TURUN KAUPPAKORKEAKOULU
Turku School of Economics

ABSTRACT

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Author(s)	Tommi Rinta-Kartano	Student number	417219
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Supervisor(s)	D.Sc. Erkki Vuorenmaa M.Sc. Minna Vähäsalo		

Abstract

The behavioural finance literature expects systematic and significant deviations from efficiency to persist in securities markets due to behavioural and cognitive biases of investors. These behavioural models attempt to explain the coexistence of intermediate-term momentum and long-term reversals in stock returns based on the systematic violations of rational behaviour of investors. The study investigates the anchoring bias of investors and the profitability of the 52-week momentum strategy (GH henceforward). The relatively highly volatile OMX Helsinki stock exchange is a suitable market for examining the momentum effect, since international investors tend to realise their positions first from the furthest security markets by the time of market turbulence.

Empirical data is collected from Thomson Reuters Datastream and the OMX Nordic website. The objective of the study is to provide a throughout research by formulating a self-financing GH momentum portfolio. First, the seasonality of the strategy is examined by taking the January effect into account and researching abnormal returns in long-term. The results indicate that the GH strategy is subject to significantly negative revenues in January, but the strategy is not prone to reversals in long-term. Then the predictive proxies of momentum returns are investigated in terms of acquisition prices and 52-week high statistics as anchors. The results show that the acquisition prices do not have explanatory power over the GH strategy's abnormal returns. Finally, the efficacy of the GH strategy is examined after taking transaction costs into account, finding that the robust abnormal returns remain statistically significant despite the transaction costs.

As a conclusion, the relative distance between a stock's current price and its 52-week high statistic explains the profits of momentum investing to a high degree. The results indicate that intermediate-term momentum and long-term reversals are separate phenomena. This presents a challenge to current behavioural theories, which model these aspects of stock returns as subsequent components of how securities markets respond to relevant information.

Key words	Anchoring bias, 52-week high, efficient market hypothesis, behavioural finance, limits to arbitrage
Further information	

TURUN KAUPPAKORKEAKOULU
Turku School of Economics

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Tiivistelmä

Käyttäytymistieteelliseen rahoitukseen perustuva kirjallisuus olettaa rahoitusmarkkinoilla vallitsevan systemaattisia ja merkittäviä poikkeamia tehokkuudesta, mikä johtuu sijoittajien tekemistä käyttäytymisperusteisista ja kognitiivisista virheistä. Käyttäytymisperusteinen rahoitus pyrkii mallintamaan keskipitkän aikavälin hintamomentin ja pitkän aikavälin tuottojen kumoutumisen välistä yhteyttä perustuen systemaattisiin poikkeamiin sijoittajien rationaalisesta käyttäytymisestä. Tutkielma tarkastelee hintatasoihin ankkuroitumisen aiheuttamaa vääristymää ja 52-viikon korkeimpaan arvoon perustuvan momenttistrategian eli GH-strategian tuottavuutta. Suhteellisen korkean volatiliteetin omaava OMX Helsingin pörssi soveltuu momentti-ilmiön tutkimiseen, sillä kansainvälisillä institutionaalisilla sijoittajilla on taipumus realisoida sijoituspositiot ensimmäisenä kaukaisilta osakemarkkinoilta markkinaturbulenssin aikana.

Empiirinen aineisto koostuu Thomson Reuters Datastream -aineistosta ja NASDAQ OMX Nordic -verkkosivuilta kerätyistä pistehinnoista ja markkina-arvoista. Tutkimuksen tavoitteena on luoda 52-viikon korkeimpaan arvoon perustuva nollainvestointiportfolio. Tulokset osoittavat poikkeavien tuottojen olevan vakaita tutkitulla aikavälillä. Lisäksi strategian havaitaan olevan tappiollinen tammikuisin ja poikkeavien momenttituottojen säilyvän vakaina myös pitkällä aikavälillä. Tutkimuksessa havaitaan myös, ettei ostohintoihin perustuva ankkurointimalli pysty ennustamaan GH-strategian poikkeavia tuottoja. Otettaessa transaktiokustannukset huomioon GH-strategian tuotot säilyvät tilastollisesti merkittävinä.

Arvopaperin pistehinnan ja 52-viikon korkeimman arvon välinen etäisyys on olennainen tekijä ennustettaessa momenttisijoittamisen poikkeavia tuottoja. Tulosten perusteella keskipitkän aikavälin hintamomentin ja pitkällä aikavälillä tapahtuvien hintojen kumoutumisten havaitaan olevan erillisiä ilmiöitä. Nämä havainnot ovat merkittävä haaste nykyisille käyttäytymisperusteisille rahoitusmalleille, jotka mallintavat kyseisiä osaketuottojen aspekteja peräkkäisinä osatekijöinä selittäessään sitä, miten markkinat vastaavat olennaiseen markkinainformaatioon.

Asiasanat	Ankkurointi, 52-viikon korkein arvo, tehokkaiden markkinoiden hypoteesi, käyttäytymistieteellinen rahoitus, arbitraasin rajoitteet
Muita tietoja	

Turun yliopisto
University of Turku

THE ANCHORING BIAS OF INVESTORS AND THE 52-WEEK HIGH MOMENTUM STRATEGY IN THE OMX HELSINKI STOCK EXCHANGE

Psychological Approach to Market Efficiency

Master's Thesis
in Accounting and Finance

Author:
Tommi Rinta-Kartano 417219

Supervisors:
D.Sc. Erkki Vuorenmaa
M.Sc. Minna Vähäsalo

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Table of Contents

1 INTRODUCTION 5

1.1 Background of the Thesis 5
1.2 Objectives and Research Limitations of the Study 8
1.3 Data and Sample Selection 9
1.4 Research Methods 13
1.4.1 Momentum Revenues Based on Raw Returns 13
1.4.2 Seasonality in Long-Term Momentum Returns 15
1.4.3 Anchoring Model for the Purchasing Price 16
1.4.4 Transaction Cost Analysis 18
1.5 Structure of the Study 19

2 THEORETICAL FRAMEWORK 21

2.1 Efficient Market Hypothesis 21
2.1.1 Versions of the Efficient Market 23
2.1.2 Empirical Foundations of Market Efficiency 25
2.1.3 Efficiency of the Finnish Stock Market 28
2.2 Psychology and Investing 30
2.2.1 Behavioural Finance 30
2.2.2 Heuristic Simplification 31
2.3 Anchoring and Adjustment 33
2.3.1 Anchoring Heuristic 33
2.3.2 Social Interactions and Peer Effect 35
2.4 Limits to Arbitrage 36
2.4.1 Fundamental Risk 37
2.4.2 Noise Trader Risk 38
2.4.3 Implementation Costs 41
2.5 Momentum Investing 43
2.5.1 Momentum and Reversals 44
2.5.2 Rational and Psychological Interpretations 47
2.5.3 Deteriorated Profitability in January 49
2.5.4 Liquidity Risk, Transaction Costs and Tax Efficiency 51
2.5.5 Perceptions of Market and Firm-Specific Risk Factors 53
2.6 52-Week High Momentum Investing 55
2.6.1 The 52-Week High Strategy 55
2.6.2 Efficacy and Proxy Indicators for Abnormal Returns 58
2.7 Hypotheses Formulation 61

3 EMPIRICAL RESULTS 65
3.1 Momentum Revenues Based on Raw Returns 65
3.2 Comparison of the JT and the 52-week High Momentum Strategies 67
3.3 Seasonality in Long-Term Momentum Revenues 69
3.4 Robustness 72
3.5 Anchoring Model for Purchase Price 75
3.6 Transaction Costs 77
4 SUMMARY AND CONCLUSIONS 80
REFERENCES 84
APPENDIX 1 THE DISPOSITION EFFECT 93

List of Figures

Figure 1 Cumulative abnormal returns before takeover attempts (Keown & Pinkerton 1981, 861) 26
Figure 2 Stock price reactions to CNBC reports (Busse & Green 2002, 422) 27
Figure 3 Prospect theory value function (Kahneman & Tversky, 1979) 94

List of Tables

Table 1 Summary statistics on the OMX Helsinki stock exchange 11
Table 2 Momentum portfolio returns 65
Table 3 Pairwise comparisons of the 52-week high and the JT momentum strategies 68
Table 4 Long-term reversals and the January effect 69
Table 5 Post holding period returns of winner, loser and momentum portfolios ... 70
Table 6 Long-term momentum returns in subperiods 73
Table 7 Comparison of the 52-week high and the reference price strategies 76
Table 8 Estimates of trading costs for the momentum strategies 78

1 INTRODUCTION

1.1 Background of the Thesis

Investors' thinking about financial markets has been guided by the theory of market efficiency for over four decades. The efficient market hypothesis (EMH henceforward) was first introduced by Fama (1970) to demonstrate that information available about a capital asset is entirely reflected in the price of that asset. This means that active traders should find it difficult to outperform passive strategies, such as holding market indexes. Therefore, abnormal returns would require differential insight, which is difficult to acquire in a highly competitive market. The EMH became extensively accepted among researchers in relatively short order. For example, Jensen (1978a, 95) asserted that the EMH has the most solid empirical evidence supporting it. Indeed, the EMH has been extensively and successfully tested examining the stock price data of publicly traded securities (Fama, 1970; Jensen, 1978a). The theory yet continues to serve as a basis for regulatory policy institutions and investment strategies.

In previous decades, scholars and investors have had a growing loss of confidence in the EMH (Malkiel, 2003) as stock prices misled them radically and frequently from intrinsic values. Especially, the recent developments of financial market, such as the subprime crisis, have opened the door to other theories as explanations for asset pricing. The most apparent of which is behavioural finance, assuming that investors' irrationality interferes with the correctness of security prices (Akerlof & Shiller 2009, 171–173). In other words, the behavioural finance literature expects systematic and significant deviations from efficiency to persist while explaining the anomalies of the EMH and generating new predictions.

Multiple studies have documented significant evidence that stock prices do not follow random walks and that returns are predictable. The most famous of which was introduced by Jegadeesh and Titman (1993), who argue that stock returns exhibit momentum behaviour at intermediate horizons. They demonstrate the effectiveness of an active portfolio strategy, which buys the top 10% and sells the bottom 10% of stocks ranked by returns over the past six-month period. The strategy yields profits of 1% per month by holding a portfolio generated in accordance to these terms for six months. In this study, the strategy is referred to as the JT momentum strategy. Later studies show that the momentum effect is followed by reversals in stock returns (De Bondt & Thaler, 1985; Lee & Swaminathan, 2000; Jegadeesh & Titman, 2001). This means that poorly performed stocks in the past have a tendency to perform better over the following 3 to 5 years.

Multiple theoretical models attempt to explain the coexistence of intermediate-term momentum and long-term reversals in stock returns based on systematic violations of investors' rational behaviour (Barberis, Shleifer & Vishny, 1998; Daniel, Hirshleifer & Subrahmanyam, 1998; Hong & Stein, 1999). These models can be divided into two different interpretations of the phenomenon. The first interpretation is that momentum occurs, since investors are slow to reconsider their prior beliefs when new information becomes available (Barberis, Shleifer & Vishny, 1998; Hong & Stein, 1999). Consequently, long-term reversals occur when investors eventually adjust, they tend to overreact to that information. The second interpretation is that momentum occurs due to investors overreacting to prior information when it is confirmed by new information; therefore, reversals occur when the overreaction is corrected in long-term (Daniel et al., 1998). These models interpreting the momentum effect are analogical in terms that intermediate-term momentum and long-term reversals are subsequent components of how security markets process new information.

George and Hwang (2004) find that an easily accessible 52-week high price statistic explains the profits from momentum investing. They argue that favourable new information has recently become available for a stock with a price level at or near its 52-week high. The models above support this approach in explaining momentum, since they predict that investors are slow to react to relevant information. They discover that profits to a momentum strategy formulated based on a stock price's nearness to the 52-week high is superior compared to those in which the arrival of information is measured by a return computed over a fixed-length interval in the past. This leads to a notion that the 52-week high is a more suitable predictor of investors' under reaction to relevant information, since the stock price resolves without long-term price reversals when the initial under reaction is recognized.

The description is consistent with the anchoring bias in Kahneman, Slovic and Tversky (1982, 14–20). They asked subjects to estimate a quantity, such as the number of African nations in the UN, as an increment to a randomly generated number. Their results illustrate that estimates are higher for subjects who are shown higher random numbers, and vice versa. Similarly, George and Hwang's (2004) results indicate that investors might use the 52-week high statistic as an anchor when evaluating the increment in a stock price suggested by new information.

Momentum profits may reverse in January due to the tax-loss selling of loser stocks or window dressing in December, which is followed by the subsequent recovery in values of those stocks in the following January. Jegadeesh and Titman (1993, 2001) document negative returns of the JT strategy in January. By contrast, Moskowitz and Grinblatt (1999) discover that winner industries outperform loser industries regardless of the January effect. Finally, George and Hwang (2004) find that the 52-week high

strategy (GH henceforward) generates higher returns in calendar months outside of January, and significantly negative return in January.

It is critical that anomalies in financial markets pass the out-of-sample test in order to show that the results are not subject to data mining. Although the JT strategy has been extensively studied with international data, only a few papers have studied the GH strategy in international stock markets despite the fact that the 52-week high values of individual stocks are available without difficulty around the world. As an illustration, the 52-week high statistic is available for stocks listed on the Finnish stock exchange from the *Financial Times website*.

To exemplify the international studies regarding the GH strategy, Marshall and Cahan (2005) find remarkable profits for the GH strategy in the Australian stock market. As an illustration of proxy indicators, the high volume stocks appear to drive the winner portfolio profits in various stock markets; however, they do not examine whether the GH profits reverse in long-term. In the perspective of price reversals, Du (2008) finds that the GH profits reverse in long horizons using 18 stock market indices, whereas Alsubaie and Najand (2008) discover short-term price reversals instead of price continuation after stocks reach their 52-week high in the Saudi stock market. Consistent with the initial findings, Burghof and Prothmann (2009) demonstrate that the GH strategy is profitable in the UK market and that the profit is correlated with information uncertainty, which demonstrates that the winner portfolios yield higher returns and the loser portfolios generate lower returns with a higher degree of information uncertainty. Finally, Liu et al. (2011) investigate the GH strategy in 20 major stock markets finding that the 52-week momentum effect is robust in international markets, and the 52-week high statistic for a stock is a better predictor of future stock returns than its acquisition price or the macroeconomic risk factors.

Regardless of the aforementioned findings, the 52-week high statistic may be in the dominant role of explaining the January effect and the abnormal momentum profits to the extent that investors use the 52-week high as an anchor in valuing the potential impact of new information (George et al., 2004). The major inconsistency among academic papers is with respect to the existence of subsequent reversals to price momentum, which questions the validity of the behavioural models (Barberis et al., 1998; Daniel et al., 1998; Hong et al., 1999), interpreting the momentum effect and price reversals as subsequent components. Also, a sizable number of studies have discovered that momentum profits may not be significant in most security market when transaction costs are taken into account, which leads to a question whether the abnormal returns of momentum investing are only a statistical fluke in stock prices (Carhart, 1997; Grundy & Martin, 2001; Korajczyk & Sadka, 2004; Liu et al., 2011).

In brief, as the securities markets are predicted to be competitive enough, the EMH argues that only investors with differentially superior investment strategies based on

publicly unknown insight should be able to earn abnormal profits. Furthermore, the margin of superior profits earned by professional managers is commonly difficult to detect in long horizon, which is why the use of active investment strategies might not be justified. However, the existence of momentum profits has been extensively studied to falsify this statement in international stock markets. Especially, the OMX Helsinki stock exchange is an appealing target market for testing the GH strategy insofar as the Finnish stock market is prone to an intermittent 'periphery syndrome,' which occurs due to international institutional investors realizing their positions from the furthest stock markets when the markets are subject to high volatility (Leivo & Pätäri, 2011). In more detail, the combination of the periphery syndrome and the relatively low liquidity of the OMXH result in steeper price fluctuations compared to the major stock exchanges. Therefore, the study will test the efficacy and the long-term seasonality of the GH strategy in the Finnish stock market, since greater opportunities to earn abnormal profits should exist in comparison to the major stock markets. In addition, the study also seeks to investigate whether a model based on the acquisition price of a stock as an anchor succeeds in predicting momentum in stock prices without long-term reversals, and whether the efficacy of momentum investing truly remains significant after transaction costs are taken into account.

1.2 Objectives and Research Limitations of the Study

This thesis studies the anchoring bias of investors and the profitability of the 52-week high momentum strategy (GH henceforward) in the Finnish stock market. The objective of this thesis is to provide a thorough research on the matter by forming a zero investment portfolio based on the GH strategy. Thereby, this thesis participates to the ongoing debate on the efficiency of security markets by testing the successfulness of momentum strategies in the Finnish stock exchange. Another objective is to further investigate whether the anchoring bias of investors is statistically significant when it comes to the profitability of momentum investing.

In order to fulfil the objectives of the study, several problems need to be taken into consideration. First, the interpretation of the results may remain inadequate without the comparison of the momentum strategies; therefore, JT momentum profits are also calculated for the purpose of comparison. Second, previous studies have demonstrated decreased profitability of momentum strategies in January. Hence, the seasonality of the GH strategy is investigated by taking the January effect into account. Third, the anchoring effect of investors has been reported to explain the momentum effect, which is why the acquisition price and the 52-week high value of an individual stock are investigated whether they serve as descriptive predictors of future returns in the OMX Helsinki stock

exchange. Finally, the profitability of momentum portfolios is examined after taking the limits to arbitrage into consideration.

Based on the aforementioned notions, the following sub-questions have been formulated to address the objectives of the study:

- What is the outcome of using the 52-week high strategy in the Finnish stock exchange?
- How does the abnormal returns of the 52-week high strategy fluctuate in long-term?
- What is the relevance of the January effect to the 52-week high strategy?
- What anchors investors use when conducting investment decision-making processes in the Finnish stock exchange?
- How limits to arbitrage affect the profitability of the 52-week high strategy?

The efficient market hypothesis and a few theories of behavioural finance are covered to establish an extensive understanding of the rationality of investors. As behavioural finance consists of multiple theories based on the irrationality of investors, it is essential to include only the most influencing theories to form sufficient understanding of the psychological biases related to momentum investing. Only momentum strategies are included in this study to investigate the profitability of such active portfolio strategies.

1.3 Data and Sample Selection

The behavioural finance theory proposes that stock markets are prone to systematic errors in stock prices if irrational investors are subject to psychological biases. Thereby, this study seeks to discover whether the 52-week high can be used to forecast systematic mispricing in the future returns of stocks, which depends on investors' tendency to use the 52-week high statistic as an anchor to value the potential impact of new information to stock prices. This market behaviour is utilized by forming a non-investment portfolio on the grounds of the GH strategy. For the purpose of comparison, also JT strategy and a strategy based on acquisition prices are examined. This follows that momentum profits of the momentum strategies are adjusted for transaction costs. To address the purposes of this study, the empirical sample comprises common stocks listed on the OMX Helsinki stock exchange. Prior literature has studied the JT and the GH strategies for most of the significant foreign stock exchanges, including the developed countries and a few emerging markets, but not in the relatively volatile, illiquid Finnish stock market.

In spite of the fact that market information is widely available for the OMX Helsinki stock exchange from various data sources, the data collection process has not occurred

without facing obstacles. Thereby, this study relies on various data sources to collect the needed types of data: the Thomson Reuters Datastream database and the NASDAQ OMX Nordic website. The first phase of this study consists of examining the GH and the JT strategy. For this purpose, adjusted closing prices and market capitalization for individual stocks are collected on a monthly basis from Thomson Reuters Datastream. Both listed and delisted stocks are included in the sample to improve the statistical reliability of the empirical data. The sample of companies listed in the OMX Helsinki stock exchange consists of 194 companies of which 65 are delisted, gone bankrupt or have delisted from the stock exchange due to a merger.

The author was not able to have a further access to Datastream, which is why also the NASDAQ OMX Nordic website is used as a secondary data source. As the latter phases of the empirical part include examining the purchase prices of stocks as anchors and defining the average transaction costs related to momentum investing, the empirical data is extended to the adjusted daily closing prices of the companies listed in the OMX Helsinki stock exchange. However, the manual data collection from the website is limited, since the data source covers no information on delisted companies. Thereby, the sample collected from the website concludes 129 companies listed on the stock exchange.

The sample period of this thesis is from January 1998 until June 2011. This period is chosen as it consists of both market peaks and market crashes in a relatively short time period. These significant market fluctuations have been regarded to be somewhat influenced by market psychology and irrational investor behaviour in terms of various market crises. The other reasons for selecting this time period are due to the fact that the stock market data is widely available through the data sources, and a strong interest to investigate whether psychological biases have had an impact on the OMX Helsinki stock exchange in the 21st century. The common statistics for the OMX Helsinki stock market are illustrated in Table 1.

Table 1 Summary statistics on the OMX Helsinki stock exchange

This table reports the sample period, the number of stock at the end of each period, the average monthly returns and the standard deviation of monthly returns for the OMX Helsinki stock exchange. The data is obtained from both Datastream and the NASDAQ OMX Nordic website. A firm whose market capitalization is below 5% of all stocks in each month is excluded within the market. Furthermore, a stock whose monthly return is below the 1 percentile or above 99 percentile of the return distribution is excluded in each month. The number of stocks is required to be greater than 100 in each month of the sample. "No. of Stocks" is the number of firms at the end of each sample period as of January 1998. Monthly logarithmic returns are reported in euros and are demonstrated as percentages. The last four columns display the average monthly equal-weighted (EW Mean) and value-weighted (VW Mean) returns, and also standard deviations ("EW Std" and "VW Std") of all stocks in each period. The weights in value-weighted returns in each month are calculated on the grounds of firm market capitalization at the end of the previous month.

Sample Period	No. of Stocks	EW mean	EW std	VW mean	VW std
1998.1–1998.12	121	-4.55	12.32	3.73	9.55
1999.1–1999.12	145	1.91	12.76	7.67	9.56
2000.1–2000.12	149	-1.96	14.51	-1.33	8.15
2001.1–2001.12	148	-1.49	15.19	-4.18	12.25
2002.1–2000.12	145	-1.73	11.78	-4.05	8.07
2003.1–2000.12	138	2.55	10.84	0.09	5.69
2004.1–2000.12	133	0.74	8.05	-0.15	6.76
2005.1–2000.12	133	1.80	7.60	2.23	5.30
2006.1–2000.12	135	1.21	8.13	1.19	5.16
2007.1–2000.12	132	-0.47	8.87	1.49	5.98
2008.1–2000.12	127	-5.62	10.91	-6.86	9.08
2009.1–2000.12	125	2.74	10.37	0.95	8.39
2010.1–2000.12	122	1.05	7.68	1.14	6.78
2011.1–2011.6	121	-1.12	8.60	-2.45	7.12
Pooled Sample		-0.03	10.80	0.05	7.72

Table 1 displays the sample period and the number of stocks in the OMX Helsinki stock exchange as of January 1998. A requirement is set that the market needs to include at least 100 stocks in each month as the Finnish stock market consists of only 121 stocks at the end of the sample period. This is a relatively small number of stocks in comparison to the most populated stock markets. The equal-weighted and the value-weighted average monthly returns and their standard deviations are reported in the last four columns. The returns are calculated in euros and reported as percentages. The equal-weighted monthly returns range from -5.62% to 2.55%, and the value-weighted returns range from -6.86% to 7.67%. The high degree of significant market fluctuations is explained with the fact that the sample period concludes the ".com" bubble burst, the subprime crisis and the European debt crises. Especially the OMXH plummeted due to the subprime crisis, which is demonstrated by significantly deteriorated market returns in 2008. Thereby, the OMXH earns the lowest equal-weighted and value-weighted returns as compared to the international sample in Liu et al. (2011), which does not account for the crises. In addition to the significantly low revenues during the sample period, the Finnish stock market is among the most volatile markets regarding the standard deviations of both the equal-weighted and the value-weighted monthly returns. For the market, standard deviations range from 7.60% to 15.19% for the equal-weighted returns and 5.16% to 12.25% for the value-weighted returns. In general, the OMXH exhibits

similar volatility as emerging markets for which small-cap stocks account to a high degree.

Quality issues are not unusual for international and national stock market data, which is why the procedure introduced in Ince and Porter (2006) is followed. Based on the procedure, other investment instruments but stocks are excluded from the data sample. In addition, all monthly observations are deleted from the end of the sample period until the first month with a nonzero return, and also identify this month as the last trading month of the stocks. June 2011 is designated as the final month; therefore, the subprime crisis and the European debt crisis are taken into account regardless the fact that it may skew the statistics. Finally, the extreme values are filtered based on a procedure. This means that stocks, which are below 5% in terms of market capitalization, are excluded in the data every month, and assign returns as missing for any stocks below the 1% or above 99% of the return distribution in each month (Hong et al., 2003).

The adjusted closing prices collected from the data sources have been amended to account for splits and changes in share capital, dividends and other value relevant transactions. It is often used as a tool when examining historical returns, since it gives an accurate representation of a firm's equity value beyond the market price. The returns are calculated as logarithmic differences, which are regarded as more suitable for financial research. Especially, the logarithmic returns have favourable attributes for examining historical prices, since they are more normally distributed and symmetrical as compared to arithmetic returns. The equation for the logarithmic return is as follows (Vaihekoski 2004, 193–194)

$$r_{i,t} = ln \frac{P_{i,t} + D_{i,t}}{P_{i,t-1}}, \tag{1}$$

where r_t is the logarithmic return, ln is the natural logarithm, P_t is returns at time period t after the dividend, P_{t-1} is returns at time period $t-1$ prior to the dividend, and D_t is the dividend at time t for a stock i. The data is first processed in Microsoft Excel to improve the data based on the aforementioned procedures. This follows that the processed and modified returns are analysed in Stata, which includes functionality to correct autocorrelation and heteroscedasticity in regression analysis. The Stata 'xtfmb.ado' file is employed, which is provided by Daniel Hoechle, for the Fama-MacBeth regressions throughout the empirical part in this paper.

1.4 Research Methods

1.4.1 Momentum Revenues Based on Raw Returns

This study examines the profitability of the GH strategy. Although the strategy has been examined in multiple foreign markets, this study presents a comprehensive view on whether the strategy is profitable in the Helsinki stock exchange. For the purpose of comparison, this study commences the analysis by looking at the JT strategy within the Finnish stock market. Conventionally, formulating winner and loser portfolios on the grounds of past twelve-month returns implement the JT strategy in which the top 10% are assigned as winners and the bottom 10% as losers. A zero-cost JT portfolio is then constructed with equal weights in each stock, where the purchase of the winner portfolio is financed by simultaneously short selling the loser portfolio. The resulting JT momentum portfolio is then held for the following K-month holding period without rebalancing. (Jegadeesh et al., 1993.)

Under the modified momentum approach, the JT momentum strategy is followed with an exemption that the winner portfolio contains the top 30%, and the loser portfolio consists of the bottom 30% of stocks. The use of the top and bottom 30%, as opposed to 10%, of stocks is in parallels with the 52-week high literature. Specifically, stocks are ranked in ascending order on the grounds of their individual discrete buy-and-hold returns over a J-month formation period. Based on the ranking, portfolios P_1 and P_3 are created, where P_1 refers to the portfolio of stocks with the 30% lowest J-month formation period returns, and portfolio P_3 consists of the 30% highest J-month formation period returns. Consistent with the literature on the GH strategy (George et al., 2004) and the JT strategy (Jegadeesh et al., 1993), the analysis of this study focuses on the six-month formation and holding period strategy. Furthermore, this study employs rolling monthly windows when creating formation and holding periods to strengthen the statistical power of the resulting analysis.

The raw profits from the equal-weighted, zero-cost momentum portfolio are calculated according to

$$R_{BHR_{P_3\text{-}P_1}} = R_{BHR_{P_3}} - R_{BHR_{P_1}}, \tag{2}$$

where

$R_{BHR_{P3\text{-}P1}}$ = the buy-and-hold raw profit from the momentum portfolio over the holding period

$R_{BHR_{P1}}$ = the buy-and-hold return to the loser portfolio over the holding period

$R_{BHR_{P3}}$ = the buy-and-hold return to the winner portfolio over the holding period

The 52-week high investing strategy (GH henceforward) is implemented following the method used in George and Hwang (2004). To examine the profitability of the zero-cost investment portfolio formulated by the GH strategy, this study follows a similar approach to the modified JT momentum strategy. Thereby, individual stocks are ranked based on the ratio of the current price to the past 52-week high at the end of each month, and a zero-investment portfolio is then formulated by purchasing the top 30% and short-selling the bottom 30% of stocks. Specifically, stocks are ranked in ascending order according to

$$52\text{-}week\ ratio = \frac{P_{i,\,t-1}}{high_{i,t-1}}, \tag{3}$$

where the ratio of the proximity of a stock's price to its 52-week high is calculated by dividing the closing price of stock *i* at the end of month, $P_{i,t-1}$, by the highest price of stock *i* over the previous 12-months, $high_{i,t-1,}$, where the 12-month period ends on the last day of month *t-1*.

Based on this ranking, the stocks are sorted into three portfolios, P_1–P_3, where portfolio P_1 consists of the 30% of stocks whose prices are the furthest, and P_3 concludes 30% of stocks whose prices are the closest to their 52-week high price. This is followed by the formulation of a zero-cost, equally weighted 52-week high momentum portfolio, where the purchases of P_3 are financed with the simultaneous short sale of P_1. Following the method used in George and Hwang (2004), the resulting portfolio is then held for the following six months without rebalancing. Their results indicate that the results based on six-month holding periods do not significantly differ from the results when 12-month holding periods are used.

The buy-and-hold average returns are used from the winner and the loser portfolios to calculate the raw profit from the 52-week high momentum portfolio, which is defined by

$$R^{52wk}_{BHR_{P3\text{-}P1}} = R^{52wk}_{BHR_{P3}} - R^{52wk}_{BHR_{P1}}, \tag{4}$$

where

$R^{52wk}_{BHR_{P3\text{-}P1}}$ = the buy-and-hold raw profit from the GH portfolio over the holding period

$R^{52wk}_{BHR_{P3}}$ = the buy-and-hold return to the GH winner portfolio over the holding period

$R^{52wk}_{BHR_{P1}}$ = the buy-end hold return to the GH loser portfolio over the holding period

The strategy is to hold a self-financing portfolio in which long positions are taken in the winner and short the loser portfolios. Portfolios are equal-weighted, since the smallest companies need to be given equal weight to the largest companies. To abstract from bid-ask bounce, a month is skipped between ranking and holding periods in regression tests. The winner and loser portfolios are held for six months, and the equal-weighted average monthly returns are calculated from six separate winner and loser portfolios each month.

1.4.2 Seasonality in Long-Term Momentum Returns

The behavioural literature is mostly motivated by the evidence, which suggests that the post holding period returns in longer horizon may be negative, indeed. Thereby, a great number of hypotheses have been proposed to explain the profitability of momentum strategies in long-term. This section investigates whether the performance of momentum portfolios is prone to price reversals over longer horizons to differentiate among behavioural interpretations. This follows that the returns of the portfolios are examined in the periods following the portfolio holding periods.

To interpret the overreaction in long horizon and the intermediate-term momentum, Barberis et al. (1998) introduce a model, which combines conservatism bias with what Tversky and Kanheman (1974) refer to as the representative heuristic. The model argues that investors may mistakenly come to a conclusion that firms realizing abnormal earnings will continue in the future. Although the conservatism leads to under reaction when observed in isolation, together with the representative heuristic it may lead to significant negative returns in long-term for stocks with consistently favourable returns in the past. Daniel et al. (1998) propose an alternative model in which informed investors suffer from a self-attribution bias. This follows that they attribute the performance of ex post winners to their stock selection skills and that of the ex post losers to poor luck, which results in investors becoming overconfident about the precision of their signals for these stocks. Thereby, the momentum profits are driven by the delayed overreaction of investors, which is followed by price reversals to their fundamentals when the market recognizes the overreaction. Finally, Hong and Stein (1999) argue that the momentum is driven by the informed investors who obtain signals about future cash flows while ignoring information in the history of prices. This information is transmitted with a delay, since the signals are only partially incorporated in the prices until enforced by investors who trade based on the limited history of prices instead of observing fundamental information. These models are in parallels regarding the fact that prices eventually revert to their fundamentals, which is referred to as price reversals.

To test these models, the returns of the momentum portfolios are examined following the initial formation date. Although the models do not provide information on the length of the post holding period when price reversals are expected, Jegadeesh and Titman (2001) examine momentum portfolio returns up to five years after the formation of the portfolio. Thereby, this study examines the post holding period returns on an annual basis over the time period of five years after the portfolio formation.

Momentum profits may reverse in January due to the tax-loss selling of loser stocks, or windows dressing in December and the subsequent rebound of the same stocks in the following January. Jegadeesh and Titman (1993, 2001) find significant seasonality in the momentum profits of the JT strategy. In particular, the winner portfolios outperform loser portfolios in all months except for January, when the JT strategy is prone to significant negative returns. Similarly, George et al. (2004) find that the 52-week high strategy earns significant returns in calendar months excluding January, and utterly negative returns in January. This study examines whether this reported seasonality is only a statistical fluke. If tax-loss trading tends to drive temporal return relations at certain times of the year, it is not possible to uncover them without isolating these effects by season. Thereby, the out-of-sample performance of the momentum strategies is examined in January and outside of January to test whether this seasonality exists in the OMX Helsinki stock exchange.

1.4.3 Anchoring Model for the Purchasing Price

George et al. (2004) suggest that the predictability of the 52-week high strategy is subject to the anchor-and-adjust bias, which is a cognitive bias affecting investors' investing decision-making process. Similarly, the anchoring model in Grinblatt and Han (2002) assumes that the anchor is the price at which investors acquire shares. The model predicts momentum behaviour for stocks when their prices are at or near a long-term high or low reference price. This study further examines whether the acquisition price or the 52-week high price is a suitable predictor of future momentum returns.

The main assumptions in Grinblatt and Han's (2002) model are that irrational investors dislike recognizing losses on their trades and that the demands of entirely rational investors are price elastic. This follows that the irrational investors' demand functions are negatively dependent on imbedded capital gains, which affects market prices. The authors predict that momentum behaviour occurs in the market when a stock's price is near to its long-term high or low value. This prediction leads to the following intuition that the stock's market price appreciates above the price at which irrational agents acquired the share in case of favourable news. This will understate the full impact of the news on fundamental values, since irrational investors have a greater selling pressure

than in a rational market. Thereby, a stock at or near its long-term high is more likely to have experienced favourable news in the past, and to be trading above acquisition prices. This leads to an assumption that the current price will not fully reflect the impact of news on fundamentals. This behaviour results in momentum if the market price further increases until it converges with its fundamental value. By contrast, if a stock has suffered losses in the past or is near its long-term low, the stock price tends to be higher than in a rational market. Consequently, momentum occurs when the market price continues to decline until it converges with its fundamental value.

Based on Grinblatt and Han's (2002) model, stocks are ranked based on their embedded capital gains, which are measured with the reference price (RP)

$$RP_t = \frac{V_{t-1}(1-V_t)P_{t-1}+V_{t-2}\left(1-V_{t-1}\right)(1-V_t)P_{t-2}+ \ldots +V_{t-24}\left(1-V_{t-23}\right)\ldots(1-V_t)P_{t-24}}{V_{t-1}(1-V_t)+V_{t-2}\left(1-V_{t-1}\right)(1-V_t)+ \ldots +V_{t-24}\left(1-V_{t-23}\right)\ldots(1-V_t)}, \quad (5)$$

where P_t is the price at the end of month t, and V_t is the stock turnover in the same month. Although George and Hwang (2004) and Grinblatt and Han (2005) measure the reference price as a weighted average of prices over the past 60 months, a considerable portion of the stocks in this study's sample does not have comparable shares' outstanding data at the NASDAQ OMX Nordic website. To ensure that there are enough samples in the following empirical analysis, the reference price is measured as a weighted average of prices over the past 24 months, which is in parallels with the procedure in Liu et al. (2011, 197).

The Fama-Macbeth (1973) method is used to analyse the relation among stock returns and selected proxy variables. All proxy variables are included simultaneously as in Equation (6), since the combination of the proxy variables rather than a single variable can characterize a distribution more accurately. As the portfolio at month t is constructed using six winner and loser portfolios ranked in month $t - j$ (j = 2, ..., 7), a set of six cross-sectional regressions is implemented in each month. Following the approach introduced by George and Hwang (2004), dummy variables $RPH_{i,t-j}$ and $RPL_{i,t-j}$ are defined for the RP strategy on the grounds of stock embedded capital gains relative to the reference price as follows: $RPH_{i,t-j}$ takes value 1 if stock i's embedded capital gain is in the top 30% on the formation month $t - j$ (j = 2, …, 7), whereas $RPL_{i,t-j}$ takes value 1 if stock i's embedded capital gain is in the bottom 30%, and 0 otherwise. Finally, regression analysis is implemented to compare the GH and the RP strategies, which allows taking the effect of other variables affecting stock returns into account. These other variables include firm size and stock return in the previous month. Following the approach in George and Hwang (2004), the following Fama and Macbeth (1973) cross-sectional regression for individual stocks is calculated every month in the OMX Helsinki stock exchange

$$R_{it} = b_{0jt}+b_{1jt}R_{i,t-1}+b_{2jt}lnsize_{i,t-1}+b_{3jt}GHH_{i,t-j}+b_{4jt}GHL_{i,t-j}+b_{5jt}RPH_{i,t-j}+b_{6jt}RPL_{i,t-j}+e_{it}, \quad (6)$$

where R_{it} and $R_{i,t-1}$ are stock i's return in months t and $t-1$, and $size_{i,t-1}$ is the market capitalization of stock i in month $t-1$. $GHH_{i,t-j}$ is the 52-week high winner indicator variables, which takes value 1 if stock i is ranked in the top 30% on month $t-j$, and 0 otherwise. By contrast, $GHL_{i,t-j}$ is the 52-week high loser indicator variable, which takes value 1 if stock i is ranked in the bottom 30%. $RPH_{i,t-j}$ and $RPL_{i,t-j}$ are RP winner and loser indicator variables defined on the grounds of the embedded capital gains in relation to a reference price, which is a weighted average of prices over the past 24 months. The coefficient estimates of an independent variable are the average of six ($j = 2, \ldots,7$) estimates. Fama (1976) argues that the coefficient estimate b_{0jt} can be interpreted as the return to a neutral portfolio, which has hedged out the effects of bid-ask bounce, size and momentum identified by the two strategies. In addition, the GH winner stock coefficient estimate, b_{3jt}, can be interpreted as the return in excess of b_{0jt}, which can be earned by taking a long position in the GH winner portfolio. Similarly, the remaining coefficient estimates have similar interpretations. The error term, e_{it}, contains the cross-sectional variation across stocks in month t, which is not captured by the proxy variables. The outcome of this analysis will show the time-series average of the month-by-month estimates of these coefficients and associated Newey-West adjusted t-statistics. The difference between the GH and the RP winner and loser dummies represent the return from a zero-investment portfolio, which takes a long position in winners and shorts losers after controlling for other explanatory variables.

1.4.4 Transaction Cost Analysis

Transaction cost estimates are not available without difficulty in the Helsinki stock exchange. Thereby, an innovative LDV trading cost approach in Lesmond et al. (1999) is adapted to, endogenously, estimate the effective transaction costs. The model requires no bid-ask spreads, commission fees or price-impact costs for this inclusive measure, but instead it uses only daily return series. The main hypothesis of the approach is that investors trade only if the value of the accumulated information exceeds the marginal cost of trading. Therefore, the incidence of zero returns is the key feature of the data, which allows for the transaction cost estimations. As an illustration, the frequency of experiencing a daily return of exactly 0% is greater for firms with larger trading costs, since they discourage investors from trading based on relevant news. This follows that the returns associated with nonzero-return days are expected to be larger to exceed the

trading cost threshold, since firms with larger trading costs require a larger accumulation of news.

Lesmond et al. (1999) show that the LDV model of the relation between measured returns, $R_{i,t}$, and true returns, $R^*_{i,t}$, is given as

$$R^*_{i,t} = \beta_{m,t} R_{m,t} + \epsilon_{i,t} \tag{7}$$

where

$$\begin{aligned} R_{i,t} &= R^*_{i,t} - \alpha_{1,i} \quad && if \quad && R^*_{i,t} < \alpha_{1,i} \\ R_{i,t} &= 0 && if && \alpha_{1,i} \leq R^*_{i,t} \leq \alpha_{2,i} \\ R_{i,t} &= R^*_{i,t} - \alpha_{2,i} && if && R^*_{i,t} > \alpha_{2,i} \end{aligned}$$

Equation 7 shows that $\alpha_{1,i} < 0$ is the sell-side trading cost for asset i and $\alpha_{2,i} > 0$ is the purchase side cost. The informed investor's reservation price for trades, $R^*_{i,t}$, is bounded by the related trading costs $\alpha_{1,i}$ *and* $\alpha_{2,i}$. Lesmond et al. (1999) use the common "market model" regression with the intercept suppressed. Based on the model, $R_{m,t}$ is the measured daily return on the market index collected from the OMX Nordic website and $\varepsilon_{i,t}$ captures all other information. As a clarification, investors make trading decisions based on the observable marketwide information and all other information. The other information could contain accumulated past marketwide and firm-specific information, which has not yet been incorporated into the price.

The LDV estimate of transaction costs includes not only the explicit costs but also the implicit costs to produce trading cost estimates, which should be higher than estimates based on the spread costs in a stand-alone basis. To illustrate, the explicit costs consist of the bid-ask spread and commissions, whereas the implicit costs refer to factors, such as short-sale constraints, taxes and price impact. Lesmond et al. (1999) show that the LDV estimate is at least 30% lower than quoted spread plus commission, which is considered as the most accurate estimate of transaction costs. Thereby, the LDV estimates appear relatively conservative compared to the most reliable estimates of transaction costs. With this approach, the authors estimate that the round-trip transaction costs are 1.2% and 10.3% for the largest and smallest decile stocks from 1963 to 1990.

1.5 Structure of the Study

The first chapter presents the data sample and the research methods, which are used in this study to provide further insight into momentum investing in the OMXH. The availability and suitability of the collected data sample is introduced and evaluated. Then the methods are presented insofar as the formation of momentum portfolios, the seasonality

of abnormal returns and the purchase price model are concerned. Also, the estimation procedure of transaction costs is introduced.

The second chapter will provide the theoretical framework of this study. The chapter begins with the perspective of traditional finance theory. This follows that the efficient market hypothesis is reviewed to develop an understanding of the underlying simplified assumptions. In addition, the efficiency of the NASDAQ OMX Helsinki stock exchange is discussed. The following sections adopt the perspective of behavioural finance, which review literature related to heuristic simplification and limits to arbitrage. The former refers to irrational investors who frequently process information by utilizing shortcuts and emotional filters while conducting complicated analyses, whereas the latter refers to fundamental risk, noise trader risk and implementation costs. The last sections of chapter two cover literature related to momentum investing and the 52-week high momentum strategy.

Chapter three presents descriptive statistics of the momentum portfolios and performed preliminary tests. These portfolio returns are reported and analysed whether the 52-week high statistic is a proxy for future momentum returns and whether the returns are robust among three subperiods. In the last sections of chapter three, the efficacy of the purchase price model is reviewed after introducing additional control variables; and the portfolio returns are reported after transaction costs are taken into account. Finally, chapter four summarizes and concludes the key findings of the study and presents various research topics for further studies.

2 THEORETICAL FRAMEWORK

2.1 Efficient Market Hypothesis

The efficient market hypothesis (EMH henceforward) proposed by Fama (1970) has had a great influence on theory and practice in the field of finance. According to the hypothesis all newly generated information is, instantaneously and sufficiently, reflected in stock prices. Thereby, any information used to predict stock performance should be reflected in the stock prices. In addition, the EMH states that financial securities markets such as bond and stock markets are efficient. The theory also rules out the possibility of trading systems based on currently available information, which have expected returns in excess of equilibrium expected returns. Therefore, average investors should not consistently be able to beat the market, but instead they waste the majority of resources dedicated to analysing, selecting and trading securities (Shleifer 2000, 1). This means that active traders should find it difficult to outperform passive strategies, such as holding market index funds, since it requires difficultly acquirable and differential insight in a highly competitive market. In other words, the EMH provides theoretical background for the passive investment strategies instead of active portfolio management strategies.

After the introduction of the EMH, it became extensively accepted among researchers. Academics developed powerful theoretical justifications why the hypothesis should hold, and also a wide scale of empirical studies emerged supporting the hypothesis. For example, Jensen (1978a, 95) asserted that the EMH has the most solid empirical evidence supporting it. Indeed, the EMH has been extensively and successfully tested examining the stock price data of publicly traded securities (Fama, 1970; Jensen, 1978a).

The traditional finance seeks to understand financial markets using models in which investors are rational. The interpretations of 'rationality' can be divided into two factors. First, when investors receive new information, they update their beliefs correctly. Second, if investors are given their beliefs, they make choices that are normatively acceptable insofar as they are consistent with the notion of subjective expected utility. (Barberis & Thaler, 2003.) Specifically, investors' are rational when they value a security for its fundamental values, which is the net present value (NPV) of its future cash flows discounted by their risk characteristics (Shleifer 2000, 2). By assuming that investors strive to maximize their utility, the EMH has provided powerful tools for them. As an illustration, investors are able to obtain the highest expected return for estimated risk by using the modern portfolio theory. In addition, pricing models; such as the capital asset pricing model, the arbitrage pricing theory and the option pricing theory; are capable of providing guidance for valuing securities and insights into expected risks and returns. (Nofsinger 2011, 3.)

The theoretical perspective for the EMH is also fundamentally based on three arguments, which rely on the gradual assumptions of investors' rationality. First, investors' valuations of securities are assumed to be rational. Second, insofar as investors are not rational, investors eliminate each other's actions without affecting prices as they trade randomly. Third, insofar as investors are irrational in corresponding ways, rational arbitrageurs eliminate their influence on prices. In such a market, prices could temporarily deviate from fundamental values, but the existence of rational and well-capitalized arbitrageurs' trades restore the equilibrium in which market prices reflect intrinsic values. (Shleifer 2000, 2.)

The EMH is fundamentally based on three market conditions: there are no transaction costs in trading securities; all information is available without cost to all market participants, and all agree on the implications of information for the current value and distributions of securities' future prices. These conditions are sufficient for market efficiency but not necessary. Consequently, a market with such conditions obviously reflects all available information. (Fama 1970, 387–388.)

Hypothetically, no arbitrage opportunities should exist in an efficient market, and no above-average returns should be earned without taking a greater risk. If all the prices of securities are correctly prices, even a blindfolded chimpanzee throwing darts at the stocks pages could earn equal or better profits than professional investors. An indicator of market efficiency is the observation that professional investors find it difficult to beat the market index in long-term. (Malkiel 2005, 1–2.)

Unfortunately, such an efficient market in which all information is freely available and investors totally agree on its implications does not describe markets found in practice. Fama (1970, 387) argues that these conditions are adequate for market efficiency but not necessary. To exemplify, the implication that investors take account of all available information, including large transaction costs hindering the flow of transactions, does not imply, in itself, that prices will not "fully reflect" available information when transactions do take place. Securities markets may be efficient if adequate numbers of investors have access to available information, and disagreement among market participants about the implications of available information does not imply market inefficiency unless investors exist who can consistently make better evaluations of available information than are implicit in market prices.

Similarly, Grossman & Stiglitz (1980) argue that it is not possible that a competitive market is always in equilibrium in which case prices should be such that all arbitrage profits are eliminated; therefore, the assumptions that all markets, including that for information, are always in equilibrium, perfectly arbitraged and inconsistent when arbitrage is costly, are not in parallels with the securities markets found in practice. Investors have an incentive to spend time and resources to analyse and uncover new information solely if such activity is likely to generate higher investment returns. Further-

more, it is not surprising to discover that the degree of efficiency differs among various markets. As an illustration, emerging markets may be less efficient than developed markets, since emerging markets are less frequently analysed and accounting disclosure requirements tend to be less accurate.

When investors discover new information about fundamental values of securities, they instantly bid the values to their fair levels depending on the quality of new information. In other words, if prices are instantly bid to their fair levels corresponding to all available information, the price development occurs only in response to new information, which must be entirely unpredictable. As a consequence, security prices immediately include the available information and prices should adjust to new levels depending on the present values of cash flows. (Shleifer 2000, 2.)

Stock prices should follow a random walk according to which returns are unpredictable in competitive markets with rational risk-neutral investors. This assumption is based on a conception of random and unpredictable fluctuations in stock prices. Strictly speaking, the stock prices should be characterized as following a submartingale, meaning that the expected change in price can be positive, presumably as compensation for the time value of money and systematic risk. Based on this assumption, the expected return may only change over time as risk factors change. Although a random walk is more restrictive that it constrains successive stock returns to be independent and identically distributed, the term "random walk" is commonly used in more flexible sense that price changes are essentially unpredictable. (Fama 1970, 386–387.) As an illustration, markets are rational when randomly and gradually developing stock prices are the necessary consequence of intelligent investors, who compete to discover appropriate information for conducting unique investment strategies before the rest of the market participants become aware of that information. As a consequence, security prices can be considered to follow random walks. (Shleifer, 2000, 2–3.)

To summarize, it was explained why prices in competitive markets must follow random walks and efficient markets reflect all available information. As investors try to take advantage of the information in past stock prices, they instantly adjust the prices in doing so until the superior profits from studying historical price movements disappear. As a result, patterns in prices will no longer exist and price changes in one period will be entirely independent of changes in the next, which means that the stock price will follow a random walk.

2.1.1 Versions of the Efficient Market

All the empirical research on the theory of efficient markets is concerned with whether prices "fully reflect" specific subsets of available information. As a brief clarification,

market efficiency can be divided into external and internal efficiency. Traditionally, economists define three levels of market efficiency, which are distinguished by the degree of information reflected in security prices. Information can be classified into three versions based on the point of time of generation: historical, public and future information. Furthermore, it is common to distinguish between three versions of the EMH depending on how information reflects to stock prices: the weak form EMH of historical information, the semi-strong form EMH of public information and the strong form EMH of future information. As a simplification, these versions differ by the degree in which information is reflected to the stock prices. (Fama 1970, 388.)

The initial studies were concerned with what is referred to as weak form tests. The information subset of interest in the weak form tests is only past prices or return histories. Historical data can be obtained by investigating market-trading data, such as the history of past returns and prices, which should be virtually costless to obtain. (Fama 1970, 388.) Therefore, it should be impossible to gain superior risk-adjusted profits on the grounds of the knowledge of past prices and returns (Shleifer 2000, 6). Most of the results come from the random walk literature with which the weak form of the EMH is consistent. Thereby, their results are in parallels with the hypothesis that returns are entirely unpredictable based on historical returns. (Fama, 1970.)

Attention was turned to semi-strong form tests when numerous tests seemed to support the efficiency hypothesis at weak form level. The semi-strong form hypothesis requires that prices reflect not only historical information but also public information, such as announcements of stock splits, annual reports and security issues. In other words, the semi-strong form tests are concerned with the speed of price adjustments to other obviously publicly available information. (Fama, 1970.) If markets are efficient in this sense, investors cannot earn superior risk-adjusted returns, since security prices adjust instantly to any publicly available information (Shleifer 2000, 6).

Finally, investors may still earn abnormal risk-adjusted profits by discovering information that is not yet public which is often described as insider information (Shleifer 2000, 6). As a clarification, the strong-form hypothesis states that security prices also reflect all future information. These strong form tests in which the corner is whether any investor or groups, such as the management of a mutual fund, have monopolistic access to information relevant for the recent formation of prices. (Fama 1970, 388.) However, it is difficult to earn profits based on insider information, since any leaked news related to a security will be quickly and accurately reflected to the value of the security (Shleifer 2000, 6).

Fama (1970, 388) argues that critical evidence against the hypothesis in the weak and semi-strong form tests does not exist, meaning that prices seem, efficiently, to adjust to publicly available information. Furthermore, the author states that only limited evidence exists against the hypothesis in the strong form tests. Based on this notion, it can be

concluded that monopolistic access to information about prices is not a widespread phenomenon in the investment community.

In brief, the EMH is divided into three types by the degree of information reflected to the value of a stock: the weak form efficiency, the semi-strong form efficiency and the strong form efficiency. However, the main hypothesis of the EMH in the earlier studies is that security prices always "fully reflect" all available information. It is obviously a null hypothesis, which is not regarded to be literally true. The categorization of the efficiency tests into weak, semi-strong and strong form tests address the level of information consistent with the EMH. In the next section, examples of insider trading will be given to illustrate how the market price of a security fluctuates after a merger announcement. Although the EMH seems to have strong support from earlier empirical studies, the upcoming sections will show that those findings might not be in parallels with the recent occurrences of financial markets.

2.1.2 Empirical Foundations of Market Efficiency

This section covers examples of the empirical foundations of the EMH to illustrate how the market price of a security reflects to a merger announcement. The empirical foundations of the EMH can be divided into two categories. First, the value of a security should react to all available information both quickly and correctly. The meaning of quickly is that investors, who react to new information late, should not be able to profit from this information; whereas the latter term means that the price adjustment based on new information should be accurate, on average, and there should be no recognizable price trends or predictable price reversals after the initial effect of new information. Second, a security's price should not move without new available information about the value of the security. (Shleifer 2000, 5.)

The semi-strong form efficient market hypothesis states that all public information is reflected in the market price of a security; consequently, only those investors possessing inside information should be able to outperform the market on a risk-adjusted basis. To help prevent trading on non-public information, Rule 10b-5 of the Securities Exchange Act of 1934 regulates trading by insiders. It requires trading by corporate officers, directors and substantial owners to be reported to the S.E.C. in the United States of America. To clarify, other developed countries have similar regulations with regard to trading by insiders. As it would be impossible to monitor trades by relatives and friends of the insiders, regulations consider anyone possessing non-public information to be a de facto insider and prohibits trading based on this information. Despite of these regulation measures, trading on insider information does exist to some extent; however, the degree

to which insider information is leaked and the magnitude of trading on this insider information is unknown. (Keown & Pinkerton 1981, 855.)

One testing strategy is to examine news events related to individual companies to investigate whether prices adjusted to news events instantly or over a period of days. As an illustration, Keown and Pinkerton (1981) provide evidence of excess returns earned by investors in acquired firms prior to the first public announcements of intended mergers, which is based on a sample of 194 target firms. This is illustrated by Figure 1, which shows how the release of news affects the response of a stock price in efficient markets.

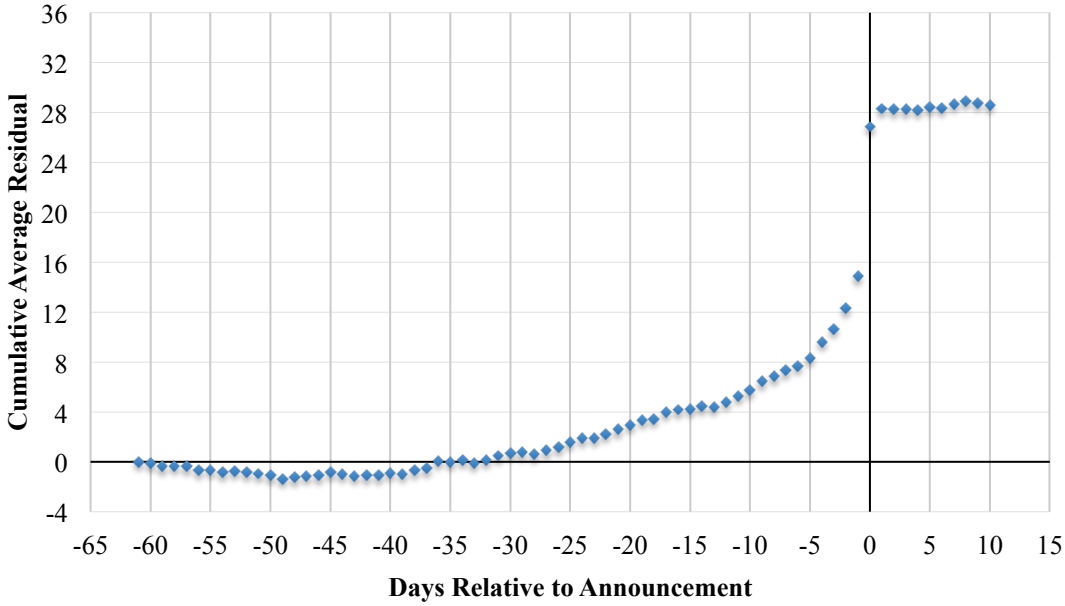

Figure 1 Cumulative abnormal returns before takeover attempts (Keown & Pinkerton 1981, 861)

When public becomes aware of a takeover attempt, the stock price of a typical target appreciates on the public announcement day. However, the increase in the share price on the announcement day is not followed by a trend or price reversals, which demonstrates that the price of the typical take-over target instantaneously adjusts to the public information of the bid. This adjustment in prices also supports the semi-strong form of the EMH. (Shleifer 2000, 7.) This suggests that the new stock prices reflect the magnitude of the takeover premium based on available information. Nonetheless, it is illegal insofar as the preannouncement trading is based upon insider information (Keown & Pinkerton 1981, 866).

Keown and Pinkerton's (1981) findings show what appears to have been common knowledge in the traditional finance theory: impending merger announcements are poorly held secrets, and trading on this information exists in large numbers. Nonethe-

less, the authors' results support the semi-strong form efficient market hypothesis, since the market reaction to the new public information is complete by the day after the announcement.

By examining the development of intraday prices, it may be possible to find evidence of rapid response to new information. A study by Patell and Wolfson (1982) shows how rapidly stock prices develop when information about a corporate dividend or an earnings announcement comes available. They find that the major part of the adjustment in a stock price occurs within 5 to 15 minutes of the announcement. However, profound changes have taken place in securities since the early studies of market efficiency. In contrast with the past, financial information is more readily available to market participants, trading costs have fallen significantly and technology has accelerated the pace at which markets operate. Therefore, it should take less than five minutes for prices to incorporate information. To enlighten this assumption, Busse and Green (2002) tracked the rapid adjustment of minute-by-minute stock prices to announcements, which are featured on both positive and negative 'Midday Call' segments. These segments are broadcasted on the cable television financial news provider CNBC, which are designed to inform viewers of developments affecting individual stocks or the market as a whole based on the opinions of security analysts. Figure 2 illustrates how minute 0 is the time when a stock is mentioned on a midday show.

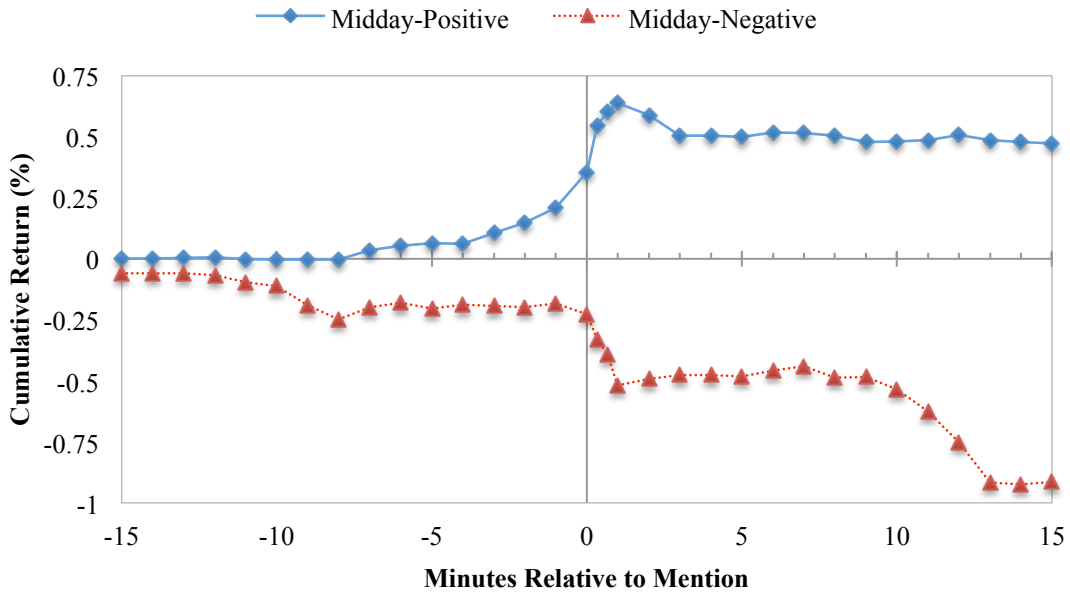

Figure 2 Stock price reactions to CNBC reports (Busse & Green 2002, 422)

The bottom line demonstrates returns on stocks with negative reports, whereas the top line is the average price development of stocks, which receive positive reports. According to their findings, the market has fully discovered the correct stock price within 5

minutes of the positive announcement, whereas the bottom line levels off within 12 minutes. (Busse et al. 2002, 422.)

Busse et al. (2002, 435) argue that low barriers to entry and competition among traders in an equilibrium setting, such as in Grossman and Stiglitz (1980), ensure that traders' profits will be small but positive, on average, compensating them only for their efforts in gathering information. Their evidence supports the notion that active traders enhance market efficiency. In spite of the fact that security prices do not fully reflect all available information instantaneously, their results indicate that the securities markets are efficient enough that a trader cannot generate profits based on widely disseminated news unless he acts almost immediately.

2.1.3 Efficiency of the Finnish Stock Market

The Helsinki Stock Exchange (HEX) was founded in 1912, which was firmly regulated and considered as underdeveloped in comparison to major stock exchanges. Financial market deregulation begun in 1980s, which proceeded from the liberalization of the money market to the abolishment of all capital movements in Finland. The market was opened to foreign ownership in 1993, when improvements in Finnish legislation were amended to comply with the European Union directives and the HEX was integrated with the other Nordic stock exchanges to establish the OMX. (Vaihekoski, 1997; Pörssisäätiö, 2010.)

Korhonen (1977) is among the first researchers to study the efficiency of the HEX, arguing that the stock market is relatively efficient in the weak form despite the small size and illiquidity of the HEX. Stock prices appeared to fluctuate in a random walk, and no exploitable leads or lags were discovered based on a small data pool, which concluded only 18 public limited companies. The results of Berglund et al. (1983) show that serial correlation is apparent in the stock returns, but returns obtained by handpicking suitable buy and sell orders may not exceed the related costs of information gathering and transaction costs. However, both Virtanen and Yli-Olli (1987) and Kallunki et al. (1997) find divergent results, which indicate the existence of market anomalies and deviations from the market efficiency. This significant finding shows the existence of fluctuation from the random walk hypothesis as future returns can be predicted on the grounds of historical data. In addition, Knif and Löflund (1997) find first order serial correlation; and suggest that the friction in the trading process and thin trading is a significant source of the serial correlation structure in stock returns. Nonetheless, it may also be caused by the predictability of a time-varying risk premium, which utilizes historical information.

The Helsinki stock exchange has been investigated whether it can be regarded as semi-strong efficient. Schadéwitz and Blewins (1998) study the speed of adjustment of share prices to the announcement of unexpected earnings, finding that the adjustment of the share prices to new information is delayed due to inefficiencies in the semi-strong form of the EMH. Similarly, Ekholm (2002) discovered that the stocks market reactions to new interim information are lagged, since a portion of financial statement signals are a proxy for risk while the other portion contains information to which market reacts with a delay. However, the author does not specify whether this occurs due to market inefficiency or an expected return specification problem.

Academic papers have also investigated the behaviour of investors surrounding announcements. Booth et al. (1999) argue that casual investors and institutional investors behave in a distinct manner and that investors tend to increase the amount of sell orders after negative earnings surprises occur. Similarly, Ekholm (2002) argue that the majority of investors are biased towards increasing their holdings after a published earnings announcement. Specifically, positive earnings surprises increase the probability at which institutional investors take a larger holding of a company, whereas the reaction of small and foreign investors is to liquidate a part of their profits after positive earnings announcements.

The OMX Helsinki stock exchange provides a suitable security market for examining market anomalies, such as the momentum effect, since it is prone to irregularly occurring 'periphery syndrome.' It is an outcome of the herding behaviour of international institutional investors, who first realise their equity positions from the furthest security markets by the time of market turbulence. The results of Yu (2008) show that the herding behaviour of institutional investors stimulates price momentum. This market behaviour is strengthened by the relatively low liquidity of the Finnish stock market, which results in steeper stock price fluctuations compared to the major stock markets. In other words, stock prices tend to raise relatively more during 'bull' periods and fall more during 'bear' periods in Finland due to relatively thin trading. This follows that the OMX Helsinki stock exchange is, on average, prone to higher degree of market volatility than more developed stocks exchanges. As a consequence, a momentum investment strategy should have greater opportunities to earn abnormal profits. (Leivo & Pätäri, 2011.)

As a conclusion, prior studies support the notion that Finnish stock market is efficient insofar as widespread profitable trading opportunities do not persist for a long period of time. Especially, the availability and timeliness of information has exponentially increased, and the stock market can be presumed to act more efficiently. Nonetheless, market efficiency requires that vigilant market participants monitor financial markets and actively trade away prices (Busse et al. 2002, 435). In traditional finance theory, rational arbitrageurs enforce the law of one price when they profit from simultaneously buying and selling identical assets at different prices. Thereby, effectively identical se-

curities should have identical prices in stock markets due to rational market participants. The assumption is limited by the simplified presumption of relying on investors' rationality, excluding the importance of market participants' psychological tendencies to simplify information while conducting investment decisions or processing overwhelming amounts of information. The following sections will provide further clarification regarding the cognitive and behavioural tendencies of investors to make irrational investment decisions.

2.2 Psychology and Investing

2.2.1 Behavioural Finance

Both the theoretical foundations of the EMH and the empirical evidence supporting it have been challenged in the last few decades. Since Keynes's (1936) famous authoritative declaration that most investors' decisions "can only be taken as a result of animal spirits – of a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of benefits multiplied by quantitative probabilities," numerous studies have been devoted to examine the efficiency of stock market price formation. The majority of those studies were unable to reject the efficient markets for common stocks in Fama (1970). Although several seemingly anomalous deviations from market efficiency have been documented, such as the studies listed in Jensen's (1978b) volume on anomalous evidence regarding market efficiency, many financial economists supported Jensen's (1978a) belief that "there is no other proposition in economics than the Efficient Markets Hypothesis."

Particularly behavioural finance has emerged as an alternative view of financial securities markets (Shleifer 2000, 2). Behavioural finance argues that traditional financial theory ignores how real investors establish decision-making processes, and that it is essential to take investors' behavioural aspect into consideration (Barberis et al. 2003, 1056–1057). Despite behavioural finance is a relatively new but rapidly expanding field of science, it strives to provide explanations for investors' investing decisions by merging behavioural and cognitive psychological theories with conventional economics and finance (Baker & Nofsinger 2010, 3). More specifically, the field has two main elements: limits to arbitrage, which argue that it can be difficult for rational investors to undo the fluctuations caused by irrational traders; and psychology, which catalogues the various kinds of deviations from full rationality investors might expect to see (Barberis et al. 2003, 1053).

Whereas traditional finance assumes that investors are rational and provides us misguided tools; such as arbitrage theory, portfolio theory, asset pricing theory and option pricing theory; to guide investors how they should behave to maximize their wealth, behavioural finance has its basis on how investors in reality behave in a financial setting (Nofsinger 2011, 5). The growth of behavioural finance research has been fuelled by the inability of the traditional utility maximization of rational investors within the efficient markets framework to explain numerous anomalies (Baker et al. 2010, 3). The anomalies literature is interpreted by a growing number of economists as consistent with irrationalities, which characterize how individuals make complicated decisions. These irrationalities are divided into two categories. First, investors do not process information appropriately, which infers factual probability distributions about the future rates of returns. Second, even if given a probability distribution of returns, investors frequently make incoherent or systematically suboptimal decisions. (Barberis et al. 2003, 1054.)

Predictable decision errors made by irrational investors can affect the function of the markets, indeed. Empirically, behavioural finance literature contributes to this problem by documenting actual investor behaviour and price patterns that seem inconsistent with traditional models, which rely on the hypothesis of rational investors; and by providing new theories to explain these behaviours and patterns (Vissing-Jorgensen 2003, 139). Furthermore, investors' reasoning errors affect their investment decisions and eventually their wealth; therefore, investors who understand the tools of modern investing are still prone to failures if they let psychological biases control their decision-making processes (Nofsinger 2011, 3).

In brief, systematic and remarkable deviations from efficiency are expected to persist for long periods of time due to behavioural factors. An underlying assumption of behavioural finance is that the information structure and characteristics of investors methodically affect individual investors' decision-making processes and market outcomes (Baker et al. 2010, 3). As decision-making processes are influenced by multiple situational factors, it is vital for investors to realise how emotions and cognitive biases affect financial decisions, corporations and financial markets (Nofsinger 2011, 5). The significant contribution of behavioural finance literature is to categorize these behavioural biases and cognitive heuristics by their source.

2.2.2 Heuristic Simplification

Human brain does not work like a computer, but instead information processing is prone to shortcuts and emotional filters to shorten analysis time. The human brain uses inputs, such as the facts of a situation and probability estimates, in quantifying certainties. The source of bias arises from heuristic simplification, which exists due to limita-

tions on cognitive resources, such as memory, attention and processing power (Hirsleifer, 2001). As a result, the human brain frequently processes information by utilizing shortcuts and emotional filters while implementing complicated analyses which influences investors' decision-making processes in an irrational manner. Therefore, a decision conducted on the grounds of such shortcuts and filters is not the same decision, which an investor would make without these filters. Due to their existence in investment decision-making processes, the activities of the reason or logic portion of the brain, which are referred to as cognitive processes, yield systematic and predictable cognitive errors. As an illustration, investors routinely violate conventional concepts of risk aversion and execute predictable errors in their forecasts. Thereby, decisions and the final results of those decisions are frequently biased regardless of whether emotions affect outcomes. The impact of these suboptimal financial decisions has consequences for the efficiency of securities markets. (Baker et al. 2010, 3; Nofsinger 2011, 5–6.)

Although it is possible to become aware of cognitive biases, it is difficult to avoid them when it comes to decision-making processes. These restricting factors can be distinguished in two ways. First, various cognitive errors result from self-deception, which occurs due to the fact that investors tend to misinterpret the accuracy of private information and overestimate their skill level in analysing it (Odean, 1998). In other words, their predictions of probabilities of events are overestimated in relation to the true frequency when the event will likely occur; therefore, the confidence intervals that investors provide for quantities are overly narrow. Self-attribution bias leads investors to believe that the experienced successes are attributed to skill, whereas failures are caused by bad luck (Nofsinger 2011, 12). This self-deception helps investors to deceive others; and provides them a possibility to survive the natural selection process. Surprisingly, professional investors can be more prone to overconfidence than common investors when the level of predictability is low and evidence is ambiguous (Griffin & Tversky, 1992). Overconfidence has also been studied to be greater for challenging investment decision tasks, and investors have a tendency to be more confident when feedback on their decisions is deferred or inconclusive. (Hirsleifer 2001, 1548–1551.)

Second, it is not surprising that biased decisions often occur when emotions are involved in a decision-making process if current mood and anticipated feelings about the final result of a decision become inputs. Felt moods and emotions affect investors' perceptions of and choices with respect to risk. Specifically, investors in pleasant moods are more optimistic in their decision-making processes in comparison to those in unpleasant moods (Wright & Bower, 1992), who are associated with more detailed and critical strategies based on the same information. (Hirsleifer 2001, 1550–1551.) As a conclusion, investors do not only make predictable errors in their forecasts based on available information, which might not be adequate or accurate, but also they might fail in analysing the information effectively.

Briefly, regardless of perfect information processing, heuristic simplification has a remarkable effect on how investors valuate risk-return trade-offs. However, the existence of irrational investors is not, by itself, a sufficient argument to render the inefficiency of securities markets insofar as arbitrageurs take advantage of profit opportunities, which forces securities' market prices to match intrinsic values.

2.3 Anchoring and Adjustment

2.3.1 Anchoring Heuristic

This study examines the behaviour of financial market participants from the perspective of the anchoring bias. The anchoring and adjustment heuristic is one of the most investigated psychological biases, which lead individuals to execute suboptimal decisions. Hirshleifer (2001, 1535) characterizes the anchoring bias as a significant part of "dynamic psychology-based asset-pricing theory in its infancy." Despite of the theory's early stage, the recognition of the anchoring and adjustment bias is significant to market participants.

Anchoring has a compelling role in the financial markets, since it is inherent in the process of estimation. Tversky and Kahneman (1974, 1124) suggest that individual investors use cognitively tractable decision strategies, which are known as heuristics, to cope with complex and uncertain situation. These heuristics reduce the inference of complex tasks to relatively easy cognitive operations. Although these mental shortcuts help individual investors in dealing with complex and uncertain situations, they may also lead to systematically skewed outcomes. The authors suggest that anchoring is a process in which investors formulate estimates by beginning from an easily available reference value, which is adjusted to yield the final estimate. The initial value may be suggested by the formulated problem, or it may be the result of a partial computation. Regardless of the case, the adjustments implemented by investors are typically insufficient to account for changes in intrinsic values, since they fail in properly adjusting their final estimates away from the crucial but over-emphasized anchor value.

As it was exemplified, investors have difficulties in evaluating the precision of their knowledge and prior signals. The following question illustrates this bias further:

> *"In 1928, the modern era of the Dow Jones Industrial Average (DJIA) began as it expanded to 30 stocks. In 1929, the index started the year at 300. At the end of 2008, the DJIA was at 8,776. The DJIA is a price-weighted average. Dividends are omitted from the index. What would the*

> *DJIA average have been at the end of 2008 if the dividends were reinvested each year?" (Clarke & Statman, 2000.)*

If investors are asked to set their DJIA minimum and maximum guesses with 90% certainty that the correct value lies within the range they choose, should they be able to get the correct answer with the probability distribution of 90%. If dividends were reinvested in the DJIA, the average would have been 227,000 at the end of 2008. The answer surprises most of the investors. The observation withstands even if investors learn that most people set their prediction range too narrowly, and also they continue to do it even after experiencing the problem. (Clarke & Statman, 2000.) This observation illustrates a crucial aspect of investor psychology, which is commonly referred to as the anchoring and adjustment bias. In the case of the example, this behaviour can be interpreted based on the anchoring and adjustment bias that investors base their predictions by starting at the anchor to which they add an appropriate amount to compensate for the dividends.

The description is consistent with the research on the adjustment and anchoring bias surveyed by Kahneman, Slovic and Tversky (1982, 14–20). They asked subjects to estimate a quantity, such as the number of African nations in the UN, as an increment to a number while shown a randomly generated number. Their results illustrate that estimates are higher for subjects who are shown higher random numbers, and vice versa. Northcraft and Neale (1987, 95) argue that experts are susceptible to decision bias even in the confines of their 'home' decision setting, and they are less likely than amateurs to admit or perhaps understand their use of heuristics in producing biased judgements. Furthermore, the effects of anchoring bias are not remarkably influenced by the ease with which respondents can imagine the outcome. Similarly, Wright and Anderson (1989) argue that the anchoring effect is dominant in investors' decision-making processes, since situational familiarity does not result in a statistically significant decrease in anchoring.

Investors have a tendency to anchor on their stock purchase price and the recent highest stock price, which affects their decision-making processes. As the past stock price may be a vital anchor point for individual investors, Shiller (1999, 17) suggests that new prices will tend to be close to past prices if the past prices are taken as suggestions of the new prices. Furthermore, the author suggests that the more ambiguous the value of the security, the more critical anchoring is likely to be for investors. This hypothesis would explain the negative return-flow relationship, since investors would perceive a stock as cheap after the stock price fall, and vice versa. Similarly, George and Hwang (2004) document 52-week high momentum and relate it to the anchoring and adjustment bias. They suggest that investors use the 52-week high value as an anchor in their investment decision-making processes. In such case, investors are reluctant to bid the price adequately high when a stock price is at or near its highest value, which is

pushed by favourable news. These findings point out that when assessing the incremental value, which is implied by new information, investors' estimation is significantly influenced by the historical time-series patterns of prices at the firm level due to heuristics and anchoring biases.

2.3.2 Social Interactions and Peer Effect

Social interactions and the peer effect can be considered as sources of bias as they overcome reason (Hirshleifer, 2001). An anchor does not necessarily need to be a numerical value, but it can also be based on opinions or attitudes. In financial markets anchors can be based on the opinions or the attitudes of friends or experts, including even data and forecasts, which may initially appear unrealistic; therefore, external information collected by analysts have an anchoring effect on individual investors' decision-making processes. For instance, asking a 'bull' about an index results in a comparatively high anchor value of the index. The anchor tends to remain high even after adjustment on the basis of an individual investor's own estimates. Similarly, a lower estimation value will result if the investor is conferred with a 'bear' consultant. (Goldberg & Nitzsch 2001, 45–48.)

The effect of anchoring bias on market participants, such as analysts and investors, has not been extensively investigated. Plous (1989) argues that anchoring bias exists even after correcting for various social demand biases, such as the existence of expert opinion running against the initial anchor. Whyte and Sebenius (1997) provide results, suggesting that conducting decision-making processes in groups do not mitigate the effect of the anchoring bias on individual investors' judgements.

Little attention has been paid to the cross-sectional patterns of firms' earnings, which could potentially influence analysts' or investors' judgments under uncertainty. Cen, Hilary and Wei (2011, 24, 36–37) investigate the proposition that market participants are affected by anchoring bias when estimating the future profitability of a company. They postulate that analysts and investors may use the industry median-adjusted forecasted earnings per share (FEPS) as an anchor in forming their earnings forecasts, which tend to be adjusted towards the industry median. In other words, if a firm has higher FEPS than the industry median, the formulated earnings forecasts are more likely to be underestimated, and vice versa. Consistent with the results in George and Hwang (2004), analysts and investors tend to make more pessimistic forecasts when the current FEPS is closer to the historical maximum stock values while having a tendency to form optimistic forecasts when the current FEPS is closer to the historical minimum. The provided results, which are consistent with the aforementioned notions, indicate robust support for the anchoring and adjustment bias hypothesis.

Financial analysts' publicized predictions about the future earnings of the followed firms tend to deteriorate in long-term (Hilary & Menzly, 2006; Cen et al., 2011). Hilary and Menzly (2006) investigated the predictions of analysts after they have shown a series of successful estimates. They find that analysts' next predictions are, on average, likely to deteriorate in terms of accuracy and deviate from the other analysts' forecasts. To exemplify, analysts who perform satisfyingly for a few quarters tend to follow with predictions, which deviate from other analysts' estimates and eventually have more significant errors. This irrational behaviour demonstrates that both analysts' prior success leads to overconfidence.

In brief, investors are prone to errors in information processing in various ways. The anchoring and adjustment bias was introduced as a crucial illustration of factors, which affect investors' decision-making processes while implementing them on the grounds of psychological filters. It refers to the phenomenon in which investors tend to cling onto a specific piece of information in the process of investment decision-making while refusing to adjust to the changing environment or new information (Hirshleifer 2001, 1535). The highlighted point is that investors might anchor on the purchase price of a stock or another price level in the past.

2.4 Limits to Arbitrage

The basis of behavioural finance is the existence of behavioural biases among investors, which will affect asset prices and returns on a sustained basis only if limits to arbitrage also exist. Limits to arbitrage prevent rational arbitrageurs from fully exploiting short-term mispricing caused by irrational investors. Therefore, the critique for behavioural finance is that the actions of such arbitrageurs are limited in practice and insufficient to force prices to match intrinsic values. (Barberis et al. 2003, 1056.)

Arbitrage is a risky process due to limits to arbitrage constraining the possibility to yield riskless profits at no cost. In principle, persistent mispricing is an instant evidence of limited arbitrage, since the mispricing would quickly disappear if arbitrage were not limited. However, the most pricing phenomena can be interpreted as deviations from fundamental value, whereas only a few cases support the assumption that the presence of a mispricing can be established beyond a reasonable doubt. (Barberis et al. 2003, 1061.) Fama (1970) refers to aforementioned phenomenon as a joint hypothesis problem according to which investors need a model of proper discounting to claim that the market value of a security is parallel to its properly discounted future cash flows. Thus, any test of mispricing is inevitably a joint test of mispricing, and also a test of the model of discount rates, which makes it difficult to provide definitive evidence on inefficiency.

Regardless of this difficulty, researchers have uncovered a number of financial market occurrences in which the law of one price is violated.

Evidence supports that limits to arbitrage exist in the failure to eliminate obvious and straightforward mispricing situations. For example, Mitchell, Pulvino and Stafford (2002, 551) document 82 cases in which the market value of a company is less than the market value of the company's stake in its subsidiary. This finding implies that arbitrage opportunities lead to prompt corrections of the pricing anomaly. Nonetheless, the authors find a degree of persistence indicating barriers to arbitrage; therefore, it seems that violations of the law of one price suggest the presence of irrational investors and limits to arbitrage.

Price momentum in stocks is posing the greatest challenge to rational pricing theories. The theoretical literature emphasizes 'dumb money' and limits to arbitrage in explaining price momentum in stocks. Whereas the former refers to an individual investor who fares inadequately and whose transactions are regarded as market noise by professional investors, the latter implies that momentum cycles should last longer and interruptions in profitable momentum cycles should be shorter when arbitrage capital is in short supply. Shleifer and Vishny (1997) propose that momentum persists, since limits to arbitrage are imposed by slow movements of capital available to arbitrageurs. Particularly, the fact that momentum strategies involve frequent losses makes it difficult for arbitrageurs to drive momentum profits out of the market. This is the main argument of the limits to arbitrage when it comes to persistent anomalies. (Chabot et al. 2009, 3, 26–27.)

2.4.1 Fundamental Risk

Fundamental risk limits the activity of traders when it comes to exploiting the mispricing opportunity. It is an exposure to losses from a situation affecting a company, which can be caused by natural or social phenomena. An underpriced security may present a profit opportunity, but it is not risk-free due to fundamental factors. When a mispriced asset lacks a fairly priced substitute, arbitrageurs confront fundamental risk, since they are unable, effectively, to hedge their position in the mispriced asset from unfavourable changes in fundamentals. To illustrate, Wurgler and Zhuravskaya (2002, 585) argue that arbitrage is weaker and likely to be more frequent and severe among securities without similar substitutes. While the market price of a stock should eventually converge to the intrinsic value, it may not happen until after the trader's investment horizon. (Barberis et al. 2003, 1057.)

In reality, arbitrage opportunities entail both costs and risks, which limits arbitrage and allows deviations from fundamental value to persist under some conditions. If the

mispriced security lacks a close substitute for shorting purposes to mitigate the related fundamental risk, to which the arbitrageur is exposed, arbitrage is limited by the following adequate conditions. First, arbitrageurs are risk averse, which ensures that the mispricing cannot be corrected by a single arbitrageur, who takes a large position in the mispriced security. Second, the fundamental risk is systematic; therefore, taking a large number of such positions cannot diversify it. This ensures that the mispricing cannot be corrected by a large number of investors, who add a small position in the mispriced security to their holdings. The existence of noise trader risk or implementation costs will only further limit arbitrage. (Barberis et al. 2003, 1059.)

The frequent discounts for closed-end funds (CEF) serve as an illustration of both fundamental and noise trader risk. Shares of CEFs are traded on organized exchanges, which can be purchased through brokers, who usually sell them for substantial discounts from net asset value (NAV). While various economic and behavioural explanations for this phenomenon have been offered over the years, the discounts for CEFs remain a puzzle. (Day, Li & Xu 2011, 592.) This is a violation of the law of one price, since investors might mistakenly expect the value of the fund to be equal with the value of the shares it holds. However, there are a few separating factors between the value of the closed-end fund and its underlying assets. Lee, Shleifer and Thaler (1991, 76–77, 106–108) suggest that the patterns of discounts and premiums on CEFs are driven by changes in investor sentiment. Discounts on various funds move together and are correlated with the return on small stocks, which suggests that investors are affected by common variation in sentiment. For example, an investor may consider buying funds at a discount in relation to NAV, and selling those at a premium. Nonetheless, the cap between discounts and premiums can extend, which makes this strategy subject to fundamental risk. Pontiff (1996, 1135) finds that the market value of a closed-end fund is more likely to deviate from the value of its assets for funds with portfolios, which are difficult to replicate; for funds, which pay out insignificant dividends; for funds with lower market values; and when interest rates are high. In other words, the lack of an adequate substitute makes the strategy prone to fundamental risk in the form of extending cap among discounts and premiums.

2.4.2 Noise Trader Risk

Arbitrage opportunity can still be limited in case if a perfect substitute security does exist. Noise traders are irrational investors who hold a single stock or a small number of stocks instead of buying and holding a market portfolio or diversifying adequately. Most of their investment decisions are based on feelings or various pseudo-signals. As an illustration, these pseudo-signals may be either advice from a broker or a friend, buy

and sell signals formulated based on technical analysis or other sources of information, which are not relevant or is already compounded in the stock price. (Shleifer & Summers, 1990.)

Scruggs (2007, 77–78) examined the fraction of total return variation unexplained by fundamentals and the short-run risk formulated by arbitrageurs engaged in long-short pairs trading. The author found that only about 70% of daily return variation is explained by fundamentals, whereas the remaining 30% attribute to noise. Therefore, noise trading significantly contributes to daily return variation. This is noteworthy, since noise traders create new investment opportunities for momentum traders by slowing the adjustment speed of prices to new information (Chabot et al. 2009, 3). By assuming that the existence of a perfect substitute security makes the arbitrageur immune to fundamental risk and that there are no implementations costs, only noise trader risk should remain. De Long et al. (1990, 735–736) argue that noise trader risk is, by itself, sufficient to limit the arbitrage opportunities. The adequate conditions are similar to the aforementioned but with one crucial difference. As mentioned before, the first condition states that arbitrageurs are risk averse while the second condition states that noise trader risk is systematic. The significant contribution of Shleifer and Vishny (1997, 54) is to specify the relevance of the first condition: "the possibility of an early, forced liquidation means that many arbitrageurs effectively have short horizons."

Noise trader risk, which was introduced by De Long et al. (1990) and further studied by Shleifer and Vishny (1997), is the risk related to the mispricing being exploited by arbitrageurs in short-term. Even if, a closely priced substitute is available, arbitrageurs still confront the pessimistic investors causing the stock to be undervalued. The importance of the risk is significant, since it can force arbitrageurs to liquidate their positions early, which makes them subject to steep losses. Most real-world arbitrageurs are managing money for their clients, who might lack the specialized knowledge to evaluate the arbitrageur's strategy; therefore, simply evaluating the success of the arbitrageur on the grounds of earned returns. More specifically, if a mispricing which the arbitrageur is trying to exploit generates negative returns, average investors might judge the arbitrageur as incompetent and withdraw their funds. In such case, the arbitrageur will be forced to liquidate position prematurely. In order to prevent such premature liquidations from transpiring, the arbitrageur may act less aggressively when it comes to benefiting from the mispricing. (Barberis et al. 2003, 1057–1058.)

Closed-end fund discounts are an example of anomalies, which demonstrates how the existence of pessimistic investors causes the stocks of CEFs to be undervalued. Ross (2002) illustrates that the discounts can be reconciled with investors even if expenses or fund abnormal returns are modest. There are two claims to the NAV: that of investors and that of the fund manager. By assumption, the manager will take the fees at a percentage rate of the NAV, and investors will perpetually receive dividends and capital

gains from the NAV at a percentage rate. The value of the two holdings is their respective shares of the cast flows. In such case, the discount rate to the NAV is the value of the managerial fees divided by the NAV. The author's analysis might explain why the expectations of investors force closed-end funds to be issued to the public at a discount. If investors do not expect the alpha to exceed the expense ratio, they will simply not purchase shares in the fund. The fact that most premiums eventually turn into discounts demonstrates how difficult it is for the management to fulfil investors' expectations.

In a similar way, the relative mispricing among Siamese twin stocks are cited as a puzzling violation of the law of one price, which are securities with the same cash flow streams but sell at different prices. Froot and Dabora (1999, 190–192) empirically studied Siamese twin securities such as Royal Dutch and Shell. All cash flows are effectively split 60:40 due to a merger agreement in 1907. Shareholders of Royal Dutch receive 60% of the cash flows, and those of Shell receive 40%. According to the EMH, the stock price of Royal Dutch should be 1.5 times the price of a share of Shell. The Siamese twin securities should respond identically to news about intrinsic value as they are exposed to the same fundamental risk factors, and shorting shares are not prone to substantial implementation costs. However, the relative value of the two companies has fluctuated significantly from this parity ratio in reality due to noise trader risk. Investor sentiment can cause a share to be undervalued in relation to the other; therefore, the value of that share can become even more undervalued in the short term. (Barberis et al. 2003, 9.) The fluctuation of different stock markets and currencies explain the variation further. When the U.S. market appreciates in relation to the U.K. market, the stock price of Royal Dutch has a tendency to rise in comparison to the price of its twin Shell. This occurs because of the shares of Royal Dutch are traded relatively more in New York, while the shares of Shell are traded comparatively more in London. In a similar way, the price of Royal Dutch tends to increase in relation to the value of the stock of Shell when the dollar appreciates against pound. (Rau 2010, 345.)

Arbitrageurs may prefer to trade in the same direction as noise traders; thus, exacerbating a mispricing rather than betting against it. For instance, De Long et al. (1990, 705) study positive feedback traders, who extend their long positions of an asset this period if the asset performed adequately in the previous period. Arbitrageurs avoid selling or shorting the asset if noise traders push the price of the asset above its fundamental value. Instead of selling or shorting the asset, knowing that the appreciated price in the past will attract more feedback traders next period, arbitrageurs prefer to buy it. This leads to even higher prices, which is an appropriate time for the arbitrageurs to exit at a profit.

When it comes to momentum trading, profit opportunities are subject to the relative supply of capital available to sophisticated arbitrageurs and noise traders. Noise traders slow the adjustment speed of prices to new information, which creates new investment

opportunities for momentum traders. By contrast, if time periods are abundant in investment capital, market is likely to awash with sophisticated traders who attract arbitrage capital and expand their positions without difficulty. Therefore, momentum profits are most likely to persist in periods when capital available to sophisticated arbitrageurs is in short supply compared to noise traders. The entry of sophisticated leveraged traders can quickly exhaust the profits from momentum investing. When profit opportunities do not longer exist and sophisticated arbitrageurs post losses with more regularity, they exit and the profit opportunities return. (Chabot et al. 2009, 3.)

Creditors can significantly exacerbate the noise trader risk insofar as they see the value of their collateral erode after poor short-term returns; thus, triggering the premature liquidation of the arbitrageur's position. The forced liquidation is the necessary consequence of the worsening position at the mispricing opportunity. As an illustration, many arbitrageurs sell securities short in their efforts to remove fundamental risk; however, they are prone to a possibility that the borrowed security needs to be returned to the original owner. In such case, the arbitrageur might be forced, prematurely, to close the position if other shares are not available to borrow. Especially, this may occur during a temporary worsening of the mispricing, which makes the arbitrageur cautious when betting on the mispricing opportunity. (Barberis et al. 2003, 1057–1058.) The following section examines further this scenario in which shorting opportunities deteriorate due to increased implementation costs.

2.4.3 Implementation Costs

Another limit to arbitrage opportunities is high implementation costs for any arbitrage trading. Implementation costs refer to anything that makes establishing a short position less attractive than a long position. Transaction costs such as commission fees, bid-ask spreads and price impact can make a mispricing less attractive for arbitrageurs to exploit it. Furthermore, short-sales constraints are included in the implementation costs category, since shorting is often a necessary part of the arbitrage process. Taking a short position in an overpriced security may be impossible due to several factors. First, if stock lending is prohibited, investors such as pension or mutual fund managers have to act on the grounds of strict limitations on their discretion to short securities. Second, if no shares are available to be borrowed or establishing a short position is not attractive due to high implementation costs. To illustrate, short-sellers may have to return the borrowed security on little notice, which causes the horizon of the short sale to become uncertain. (D'Avolio 2002, 302–303; Barberis et al. 2003, 1058.) These constraints on establishing a short position limit the ability of arbitrage activity to force market prices to intrinsic values.

Due to implementation costs, the condition in which the fundamental risk is systematic may not be necessary. To illustrate, individual arbitrageurs may not want to intervene in an attempt to correct a mispricing if learning about the mispricing is costly or the resources required to exploit the mispricing are expensive. In addition, arbitrageurs may also hesitate to exploit the mispricing if they are not aware of the number of other arbitrageurs following the same mispricing opportunity; thereby, those hesitating arbitrageurs may prefer to wait until the market price of that security reverts to its intrinsic value. (Barberis et al. 2003, 1059–1060.)

To exemplify implementation costs, Lamont and Thaler (2003, 197–200) examine how the market value of the spun-off subsidiaries of tech companies exceeded that of the parent company, which retained a majority stake in the spinoff. More specifically, several equity carve-outs have violated the law of one price due to inability to short, which leads to extreme price mismatches. An illustration of this involves 3Com, which decided to spin off its Palm division. This means that 3Com created an independent company through the sale of new shares of the existing Palm division. 3Com sold a small part of its stake in Palm to the general public with an initial public offering in March 2000. In this transaction, which is also called an equity carve-out, 3Com announced that it would distribute the remaining 95% of its Palm shares to 3Com shareholders later in a spinoff; therefore, each shareholder would receive 1.5 shares of Palm for every share of 3Com in the spinoff. One might expect 3Com's stock price to be considerably above 1.5 times the share price of Palm, since it held about $10 per share in cash and securities in addition to its other profitable business assets. The day before the Palm IPO, 3Com closed at $104.13 per share; and Palm closed at $95.06 per share after the first day of trading, which implies that the price of 3Com should have appreciated to at least $145. Instead, Palm shares at the IPO sold for more in comparison to the shares of 3Com as 3Com depreciated to $81.81 per share. Therefore, the implied value of 3Com's non-Palm assets and businesses was $63. In other words, the stock market value of 3Com's non-Palm business depreciated $22 billion. (Rau 2010, 345.) In this example, an arbitrage strategy might seem obvious, but the limit to arbitrage was the inability of investors to sell Palm short, since nearly all Palm's available shares were borrowed and sold short or were quoted a significant borrowing price (Barberis et al. 2003, 11).

To summarize, limits to arbitrage prevent rational arbitrageurs from exploiting short-term mispricing caused by irrational investors. Particularly, the distinguished violations of the law of one price constitute a fundamental empirical challenge to the EMH, which implies that a stock price should, on average, reflect its intrinsic value. However, arbitrageurs should not be able to force the stock price to the intrinsic value insofar as the limits to arbitrage exist. The most significant of which are fundamental and noise trader risk. The former is the exposure to losses from a situation affecting a company, which is

caused by natural or social phenomena. The latter refers to the risk that the mispricing exploited by the arbitrageur worsens in short-term despite the existence of a perfect substitute security, which forces arbitrageurs to liquidate their positions unfavourably early. This follows that the adjustment speed of prices to new information decelerates due to noise traders, creating new investment opportunities for momentum traders. Finally, implementation costs refer to anything that makes establishing a short position less attractive than a long position.

2.5 Momentum Investing

Momentum investing has been known by financial academics for decades. As a standalone investment strategy, momentum produces better abnormal performance than either size or value based investment strategies. The momentum effect exists virtually in all securities, market sectors, international markets and various asset types. (Asness et al. 2009, 29.) It provides powerful means to increase portfolio efficiency, diversification and extraordinary returns. However, momentum investing has been difficult to access for most investors, but financial companies have recently launched products, giving more investors an access to utilize momentum. To illustrate, Dorsey-Wright's ETF provides technical tools for investors; whereas the other models are proprietary, such as the ones provided by MSCI. Furthermore, AQR Capital Management launched a transparent momentum-investing index with multiple funds designed to track the index. In principle, momentum-investing strategies seek to identify securities with significant performance in the past; and predict which of the successful securities will continue to outperform in the future regardless of the market conditions. However, momentum is distinct from apparent trend-following strategies, since the strategy is robust regardless of 'bull' or 'bear' markets. (Moskowitz 2010, 22.)

The momentum effect demonstrates significant robust marginal explanatory power in all capitalization groups, such as microcap stocks, small-cap stock and large-cap stocks. Fama and French (2008, 1669–1670, 1674) examine the correlation structure of momentum investing on the grounds of regression analysis, equal-weighted and value-weighted sort returns. Despite of minor conflicts, all these approaches concur with the argument that the correlation between momentum and average returns is similar for small-cap and large-cap stocks, but only about half as strong among microcaps.

The valuable attribute of momentum strategies across asset classes in a unified setting is the intriguing global co-movement structure. Especially, the use of the momentum effect can provide necessary tools for overlaying and improving any asset allocation strategy. The unique correlation structure of momentum investing makes it a valuable alternative to growth strategies and an impeccable complement to value strategy to

be used in an investment portfolio. This global factor structure is consistent with the presence of underlying economic factors influencing part of the momentum returns. In addition, the robustness of the structure improves when extreme returns events occur. (Asness et al. 2009, 27, 29.)

The abnormal returns of momentum investing are positively correlated to those of growth and negatively correlated to those of value within and across markets and asset classes. First, although a momentum strategy tends to move in parallels with growth stocks, it tends to yield higher returns with larger Sharpe ratios. Shifting securities from growth to momentum portfolios results in a more efficient portfolio with a higher expected return, when it comes to a typical investor with growth exposure. In addition, momentum investing helps market participants to identify the best of growth stocks, which are more likely to outperform the market. (Moskowitz 2010, 24.) Second, the benefit of combining value and momentum investing in a portfolio is diversification across markets and asset classes. To illustrate, the combination of the value and the momentum strategies mitigates the extreme negative return episodes formulated by a value-investing strategy. (Asness et al. 2009, 16, 29.)

In brief, momentum investing is a powerful strategy, which is not matched in its predictive robustness. For the past two decades, academics have referred to size, value and momentum as the tree essential pillars of a portfolio. Whereas, size and value investing have low-cost, accessible and transparent investment tools available to all investors, the availability of tools to utilize momentum has been limited to hedge funds, institutional investors or expensive active portfolios until recently. The introduction of low-cost momentum funds, which are based on transparent indices, represents a crucial development in acceptance of momentum strategies. It is supported by research, successfully used by leading institutional investors and available to the broader investment community due to investable indices. Particularly, momentum investing provides necessary tools for handpicking the best outperforming stocks while mitigating growth exposure or diversifying the portfolio when combined with a value-based strategy. (Moskowitz 2010, 24–26.) However, regardless of the multiple ways to utilize momentum in a portfolio, the empirical part of this study examines momentum strategies in a stand-alone basis.

2.5.1 Momentum and Reversals

After the discovery of the EMH, a great number of financial studies have tested the hypothesis. For example, Shiller (1981) found that the stock market prices are considerably more volatile than could be justified by a model in which prices are comparable to the expected net present value (NPV) of future dividends. This finding pointed the way

to a new field of research. In order to test the weak form of the hypothesis, researchers measured the profitability of trading rules used by investors, who had discovered patterns in security prices to earn abnormal profits. There are several patterns throughout the world, which are categorized under the following groups: returns over short and intermediate horizons.

Early tests of market efficiency were tests of the weak form, which investigated abnormal returns over short horizons. Especially, these tests are regarded as tests of the efficacy of technical analysis. One way to identify trends in historical security price data is to evaluate the tendency of stock returns in relation to past returns, which is known as serial correlation. For example, positive serial correlation or momentum means that positive returns have a tendency to be followed by positive returns. Both Conrad and Kaul (1988) and Lo and MacKinlay (1988) attempted to characterize the stochastic behaviour of expected returns on common stock. They detected unusual predictable components in weekly returns of NYSE stocks on size-based portfolios assuming that errors are normally distributed. In addition, they found positive serial correlation over short horizons; thus, their empirical results indicate that the random walk model is not compatible with the stochastic behaviour of weekly returns, especially, for the small-cap stocks. However, the correlation coefficients of weekly returns tend to be relatively small in terms of large-cap stocks for which price data is the most reliably up to date. These results do not necessarily imply that the stock market is inefficient or that prices are not rational assessments of fundamental values, but they impose restrictions upon the number of plausible economic models for asset pricing (Lo et al. 1988, 61).

Although numerous ways to predict security returns based on past returns have been identified, the momentum effect is possibly the most significant breakthrough in the field of finance for decades. In more detail, trading strategies formulated based on the momentum effect by buying past winners and selling past losers realise significant abnormal returns. Jegadeesh and Titman (1993, 65, 89) discovered evidence supporting the momentum effect while investigating intermediate-horizon stock price behaviour in the early 1990s. They argue that the strategy earns positive abnormal returns above the market index and produces better abnormal performance when compared to size and value investment strategies.

Jegadeesh and Titman (1993, 65, 89) formulate a portfolio following the momentum strategy, which handpicks stocks based on their past 6-month returns and holds them for six months. This strategy realises a compounded excess return of 12.01% per year over the 1965 to 1989 period. The research data indicates that underperforming value stocks in long-term with high recent momentum over the period of six to twelve month returns will outperform by a wider margin, which is also the period when the price fluctuations of the stocks in the winner and the loser portfolios are the most predictable. In other words, stocks with low returns over the past year tend to have reduced returns for the

following six to twelve months, whereas stocks with strong past returns tend to have high future returns. Regardless the fact that the performance of individual stocks is highly uncertain, portfolios including the best-performing stocks of the recent past seem to outperform other stocks with reliability to provide profit opportunities.

Jegadeesh and Titman (1993, 89) study the returns of the zero-cost winner minus loser portfolio in each of the 36 months following the portfolio formation date. The returns of stocks in the winner and the loser portfolios fluctuate around their earnings announcements in the 36 months following the formation period. Specifically, stocks in the winner portfolio realise remarkably higher returns compared to the stocks in the loser portfolio surrounding the quarterly earnings announcements. This momentum portfolio realises positive returns in each of the twelve months after the formation date with the exception of the first month. However, the long-term price fluctuations of these past winner and loser stocks reveal that half of their abnormal returns in the first year after the portfolio formation date dissipate within the following two years. Systematic risk or lead-lag effect, which results from delayed price reactions to fundamentals, do not account of the abnormal profitability of momentum investing, but rather the authors' results are in parallels with delayed price reactions to firm-specific information.

Although abnormal returns in short and intermediate horizons suggest momentum in the stock market prices, tests of long-horizon returns have discovered suggestions of conspicuous negative long-term serial correlation in the performance of securities markets (De Bondt & Thaler, 1985; Fama & French, 1988; Lee & Swaminathan, 2000). Negative serial correlation or the reversal effect means that positive returns tend to be followed by negative returns, and vice versa. De Bondt et al. (1985, 793, 804) compared the performance of two groups of companies: extreme losers and extreme winners. Specifically, they ranked the performance of stocks over the 5-year period and grouped the stocks into portfolios based on investment performance. The base-period "loser" portfolio, which included the 35 stocks with the worst investment performance, outperformed the "winner" portfolio with the top 35 stocks by an average of 25% in the following 3-year period. In other words, these results on the average performance of the portfolios indicate significant post-formation returns of the extreme losers and relatively scarce returns of the extreme winners.

In brief, anomalies literature provides evidence for short-term and intermediate-term price momentum in securities markets and across particular stocks. Furthermore, evidence demonstrates that the stock market overreacts to relevant news, since recent loser portfolios rebound and winner portfolios fade away in long-term. Due to these occurrences of clearly visible overshooting, which are followed by price reversals, the stock market has the appearance of fluctuating around its fair value. Both momentum and reversals in stock prices constitute a serious challenge against the validity of the efficient market hypothesis.

2.5.2 Rational and Psychological Interpretations

Academic literature explaining momentum and reversals is somewhat inconsistent due to studies taking both rational and irrational approaches. Fama and French (1988, 247) introduced two competing economic interpretations for the strong predictability of long-term returns due to slowly decaying price components: the predictability of long-term returns can result from time-varying equilibrium expected returns produced by rational pricing in efficient markets, or the price behaviour is in parallels with the common models of irrational markets in which stock prices take temporary fluctuations away from fundamental values.

The former interpretation depends on the variance of risk premiums over time, which leads to overshooting and correction as a rational response of market prices to changes in discount rates. The results can be explained by the systematic risk of portfolios and the size effect, since outperforming stocks will typically become expensive, and expensive stocks tend to underperform less-expensive stocks. This phenomenon is regarded as the value effect according to which long-term past performance is an appropriate indicator of value. (Moskowitz 2010, 24.) However, the reversal effect cannot be explained by the greater riskiness of the underperforming stocks when standard risk adjustments are used, such as the Capital Asset Pricing Model (Shleifer 2000, 17–18).

The latter interpretation has given rise to a hypothesis according to which stock markets might under react to relevant news. The results in Jegadeesh and Titman (1993, 90) indicate that stock markets might under react to information about the short-term prospects of firms but overreact to information about their long-term prospects. This interpretation is plausible insofar as the nature of information available about a company's short-term prospects, such as earnings forecasts, is different from the nature of more ambiguous information, which investors use to assess the firm's long-term prospects.

Jegadeesh and Titman (2001, 700–701, 708) evaluate behavioural explanations for the profitability of the JT momentum strategy. Their results indicate that momentum profits have continued in the 1990s, which shows that the original results were not subject of data snooping bias. Furthermore, they reinforce the empirical evidence of momentum in stock prices with an argument that the abnormal performance of a momentum portfolio is generated by delayed overreaction, supporting the behavioural models of investing.

The hypothesis is consistent with the psychological approach of asset pricing concluding several interpretations. First, Daniel et al. (1998, 69) present a model in which an investor is overconfident and also suffers from a self-attribution bias. They argue that the potential for overreaction in security prices is subject to increased investor overconfidence when the investor's overweight initial private signals in estimating the value of a security are confirmed by public information. Thereby, mispricing is only partially

corrected when information becomes public, but investors' self-attributing behaviour generates delayed overreaction to information that is eventually reversed.

Second, Barberis et al. (1998) introduce a model of investor sentiment on how investors' believes are formulated. The behaviour of a given firm's earnings moves between two regimes: (1) earnings are mean reverting and (2) earnings are likely to rise further after an increase. Each period, the investor observes earnings and updates beliefs about the current state. The former regime is supported by the under reaction evidence, which shows that, over horizons of 12 months, news is incorporated only slowly into security prices as investors under react to news. This is in parallels with the conservatism bias, which is defined as the slow updating of models insofar as new information is concerned (Edwards, 1968). The model of investor sentiment suggests that the investor raises the prospect of the mean-reverting regime when a positive surprise is followed by a negative surprise. By contrast, the latter regime is supported by the overreaction evidence, which shows that, over longer horizons of 3-5 years, security prices overreact to consistent patterns of news pointing in the same direction. In other words, securities with a long record of favourable news tend to become overpriced and have subsequent lower returns, which is consistent with the results in Tversky and Kahneman (1974) on the behavioural heuristic referred to as representativeness. In other words, investors tend to view events as typical or representative of a specific class and ignore probability estimates in the process. Thereby, the investor raises the likelihood of the trending regime when a positive earnings surprise is followed by another positive surprise. For example, investors might classify stocks as growth stocks based on the history of consistent earnings growth while ignoring the likelihood that only a few companies constantly grow.

Third, the momentum effect and subsequent reversals can also be interpreted on the grounds of news watchers and rational momentum traders. Hong and Stein (1999, 2147) introduce a model in which the ability of investors to use information about an economy is limited by communication frictions. In the model, private information diffuses slowly through the investors, which causes under reaction in the short term. Specifically, the extreme loser stocks are typically companies with several years of poor news, which are extrapolated to the valuation of future prices causing investors to undervalue the intrinsic values of those companies, whereas the extreme winner stocks are companies with several years of favourable news. The news watchers mainly focus on their private information about future fundamentals and do not base their information on price trends, whereas the momentum traders mainly concentrate on price trends. The authors assume that information about future fundamentals spreads gradually through the news watchers group, which causes security prices under react to fundamental news. Momentum traders accelerate the price trend, but cause a subsequent overreaction at long-term when it is recognised, which is also referred to as the reversal effect.

In brief, the behavioural interpretations are consistent to the extent that intermediate-term momentum and long-term reversal are subsequent patterns in stock price behaviour. As a collective psychological interpretation of this pattern is that overreaction in intermediate horizon occurs due to momentum in prices, which leads to long-term reversals when the market recognizes its past errors.

2.5.3 Deteriorated Profitability in January

The studies of momentum investing have reported negative results in January, since the long-term losers outperform the long-term winners only in January. Due to the existence of this market behaviour, it is unclear whether results can be attributed to overreaction. Jegadeesh and Titman (1993, 79) find that the momentum strategy loses about 7% on average in each January, but yields positive abnormal returns in each of the other months. However, the negative average return in January is not statistically significant when it comes to large-cap firms. Similarly, George and Hwang (2004) find that the 52-week high strategy generates higher returns in calendar months when January is not included, and significantly negative return in January.

Since Rozeff and Kinney (1976) provided the first empirical evidence regarding one of the most extensively recognized anomalies, the January effect, which has gained attention from academics and practitioners. It refers to the observation that the month of January appears to have systematically higher returns than other months of the year. Regarding the size-effect of stock returns, Banz (1981) documented the small-firm effect in a study observing the historical performance of portfolios, which are formed by dividing the NYSE stocks into 10 portfolios each year based on firm size. The author's results indicate that, between 1936 and 1975, the common stock of small firms had, on average, higher risk-adjusted returns than the common stock of large firms. Although the smaller-firm portfolios have a tendency to be riskier, there is a coherent premium for the smaller-sized portfolios even if returns are adjusted for risk using the CAPM. Later studies found that small-firm effect occurs practically in January (Keim, 1983; Reinganum, 1983).

Various studies have investigated the underlying reasons of the January effect. Other studies have identified that market microstructure effects, such as bid-ask spreads and thin-trading which are more pronounced for smaller and lower priced stocks, are vital factors in explaining the abnormally high returns in January (Roll, 1981). Despite the importance of their findings, the empirical literature on the January effect suggests behavioural interpretations for the abnormally high returns in January. The most significant among these theories are the tax-loss selling hypothesis (Wachtel, 1942) and the window dressing hypothesis (Haugen & Lakonishok, 1988).

First, the tax-loss selling hypothesis suggests that investors sell the losing stocks in their portfolios at the end of the year to gain tax benefits. Constantinides (1984) demonstrates that stock markets should not be prone to increases in tax-loss selling at the end of the year insofar as no transaction costs exist and investors treat short and long horizons equally. However, Grinblatt and Keloharju (2001, 2004) find that Finnish investors, for instance, are subject to common folk wisdom that investors take the tax implications of their portfolios into consideration at the end of the year. Supporting this approach, Hvidkjaer (2006) examines buying and selling pressure from quoted daily spreads. Their results indicate year-end selling pressure in firms, which have performed inadequately over the prior year, and subsequent buying pressure in the firms in January.

Grinblatt and Moskowitz (2004, 543, 577) examine variations in tax-loss selling in the profitability of momentum strategies, finding that these seasonal effectiveness fluctuations are related to tax-loss trading in terms of how tax regimes affect the relation between past and expected returns in December. Specifically, when effective capital gains tax rates are expected to decrease, which provide an incentive to accelerate the realization of losses, increased selling pressure on losing stocks improves the profitability of momentum strategies in December. This is followed by a subsequent recovery in January. Their results also indicate that a part of the intermediate-term momentum and long-term reversals evolve independently, since the long-term reversal effect appears only in January, but significant momentum exists outside of January. The link between the effects is likely to be driven by tax-loss selling at the end of the year.

Second, the window dressing hypothesis suggests that investors sell certain stocks at the end of the year to present an acceptable portfolio of stocks to fund holders in their year-end reports. The incentive to window-dress is greater when the annual performance of a portfolio manager is compared to peer's performance or when annual statements show individual returns for each stock held in addition to the overall returns of the portfolio. (Haugen & Lakonishok, 1988.) Both of these theories suggest that investors repurchase the stocks in the following year, which creates the abnormal returns observed in January. Evidence from Chen and Singal (2004) has identified the tax-loss selling hypothesis as the most likely explanation for the January effect. Nonetheless, the theory may not be sufficient to explain the abnormally large returns observed in many countries where the tax year for individuals is not the calendar year (Brown et al., 1983; Fountas & Segredakis, 2002).

Regardless of strong empirical support for the existence of the January effect, recent research has argued that the magnitude of the anomaly has declined. Empirical literature has provided straightforward explanations for this phenomenon; such as low cost alternatives to profit from the effect are widely available to investors, and investors have had the knowledge and instruments to take advantage of the January effect. Mehdian and

Perry (2002) and Gu (2003) suggest that the January effect has disappeared or, at minimum, has been in decline since 1987. These results indicate that investors may have begun taking advantage of the January anomaly.

Despite the importance of the results in Mehdian et al. (2002) and Gu (2003), Moller and Zilca (2008) argue that the results of their studies are limited by the fact that they use only monthly returns to draw their conclusions. Investigating the daily pattern of the January effect, rather than measuring the effect at the monthly level, provide a more accurate picture of the evolution of the January effect. The examination of daily trading volumes suggests a substantial decline in trading volume intensity, a shorter duration of the effect, and a mean reverting component in the second part of January. In addition, the evidence from the daily analysis shows higher abnormal returns in the first part of January and lower abnormal returns in the second part of January in the 1995–2004 period. The most likely explanation according to Mehdian et al. (2002) is that, in recent years, investors have become more knowledgeable and sophisticated, and they are less willing to buy stocks when the January effect peaks. Supporting these results, Easterday et al. (2009, 1192) find that the effect persists in the 1946–2007 time period and that January premiums have not declined.

In brief, the finding that January effect has not been arbitraged away is compatible with the behavioural finance literature. Although it may be possible to exploit this phenomenon in stock markets, the studies of momentum investing strategies have reported negative results in January due to taking a short position against these appreciating loser stocks (Jegadeesh et al., 1993; George et al., 2004).

2.5.4 Liquidity Risk, Transaction Costs and Tax Efficiency

In a similar way to any other investment strategy, momentum investing does not always deliver positive abnormal returns, but instead it will occasionally underperform. Momentum investing tends to be profitable when value investing fails due to the negative correlation structure between the strategies. Especially, the importance of liquidity risk on momentum strategies has risen over the past decades. In addition to liquidity risk, a recent topic of academic debate is whether momentum strategies are profitable when transaction costs and taxation are taken into account.

A statistical perspective provides valuable information on the correlation structure of liquidity risk, which illustrates that momentum is effective in illiquid markets and performs poorly in liquid markets. Thereby, liquidity risk is indispensable when momentum investing is concerned, since it is negatively correlated with momentum investing (Markowitz 2010, 25). Asness et al. (2009, 26) argue that the correlation structure holds both in terms of performance and the arising statistical power to identify economic ex-

posures, which are not easily detectable when examining any strategy in isolation. The results highlight the increasing importance of liquidity risk on the efficacy of both value and momentum strategies. Their findings suggest that momentum can be used as a valuable tool for hedging liquidity risk insofar as limits to arbitrage enable it. This is a crucial notion when the economy suffers severe illiquidity and value investing fails miserably, such as the subprime crisis in 2008.

In the absence of a suitable risk premium-based explanation for momentum profits, a question rises whether the apparent momentum profits exceed transaction costs. Carhart (1997, 79–80) demonstrates short-term persistence in equity mutual fund returns with common factors in stock returns and investment costs. The momentum strategy yields a return of 8% per year by buying last year's top-decile mutual funds and selling last year's bottom-decile mutual funds. Although the top-decile mutual funds earn profits in excess of their investment costs, most funds underperform by the magnitude of their expense ratios, portfolio turnover and load fees. Regarding the magnitude of transaction costs, Grundy and Martin (2001) calculate that at transaction costs of 1.5% the profits on a momentum strategy become statistically insignificant, and that the profits are driven to zero at transaction costs of 1.77%. Similarly, Korajczyk and Sadka (2004, 1040) argue that the estimated abnormal returns of some momentum strategies vanish after an initial investment of $4.5 to over $5.0 billion is engaged by a single fund in such strategies. Moreover, the statistical significance of these excess returns disappears after $1.1 to $2.0 billion is engaged in the momentum strategies.

The tax efficiency of a momentum strategy varies when examined in a stand-alone investment basis or as part of an extensive asset allocation framework. In the latter point of view, revenues need to be considered as part of overall revenues of a portfolio, which may create different tax implications from a stand-alone investment. Israel and Moskowitz (2010, 31–32) find that, despite significantly higher turnover, the momentum strategy is more tax efficient within a stand-alone basis than value strategies, and it has a substantially lower tax rate when examined in the context of a broadly allocated portfolio. This statement holds due to significant losses in short-term, generated by momentum, which is used to diminish other revenues in the broad portfolio. In contrast, value investment strategies expose investors to significant, tax-sensitive dividends, which are treated in similar ways in a stand-alone setting or within a broader allocation.

When the tax optimized or tax aware versions of different equity types are concerned, capital gains minimization can significantly improve the after-tax performance of a momentum strategy without considerable tracking error or strategy drift. Whereas minimizing dividend exposure can be costly to both value and growth strategies in terms of lower average returns, substantial tracking error and strategy drift; minimizing dividends improves the after-tax returns of the momentum strategy and the momentum portfolio is not prone to incurred strategy drift. Hence, the tax aware versions of mo-

mentum investing improve outperformance in relation to value and growth strategies. These results are the most robust in broader portfolio framework and 'bear' markets. (Israel et al. 2010, 32.)

As a conclusion, momentum can be used as a tool for hedging liquidity risk to the extent that limits to arbitrage enable it. Especially, investigating a momentum strategy in relatively illiquid and volatile stock markets, such as the OMX Helsinki stock exchange, may result in fascinating empirical observations. Regardless of the high transaction cost, limits to arbitrage do not explain the underlying causes for the existence of abnormal momentum profits. Finally, momentum strategies are tax efficient, since the substantially low tax rate in the broad portfolio framework is explained by significant losses in short-term.

2.5.5 Perceptions of Market and Firm-Specific Risk Factors

Since the introduction of the momentum effect in Jegadeesh and Titman (1993), which focused on U.S. equities over the period of 1963 to 1990, a great number of academic papers have been dedicated to investigate it. In recent decades, it has been in a seminal part to influence academic models and empirical studies on asset pricing due to the failure of the three-factor model to capture momentum returns (Fama & French 1996, 81). Particularly, academic literature finds strong support for the momentum effect in the out-of-sample period after the original research was published. To illustrate, Chabot et al. (2009) find compelling evidence for short-term reversals, intermediate-term momentum and long-term reversals in the U.S. over the period of 1926 to 2008 and as long back as the Victorian age data of the London stock exchange. The results indicate that the profits are not a compensation for economy wide systematic risk, which is captured by the standard CAPM or macroeconomic factor models. Especially, the existence of price momentum during the Victorian age eliminates the possibility that price momentum is an artefact of data mining.

The evidence of abnormal momentum profits has been extended to stocks in other developed countries. Rouwenhorst (1998, 268) examines the momentum effect with respect to a sample, which consists of monthly returns for stocks from 12 European countries over the period of 1978 to 1995: Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Sweden, Spain, Sweden, Switzerland and the United Kingdom. The results indicate that an internationally diversified momentum portfolio, which invests in past winners and shorts against past losers, yields about 1% per month. The results are robust with regard to the use of momentum investing in a global setting, since the momentum effect is present in all 12 markets in the sample. The outperformance lasts for a year, which cannot be attributed to conventional measures of risk. Re-

garding the global factor structure, the author finds that the momentum effect is negatively related to firm size, which is not limited to small-cap stocks. Controlling for exposure to a size factor or market risk increases the abnormal profitability of the momentum strategies. The evidence of significant momentum profits has also been extended to stocks in developing countries. Rouwenhorst (1999, 1441–1442) finds that the factors driving cross-sectional differences in the expected returns of 20 emerging equity markets are similar to those documented for the developed markets. Although the momentum effect is not as universal in the emerging markets as compared to the developed markets, the results suggest that those emerging markets exhibit momentum.

Chui et al. (2000, 1–4, 25–27) examine the profitability of momentum strategies in eight different Asian countries: Hong Kong, Indonesia, Japan, Korea, Malaysia, Singapore, Taiwan and Thailand. The results indicate that the JT momentum strategy is utterly profitable when implemented on Asian stock markets except for Japan. The authors provide a few interpretations for the results. First, a great number of public companies in Asian countries are affiliated with corporate groups, which are associated with either a bank or a powerful family. However, the results indicate that the momentum effect is more apparent among independent firms instead of group-affiliated firms. Second, the greater potential to manipulate stock prices in civil law countries induces negative correlation, which offsets the momentum effect. Finally, the results indicate that price reversals tend to occur within nine to ten months after the portfolio formation date, which is in parallels with the prediction of the behavioural models.

Griffin, Ji and Martin (2003, 2517, 2545) investigate the linkages among macroeconomic risk and the momentum effect with international data, which consists of stocks in 40 stock markets. The results are consistent with the argument that abnormal returns solely compensate investors for holding high macroeconomic risk in their momentum portfolios. In addition, they find that momentum is not a reward for price business cycle risk, since the JT strategy earns positive abnormal returns both in ‘bull’ and ‘bear’ business cycles. Finally, the results indicate significant international evidence of price reversals, which is incompatible with the risk-based explanations of momentum.

Griffin et al. (2005, 24, 37) investigate 40 markets for momentum in stock prices, and find that the JT momentum strategy yields high profits in a great number of stock markets. These momentum profits are not only driven by short positions, since taking long positions in stocks with high past returns would have generated long-run passive strategy returns to outpace market indices. However, the authors argue that, superficially, momentum investing is not as risky in terms of time series average exposure to traditional factors as market or regional indices, since the JT momentum strategy utterly benefits from diversification as opposed to the market index strategy. Regardless of the exposure structure, momentum investing is, occasionally, associated with negative returns, which cluster in January for 16 out of 40 markets.

In brief, volatile momentum profits are driven by both short positions in stocks with low past returns and long positions in stocks with high past returns. In addition, the abnormal profits are not subject to time series average exposure to traditional factors, since the efficacy of momentum investing benefits from international diversification. This mitigates both macroeconomic and political risk for which higher momentum profits are compensated. Furthermore, the abnormal returns of sufficiently diversified momentum portfolios are robust both in 'bull' and 'bear' markets, which suggests that the profits are not a reward for priced business cycle risk. Finally, momentum is driven by firm-specific factors, such as firm size and company structure. As an illustration, momentum tends to be more significant among small-cap stocks, and abnormal momentum profits are greater for independent firms than for group-affiliated ones.

2.6 52-Week High Momentum Investing

2.6.1 The 52-Week High Strategy

The most intriguing results are expected to appear from the integration of the 52-week high statistic with momentum investing. George and Hwang (2004) find that nearness to the 52-week high is a better predictor of future returns than past returns, and also that nearness to the 52-week high is predictive whether or not stocks have experienced extreme past returns. Thus, they suggest that price levels are more crucial determinants of the momentum effect than past price changes. As market efficiency is concerned, the results of both Jegadeesh and Titman (1993) and George and Hwang (2004) indicate a serious challenge to the view that securities markets are semi-strong form efficient. Especially, the finding is remarkable due to the fact that the nearness of a stock's price to its 52-week high is a piece of information, which is easily accessible to investors due to many newspapers identifying stock prices that hit their 52-week highs and lows.

The 52-week high momentum strategy (GH henceforward) measures the performance of an individual stock by the nearness of the current price to the 52-week high. Based on the GH strategy, a long position is taken in a stock whose current price is near the 52-week high, whereas short positions are taken in stocks whose current price is far from the 52-week high. George and Hwang (2004) argue that after controlling for the size effect and the impact of bid-ask bounce, returns associated with winners and losers identified in terms of the GH strategy are about twice as large as those associated with the momentum strategy in Jegadeesh and Titman (1993). These results are even more robust outside of January.

George and Hwang's (2004) results indicate that the 52-week high value is a predictive proxy whether or not individual stocks have had extreme returns, which is in parallels with the assumption of the anchor-and-adjust bias. As an interpretation of the strategy, investors assess the potential impact of new information against the 52-week high as a reference point. Specifically, when favourable news forces a stock's price close to the 52-week high, investors are reluctant to bid the stock price to higher-level even if information verifies it. By contrast, if unpleasant information pushes a stock price to a noticeable distance from its 52-week high, investors are initially unwilling to sell the stock at a low price implied by the new information. In both cases, a delayed reaction to the information results in either appreciating or depreciating price continuation. With reference to these observations, investors' unwillingness is at price levels, which are near and far from a stock's 52-week high. When the stock's price is neither near nor far from the 52-week high, prior information adjusts more quickly and no noticeable predictability exists when information becomes available.

The evidence in Grinblatt and Keloharju's (2001) detailed study on the Finnish stock market is in parallels with this interpretation. They find that price-levels affect investors' trading patterns to a great extent, since they tend to sell a stock whose price is near a historical high, whereas they are more likely to buy a stock near to its historical low. When information is eventually taken into account, gradual increase in the stock's price results in price continuation. When past performance is measured on the grounds of nearness to the 52-week high, the results in George and Hwang (2004) indicate that the anchoring effect is the best psychological bias to characterize under reaction, which leads to stock markets resolving without long-term reversals. This finding suggests that intermediate-term momentum and long-term reversals are not subsequent component caused by the same investor behaviour which is inconsistent with the behavioural models of the same phenomena in Barberis et al. (1998), Daniel et al. (1998) and Hong and Stein (1999).

As opposed to the behavioural models in Barberis et al. (1998), Daniel et al. (1998) and Hong and Stein (1999), models in which investors' valuations depend on nearness of a stock price to its anchor are successful in interpreting the observed price dynamics. As an interpretation of the results, Grinblatt and Han (2002) argue that a subset of investors tend to hold onto losing stocks and sell winning stocks in their portfolios, since realizing the losing stocks would result in the identification of losses. Shefrin and Statman (1985) refer to this phenomenon as "disposition effect," which appears to influence

investor behaviour in many countries across both experimental markets and financial markets.[1]

Grinblatt and Han (2005, 311) introduce a model based on a prediction of disposition behaviour, which differs from other behavioural models in suggesting that aggregate capital gains is a critical variable in forecasting the cross-section of returns. As an illustration, when pleasant information becomes available about a security, investors who are subject to the disposition effect are disposed toward selling winner stocks and holding losing positions. Consequently, this behaviour slows the rate at which information can be reflected in a stock price. They find that a predictive proxy providing information on investors' tendency to sell or hold a security explains the level of momentum profits. Thereby, the acquisition price of the security may serve as an anchor, when demand functions are negatively related to embedded gains. They show that this dependence results in momentum behaviour in stock prices, which are at or near the long-term high and low.

The interpretation for long-term reversals lies beyond the anchoring bias. Klein (2001) explains long-term return reversals with a model in which a representative investor is motivated by tax avoidance insofar as his demand for shares is positively related to the embedded capital gains. In a similar way to the disposition model, the anchor is the price at which shares are acquired. Strategies based on the purchase price anchor seem to generate significant profits, which are not prone to reversals. Nonetheless, George and Hwang (2004) demonstrate that profits from this strategy are strongly dominated by profits from the GH strategy.

In brief, George and Hwang (2004) introduced the GH strategy in which performance of individual stocks is measured by reference to how close the current price is to the 52-week high. Specifically, the strategy takes long positions in stocks whose current price is close to the 52-week high, whereas short positions are taken in stocks with a current price far from the same anchor. The results of such a strategy indicate that the 52-week high is a predictive proxy whether or not a stock has had extreme returns. The approach is consistent with the assumption of the anchor-and-adjust bias. Particularly, it is the best psychological bias to characterize under reaction as stock markets resolve without overcorrection. The underlying reason for the momentum effect lies in the disposition effect. Specifically, insofar as a subset of investors' demand function for a share is negatively related to embedded gains, they are averse to selling the shares far from their acquisition prices, which would result in the identification of losses. However, the interpretation for long-term reversals lies beyond anchoring, but instead in repre-

[1] The explanation for the disposition effect arises from the combination of Thaler's (1985) mental accounting and Kahneman and Tversky's (1979) prospect theory, which is further illustrated in Appendix 1

sentative investors motivated in tax avoidance to the extent that their demand for a share is positively related to the embedded capital gains, and they use the purchase price as an anchor to which they add the increment suggested by new information.

2.6.2 Efficacy and Proxy Indicators for Abnormal Returns

To test the robustness of any anomaly in financial markets, they need to pass the out-of-sample test to show that the results are not an artefact of data mining. Whereas the JT strategy has been extensively studied with international data, only a few papers have studied the GH strategy in international stock markets, despite the fact that the 52-week high information of individual stocks is widely available around the world. For example, the 52-week high information is available for the stocks listed on the OMX Helsinki stock exchange from the *Financial Times* website.

To exemplify the international studies regarding the GH strategy, Marshall and Cahan (2005) provide the first out-of-sample test of the GH strategy over the 1991–2003 period; and find remarkable profits in the Australian stock market. The GH strategy earns the average returns of 2.14% per month, which is considerably more compared to the efficacy in the U.S. and the returns earned by other momentum strategies in Australia. The profitability is not only robust to stocks of different size and liquidity, but it becomes more profitable once they are risk-adjusted, which illustrates that risk-based adjustments cannot explain the abnormal profitability.

Du (2008) finds that the GH profits reverse in long-term based on 18 stock market indices. The results show that the GH strategy yields risk-adjusted returns of 0.59% per month outside of January, which are robust even when risk and transaction costs are taken into account. Although the dominance of the 52-week high as a predictive proxy supports the notion that the anchor-and-adjust bias is a better description of investor behaviour, the prices are prone to overreaction when they eventually adjust to new information. They also investigate whether the striking finding, in which momentum and price reversals are separate phenomena, is subject to data mining. Specifically, the behavioural models are driven by firm-specific risk, which has been diversified from a country portfolio. However, the logic of the behavioural models may still apply if the strategy is subject to country-specific idiosyncratic risk. Thereby, their results show that investors may still overreact to relevant news when the past error is discovered, which demonstrates the existence of subsequent reversals to momentum.

As opposed to the results of earlier studies regarding the U.S. and Australian markets, Alsubaie and Najand (2008) discover short-term price reversals instead of price continuation after stocks reach their 52-week high in the Saudi stock market. In other words, buying stocks close to their 52-week high price and selling stocks far from their

52-week high prices generate negative returns. The conflicting results can be attributed to the diffusion of information and investor overconfidence. Investors' speculative actions may lead the stock price to reach its 52-week high, which is eventually corrected when more accurate news becomes available. In particular, investors' overconfidence is the most absurd among stocks, which are more difficult to evaluate. The results also indicate that the winner portfolios, which are subject to high trading volume, drive the abnormal momentum returns in the Saudi stock market. Thereby, the strategy appears to be more profitable when conditioned on high volume stocks. If the disagreement among investors due to evaluation difficulty is proxied by trading volume, the self-biased overconfidence of investors should be more significant among high turnover stocks. This is best accounted by the behavioural explanation in Daniel et al. (1998).

Park and Moskalev (2010) argue that past returns lose their forecasting power for January and the proximity of current prices to the 52-week high is in dominant role in explaining the January reversal. This observation suggests that tax-loss selling is not the primary factor explaining the January effect. Based on the model, fund managers use a 52-week high as an anchor while assessing the performance of a stock, since fund holders do not rely on the entire cumulative return history of the stock, but rather they form their investment decisions entirely based on the highly visible 52-week high reference point. Thus, the fund managers have incentives to window-dress by selling a stock, whose December prices is far from the 52-week high, and buying or holding a stock with a market price close to the 52-week high in December. As a consequence of such activity, the prices of winners appreciate and the prices of losers depreciate in December, which is followed by price reversals in January when the reporting period has ended.

Burghof and Prothmann (2011) examine whether the 52-week high criterion has more predictive power in cases of significant information uncertainty, which is based on the psychological insight that the magnitude of behavioural biases increases in uncertainty. Information uncertainty is defined as doubt about the implications of news on a stock price (Zhang, 2006). Moreover, the information uncertainty can arise either due to the firm's underlying fundamental volatility or the quality of information. To measure uncertainty, the authors use six proxies: firm size, book-to-market ratio, the distance between the 52-week high price of a stock and its 52-week low price, stock price volatility, firm age and cast-flow volatility. With a higher level of information uncertainty, the GH winner portfolios yield higher returns, and the GH loser portfolios generate lower returns, which implies that the GH profits are positively correlated with the uncertainty measures in the UK market. The authors find a close relation between the GH and the JT strategy, since both strategies depend on the same six variables in a similar way. These findings are robust to the turn-of-the year effect, industry effects and risk adjustments.

Liu, Liu and Ma (2011) conduct a complete study on the GH strategy including individual stocks in 20 major stock markets. Their findings can be divided into various significant factors. First, the 52-week high momentum effect is robust in international markets. Their sample of eighteen major stock markets show profits from the trading strategy, which included nine out of ten European markets and the Hong Kong market. The average monthly returns range from 0.60% to 0.94%. Furthermore, they discover that none of the momentum strategies has significant profits in the following countries: Japan, Norway, Russia, Singapore, South Korea, Spain and Taiwan.

Second, Liu et al. (2011) argue that investors' anchoring and adjusting bias, while using the 52-week high as an anchor, lead to the GH profits. In order to understand whether this behavioural bias is exploitable in financial markets, it is necessary to examine the profitability of the strategy net of transactions costs. They discover that the 52-week high momentum profits are no longer significant in most markets when the transaction costs are taken into account based on the approach in Lesmond et al. (1999).

Third, Liu et al. (2011) find that instead of supporting George and Hwang's (2004) findings, the GH strategy does not dominate the JT strategy. In other words, the profits of the momentum strategies exist independently; consequently, the 52-week high phenomenon is genuine in financial markets. Fourth, their results are consistent with George and Hwang's (2004) to the extent that the long horizon performance of the GH strategy in the U.S. market supports the argument that the GH profits do not reverse.

Fifth, Liu et al. (2011) investigate the macroeconomic risk model in Chordia and Shimakumor (2002) and the anchoring model in Grinblatt and Han (2005). Their results indicate that these models fail in fully explaining the GH profits, and that the 52-week high is a better predictor of future stock returns than macroeconomic risk factors or a stock's acquisition price. In addition to these models, Chui et al. (2010) examine the Hofstede individualism index as a proxy to the level of overconfidence through countries, which are closely related to momentum profits. Nonetheless, cultural difference does not seem to be the cause of the GH profits in terms of overconfidence, since the individualism index cannot explain the variations on the GH abnormal profits across international markets.

In brief, the academic literature based on international empirical data is consistent to a high degree with the results in George and Hwang (2004). The major inconsistency among academic papers is with respect to the existence of subsequent reversals to price momentum. As an illustration of proxy indicators, the high volume stocks appear to drive the winner portfolio profits in various stock markets. In addition, the winner portfolios yield higher returns and the loser portfolios generate lower returns with a higher degree of information uncertainty. Regardless of these findings, the 52-week high statistic is in the dominant role of explaining the January effect and the abnormal momentum profits to the extent that investors use the 52-week high as an anchor in valuing the po-

tential impact of new information. Also, it is a better predictor of future stock returns than the macroeconomic risk factors or the acquisition price. Finally, a sizable number of studies have discovered that momentum profits may not be significant in most security market when transaction costs are taken into account.

2.7 Hypotheses Formulation

This thesis investigates the anchoring bias of investors and the profitability of the 52-week high investing strategy in the OMX Helsinki stock exchange. Although it approaches the momentum effect primarily from the perspective of the anchoring bias, it takes also other market anomalies into considerations. Particularly, the thesis seeks to participate to the on-going debate on the efficiency of security markets by testing the robustness of both the GH and the JT strategies. Thereby, this thesis approaches the topic strongly from the psychological perspective of finance.

On the grounds of the reviewed literature regarding momentum investing, highlighted observations have been made to fulfil the objectives of the study. The interpretation of the momentum profits may remain inadequate without examining the robustness of both momentum strategies. The research literature demonstrates that stocks with high recent returns over the period of six to twelve months will outperform by a wider margin when compared to stocks with low recent returns. This is the time period when the price fluctuations of stocks in the winner and the loser portfolios are the most predictable. (Jegadeesh et al., 1993.) The results are significant as adequately diversified JT strategy earns abnormal returns both in ‘bull’ and ‘bear’ markets (Griffin et al., 2003). In addition, the abnormal profits are not a compensation for economy wide systematic risk, which is captured by the standard CAPM or macroeconomic factor models (Chabot et al., 2009), but rather momentum is driven by firm-specific factors, such as firm size and company structure (Rouwenhorst, 1998, 1999; Chui et al., 2000).

Whether or not a stock has had previous extreme returns, the 52-week high statistic is a more predictive proxy of future returns (George et al., 2004). This approach is consistent with the assumption taken by the anchor-and-adjust bias of investors. The 52-week high winner portfolio profits appear to be driven by the high volume stocks in some stock markets (Du, 2008). Also, a higher degree of information uncertainty results in more significant returns of winner portfolios and lower returns of loser portfolios (Burghof et al., 2011). Especially, momentum investing may result in fascinating empirical observations in relatively illiquid and volatile stocks markets (Markowitz 2010, 25), such as the OMX Helsinki stock exchange.

H1: Momentum strategies realise positive returns in each of the twelve months after the formation date with the exception of the first month.

Empirical studies argue that a stock market may overreact to relevant news when the JT strategy is followed, since abnormal momentum returns in intermediate horizon are followed by subsequent price reversals in long-term (De Bondt et al., 1985). Due to these occurrences of overshooting, a stock price may have the appearance of fluctuating around its fair value. This market price observation is in parallels with the behavioural models to the extent that momentum and reversals are subsequent patterns in the stock prices, since reversals occur when the security market recognizes its past errors (Daniel et al., 1998; Barberis et al., 1998; Hong et al., 1999).

H2: The abnormal profits of the JT momentum strategy are prone to subsequent reversals in long-term as predicted by the behavioural models.

By contrast, the 52-week high statistic may be the best psychological bias to describe under reaction to relevant information, since stock markets appear to resolve without overcorrection (George et al., 2004; Liu et al., 2011). Despite the significance of this finding, the major inconsistency among academic papers is related to the existence of subsequent reversals to price momentum (Du, 2008; Alsubaie, 2008). This is explained to the extent that a subset of investors' demand function for a share is negatively related to embedded gain, which leads to a greater aversion to selling shares far from their acquisition prices as it would result in the identification of losses (Grinblatt & Keloharju, 2001; Grinblatt & Han, 2002, 2005). However, the interpretation of whether the 52-week high strategy is prone to reversals lies beyond anchoring, but instead in representative investors motivated in tax avoidance (Klein, 2001).

H3: The abnormal profits of the 52-week high momentum strategy are not subject to subsequent reversals in stock prices.

Anomalies literature demonstrates decreased profitability of momentum strategies in January, which can be explained either by tax-loss trading (Wachtel, 1942) or window dressing (Haugen & Lakonishok, 1988). The former interprets the seasonal effectiveness fluctuations in terms of how tax regimes affect the relation between past and expected returns in December. This means that taxation provides an incentive for investors to accelerate the realization of losses in December, which leads to a greater profitability of momentum strategies due to the increased selling pressure on losing stocks. This follows that those stocks are prone to price reversals in the following January. (Grinblatt & Moskowitz, 2004.) Especially, the 52-week high explains the January reversals to a high degree insofar as investors use the 52-week high as an anchor. It is in parallels with the

latter model, which interprets the seasonality with the behaviour of fund managers to sell stocks whose current price levels may not appear favourable to investors. This follows that prices of winners appreciate and prices of losers decline in December, which leads to price reversals in January when the reporting period has ended. (Park et al., 2010.) Although investors have become more knowledgeable, sophisticated and are less willing to buy stocks on the January effect peaks, the January effect still persists in the financial markets regardless of conflicting evidence (Moller et al., 2008; Mehdian et al. 2008; Easterday et al. 2009).

H4: The abnormal momentum profits deteriorate in January as predicted by the tax-loss trading and the window dressing model.

The anchoring effect of investors has been documented to interpret the abnormal momentum profits, which is why a stock's acquisition price and 52-week high are reviewed whether they are descriptive predictors of future returns in the OMX Helsinki stock exchange. Both the 52-week high value and the acquisition price are predictive proxies whether or not individual stocks have had previous extreme returns, which is consistent with the assumption of the anchor-and-adjust-bias. Thereby, investors tend to estimate the potential impact of new information against the 52-week high or the acquisition price as a reference point. This follows that investors tend to be reluctant to bid a stock price higher or lower even if it is verified by new information. (George et al., 2004; Grinblatt et al., 2005.) In spite of the relevance of the acquisition price, the 52-week high statistic is a better predictor of future stocks returns (Liu et al., 2011).

H5: Investors use the acquisition prices and the 52-week high statistics as anchors when estimating the potential impact of new information.

Finally, the profitability of momentum portfolios is investigated when the limits to arbitrage are taken into account. The theoretical literature emphasizes 'dumb money' and limits to arbitrage in describing price momentum. The former refers to irrational investors whose transactions are regarded as market noise in the security market. The latter is the pivotal element of momentum investing as momentum cycles last longer, and interruptions in the profitable cycles should be shorter, when arbitrageurs' capital is in a short supply. Furthermore, the momentum strategies involve frequent losses, which makes it difficult for arbitrageurs to drive momentum profits out of the market. (Chabot et al. 2009.)

The literature regarding the effect of transaction costs to the profitability of momentum investing is somewhat conflicting. The related costs of momentum investing should be significantly less than the added value, but still a great number of academic studies have reported that momentum profits may not be significant in most stock markets

when the transaction costs are taken into account (Liu et al., 2011). As an illustration, the momentum profits may become statistically insignificant at transaction costs of 1.5% (Grundy et al., 2001), and the abnormal returns may disappear after a sizable investment is engaged to a stock by a single fund in such strategies (Korajczyk, 2004).

H6: The abnormal returns of momentum investing may not exceed the related transaction costs.

In the perspective of acceptable research practice, this study follows the hypothetic-deductive approach to science. The theoretical framework related to the pivotal topics related to the 52-week high momentum and the anchoring bias were carefully examined to deductively derive testable hypotheses. In the following sections, the correctness of these deductively derived hypotheses is tested based on empirical data collected from the OMX Helsinki stock exchange.

3 EMPIRICAL RESULTS

3.1 Momentum Revenues Based on Raw Returns

Table 2 reports average monthly returns of momentum portfolios described above, which are also adjusted for bid-ask bounces over the period of May 1998 to June 2011. The first panel is for JT's individual stock momentum strategy, whereas the latter panel is for the 52-week high strategy.

Table 2 Momentum portfolio returns

This table reports the average monthly portfolio logarithmic returns from May 1998 through June 2011. The winner (loser) portfolio in the JT strategy is the equal-weighted portfolio of the 30% of stocks with the highest (lowest) past 12-month return. The winner (loser) portfolio for the GH strategy is the equal-weighted portfolio of the 30% of stocks with the highest (lowest) ratio of the current price to the 52-week high. All portfolios are held for six and twelve months. One month is skipped between the portfolio formation and holding period to account for the bid-ask bounce. The sample includes all stocks listed on the OMX Helsinki stock exchange with a few exceptions; t-statistics are reported in parentheses.

PANEL A: JT Momentum Strategy

	JT (12, 1, 6)		*JT (12, 6)*		*JT (12, 1, 12)*		*JT (12, 12)*	
	N	*r*	*N*	*r*	*N*	*r*	*N*	*r*
P3	162	-0.02	163	0.01	156	-0.10	157	-0.08
		(-0.09)		(0.03)		(-0.52)		(-0.44)
P1	162	-0.56	163	-0.60	156	-0.22	157	-0.30
		(-2.35)**		(-2.50)**		(-1.16)		(-1.52)
P3–P1		0.54		0.61		0.12		0.21
		(3.34)***		(3.85)***		(0.80)		(1.37)

PANEL B: GH Momentum Strategy

	GH (12, 1, 6)		*GH (12, 6)*		*GH (12, 1, 12)*		*GH (12, 12)*	
	N	*r*	*N*	*r*	*N*	*r*	*N*	*r*
P3	162	0.23	163	0.23	156	0.24	157	0.26
		(1.23)		(1.21)		(1.62)		(1.77)*
P1	162	-0.89	163	-0.92	156	-0.55	157	-0.61
		(-3.46)***		(-3.53)***		(-2.54)**		(-2.78)***
P3–P1		1.12		1.15		0.79		0.87
		(7.57)***		(7.71)***		(5.70)***		(6.30)***

Notes: *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Regarding the JT (12, 1, 6) and the JT (12, 6) strategies, the results reveal a relation between returns and momentum ranks, which confirms the results in Jegadeesh and Titman (1993, 2001). The difference between the P_3 and P_1 portfolio returns over the time period is 0.54% per month for the JT (12, 1, 6) and 0.61% per month for the JT (12, 6) strategy, which are reliably different from zero. The returns of loser portfolios

drive the returns of both strategies. Although the returns of both the JT (12, 1, 12) and the JT (12, 12) strategy are not reliably different from zero, the average returns deteriorate without price reversals after six months of the portfolio formations.

Similarly, the GH strategies reveal a strong relation among earned returns and 52-week high ratios over the sample period. The results are in parallels with the results in George and Hwang (2004), since the difference between P_3 and P_1 portfolio returns are 1.12% per month for the GH (12, 1, 6) and 1.15% per month for the GH (12, 6) strategy. In contrast to the JT strategies, the GH (12, 1, 12) strategy earns portfolio returns of 0.79% per months, whereas the GH (12, 12) strategy earns a monthly return of 0.87%. The strategies show statistical significance in earned portfolio returns, as the returns are reliably different from zero. Consistent with the JT strategies, the GH loser portfolios drive the returns of the GH strategies to a high degree.

To put the results into perspective, Table 2 presents the average equal-weighted returns for the stocks in the sample, which are selected based on both the JT and the GH strategies. Compellingly, the JT winner portfolios earn no exceeding returns over the equal-weighed index, whereas the GH winner portfolios outperform the index by more than 0.20% per month. An apparent similarity exists among the strategies, since the loser portfolios drive the returns of all strategies. Specifically, the loser portfolios of the JT (12, 1, 6) and the JT (12, 6) strategy underperform the index by more than 0.53% per month, whereas the loser portfolios of the GH (12, 1, 6) and the GH (12, 6) strategy underperform the index by more than 0.86% per month. Similarly, the loser portfolios of the GH (12, 1, 12) and the GH (12, 12) strategy underperform the equal-weighted index by more than 0.52% per month. Both types of strategies provide statistically significant predictability over the returns in the following 6-month period of the portfolio formation. The results are in parallels with the results in George et al. (2004), since the returns earned by the GH strategies are almost twice as much as that of the JT strategies. Finally, the portfolios in the following sections are constructed without adjusting for the bid-ask bounce, since the strategies account for the momentum returns to a greater degree when they are not adjusted for the bid-ask bounce.

In the sample period, past losers outperformed past winners, on average, which is inconsistent with the results in Jegadeesh and Titman (1993) and George and Hwang (2004) for the U.S. stock market. This may be explained by the high volatility of the OMX Helsinki stock exchange over the sample period. Regardless of the inconsistent results with the anomalies literature, the strategies have exceeded the returns of the equal-weighted index over the same time period. These results suggest that only loser portfolios contribute to momentum profits with statistical significance. Jegadeesh and Titman (2001) provide a suitable interpretation that momentum profits will dissipate quicker for large-cap stocks, which are cheaper to trade than small-cap stocks; and the profits from trading past winners should be eliminated more quickly than the profits

from trading losers due to the costs of short-selling. Thereby, the higher transaction costs might contribute to the notion that the loser portfolios have a greater impact on momentum profits in the OMX Helsinki stock exchange.

3.2 Comparison of the JT and the 52-week High Momentum Strategies

Although Table 2 reports that the two strategies based on past performance of individual stocks generate similar returns, the return structures are not identical. In fact, the JT's profits are to a high degree attributable to the future returns of stocks whose prices are either near or far from their 52-week high statistics. Therefore, a pairwise comparison of profits from the GH strategy against the JT strategy is implemented. This test should identify whether the JT strategy has explanatory power over the rankings implied by the GH strategy, and vice versa (George et al., 2004).

The first panel of Table 3 compares the GH strategy against the JT strategy; therefore, stocks are first collected into winner and loser groups using the JT strategy's ranking criteria, and then each of these groups is further subdivided using the 52-week high performance measure. The GH strategy maintains its profitability within the JT winner and the JT loser groups, since a self-financing strategy based on the 52-week high earns monthly returns of 0.63% and 0.79% per month among stocks, which have been classified by the JT strategy. Similarly, the monthly returns are 0.82% and 0.83% per month outside of January within the JT groups, respectively. On the contrary, the second panel compares the JT strategy against the GH strategy with similar methods. Within winners classified with the 52-week high, the profitability of the JT strategy is relatively insignificant at 0.19% per month and 0.17% per month outside of January with statistical reliability to be different from zero. These results indicate that the 52-week high performance measure is a more suitable proxy for predicting future returns.

Table 3 reports that the non-January returns for the stocks, which fall in the middle portfolios, support the fact that 52-week high is a better proxy than past returns at predicting future returns. The middle stocks should be the group at which the first grouping criterion predicts will not have extreme returns; therefore, returns should not become available by further subdividing such stocks into subgroups using another grouping criterion. The GH strategy earns 0.60% per month and 0.66% per month outside of January within the middle portfolio classified by the JT strategy. By contrast, within the middle portfolio classified by the 52-week high, the JT strategy earns no statistically significant returns over the sample period.

Table 3 Pairwise comparisons of the 52-week high and the JT momentum strategies

Stocks are sorted independently by the 52-week high measure and past 12-month returns. JT winners (losers) are the 30% of stocks with the highest (lowest) past 12-month return. GH winners (losers) are the 30% of stocks, which have the highest (lowest) 52-week high measures. All momentum portfolios are held for 6 months. Panel A reports the logarithmic average monthly returns from May 1998 through June 2011 for equal-weighted portfolios, which take a long position in the 52-week high winners and short against the 52-week high losers within winner, middle and loser categories identified by the JT strategy. Panel B report logarithmic returns for equal-weighted portfolios formed with the JT strategy within groups, which are identified as winner, middle and loser by the GH strategy. The *t*-statistics are reported in parentheses.

PANEL A

Portfolios Classified by Jegadeesh and Titman's Momentum strategy	Portfolio Classified by 52-Week High	Average Monthly Return	Ave. Monthly Return Excluding January
Winner	Winner	0.31	0.33
	Loser	-0.32	-0.49
	Winner – Loser	0.63 (4.00)***	0.82 (4.68)***
Middle	Winner	0.21	0.26
	Loser	-0.38	-0.40
	Winner – Loser	0.60 (6.69)***	0.66 (8.30)***
Loser	Winner	-0.17	-0.16
	Loser	-0.96	-0.99
	Winner – Loser	0.79 (4.88)***	0.83 (5.23)***

PANEL B

Portfolio Classified by 52-Week High	Portfolios Classified by Jegadeesh and Titman's Momentum strategy	Average Monthly Returns	Ave. Monthly Return Excluding January
Winner	Winner	0.26	0.27
	Loser	0.07	0.10
	Winner – Loser	0.19 (2.18)**	0.17 (1.90)*
Middle	Winner	0.15	0.11
	Loser	-0.01	-0.04
	Winner – Loser	0.16 (1.25)	0.15 (1.24)
Loser	Winner	-1.05	-1.13
	Loser	-1.06	-1.00
	Winner – Loser	0.00 (0.01)	-0.14 (-0.69)

Notes: *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

The results from the pairwise comparisons indicate that nearness of the current price level to the 52-week high statistic is a more suitable predictor of future returns than past returns. This suggests that a theory, in which price levels are identified as anchors, is more descriptive of the historical data than the behavioural theories based on overconfidence, conservatism or postponed diffusion of relevant information. George et al. (2004) raise a question of whether price reversals in long-term, which are built into the behavioural theories, should be integrated as part of a theory based on the anchor-and-adjustment bias. The following subsection addresses whether the future price predictability of each strategy is only a temporary phenomenon. As anchoring is assumed to be an essential component of investor behaviour, the answer to the question lies in whether investors over or under adjust when the initial anchoring bias is eventually corrected.

3.3 Seasonality in Long-Term Momentum Revenues

This section analyses the extent to which the JT and the GH strategy are prone to reversals in long-term. The method is similar to the aforementioned with the exception that the lag between the formation of a portfolio and its holding period is extended. This allows the investigation of whether momentum persists, reverses or disappears after the portfolio-holding period. Table 4 presents momentum profits over a 60-month period after the formation of momentum portfolios.

Table 4 Long-term reversals and the January effect

This table reports average monthly portfolio logarithmic returns one, two, three, four and five years after the portfolio formation from May 1998 through June 2011. See Table 2 for the description of portfolio construction. The sample includes all stocks listed on the OMX Helsinki stock exchange with a few exceptions; t-statistics are reported in parentheses.

PANEL A: JT Momentum Strategy						
Calendar Months	Months 1 to 12	Months 13 to 24	Months 25 to 36	Months 37 to 48	Months 49 to 60	Months 13 to 60
January	-2.30 (-12.66)***	-1.87 (-7.37)***	-1.69 (-10.46)***	0.12 (0.29)	-1.29 (-3.81)**	-1.01 (-3.40)**
Feb–Dec	0.23 (1.29)	-0.50 (-4.30)***	-0.17 (-2.30)**	0.20 (2.76)***	0.37 (4.69)***	-0.01 (-0.16)
All	0.21 (1.37)	-0.45 (-4.25)***	-0.18 (-2.63)***	0.18 (2.86)***	0.35 (4.74)***	-0.02 (-0.34)
PANEL B: GH Momentum Strategy						
Calendar Months	Months 1 to 12	Months 13 to 24	Months 25 to 36	Months 37 to 48	Months 49 to 60	Months 13 to 60
January	-2.01 (-8.33)***	-1.89 (-7.58)***	-1.06 (-6.36)***	0.27 (0.47)	-0.72 (-4.44)**	-0.66 (-6.09)***
Feb–Dec	0.98 (6.33)***	0.02 (0.16)	0.19 (2.60)**	0.24 (3.60)***	0.52 (6.07)***	0.34 (5.59)***
All	0.87 (6.30)***	-0.02 (-0.15)	0.13 (2.00)*	0.22 (3.68)***	0.46 (6.09)***	0.32 (5.36)***

Notes: *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

The first panel of Table 4 presents the returns of JT momentum portfolios. The momentum returns are reported in January and outside of January, which allows the examination of whether the January effect has an impact on the efficiency of the momentum strategies. Table 4 reports that the average returns deteriorate to 0.21% per month at the end of Month 12 with no statistical significance. Furthermore, the average returns are -0.45% per month in the second year and -0.18% per month in the third year. This demonstrates significant price reversals for the JT strategy in the second and the third year of the following five years. This observation is in parallels with the behavioural models, which predict that the momentum profits will eventually reverse. This follows that, over the whole period from second through fifth year, the average returns are not reliably different from zero.

By contrast, the latter panel of Table 4 presents that the GH strategy generates significant positive momentum returns during the 12-month portfolio-holding period. This follows that the abnormal returns deteriorate over the period of Month 13 through Month 24, showing no statistical significance to be different from zero. Specifically, the average profit over the first 12 months is 0.87% per month, -0.02% per month in the second year, 0.13% per month in the third year, 0.22% per month in the fourth year and 0.46% per month in the fifth year. These results are consistent with that of George and Hwang (2004), since the GH portfolio returns show no signs of price reversals over the time period of May 1998 to June 2011.

The results show seasonality in momentum returns, since price reversals are apparent in the JT strategy. This notion suggests that the identified momentum in Jegadeesh et al. (1993) is only a temporary price effect. The causes of seasonality in momentum returns are further investigated by examining winner, loser and momentum portfolios in a stand-alone basis. The returns of these portfolios are reported in Table 5.

Table 5 Post holding period returns of winner, loser and momentum portfolios

This table reports the average monthly portfolio logarithmic returns one, two, three, four and five years after the portfolio formation from May 1998 through June 2011. See Table 2 for a description of portfolio construction. The sample includes all stocks listed at OMX Helsinki stock exchange with a few exceptions; t-statistics are reported in parentheses.

PANEL A: JT Momentum Strategy						
Calendar Months	Months 1 to 12	Months 13 to 24	Months 25 to 36	Months 37 to 48	Months 49 to 60	Months 13 to 60
	Winner Portfolio (P3)					
January	1.93 (7.91)***	2.78 (10.91)***	2.60 (7.08)***	3.22 (10.14)***	2.42 (5.45)**	2.83 (43.75)***
Feb–Dec	-0.09 (-0.39)	-0.19 (-0.92)	0.02 (0.09)	0.34 (1.45)	0.51 (2.32)	0.12 (1.14)
All	-0.08 (-0.44)	-0.16 (-0.90)	0.01 (0.03)	0.31 (1.53)	0.50 (2.38)**	0.10 (1.10)
	Loser Portfolio (P1)					
January	4.22 (19.94)***	4.65 (13.63)***	4.29 (13.27)***	3.10 (6.41)***	3.32 (26.00)***	3.84 (14.63)***
Feb–Dec	-0.31 (-1.45)	0.31 (1.57)	0.19 (0.95)	0.14 (0.71)	0.14 (0.64)	0.13 (1.50)
All	-0.30 (-1.52)	0.29 (1.61)	0.19 (1.04)	0.13 (0.77)	0.15 (0.71)	0.12 (1.60)
	Momentum Portfolio (P3–P1)					
January	-2.30 (-12.66)***	-1.87 (-7.37)***	-1.69 (-10.46)***	0.12 (0.29)	-1.29 (-3.81)**	-1.01 (-3.40)**
Feb–Dec	0.23 (1.29)	-0.50 (-4.30)***	-0.17 (-2.30)**	0.20 (2.76)***	0.37 (4.69)***	-0.01 (-0.16)
All	0.21 (1.37)	-0.45 (-4.25)***	-0.18 (-2.63)***	0.18 (2.86)***	0.35 (4.74)***	-0.02 (-0.34)

The first panel of Table 5 reports evidence of reversals for the JT strategy. The average returns range from 1.93% to 3.22% per month in January for the winner portfolios while the loser portfolios are subject to losses, which range from 3.10% to 4.65% per month in January over the period of Month 1 through Month 60. Thereby, the JT momentum returns range from -2.30% to 0.12% per month in January. This leads to a notion that momentum profits deteriorate in January due to shorting against these appreciating past loser stocks. This observation is consistent with the behavioural interpretations of the January effect, such as the tax-loss selling (Wachtel, 1942) and the window dressing hypotheses (Haugen & Lakonishok, 1988). By contrast, the returns are considerably small and insignificant outside of January regarding the winner and the loser portfolios in a stand-alone basis.

Table 5 – Continued

PANEL B: GH Momentum Strategy						
Calendar Months	Months 1 to 12	Months 13 to 24	Months 25 to 36	Months 37 to 48	Months 49 to 60	Months 13 to 60
	Winner Portfolio (P3)					
January	2.42 (7.35)***	2.61 (9.62)***	3.04 (9.33)***	3.38 (7.74)***	2.49 (18.20)***	3.00 (23.26)***
Feb–Dec	0.30 (1.83)**	0.13 (0.67)	0.28 (1.43)	0.40 (1.80)*	0.61 (2.61)**	0.36 (3.43)***
All	0.26 (1.77)*	0.11 (0.54)	0.24 (1.38)	0.37 (1.90)	0.55 (2.63)***	0.35 (3.43)***
	Loser Portfolio (P1)					
January	4.43 (25.79)***	4.50 (12.56)***	4.09 (14.19)***	3.11 (6.45)***	3.21 (12.34)***	3.66 (20.34)***
Feb–Dec	-0.67 (-2.77)**	0.11 (0.54)	0.10 (0.49)	0.16 0.78	0.09 (0.39)	0.02 (0.30)
All	-0.61 (-2.78)***	0.12 (0.66)	0.11 (0.63)	0.15 (0.83)	0.09 (0.44)	0.03 (0.38)
	Momentum Portfolio (P3–P1)					
January	-2.01 (-8.33)***	-1.89 (-7.58)***	-1.06 (-6.36)***	0.27 (0.47)	-0.72 (-4.44)**	-0.66 -(6.09)***
Feb–Dec	0.23 (1.29)	-0.50 (-4.30)***	-0.17 (-2.30)**	0.20 (2.76)***	0.37 (4.69)***	-0.01 (-0.16)
All	0.87 (6.30)***	-0.02 (-0.15)	0.13 (2.00)*	0.22 (3.68)***	0.46 (6.09)***	0.32 (5.36)***

Notes: *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

The latter panel of Table 5 reports no evidence of reversals for either the GH winner or the GH loser portfolio with reliability to be different from zero. The average profits range from 2.42% to 3.38% per month for the GH winner portfolios in January, and the GH loser portfolios are prone to losses, which range from 3.11% to 4.50% per month in January over the whole period of Month 1 through Month 60. This follows that the returns of the GH portfolio range from -2.01% to 0.27% per month in January. These re-

sults indicate that past loser stocks appreciate significantly more than past winner stocks in January, which leads to deteriorating momentum profits due to shorting against those loser stocks. The results are consistent with the behavioural interpretations of the January effect. By contrast, the returns are considerably small and insignificant outside of January with the exceptional notion that the GH winner portfolio returns vary from 0.40% to 0.61% per month over the Month 37 through Month 60 with statistical reliability to be different from zero. In addition, the revenues over the whole period from Month 13 to Month 60 are 0.36% per month with statistical significance, which might demonstrate postponed price momentum of the GH winner portfolios.

The results indicate that returns predicted by the GH strategy are permanent in the OMXH based on the sample period. If the predictability of the GH strategy is associated with the anchor-and-adjust bias, the findings of this study suggest that investors tend to estimate related fundamentals appropriately when they eventually correct the anchoring bias. Investors neither overreact nor under react, which is why neither of them may be a feature of investor behaviour, when a 52-week high statistic is used as a proxy to predict future returns. Briefly, the results with respect to the GH strategy are consistent with the anchor-and-adjustment bias rather than the behavioural theories, which is in parallels with the results in George and Hwang (2004).

The results with regard to the seasonality in momentum returns have implication for the existing behavioural theories. The results strongly indicate that the impact of bias on returns is related to the proximity of a stock price to its past 52-week high statistic. In addition, a portfolio constructed in these terms is not prone to price reversals. This leads to a notion that momentum and price reversals are not explained by a common bias, which gives rise to intermediate-term predictability. In case if these two market behaviours were linked, the GH strategy should be subject to price reversals to a greater degree, since winner and loser stock identified based on the 52-week high statistic exhibit the strongest bias to interpret price fluctuations as compared to stocks identified as winners and losers on the grounds of past returns. However, the interpretation for long-term reversals lies beyond the 52-week high statistic, which follows that separate theories of intermediate and long horizon predictability in stock prices may be more descriptive of the data in comparison to an integrated theory.

3.4 Robustness

To investigate the robustness of long-term price reversals, the performance of momentum portfolios is examined in three separate subperiods. The first subperiod from May 1998 through December 2002 examines the efficiency of the JT and the GH strategy during the ‘.com’ bubble burst, whereas the second subperiod from January 2003

through December 2006 examines the efficacy during the 'bull' market period between the market crises. The last subperiod from January 2007 through June 2011 investigates whether the momentum strategies have remained profitable during the subprime crisis and the on-going European debt crisis. Table 6 reports the monthly returns of the momentum strategies for the first five years after portfolio formation over these three subperiods.

Table 6 Long-term momentum returns in subperiods

This table reports average monthly portfolio logarithmic returns within three subperiods one, two, three, four and five years after the portfolio formation from May 1998 through June 2011. See Table 2 for the description of portfolio construction. The sample includes all stocks listed on the OMX Helsinki stock exchange with a few exceptions; t-statistics are reported in parentheses.

	PANEL A: JT Momentum Strategy						
	Months 1 to 6	Months 1 to 12	Months 13 to 24	Months 25 to 36	Months 37 to 48	Months 49 to 60	Months 13 to 60
	05/1998–12/2002 (the '.com' bubble burst subperiod)						
P3	-0.96	-0.92	-0.54	0.25	1.12	1.42	0.53
P1	-1.92	-1.36	0.55	0.63	0.79	1.11	0.75
P3–P1	0.97	0.44	-1.09	-0.38	0.33	0.31	-0.22
	(2.56)**	(1.15)	(-6.04)***	(-2.98)***	(3.33)***	(2.36)**	(-2.11)**
	01/2003–12/2006 (the 'bull' market subperiod)						
P3	1.82	1.67	0.75	-0.93	-0.67	-0.57	-0.39
P1	1.39	1.47	0.12	-0.69	-0.54	-0.97	-0.60
P3–P1	0.44	0.20	0.63	-0.23	-0.13	0.40	0.21
	(2.43)**	(1.38)	(5.70)***	(-3.22)***	(-1.84)*	(8.50)***	(4.51)***
	01/2007–06/2011 (the subprime crisis and European debt crisis subperiod)						
P3	-0.61	-0.86	-0.79	1.29	0.49		
P1	-1.00	-0.83	0.11	0.89	-0.25		
P3–P1	0.39	-0.04	-0.90	0.40	0.75		
	(2.14)**	(-0.24)	(-14.06)***	(5.08)***	(5.11)***		
Pooled Sample	0.61 (3.85)***	0.21 (1.37)	-0.45 (-4.25)***	-0.18 (-2.63)***	0.18 (2.86)***	0.35 (4.74)***	-0.02 (-0.34)
	PANEL B: GH Momentum Strategy						
	Months 1 to 6	Months 1 to 12	Months 13 to 24	Months 25 to 36	Months 37 to 48	Months 49 to 60	Months 13 to 60
	05/1998–12/2002 (the '.com' bubble burst subperiod)						
P3	-0.39	-0.24	0.12	0.53	1.20	1.53	0.90
P1	-2.64	-2.07	0.09	0.54	0.87	1.00	0.64
P3–P1	2.25	1.83	0.03	-0.01	0.33	0.54	0.26
	(7.80)***	(6.55)***	(0.13)	(-0.12)	(3.03)***	(3.97)***	(2.46)**
	01/2003–12/2006 (the 'bull' market subperiod)						
P3	1.88	1.81	0.81	-0.53	-0.62	-0.60	0.30
P1	1.22	1.38	0.12	-0.77	-0.59	-0.97	-0.68
P3–P1	0.66	0.43	0.69	0.24	-0.03	0.36	0.38
	(3.41)***	(2.87)***	(8.74)***	(2.67)**	(-0.63)	(9.75)***	(10.56)***
	01/2007–06/2011 (the subprime crisis and European debt crisis subperiod)						
P3	-0.60	-0.71	-0.85	1.13	0.47		
P1	-1.04	-0.89	0.17	0.88	-0.26		
P3–P1	0.44	0.18	-1.02	0.25	0.73		
	(2.33)**	(1.10)	(-14.46)***	(2.49)**	(10.11)***		
Pooled Sample	1.15 (7.71)***	0.87 (6.30)***	-0.02 (-0.15)	0.13 (2.00)*	0.22 (3.68)***	0.46 (6.09)***	0.32 (5.36)***

Notes: *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 6 reports that the momentum strategies are significantly profitable regardless of period insofar as the strategies have a 6-month holding period, but only the GH strategy is profitable in the periods prior to the subprime crisis as a 12-month holding period is concerned. The JT average returns are 0.97% per month on the '.com' bubble burst subperiod, 0.44% per month during the 'bull' market subperiod between the crises, and 0.39% per month on the recent subprime crisis and the European debt crisis subperiod with statistical significance. Similarly, the GH average returns are also robust across the subperiods as the strategy earns 2.25% per month during the '.com' bubble burst subperiod, 0.66% per month between the crises and 0.44% per month during the recent subprime crisis and the European debt crisis subperiod insofar as the holding period is six months; and 1.83%, 0.43% and 0.18% per month for the same subperiods as the 12-month holding period are concerned. The JT and the GH strategy provide means for predicting future returns regardless of the sample period; thus, it may be stated that the momentum returns are robust and apparent in the OMX Helsinki stock exchange.

Although the results show similar profitability among subperiods during the first 12 months when compared to the pooled sample results, the returns in the post holding periods are quite different among the three subperiods. In the '.com' bubble burst subperiod, the cumulative JT returns plummet from 0.97% at the end of Month 6 to -0.97% at the end of Month 36, and then appreciate to -0.34% at the end of Month 60. The '.com' bubble burst period is followed by the 'bull' market period in which the cumulative JT momentum returns depreciate from 0.82% at the end of Month 24 to 0.64% at the end of Month 48, and then skyrocket to 1.15% at the end of Month 60. The results regarding this subperiod demonstrate that the price reversal is delayed, since significant winner portfolio returns remain over Month 1 through Month 24. Finally, in the subprime crisis and the European debt crisis subperiod, the cumulative returns depreciate from 0.39% at the end of Month 6 to -1.41% at the end of Month 24 and then appreciates to 0.47% over the next 24 month. These results for the JT strategy support the behavioural models on momentum and price reversals as subsequent components.

The other panel of Table 6 reports similar returns in the post holding periods as compared to the pooled sample results with a few exceptions. The cumulative GH returns remain constant over two years after the 12-month portfolio holding period during the '.com' bubble burst subperiod, but delayed winner portfolio profits boost the cumulative GH returns from 1.99% at the end of Month 36 to 2.94% at the end of Month 60. Similarly, the results of the GH strategy over the 'bull' market subperiod indicate that cumulative GH returns appreciate after the portfolio-holding period from 0.66% at the end of Month 6 to 1.55% at the end of Month 36. This follows that cumulative returns remain constant over Month 37 to Month 48, but the cumulative returns eventually increase to 2.94% at the end of Month 60. Finally, the results indicate that, during the recent subprime crisis and the European debt crisis subperiod, the cumulative returns plummet

after the 6-month holding period from 0.44% at the end of Month 6 to -1.16% at the end of Month 24, which argues for the existence of price reversals over the subprime crisis and the European debt crisis subperiod. This follows that the cumulative GH returns increase to 0.38% at the end of Month 48.

In brief, the results are in parallels to a high degree with the pooled sample returns with a few exceptions. The results regarding the robustness of the JT returns are consistent with the behavioural theorems on momentum and price reversals as subsequent components. In general, the results of the GH strategy provide support for the argument in George and Hwang (2004) that the GH portfolio returns are not subject to price reversals. However, the subprime crisis and the European debt crisis subperiod shows that the efficacy of the GH strategy in long-term might still be subject to reversals over the following years after the portfolio-holding period during utterly high market turbulence.

3.5 Anchoring Model for Purchase Price

George and Hwang (2004) suggest that the predictability of the GH strategy is in relation to the anchor-and-adjustment bias. As only under reaction is caused by the anchoring bias, the model should not be prone to overreactions and subsequent reversals. The results in previous sections support this hypothesis with a few exceptions. In search for a new behavioural model to explain the return predictability, the anchoring model in Grinblatt and Han (2002) is examined. Instead of the 52-week high statistic, the anchor used in this model is the price at which investors acquire shares. This follows that achieving a 52-week high is a proxy for whether the market price is higher than the acquisition price. If the underlying reason for the abnormal returns of the RP strategy is that investors anchor on the acquisition prices of their shares, then RP strategy's measure of embedded gain should be effective at predicting momentum behaviour. Thereby, the regression coefficient estimates for the RP strategy should eclipse that of the GH high variables. In order to compare the GH and the RP strategies, Fama-Macbeth regressions are estimated by setting the RP dummy variables as additional explanatory variables.

The regression coefficient estimates of the self-financing GH and RP strategies are shown in Table 7. The regression estimates show that the GH strategy yields 1.08% per month with statistical significance over the whole time period against -0.17% per month for the RP strategy without reliability to be different from zero. These abnormal returns are reported as differences against intercept. However, the profits from the GH and the RP strategy vary when observed among the three subperiods: '.com' bubble burst, the 'bull' market, and the subprime crisis and the European debt crisis subperiods. The results indicate that the returns to the GH strategy dominate those of the RP strategy re-

gardless of the time period. The abnormal returns for the GH strategy are 1.75%, 0.60% and 0.91% per month for the three subperiods, whereas results indicate -0.11%, 0.47% and -0.79% per month for the RP strategy, respectively. These subperiod results demonstrate robustness among the GH strategy returns, and that the RP strategy is inadequate in predicting the future returns of stocks listed on the OMX Helsinki stock exchange. This suggests that the GH strategy is in a dominant position interpreting the abnormal momentum returns.

Table 7 Comparison of the 52-week high and the reference price strategies

This table reports average monthly portfolio logarithmic returns within three subperiods from January 1991 through June 2011. The intercept is the return to a neutral portfolio, which has hedged out the effects of bid-ask bounce, size and momentum identified by the two strategies. $R_{i,t-1}$ is stock i's return in $t-1$, and $size_{i,t-1}$ is the market capitalization of stock i in month $t-1$. Coefficient estimates for momentum portfolios are the returns in excess of the intercept, which can be earned by taking a long position in a winner portfolio or shorting a loser portfolio. $GHH_{i,t-j}$ is the GH winner indicator variable, which takes value 1 if stock i is ranked in the top 30% in month $t-j$, and 0 otherwise. By contrast, $GHL_{i,t-j}$ is the GH loser indicator variable, which takes value 1 if stock i is ranked in the bottom 30%. $RPH_{i,t-j}$ and $RPL_{i,t-j}$ are the RP winner and loser indicator variables defined on the grounds of the embedded capital gains in relation to a reference price, which is the weighted average of prices over the past 24 months. The sample includes all stocks listed on the OMX Helsinki stock exchange with a few exceptions; Newey-West autocorrelation and heteroscedasticity corrected t-statistics are reported in parentheses.

	05/1998–12/2002 (the '.com' bubble burst subperiod)	01/2003–12/2006 (the 'bull' market subperiod)	01/2007–06/2011 (the subprime crisis and European debt crisis subperiod)	05/1998–6/2011 Overall
Intercept	-0.27	1.60	-0.64	0.19
	(-0.53)	(2.67)***	(-1.13)	(0.52)
$R_{i,t-1}$	2.55	0.09	0.16	0.90
	(2.48)**	(0.13)	(0.18)	(1.65)
lnSize	-0.05	-0.01	-0.06	-0.04
	(-0.64)	(-0.14)	(-0.76)	(-0.94)
GHH dummy	0.52	0.16	0.35	0.35
	(2.06)**	(1.18)	(2.80)***	(3.29)***
GHL dummy	-1.22	-0.44	-0.55	-0.73
	(-3.99)***	(-2.26)**	(-2.93)***	(-4.94)***
RPH dummy	-0.15	0.19	-0.24	-0.07
	(-0.60)	(1.60)	(-1.51)	(-0.66)
RPL dummy	-0.11	-0.28	0.54	0.09
	(-0.08)	(-1.11)	(2.32)**	(0.45)
GHH dummy – GHL dummy	1.75	0.60	0.91	1.08
	(5.14)***	(3.39)***	(5.23)***	(7.58)***
RPH dummy – RPL dummy	-0.11	0.47	-0.79	-0.17
	(-0.31)	(3.07)***	(-4.93)***	(-1.18)

Notes: *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

The presence of proxy coefficient estimates in regression analysis has a substantial impact on the return estimates, which are attributable to the GH strategy. The results indicate that the coefficient estimates for both the GH loser and the GH winner portfolio

account for the overall momentum returns to a great extent with statistical significance. In contrast to the results in George and Hwang (2004), the results of this study are not consistent with the disposition hypothesis in Grinblatt and Han (2002), since the purchase price model has no role in explaining momentum profits outside of the 'bull' market subperiod. Their model does not explain the findings of this study regarding the robust abnormal returns, when the 52-week high is used as a predictor of future returns. Even after the RP dummies are accounted in the regression analysis, results are still consistent with the hypothesis that investors use the 52-week high as an anchor. Thereby, the results support the view in George and Hwang (2004) to the extent that the 52-week high statistic is a better predictor of future stock returns and investors may use this anchor to evaluate the potential impact of news.

3.6 Transaction Costs

In the previous empirical sections, it was shown that GH profits are significant in the OMX Helsinki stock exchange, which are not prone to long-term return reversals except for the recent subprime crisis and the European debt crisis subperiod. In addition, these momentum profits cannot be captured by the anchoring model, which uses the acquisition price as an anchor. Especially, the robustness of the GH strategy in the stock markets is a significant sign against the market efficiency, since the 52-week high statistic is among public information, which is easily accessible to investors. In this section, the momentum strategies are investigated whether the strategies remain profitable in practice after the transaction costs are taken into account.

In Table 8, the limited dependent variable (LDV henceforward) procedure is used to estimate the trading costs for both the JT and the GH strategy in the OMX Helsinki stock exchange. Panel A shows the profitability of the JT strategy as the average of six-month buy-and-hold returns without transaction costs, which is calculated from the return difference between the winner and loser stocks on the six-month holding period. In contrast to the previous sections, the average six-month buy-and-hold returns from the momentum strategies are reported instead of monthly average returns. Results vary considerably among the three subperiods: the 'com' bubble burst, the 'bull' market, and the subprime crisis and the European debt crisis subperiods. All the markets have significant positive six-month buy-and-hold returns, except for the subprime crisis and the European debt crisis subperiod, as the returns are 6.49%, 3.40% and 0.87% for the three subperiods, respectively. Thereby, the average six-month buy-and-hold returns are 3.45% for the pooled sample.

Table 8 Estimates of trading costs for the momentum strategies

This table displays average six-month buy-and-hold returns and trading cost estimates for the JT (in Panel A) and GH (in Panel B) momentum portfolios. See Table 2 for the description of portfolio construction. The six-month buy-and-hold returns are calculated as the return difference between the winner and the loser portfolios one month after the portfolios are formed and held for six months. Transaction costs are estimated as the percentage of prices for each stock following the approach in Lesmond et al. (1999). The semi-annual returns and transaction costs are in percentages; t-statistics are in parentheses.

PANEL A: JT Momentum Strategy

	01/1998–12/2002 (the '.com' bubble burst subperiod)	01/2003–12/2006 (the 'bull' market subperiod)	01/2007–04/2012 (the subprime crisis and European debt crisis subperiod)	05/1998–4/2012 Overall
Semi-annual winner returns	-5.30 (-2.52)**	10.96 (9.25)***	-6.06 (-2.85)***	-0.92 (-0.73)
Semi-annual loser returns	-11.78 (-5.65)***	7.55 (5.10)***	-6.93 (-2.78)***	-4.36 (-3.15)***
Semi-annual returns	6.49 (3.16)***	3.40 (4.18)***	0.87 (0.91)	3.45 (4.21)***
Trading costs of winners	2.10 (16.15)***	1.62 (28.28)***	1.62 (49.90)***	1.78 (35.27)***
Trading costs of losers	2.42 (26.83)***	1.64 (23.10)***	1.97 (35.82)***	2.02 (42.23)***
Profits after trading costs	1.97 (0.93)	0.15 (0.17)	-2.72 (-2.70)***	-0.35 (-0.42)

PANEL B: GH Momentum Strategy

	05/1998–12/2002 (the '.com' bubble burst subperiod)	01/2003–12/2006 (the 'bull' market subperiod)	01/2007–04/2012 (the subprime crisis and European debt crisis subperiod)	05/1998–4/2012 Overall
Semi-annual winner returns	-0.60 (-0.41)	11.23 (10.39)***	-5.31 (-2.69)***	0.99 (0.92)
Semi-annual loser returns	-16.70 (-6.19)***	5.71 (3.87)***	-7.19 (-2.84)***	-6.61 (-4.31)***
Semi-annual returns	16.10 (8.79)***	5.52 (6.35)***	1.88 (1.77)*	7.61 (8.45)***
Trading costs of winners	1.67 (26.28)***	1.38 (27.47)***	1.55 (52.11)***	1.54 (53.37)***
Trading costs of losers	2.75 (26.90)***	1.87 (24.06)***	2.10 (38.77)***	2.25 (42.44)***
Profits after trading costs	11.69 (6.45)***	2.27 (2.43)**	-1.77 (1.58)	3.82 (4.26)***

Notes: *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Lesmond et al. (2004) find that the high transaction costs lead to the illusive profitability of the JT strategy in the U.S. market. The results in Panel A support this argument in the OMX Helsinki stock exchange, since the JT returns become statistically insignificant when transaction costs are taken into account. More specifically, the transaction costs for the JT strategy, averaged out over the three subperiods, were 1.78% for the JT

winner portfolio and 2.02% for the JT loser portfolio. This follows that the JT strategy yields no statistically significant returns after trading costs are taken into account. The semi-annual buy-and-hold returns after trading costs vary from -2.75% to 1.97% among the three subperiods, which average out to -0.35% over the pooled sample. Regardless of the low transaction cost estimates for the JT loser portfolio, the results are adequate to provide evidence for the notion that the returns for the JT strategy become statistically insignificant when transaction costs are taken into consideration. Especially, the results are reliable given the fact that the transaction cost estimates from the LDV model are conservative.

Panel B reports that the GH strategy yields significant profits in the OMX Helsinki stock exchange. Specifically, the earned returns for the GH strategy are 16.10%, 5.52% and 1.88% for the three subperiods, respectively, averaging out to 7.61% over the whole pooled sample period with statistical significance. Panel B also reports the GH returns after trading costs, which are 1.54% for the GH winner stocks and 2.25% for the GH loser stocks. After the transaction costs are taken into account, the returns remain statistically significant over the sample period except for the recent subprime crisis and the European debt crisis subperiod. The average six-month buy-and hold returns after transaction costs for the GH strategy are 11.69%, 2.27% and -1.77% for the three subperiod, which average out to 3.82% with statistical significance.

Regardless of the positive abnormal returns after transaction costs, the author has a growing suspicion whether the GH portfolio returns would remain statistically significant if the round-trip transaction costs further increased. Especially, this growing concern is based on the following argumentation: the transaction cost estimates from the LDV model are conservative; the estimates may be 30% lower than that of the quoted spread plus commission method; and the calculated LDV estimates are lower for the JT and the GH loser portfolios than expected. The incomplete dataset used to formulate the estimates of the transaction costs may be the underlying reason for the insufficient estimates. Specifically, the NASDAQ OMX Nordic website is used to collect daily stock prices as further access to Thomson Reuters Datastream is restricted for the time being. This may lead to worsened precision in predictions over the transaction costs of the loser portfolios, since the data sample consists of only companies whose stocks are currently listed on the OMX Helsinki stock exchange.

4 SUMMARY AND CONCLUSIONS

This thesis studies the anchoring bias of investors and the profitability of the 52-week high momentum strategy in the OMX Helsinki stock exchange by forming a self-financing portfolio. Particularly, the thesis participates to the on-going debate on the security market efficiency with regard to the efficacy of momentum investing in terms of the JT and the GH momentum strategies. The first of which measures the past return performance of individual stocks. Based on the ranking, the strategy takes a long position in the top 30% performing stocks and shorts against the 30% of bottom performing stocks (Jegadeesh et al., 1993). The other strategy measures performance of an individual stock based on the nearness of that stock's current price to its 52-week high statistic. This follows that long positions are taken in stocks whose current price are near to the 52-week high, whereas short positions are taken in stocks far from it (George et al., 2004). In this paper, a comprehensive study is implemented to test the efficacy of these momentum strategies in the OMX Helsinki stock exchange.

In order to investigate the efficiency of such strategies, several factors are taken into account. First, the seasonality of momentum investing is investigated with respect to the January effect and long-term price reversals, since contradictory evidence exists amongst previous studies. Second, the anchoring effect of investors is investigated in terms of the acquisition price and the 52-week high value of an individual stock whether they are suitable predictors of future momentum returns. Finally, the profitability of momentum investing is examined after taking the limits to arbitrage into consideration in terms of transaction costs. Especially, the OMX Helsinki stock exchange is an appealing target stock market for testing momentum investing to the extent that it is prone to an intermittent 'periphery syndrome.' This occurs due to international institutional investors realizing their positions from the furthest stock markets when the stock markets are prone to high volatility, which leads to steeper price fluctuations compared to the major stock exchanges (Leivo & Pätäri, 2011).

To put the results into perspective, the results are in parallels with the previous literature with respect to the efficacy of momentum investing, which shows that returns associated with the winner and the loser portfolios, identified by the GH strategy, are around twice as large compared to those associated with the JT strategy. In addition, the results remain statistically significant in the OMXH over the sample period, which demonstrates that nearness to the 52-week high is a more suitable predictor of future returns than the past returns of individual stocks. However, the results are inconsistent with previous literature insofar as loser portfolios contribute to momentum profits to a greater extent than winner portfolios. This leads to a notion that relevant information is more efficiently processed with regard to the recent winner stocks; and therefore the market prices of those winner stocks coincide quicker with intrinsic values. Jegadeesh and Tit-

man (2001) provide a suitable interpretation that momentum profits will dissipate quicker for large-cap stocks, which are cheaper to trade than small-cap stocks; and the profits from trading past winners should be eliminated more quickly than the profits from trading losers due to the costs of short-selling. However, the transaction cost analysis implemented in this study fails to provide evidence for this interpretation, since the LDV transaction cost estimates are similar for the stocks in the winner and the loser portfolios.

The existing behavioural theories of momentum assume that investors are initially reluctant or slow to update their prior beliefs about a stock's value when information arrives, and that when prior information is eventually revised, they tend to overreact to the new relevant information (Barberis et al., 1998; Hong et al., 1999). Based on the other behavioural model, investors may overreact to news when subsequent information confirms the initial signals, which are eventually corrected in long-term (Daniel et al., 1998). The connection between these behavioural theories and Jegadeesh and Titman's findings is whether extreme past returns serve as a proxy for new information. In such case, intermediate-term momentum and long-term reversals are the outcome of investors updating their beliefs. However, the results of the related studies demonstrate that the behavioural models need further clarification, which is the underlying reason for studying the anchoring bias in terms of the 52-week high as a predictor over investors' under reaction to relevant information.

Supporting the hypotheses in George and Hwang (2004), the results of this study indicate that the 52-week high statistic is an appropriate proxy for future returns whether or not individual stocks have had extreme returns. This observation suggests that price levels are vital instead of past returns, which is in parallels with the anchor-and-adjust bias. As an illustration, investors seem to anchor to the 52-week high as a reference point against which they evaluate the potential impact of new information. In case if a stock's price fluctuates near or to a new 52-week high due to desired information, the momentum effect occurs when the information eventually prevails over psychological biases and the stock price appreciates. In a similar way, investors are not prepared to sell the stock at low prices implied by new information, when unfavourable information pushes the stock's price to a long distance from its 52-week high. In this case, the information eventually prevails over psychological biases, which follows that the price depreciates. Based on the theory, investors' reluctance to adjust to new relevant information is dependent on price-levels. Supporting the anchor-and-adjust bias, the results indicate that the greatest reluctance among investors is at price levels, which are the nearest and the farthest from the stock's 52-week high. This occurs due to investors adjusting their prior information more quickly at price levels, which are neither near nor far from the 52-week high. As a consequence, those quicker adjustments to relevant news lead to worsened predictability over future returns when new information arrives.

Long-term price reversals were examined whether they occur when past performance is measured on the grounds of nearness to the 52-week high statistics. The results of the GH strategy provide support for the argument in George and Hwang (2004), which states that the GH portfolio returns are not subject to price reversals. In general, the results indicate that investors may be subject to an anchor-and-adjust bias when a stock's price is near or far from its past 52-week high, which leads to a short-term under reaction. When the information eventually prevails, the Finnish stock market resolves the bias without overreaction in long-term insofar as the GH strategy is concerned. This suggests that intermediate-term momentum and long-term reversals are not subsequent components caused by the same phenomenon. Thereby, the results provide evidence against the behavioural theories, which interpret momentum and price reversals as subsequent components (Barberis et al., 1998; Daniel et al., 1998; Hong et al., 1999). As a conclusion, separate theories explaining momentum and price reversals may be more descriptive than a theory, which integrates both phenomena into a singular cycle of how the Finnish stock market responses to relevant information.

The difference between the returns for the two momentum strategies is more significant outside of January. Particularly, the results indicate that the momentum effect is apparent in months outside of January, whereas the market recognizes its past overreaction mostly in January, which leads to reversals in stock prices. To illustrate, the GH strategy yields significant negative returns in January to the extent that the loser portfolios account for the negative momentum returns to a high degree in January. This leads to a notion that momentum profits deteriorate due to taking a short position against these appreciating past loser stocks. This observation is in parallels with the behavioural interpretations of the January effect, such as the tax-loss selling (Wachtel, 1942) and the window dressing hypotheses (Haugen & Lakonishok, 1988).

Grinblatt and Han (2002) introduce another approach based on the anchoring bias to predict momentum in stock returns. However, the results are consistent with the argument that investors use the 52-week high instead of the purchase price as an anchor to which they add the estimated impact of relevant news. This follows that, as opposed to the results in George and Hwang (2004), the results of this study are not in parallels with the acquisition price model. Nonetheless, the results are consistent to the extent that abnormal returns from the GH strategy dominate that of the purchase price-ranking criterion. Although the 52-week high as an anchor is predictive over momentum returns, the interpretation for long-term reversals lies beyond the anchoring bias. Klein (2001) suggests that a model, in which representative investors are motivated by tax avoidance, explains the reversal effect in stock prices insofar as the acquisition price is used as an anchor and demand function for shares is positively related to the embedded capital gains. Whether this approach will succeed in interpreting price reversals will surely draw interest for further studies in the future.

Once the transaction costs are taken into account, as opposed to the returns of the JT strategy, the GH profits still remain statistically significant. However, the reliability of the LDV transaction cost estimates can be questioned, since the estimates are considerably lower for the loser stocks than those for the major stock exchanges in Liu et al. (2011). This may be explained by the notion that the dataset, which is used to formulate the LDV estimates, consists of only currently listed stocks on the OMX Helsinki stock exchange. As a consequence, the LDV transaction cost estimates are considerably more conservative than that of the quoted spread plus commission method, which is considered as the most accurate model to estimate transaction costs. This raises a question whether the GH abnormal profits would still remain statistically significant if the LDV transaction cost estimates were more accurate.

This study provides support to the results in Jegadeesh and Titman (1993) and George and Hwang (2004) to the extent that the findings present a solemn challenge against the view that stock markets are semi-strong form efficient. In particular, the robustness of the GH strategy suggests that the OMX Helsinki stock exchange is not semi-strong efficient, since the nearness of a stock's current price to its past 52-week high statistic is public information. The results regarding the robust momentum profits of the GH strategy are remarkable, since the 52-week high is among information, which is easily and readily available to investors. As an illustration, nearly every newspaper publishing stock prices also identifies those stocks, which are close to the 52-week high values.

Regardless of the efforts taken in this study to examine momentum investing, a few details still need to be fulfilled. As the empirical part failed to distinguish a theorem interpreting the underlying reasons for long-term reversals after the formation of the JT portfolio, more research into momentum investing is needed with regard to a model in Klein (2001) in which price reversals are explained by the representative investors who are interested in tax avoidance. The other section of this study, which requires further clarification, is related to the estimation procedure of transaction costs. Particularly, further studies are needed to address whether the abnormal returns of momentum investing are only a statistical illusion, demonstrating only the higher level of transaction costs related to active portfolio management. As a consequence, taking transaction costs into account is a crucial part in argumentation whether financial markets are efficient insofar as the semi-strong form EMH of public information is concerned.

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Appendix 1 The Disposition Effect

The leading explanation for the disposition effect arises from the combination of Thaler's (1985) mental accounting and Kahneman and Tversky's (1979) award-winning prospect theory. In more detail, the term mental accounting describes a psychological phenomenon in which the division of payoffs into separate accounts are treated differently regardless of the fungibility of money. It captures the fact that investors view paper gains and losses as less vital than realised ones. In more detail, investors tend to divide various types of gambles into separate mental accounts, which can be distinguished as investors' behaviour to be risk averse over gambles for stocks and locally risk loving over gambles for others. The difference between risk attitudes towards these classifications of stocks is driven by whether stock has generated capital gains or losses. Therefore, investors subject to mental accounting and prospect theory have a greater tendency to sell winner stocks and hold onto losing stocks in relation to reference prices. (Grinblatt & Han 2005, 312–313.)

The aforementioned hypothesis can be illustrated in a more detailed manner by the prospect theory in Kahneman and Tversky (1979). The main argument of the prospect theory is an S-shaped value function. A simple illustration of this representation is as follows: Let *U(Y)* define investor's utility function by

$$U(Y) = \begin{cases} \dfrac{(|Y - \bar{Y}|)^{1-\gamma_1}}{1-\gamma_1}, if\ Y \geq \bar{Y} \\ \dfrac{-\lambda|Y - \bar{Y}|^{1-\gamma_2}}{1-\gamma_2}, if\ Y < \bar{Y} \end{cases}, \tag{8}$$

where $\bar{Y}$ denotes the reference point, $\gamma_1 = \gamma_2 = 0.5$ and $\lambda = 2.25$. For example, $\lambda > 1$ captures the extent of the investor's aversion to losses relative to the benchmark, whereas γ captures the degree of an investor's risk aversion.

The S-shape consists of a concave part in the domain of gains and a convex part in the domain of losses. Clearly both features could have a significant impact on the relative ranking of uncertain investment payoffs. It follows that function differs from that of a standard utility investor. Figure 3 plots an illustration of the S-shaped prospect theory value function.

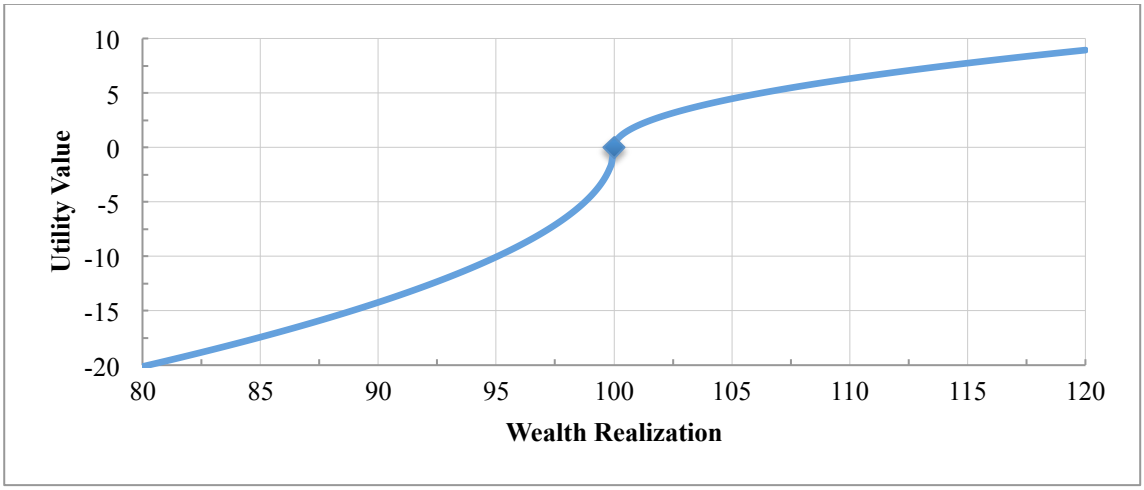

Figure 3 Prospect theory value function (Kahneman & Tversky, 1979)

The theory illustrates how investors may be risk averse when above a relative reference point, but risk loving while below the reference point. While the extreme winner stocks begin the investor from above the reference point, the extreme losers begin the investor from below it. Especially investors' willingness to hold securities may be remarkably affected if they have experienced losses in prior periods. Specifically, investors are more interested in large losers than losers, which are close to the reference point, whereas they have lesser desire to reject small winners than large winners due to the greater degree to which realizations in the convex part enter the expected value calculation. The analysis above demonstrates that the combination of prospect theory and mental accounting generate the disposition effect, which leads to a postponed adjustment to new information available to market participants. (Grinblatt et al. 2005, 312–313.)