00 % while that of P1 is practically the same. Again, P3's volatility differed much from that of two other tercile portfolios making it the most volatile and the worst-performing. P3 is the riskiest portfolio also in terms of VaR and SKAD. P1's VaR is the lowest of all portfolios and the difference between P1's and P3's VaR is 3,97 percentage points.

Table 9.

Performance comparison of 3-quantile (12,12) value and growth portfolios

This table contains performance comparison of 3-quantile portfolios with selection period of 12 months and holding period of 12 months. Portfolio 1 represents Value strategy and portfolio 3 Growth strategy. Portfolio formation criterion is yearly value of price per earnings ratio.

Time Period	**12 month formation 12 month hold**			
3-quantile portfolio	P1	P2	P3	Pm
Annual return	15,75%	16,07%	9,17%	11,10%
Annual volatility	17,04%	17,00%	24,78%	24,06%
SKAD	21,07%	19,40%	25,48%	24,29%
VaR 95 %	-6,72%	-7,40%	-10,69%	-9,81%
Beta	0,581	0,601	0,871	-
Alpha (sign.)	7,13% (0,011)	7,18% (0,003)	-0,23% (0,949)	-
SR	0,222	0,227	0,102	0,124
SKASR	0,180	0,200	0,100	0,123
Perf. Diff. Pi vs. Pm	P1 vs. Pm	P2 vs. Pm	P3 vs. Pm	-
SR diff. Z (sign.)	2,057 (0,040)	2,357 (0,018)	0,506 (0,613)	-
SKASR diff. Z (sign.)	1,208 (0,227)	0,738 (0,461)	0,545 (0,586)	-
Perf. diff. Pi vs. Pj	P1 vs. P3	P1 vs. P2	P2 vs. P3	-
SR diff. Z (sign.)	2,419 (0,016)	0,783 (0,434)	2,274 (0,023)	-
SKASR diff. Z (sign.)	1,640 (0,101)	0,562 (0,574)	1,403 (0,161)	-

P1 and P2 alphas are also close to each other. P2's alpha is the best 7,18 % and that of P1 is only 0,05 percentage points lower being 7,13 %. Alphas are significant for portfolios P1 at 5 % level and P2 at 1 % level. P3's alpha is negative but statistically insignificant. P1 reflects changes in the market portfolio's value the least with beta of 0,581 and P3 most with beta of 0,871.

The best Sharpe ratio is documented for P2. The SR difference compared to the market portfolio is significant at 5 % level for P1 and P2. Every portfolio's SKAD value exceeds their annual volatility meaning that returns are not normally distributed and it's better to use SKASR when evaluating performance of the portfolios. Based on SKASR comparisons, none of performance differences is significant.

Longer holding period doesn't make changes to the order of the tercile portfolios' annual returns. This time even P3's annual return is higher than market portfolios so all portfolios have better results than market portfolio. Lengthening of the time period adds up to P2's and P3's annual return but reduces P1's return a little. This indicates that growth strategy works better on longer holding period. The performance order of the portfolios also remains the same in terms of volatility but this time P1's volatility gets higher, while those of other portfolios decline. P3's volatility is extremely close to market portfolios value with only a difference of 0,05 percentage points. The order based on risk of these two portfolios changes in terms of both VaR and SKAD. It seems that lengthening of the holding period doesn't dramatically change VaRs for any of the portfolios unlike it did with momentum, contrarian and GARP strategies.

Table 10.

Performance comparison of 3-quantile (12,36) value and growth portfolios

This table contains performance comparison of 3-quantile portfolios with selection period of 12 months and holding period of 36 months. Portfolio 1 represents Value strategy and portfolio 3 Growth strategy. Portfolio formation criterion is yearly value of price per earnings ratio.

Time Period	**12 month formation 36 month hold**			
3-quantile portfolio	P1	P2	P3	Pm
Annual return	15,08%	17,20%	11,88%	11,10%
Annual volatility	18,27%	16,66%	24,01%	24,06%
SKAD	22,78%	19,37%	25,06%	24,29%
VaR 95 %	-6,84%	-7,17%	-10,08%	-9,81%
Beta	0,619	0,601	0,834	-
Alpha (sign.)	6,37% (0,032)	8,09% (0,000)	2,43% (0,460)	-
SR	0,201	0,247	0,133	0,124
SKASR	0,162	0,214	0,128	0,123
Perf. Diff. Pi vs. Pm	P1 vs. Pm	P2 vs. Pm	P3 vs. Pm	-
SR diff. Z (sign.)	1,616 (0,106)	3,004 (0,003)	0,198 (0,843)	-
SKASR diff. Z (sign.)	0,818 (0,418)	0,738 (0,461)	0,100 (0,920)	-
Perf. diff. Pi vs. Pj	P1 vs. P3	P1 vs. P2	P2 vs. P3	-
SR diff. Z (sign.)	1,366 (0,172)	0,156 (0,876)	1,504 (0,133)	-
SKASR diff. Z (sign.)	0,691 (0,490)	1,513 (0,130)	0,709 (0,478)	-

None of the four portfolios' return distributions are normally distributed. Their SKAD values exceed their annual volatilities. Closest to normal distribution is market portfolio which has only 0,23 percentage points difference between SKAD and volatility.

Lengthening of the holding period improves P3's alpha making alphas positive for all tercile portfolios. However, only P1 and P2 are statistically significant like they were for the shorter holding period as well. P2's beta remains exactly the same as with shorter holding period. P1's beta increases only a little and that of P2 declines. The extension of holding period makes P1 more sensitive to stock market variability than P2 while the order was the opposite on the shorter holding period.

The only significant outperformance against the market portfolio is documented for P2. Again, it would be better to use SKASR but none of performance differences is significant based on it.

5.4.1 Value and Growth conclusions

Figure 3 shows that growth strategies are the worst performers coupled with the highest risk level. Growth strategy with 36 months holding period barely beats market portfolio in terms of SKASR. Both value strategies have better performance and lower risk level than market portfolio. However, middle portfolios from both holding periods dominate the performance comparisons. This implies that extreme P/E ratios aren’t as good as the middle ones.

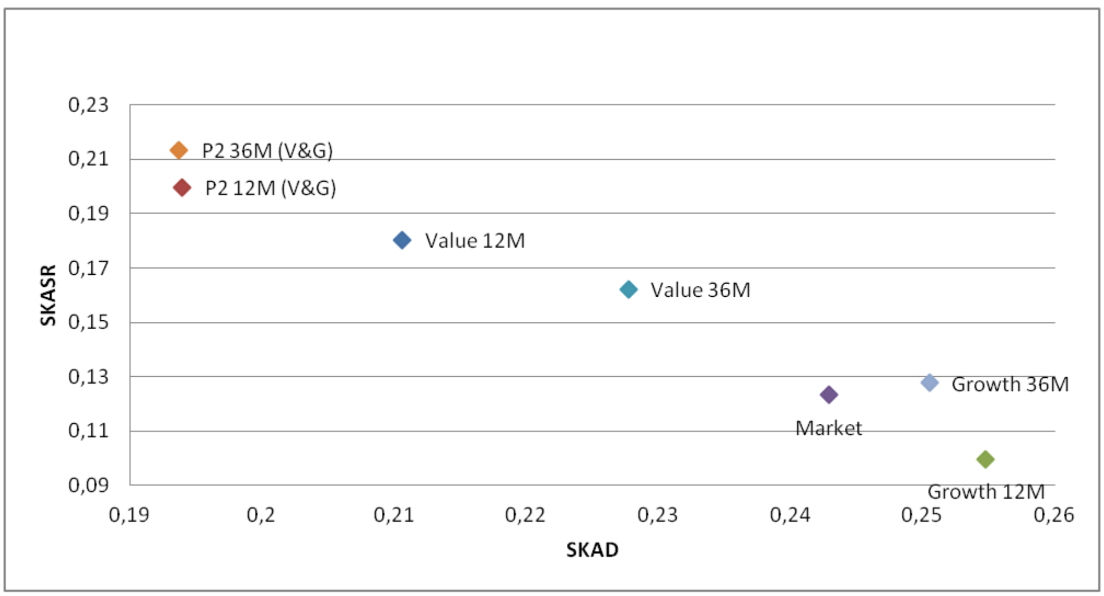

Figure 3. Value and Growth risk and performance

5.5 Price development of portfolios

There have been two major market shocks during the test period which can be seen from price development of all test portfolios but especially from the market portfolios development which is described in figure 4.

First shock was so called IT bubble which formed in the end of the 90's and bursted few years later in the beginning of the last decade. This can be clearly seen in Figure 4. The pessimism lasted until 2003 when a new rise in stock markets began. This period of rising stock markets lasted until the end of 2007.

Second shock was in 2008 when global financial crisis started from United States and spread all over the world dropping stock market prices with great magnitude. Markets started to heal at the beginning of 2009 and along with other stock markets Finnish stock market's direction turned from negative to positive and it started to recover again. All these phases can be seen in the progress of different portfolios formed with involved strategies.

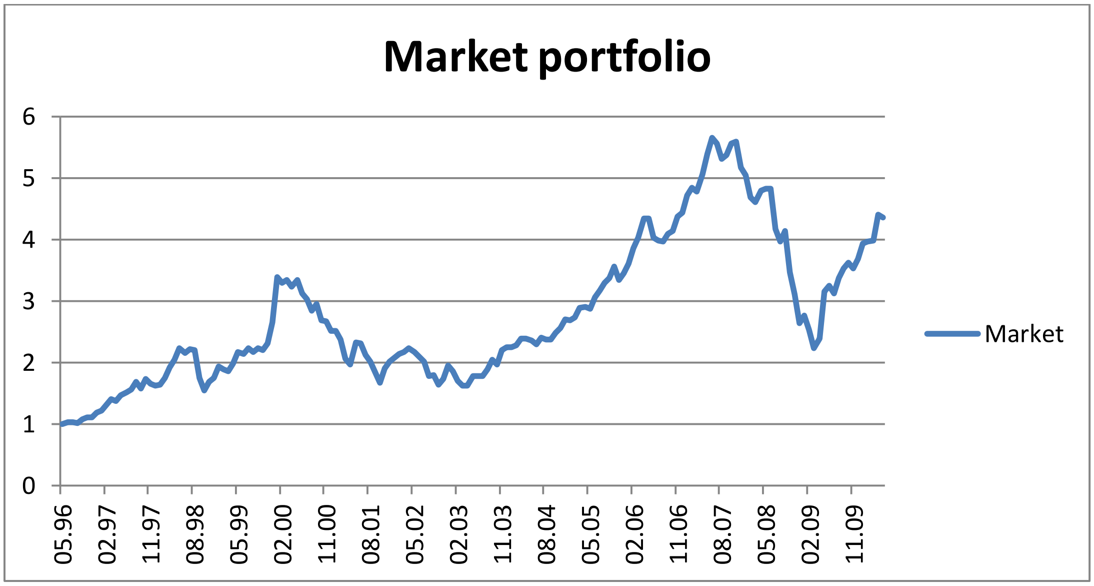

Figure 4. Market portfolio price development

There are three figures of portfolio price progression. Each figure represents one holding period and includes portfolio from every strategy constructed using that holding period. In general it can be said that many strategies seem to have correlation with each other even during long time periods.

Figure 5 shows that the momentum portfolio ranked with 52-week high price criterion has worked the best on short holding period of six months. Next in order is the momentum portfolio formed on the basis of 52-week minimum price. Both contrarian portfolios have clearly underperformed compared to momentum portfolios. Besides this, they have also underperformed compared to market portfolio.

There is only one short time period when contrarian strategy based on the formation criterion of 52-week minimum price has been able to beat the market portfolio. The period begins in the end of year 2003 and lasts a little over a year. After the end of 2003 momentum portfolios have been in their own league, especially the one based on 52-week high formation criterion.

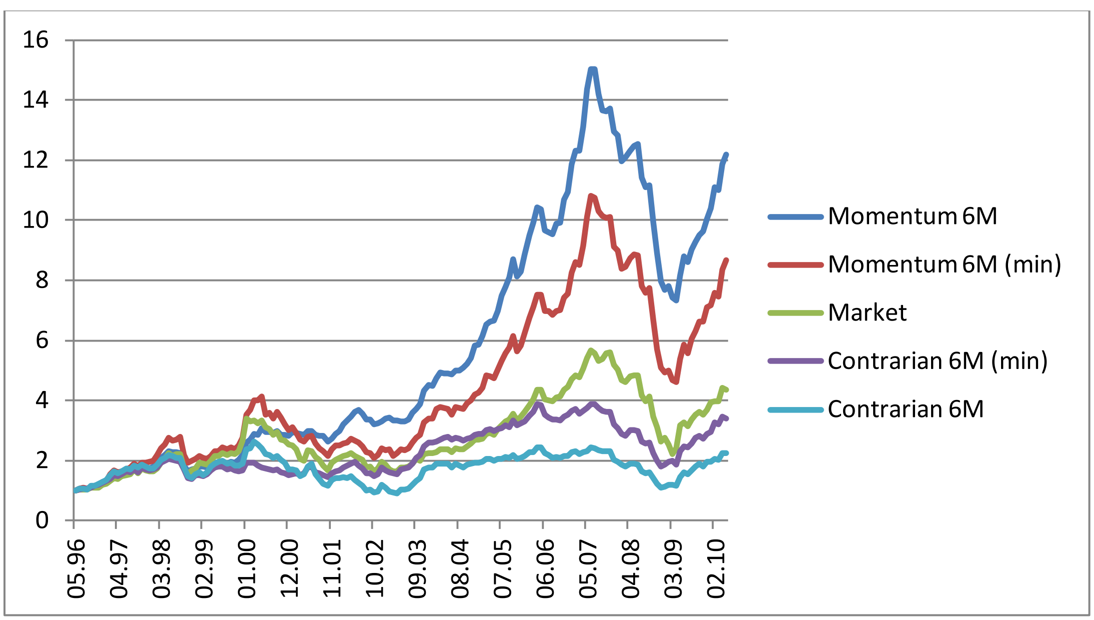

Figure 5. Portfolio price development 6 month holding period

Figure 6 presents the return indices of portfolios formed on the basis of different strategies for a longer selection period of twelve months. Again, Momentum portfolio based on 52-week high price formation criterion seems to be the strongest value creator. Other portfolios with similar price development are GARP, momentum based on 52-week low price formation criterion and value portfolio. In this comparison the gap between best performing portfolios has narrowed. Lenghtening of the time period improves the performance of contrarian strategies but they still underperform against the market portfolio. Growth portfolio belongs into the same group with them and it also underperforms against market portfolio.

Two best performing portfolios (i.e., momentum and GARP) are highly correlated with each other (correlation[7] coeffcient is 0,900 which is significant at 1 % level). Momentum (52-week low price) and value portfolios are correlated as well but their correlation coefficient is a little lower 0,846. Neighter of momentum portfolios with long holding period work as well as momentum portfolios with short holding period.

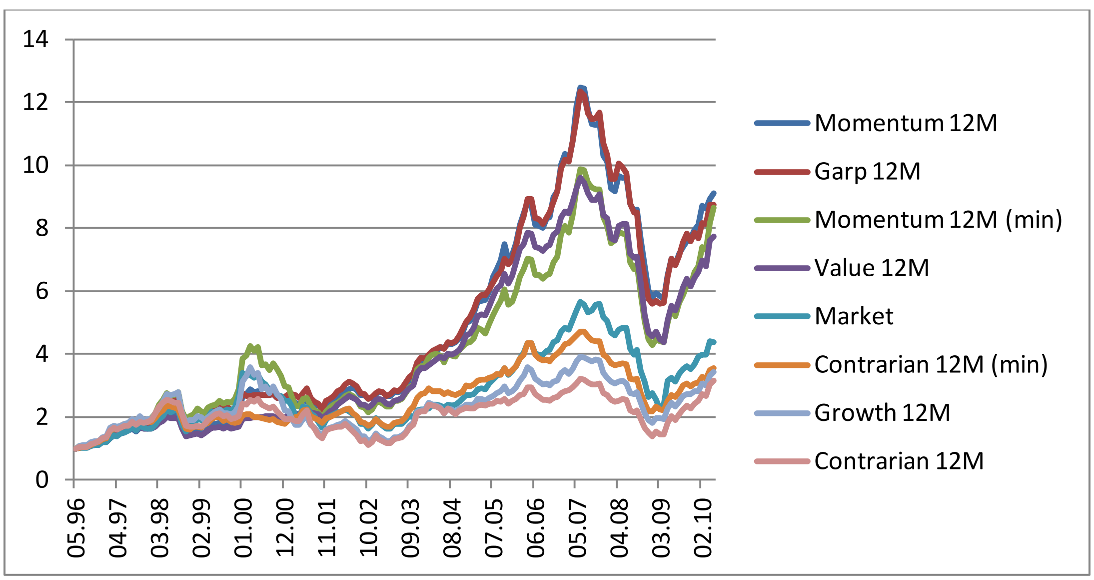

Figure 6. Portfolio value development 12 month holding period

[7] See appendix 3

For the first time, all portfolios end up above market portfolio in terms of cumulative returns in Figure 7. There is also a change in portfolios' return rank order. Momentum portfolio is no longer the best. In fact, it's only fourth in based on cumulative return ranking. GARP portfolio generates the highest return and its correlation with Value portfolio is high (correlation coefficient of 0,950, which is significant at 1 % level). Correlation between these two portfolios is especially high from the beginning of 2007 until the end of test period. Contrarian strategy seems to perform for the first time with this longest holding period as anticipated. This has also been the common result from the previous studies as well (Schiereck et al. 1999; De Bondt et al. 1985).

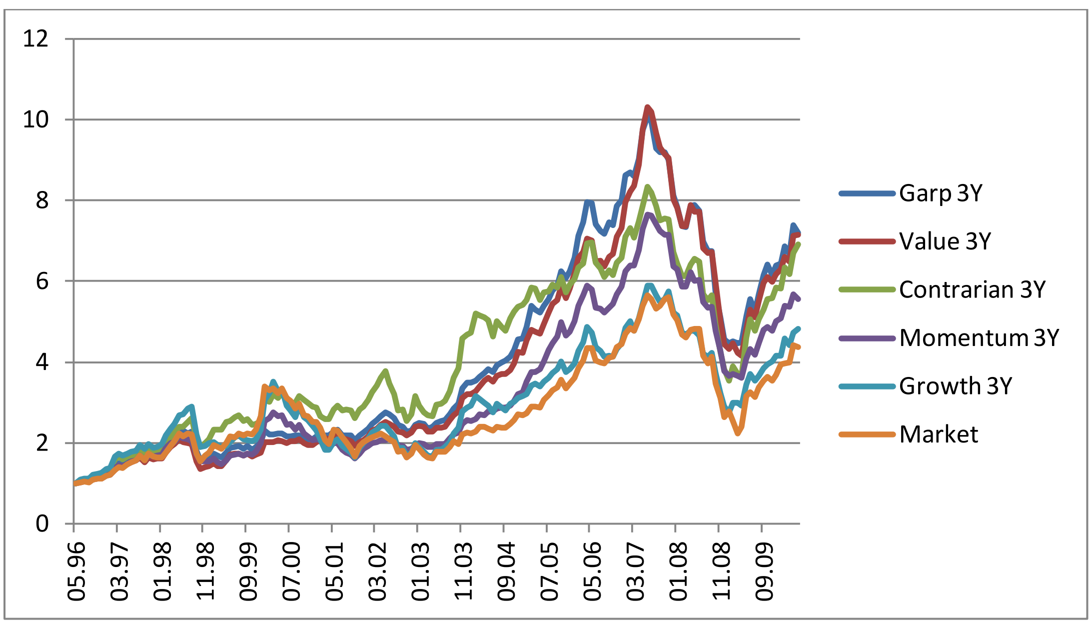

Figure 7. Portfolio price development 3 year holding period

However, cumulative returns of the best performing portfolios are lower than for shorter holding periods and correspondingly higher for the worst performing portfolios. It can be said that lengthening of the holding period makes the return differences between different strategies narrower.

6 CONLUSIONS

The main purpose of this thesis was to find out if investment strategies examined can be used to generate returns over and above the market portfolios on both absolute and risk-adjusted basis. The secondary goal was to find out if modern investment strategies like momentum, contrarian and GARP can lead to better results than so called traditional investment strategies like value and growth strategies. Strategies were evaluated on the basis of three criteria which were performance, risk and cumulative returns.

Most portfolios based on different strategies performed better than market. However contrarian strategy was exception. Four out of five contrarian strategies had inferior performance to the market portfolio. Only the one based on 36-month holding period was able to beat the market. Regarding traditional strategies, value portfolio based on both holding periods outperformed the market portfolio and only growth portfolio based on 12-month holding period underperformed against the market portfolio. Momentum portfolios formed on the basis of 52-week low price criterion and both growth strategies were riskier than the market portfolio. Momentum portfolios formed on the basis of 52-week high price criterion, GARP portfolios and value portfolios were all able to beat the market portfolio in terms of risk and performance. (Appendix 2)

Based on the results, it can't be generally said that modern investment strategies would work better than the traditional ones. Results are quite mixed within these two groups. Momentum strategy based on 6-month holding period generates the best performance and contrarian strategy based on the same holding period is the worst of all strategies. Within traditional investment strategies, value strategy was clearly the best. Lengthening of the holding period improved the performance of growth strategy more than that of value strategy. Growth strategy based on 36-month holding period performed better than the one based on only 12-month holding period. (Appendix 2).

In terms of risk the best portfolios were the middle portfolios which were built using P/E ratio as formation criterion. In this context term middle portfolio refers to portfolios between value and growth portfolios. Next best ones were momentum portfolios formed on the basis of 52-week high price criterion and contrarian strategies formed on the basis of 52-week low price criterion. Portfolios with the highest risk scores were both growth portfolios and both momentum portfolios formed on the basis of 52-week low price criterion. Most portfolios got higher SKAD compared to annual volatility meaning that return distributions were not normally distributed for most portfolios. (Appendix 2).

In terms of absolute return short-term momentum strategies dominated the results. Next best was short-term GARP strategy. Based on cumulative returns, it can be stated that momentum portfolios perform better on shorter holding period and contrarian strategies on longer holding period. However, overall performance of contrarian strategies was poor. The only one of them outperforming the market was the one with 36-month holding period. This supports the results of previous studies that longer holding periods are required in order to benefit from contrarian strategies (Schiereck et al. 1999; De Bondt et al. 1985). (Appendix 1).

In further studies these variations of the strategies employed could be tested on other regional stock markets. Also different lengths of selection and holding periods could be used to find out whether some other combination worked even better for some of the strategies employed. Extension to this study could also be the use of different portfolio-forming criteria.

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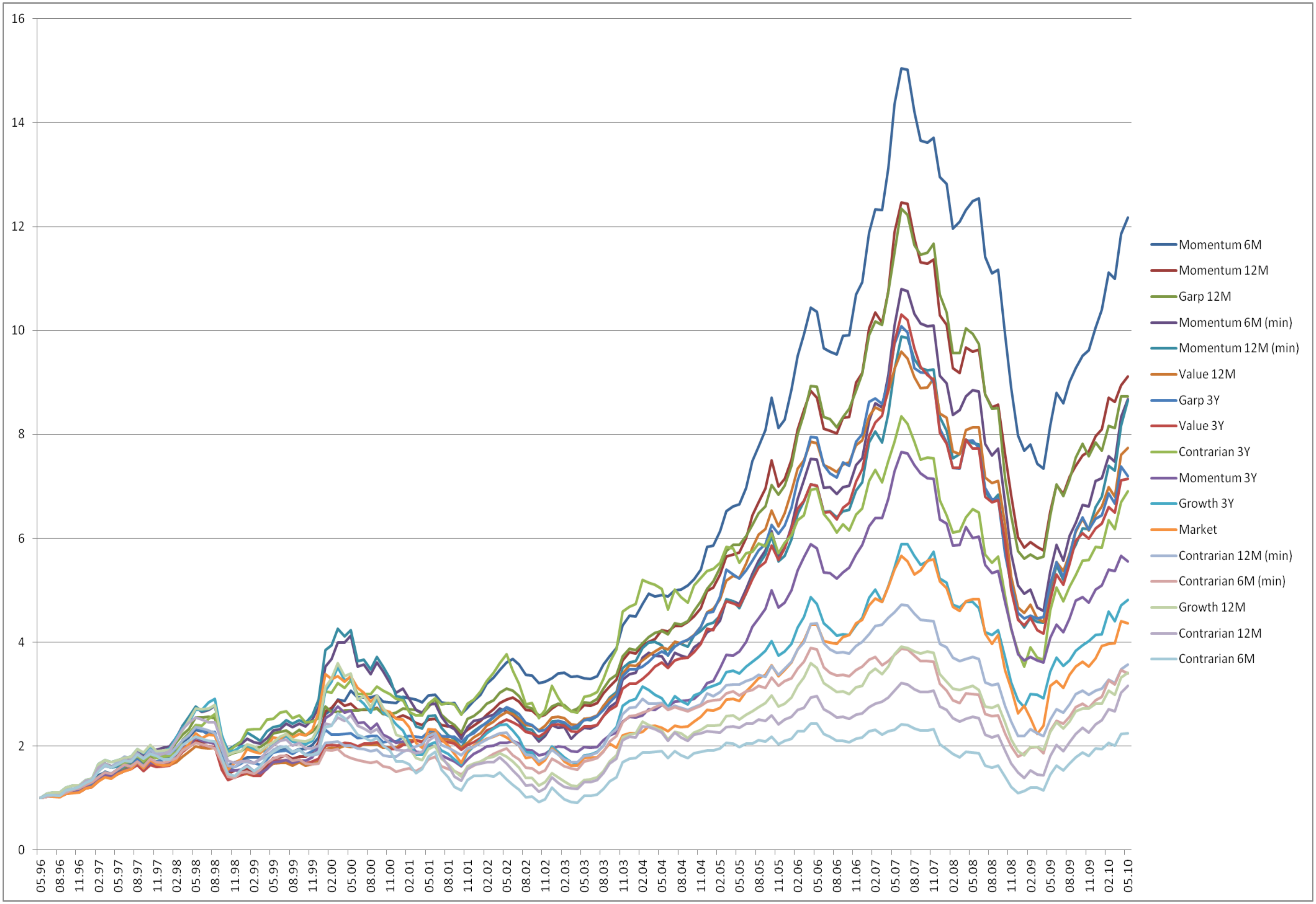
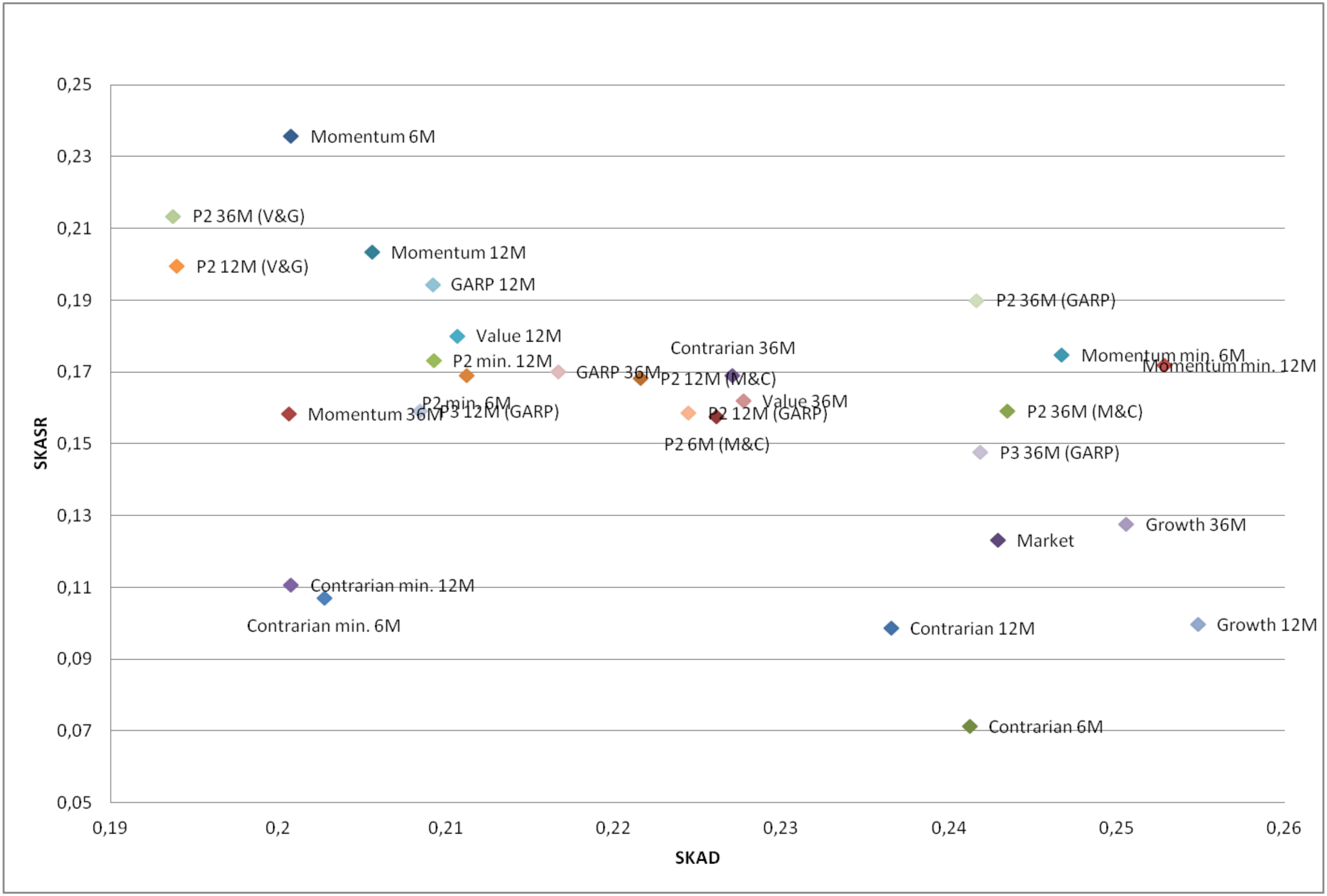
Appendix 1. Cumulative returns



Appendix 2. Performance and risk



Appendix 3. Correlation

	Contrarian 3Y	*Garp 12M*	*Garp 3Y*	*Momentum 12M*	*Contrarian 12M*	*Momentum 6M*	*Contrarian 6M*	*Momentum 12M (min)*	*Contrarian 12M (min)*	*Momentum 6M (min)*	*Contrarian 6M (min)*	*Value 12M*	*Growth 12M*	*Value 3Y*	*Growth 3Y*
Contrarian 3Y	1														
Garp 12M	0,84251906	1													
Garp 3Y	0,839504669	0,944269862	1												
Momentum 12M	0,823163002	0,899705363	0,902708333	1											
Contrarian 12M	0,90393804	0,849143297	0,8092187	0,78560665	1										
Momentum 6M	0,822269095	0,897051203	0,89645417	0,949511301	0,780741297	1									
Contrarian 6M	0,875330212	0,810145304	0,781931784	0,774038537	0,949590089	0,718101519	1								
Momentum 12M (min)	0,887692576	0,86362051	0,859594703	0,916646573	0,858448334	0,891720144	0,85468802	1							
Contrarian 12M (min)	0,867070116	0,885816316	0,870182171	0,820729263	0,906068548	0,833277324	0,870180782	0,798342561	1						
Momentum 6M (min)	0,880805346	0,886006092	0,875989142	0,91811245	0,873329582	0,912232395	0,852107374	0,971657135	0,829131398	1					
Contrarian 6M (min)	0,870221599	0,856036996	0,855665761	0,817335518	0,892315331	0,774580482	0,923270151	0,81681445	0,927080929	0,807213864	1				
Value 12M	0,8457037	0,929937085	0,933998623	0,892042433	0,840255325	0,895520226	0,813471299	0,845918762	0,896653891	0,871594719	0,886165862	1			
Growth 12M	0,907503181	0,830785475	0,813515939	0,860034723	0,908971858	0,836198422	0,898954179	0,945328409	0,846257535	0,934092894	0,836767859	0,801308526	1		
Value 3Y	0,840867393	0,925863886	0,946959911	0,909288894	0,810444422	0,898971594	0,782710848	0,855910313	0,871676377	0,879442721	0,854179377	0,962670395	0,799819626	1	
Growth 3Y	0,907935257	0,841436446	0,812140369	0,877257062	0,887103	0,851596327	0,874534571	0,931058515	0,843130532	0,921832441	0,836073769	0,807243358	0,968818005	0,794251509	1