Jørgen Foss
Ane Warholm

BI Norwegian Business School –

Master Thesis

A Behavioristic Study on Overreaction and Underreaction: When and Why Does it Occur?

Hand-in date:
01.09.2016

Campus:
BI Oslo

Examination code and name:
GRA 1903 Master Thesis

Program:
Master of Science in Financial Economics
Master of Science in Business – Major Finance

Supervisor:
Kjell Jørgensen

Abstract

The following thesis is a study of two related concepts known as "Overreaction" and "Underreaction". Overreaction and underreaction, both of which have been offered by behaviorists as possible explanations to asset mispricing, provides a more comprehensible framework for empirical work, than merely studying all investor anomalies. As research on these phenomena's in Norway has been fairly scarce, we first make use of different models in order to prove their presence in the Norwegian Stock Market. Collecting returns from all non-financial firms listed on Oslo Stock Exchange from the period of 1999-2014, we explore whether there are negative serial autocorrelation in the long run (24 months) and positive autocorrelation in returns in the short run (6 months). Next, the findings are risk-adjusted and tested for robustness in order to assess whether these findings are in fact due to overreaction and underreaction by investors. Finally, we compare and review the existing literature on the two phenomena´s occurrence in the market: to qualitatively assess *when* and *why* they might occur.

Our findings seem to be in support of the Overreaction Hypothesis: both non-adjusted and risk-adjusted abnormal returns on Norwegian data seem to be too extreme to accord with market efficiency. While some results lack statistical significance, our general findings are in congruence with the main consensus within recent academia. As for underreaction, however, we did not find evidence of positive serial autocorrelation in the short term on our specific sample. Reviewing a broad collection of related literature, we argue that overreaction occurs *prior* to portfolio formation, while underreaction occurs after. Put simply, investors overreact to future news announcements and thus drive the price of growth stocks too high and the price of value stocks too low. After portfolio formation, on the other hand, investors underreact to news that contradicts their prior and embedded beliefs. Finally, we hypothesize that overreaction is best explained by the Representativeness Heuristic, which means that investors perceive past performance to be representative for the future, ignoring some of the fundamental aspects. Lastly, we believe that underreaction is a result of a cognitive bias known as the Conservatism Bias. And to avoid the negative psychological repercussions of changing an embedded belief, underreaction is also a result of investors´ slow diffusion of contradictory, new information.

1 INTRODUCTION 1

2 LITERATURE REVIEW 3

2.1 INTRODUCTION AND EVIDENCE 3
2.2 CRITIQUE OF INFERENCE 4
2.3 IS THE EVIDENCE ROBUST? 6
2.4 WHY DOES IT OCCUR? 6

3 METHODOLOGY AND DATA 7

3.1 DATA 7
3.2 TESTING FOR OVERREACTION 8
3.2.1 ANOTHER WAY TO GO… 11
3.3 TESTING FOR UNDERREACTION 12
3.4 WHY – THE FINAL PUZZLE 13

4 FINDINGS 14

4.1 OVERREACTION 14
4.1.1 ROBUSTNESS TESTS 15
4.1.2 JANUARY EFFECT 16
4.1.3 SIZE EFFECT 16
4.2 UNDERREACTION 17
4.2.1 ROBUSTNESS TESTS 18

5 WHEN DOES IT OCCUR? 19

5.1 THE STATE OF THE MARKET 19
5.2 PORTFOLIO FORMATION 20
5.3 EARNINGS ANNOUNCEMENTS 21

6 WHY DOES IT OCCUR? 23

6.1 OVERREACTION - BEHAVIORAL BIASES 23
6.2 UNDERREACTION – BEHAVIORAL BIASES 24

7 CRITIQUE OF METHODOLOGY 26

8 CONCLUSION 27

9 REFERENCE LIST 29

10 APPENDIXES 34

10.1 TABLE 1A –– OVERREACTION – ARBITRAGE PORTFOLIO 34

10.2 TABLE 2 – JANUARY EFFECT – CARS 35

10.3 TABLE 2A – JANUARY EFFECT – ARBITRAGE PORTFOLIO 36

10.4 TABLE 3 – SIZE EFFECT – WINNER HIGH, LOW VERSUS LOSER HIGH, LOW 37

10.5 TABLE 4 – UNDERREACTION – CARS 39

10.6 TABLE 4A – UNDERREACTION – ARBITRAGE PORTFOLIO 42

1 Introduction

Ever since Daniel Kahneman and Amos Tversky published *Judgement Under Uncertainty* in 1973 and *Prospect Theory* in 1979, the school of thought now known as Behavioral Finance has grown to be a highly influential field within economics and finance.

By intertwining cognitive psychological theory with conventional financial theory, behavioral finance provides solutions as to why irrational decision-making takes place. For instance, the prospect theory states that people value gains and losses differently, and that losses entail a bigger emotional impact; the anchoring bias states that people might overlook fundamentals, and thus "anchor" their decision based on quickly attainable information, although this information might be completely irrelevant for the decision at hand; while the overconfidence bias states that people might exaggerate their abilities to perform a particular task (e.g. investor's stock-picking). These are just a few of the anomalies contradicting rational and logical investor behavior.

Hence, by studying the violations of the "rational, utility maximizing man" (and when and why these violations occur), one could perhaps undertake better investment decisions. More importantly, the study could serve as a prelude to assessing "the missing link" between fair asset prices and actual asset prices. The potential to better understand this infamous price gap, looking at financial data through the lens of cognitive psychology, is something we find to be highly intriguing.

However, behavioral finance has not gone uncriticized. Particularly, the father of the Efficient Market Hypothesis, Eugene Fama (Fama hereafter), was rather skeptical towards the validity of "the psychological investor". His 1970 article *Efficient Capital Markets: A Review of Theory and Empirical Work* had solid support among researchers, so behaviorists suggesting that markets were (at least to a certain extent) inefficient, was controversial.

While we will state and discuss the critiques leveled at behavioral finance more detailed in the Literature Review section, a general commonality is that

many perceive behavioral finance as simply a collection of psychological anomalies that "cancel each other out". It could for instance be argued that the anchoring bias and the availability bias is somewhat saying the same thing. Recall that the anchoring bias is the tendency to anchor ones decision based on quickly attainable information, where the latter is defined as the notion of adding more weight to recent information than what would be justifiable. Hence, anchoring towards this new information is the same as overvaluing this new information. On the other hand, exaggerating one's stock-picking abilities (i.e. being overconfident), could be interpreted as *undervaluing* new information, because by being overconfident you put more faith in the precision of your estimates than the available information would call for. Suddenly, the critique now seems quite fair and legit.

Fortunately – at least for advocates of behavioral finance – it takes more than this to abandon the field as an important academic alternative to investor rationality. This brings us to our research topic: instead of working with many different biases and anomalies, much of the latest work within the field has turned to two terms known as Overreaction and Underreaction. Our thesis will continue this path, and correspondingly study these phenomena specifically in Norway. First, by investigating whether we find evidence for their occurrence. And secondly – if we find such evidence – to provide answers to *when* and *why* they occur.

If we manage to successfully provide valid inferences and statistically significant answers to this, we believe our thesis could potentially serve as an important contribution to behavioral economists, considering that our research question is something that has been suggested and proposed by many experts – without, to our knowledge, ever explicitly being done before.

Even in *Market Efficiency, Long-Term Returns and Behavioral Finance* (1998), Fama wrote that although the behavioral finance literature does not clearly lean towards either side (i.e. overreaction or underreaction): *"This is not lost on behavioral finance researchers who acknowledge the issue: We hope future research will help us understand why the market appears to overreact in some*

circumstances and underreact in others (Michaely, Thaler and Womack, 1995: 606)". Additionally, Daniel, Hirshleifer and Subrahmanyam (DHS hereafter) stated in their 1997 and 1998 article: *"Although behavioral hypotheses of either underreaction or overreaction have been proposed, an integrated theory is needed to make predictions about when over- or underreaction will occur"* (DHS 1997: 39; 1998:1865).

The following body of arguments, and our thesis in general, seeks to do just that: integrate the theory and provide feasible explanations as to why and when overreaction and underreaction might occur in the market.

The remainder of the thesis proceeds as follows. Section 2 will briefly review the relevant literature with which our thesis is based on. Section 3 contains our methodology and the data collection process. In section 4 we present our findings and discuss them. Section 5 is devoted to stating some drawbacks of our methodology, while section 6 concludes.

2 Literature Review

2.1 Introduction and Evidence

Three decades ago, when overreaction and underreaction first were proposed as behavioral explanations to asset mispricing, up until today, extensive research have been conducted in order to prove its presence in the stock market.

Now, while some may still disagree, and despite that some studies are not conclusive, the recent academic consensus, however, is that overreaction and underreaction takes place. Many previous studies have used negative autocorrelation in stock returns in the long run (two years or more) as evidence of overreaction, whereas positive autocorrelation in stock returns in the short run (one month to one year) has been used to reflect underreaction. Recall that a positive autocorrelation in stock returns is most commonly defined as the Momentum Effect.

For instance, as stated in the classic study conducted by DeBondt and

Thaler (1985) (DBT hereafter), there is strong evidence of overreaction in the stock market. After ranking the New York Stock Exchange's best performing stocks up against the worst performing stocks, thus creating a "winner" and "loser" portfolio, they compared the portfolios performance going forward. They discovered that the losing portfolio strongly outperformed the winning portfolio, which necessarily had to imply that investors were overreacting (at least to something), and thus validated the Overreaction Hypothesis (Thaler 2015).

Bauman, Conover and Miller (1998) (BCM hereafter) came to the same conclusion: since value stocks (losers) outperformed growth stocks (winners), it *"suggests that investors overreact to past growth rates in EPS by driving the market prices of growth stocks too high, and the prices of value stocks too low"*.

Dreman and Lufkin (2000) (DL hereafter) took it a step further: while they successfully provided evidence of overreaction, they stated that nothing could explain it except psychological influences, and also that overreaction and underreaction might be part of the same process, considering that investors seem to fail to adjust forecasts sufficiently. Put simply, investors first overreact by excessively favoring stocks, and then underreact to this asset mispricing. Concurrently, Ikenberry and Ramnath (2000) found support for this adjustment delay, in the sense that the market underreacts to news.

When addressing the question of *when* these phenomena occur, DL (2000) showed that the performance of "winner" stocks increased significantly in the period before portfolio formation, with only a minimal improvement in fundamentals; while the performance of "loser" stocks displayed an almost mirror image. This picture was sharply reversed a year after portfolio formation. Hence, they convincingly argued that overreaction occurred prior to portfolio information (DL, 2000: 73).

2.2 Critique of Inference

Despite the seemingly sound research conducted on these two phenomena, not everyone agrees that the value-stock effect, for instance, should be accredited to

"overreaction", nor that it should be credited to irrational investor behavior for that matter.

Fama (1998) argued that some of the anomalous return patterns, for instance the return difference chronicled by DBT (1985), are highly sensitive to empirical methodology. Additionally, and as summarized in Clements, Drew, Reed and Veeraraghavan (2009), numerous contradictory studies has been presented, which stands in sharp contrast to the view behaviorists has on overreaction in the market:

- Chan (1988): the author argued that the seminal work conducted by DBT lacked appropriate risk-adjustment: while the single-factor CAPM had some explanatory power for the returns generated, the anomalies were not robust under the three-factor model by Fama and French (1993). Chan thus argues that the abnormal return obtained by buying a "loser" portfolio is simply a compensation for adding risk, in congruence with the Efficient Market Hypothesis;
- Ball and Kothari (1989): they conjectured there were a lack of risk adjustment in the original study of DBT, along the lines of Chan (1988);
- Zarowin (1990): the author stated that losers do *not* outperform winners after firm size and the January effect on returns is coped with;
- Conrad and Kaul (1993): the authors stated that the "winner" and "loser" portfolio returns is solely due to the January effect, and after it has been accrued for, there is no evidence for market overreaction.

Contending this, Chopra, Lakonishok and Ritter (1992) (CLR hereafter), among others, presented further evidence that was consistent with the Overreaction Hypothesis. They also reviewed the work of Ball and Kothari (1989), and discovered use of questionable empirical methodology (sample selection bias) to unjustly make overreaction less significant. Secondly, and as pointed out by DHS (1998), Loughran and Ritter (1998) stated that the methodology favored by Fama minimize the power to detect possible misvaluation effects. Lastly, given the magnitude of the return patterns, the

evidence presented by behaviorists does not accord with market efficiency (DHS 1998: 1840).

2.3 Is the Evidence Robust?

While all this may seem somewhat ambiguous, we concur with CLR (1992), Lakonishok, Shleifer and Vishny (1994), DHS (1997; 1998), BCM (1998), DL (2000), Thaler (2015), and others: the performance of value stocks cannot exclusively be explained by added risk.

Finally, and in the upcoming sections, our assumption will be that the abnormal return derived from a contrarian strategy[1] could partially– but significantly– be explained by overreaction. Furthermore, that underreaction (being just as a significant phenomena) plays a key role in this process in the sense that investors likely underreact to recent information that could otherwise help them adjust their biased forecasts.

Most importantly, our conjecture is that the general evidence on overreaction and underreaction are robust, and that the two phenomena needs to be recognized as possible explanations to asset mispricing; and assessing when and why these phenomena occur is something that might add additional credibility both to behavioral finance in general, and to the Overreaction Hypothesis in particular.

2.4 Why Does it Occur?

Gary Antonacci, an award-winning author and a Harvard alumni, stated recently on his popular blog *Dual Momentum* that:

> *"Underreaction likely comes from anchoring, conservatism, and the slow diffusion of information, whereas overreacting is due to herding behavior, representativeness, and overconfidence"* (Antonacci 2015).

[1] Buying low-price value stocks and selling high-price growth stocks.

[2] As stated in Fama and French (1992): *"financial firms are excluded due to the fact that the high*

Despite this, there are still huge uncertainties and little empirical evidence nor research as to why investors over- and underreact. However, while it might be impossible to provide sound evidence on this, there must be some commonalities in the actions of investors that result in the irrational behavior, and these commonalities should be analyzed based on the known cognitive errors in human decision-making.

Altogether, while the research conducted on *why* these phenomena occur is virtually non-existent, the goal of this thesis is to at least provide some value and – although small – be a contribution to answering this question.

3 Methodology and Data

In order to provide feasible answers to our research question, it is optimal to compare a broad collection of related literature. And in spite of the fact that most evidence seems to favor the Overreaction Hypothesis, it is still a debatable subject. Due to this, and in an attempt to add further credibility to the prominent evidence, the main starting point of our thesis will be to assess whether overreaction and underreaction does in fact occur on Norwegian data.

Additionally, we will test for overreaction and underreaction separately to possibly get evidence for each of them. The results will be analyzed, and hopefully we can complement DL (2000) with their pioneering research on *when* it occurs.

3.1 Data

Using the Bloomberg database, we collected data on all listed non-financial companies on the Oslo Stock Exchange[2] (OSE hereafter) for the time period 1999-2014 (giving us 16 years of data for 498 companies). Since no one has examined the presence of over- and underreaction specifically in Norway, this

[2] As stated in Fama and French (1992): *"financial firms are excluded due to the fact that the high leverage that is normal for these firms probably does not have the same meaning as for nonfinancial firms, where the high leverage more likely indicates distress." (Fama and French, 1992: 429).* Thus, due to the fact that the inclusion of those firms could alter the conclusion, the lion´s share of quantitative research excludes these companies.

data will give us a good starting point when looking closer into the two phenomena. We collected total returns and market capitalization for every stock for our chosen time period.

To avoid the survivorship bias, we chose to include all stocks traded from 1999-2014 instead of only considering those who are still trading at the end of our sample period. A requirement for a stock to be included in the portfolio is that it must have been traded during the observation period, and at a minimum once during the test period. We use monthly returns, and the market returns are computed as the equally weighted index of all the included stocks.

3.2 Testing for Overreaction

When testing for overreaction, two different tests will be conducted. Based on earlier studies, like Kendall (1953) and Fama (1965), our first test might give us results on the negative serial correlation in the medium- to long-term, where we can determine its significance. We will then control for other risk and non-risk factors to assess the robustness of our results. If we find any mean reversion tendency in stock returns that is robust to the control of the factors mentioned above, it indicates that overreaction has occurred.

Our second test is performed to retrieve/develop data on the profitability of contrarian strategies. Lakonishok, Shleifer and Vishny (1994) state that the superior return on value stocks is due to expected errors made by investors.

The tests will be performed on sub-periods within the data sample. In every sub-period there is an observation period and a test period. The stocks will be sorted on the basis of how they performed in the observation period, and then assigned into winner (the best performing stocks), loser (worst performing stocks) and arbitrage (return gap between winners and losers) portfolios. At formation, the three different portfolios will be equally weighted, and the included stocks in these portfolios will be held through the test period.

Our sample period will include the full 16 years of data, based on monthly observations from 1999 to 2014 where we test 24 month/24 month strategies. This

gives us seven non-overlapping observation- and test periods. Using the methodology offered by DBT (1985), we compute the cumulative market-adjusted returns (CAR) for the observation period for every period and for each stock. The CAR is given by:

$$CAR_{i,t} = \sum_{t-24}^{t-1} \mu_{i,t}$$

$\mu_{i,t}$ is the market-adjusted return for stock i in month t, and is computed as:

$$\mu_{i,t} = R_{i,t} - R_{m,t}$$

Where $R_{i,t}$ is the return for stock i in month t, defined as:

$$\frac{(P_{i,t}) - (P_{i,0})}{(P_{i,0})}$$

$R_{m,t}$ is the market (average) return in month t, and is computed as the weighted average of all the stock returns.

We define the "winner" portfolio as the 20 % stocks that perform best, and include these in the top quintile (Q1). The "loser" portfolio includes the 20% stocks that have the worst performance, and will thus represent the bottom quintile (Q5). Quintiles Q2, Q3 and Q4 will accordingly consist of the portfolios in between (i.e. medium performing stocks). Next, we want to test these portfolios performance. We will thus compute the average CAR of the stocks 24 months forward. The average CAR is computed as:

$$CAR_{p,z,T} = \sum_{t=1}^{T} (\frac{1}{N} \sum_{i=1}^{N} \mu_{i,t})$$

p denotes which type of portfolio we refer to (W for winner; L for loser; A for arbitrage); *z* denotes the period (1, 2,..., 7); *T* denotes how many months we hold

onto the portfolio (i.e. 24 for our strategy of choice). The next step is to calculate the grand mean (ACAR) for the seven periods' CAR:

$$ACAR_{p,T} = \frac{\sum_{z=1}^{Z} CAR_{p,z,T}}{7}$$

We can use the $ACAR_p$ as an indication as to whether or not there are negative autocorrelations in the returns. If this is the case, there is mean reversion in the returns, which thus implies that the "losers" earn positive average test period excess returns, while "winners" earn negative excess returns (i.e. $ACAR_L>0$ and $ACAR_W<0$). This will show that the contrarian strategy will exceed the equally weighted index including all the companies in the sample, thus giving a non-zero arbitrage portfolio return (i.e. $ACAR_A \neq 0$) (DBT 1985: 797-798).

When assessing the statistical significance of our findings (like the ACARs), we adopt the methodology used by DBT (1985)[3]. First, we need a pooled estimate of the population variance in the respective CARs:

$$S_t^2 = \frac{\sum_{n=1}^{N}\left(CAR_{W,n,t} - ACAR_{W,t}\right)^2 + \sum_{n=1}^{N}\left(CAR_{L,n,t} - ACAR_{L,t}\right)^2}{2 * (N-1)}$$

With two equal sized samples N (7 for winner and 7 for loser), the variance of the difference of sample means corresponds to $2S_t^2$/N. Thus, the t-statistic for the ACAR returns for the arbitrage portfolio is:

$$T_t = \frac{ACAR_{L,t} - ACAR_{W,t}}{\sqrt{\frac{2S_t^2}{N}}}$$

When calculating the significance of the ACARs for every quintile, to assess whether they make a significant contribution to $ACAR_{W,t}$ or $ACAR_{L,t}$,
we use a *t*-statistic defined as:

[3] Most similar studies adopts the same methodology.

$$T_t = \frac{AR_{W,t}}{\frac{s_t}{\sqrt{N}}}$$

Where s_t is the winner (or loser) portfolios standard deviation, and is equal to:

$$s_t = \sqrt{\frac{\sum_{n=1}^{N}\left(AR_{W,n,t} - AR_{W,t}\right)^2}{N-1}}$$

Our main focus in the following will be to find the significance of the ACARs representing the aggregate *arbitrage portfolios*. This is because even though we can find relevant t-statistics for all of the quintiles and for all periods, they do not represent independent evidence (DBT 1985: 798).

Since we use the market-adjusted returns, it might be possible that what we observe in the pattern of returns can come from improper risk control (see *Critique of inference* in the Literature Review). This is why one would want to control for the risk and non-risk factors mentioned earlier: to assess the robustness of the negative serial correlation in returns. The following considerations should be taken into account (as suggested by related literature):

(i) Systematic Risk Adjustment (using CAPM and the Chan method)
(ii) Size Effect
(iii) January Effect
(iv) Fama and French (1993) Three-Factor Model Adjustment

3.2.1 Another way to go…

Although we will not perform the following test, Lakonishok et al. (1994) provides another possible way to go to test for overreaction: by looking at how investors typically form their portfolios. Book to Market, Cash-Flow to Price and Earnings-Price ratios are all used in the forming of portfolios; where high ratios indicate bad prospects and low ratios indicate good prospects.

However, we know that many investors have a tendency to fall victim of the availability bias. This implies that if investors put more emphasis on recent

news and thus overreacts, the long-term performance of perceived good stocks would mean-revert, which can be seen as the result of an overly optimistic investor. This suggests that value stocks (stocks with higher ratios) would give higher returns in the future, while the growth stocks (stocks with lower ratios) would earn lower returns in the future. Contrarian strategies could therefore give us information as to whether or not investors overreact based on the results from the three following conditions for overreaction:

1) The value portfolios outperform the growth portfolios.
2) The result/outcome is risk-adjusted.
3) The result/outcome can be linked to investors' extrapolation of recent news.

In order to properly validate the Overreaction Hypothesis, Lakonishok et al. (1994) stress the necessity to address all the above conditions, which means that one must check the portfolios after risk-adjustment, in addition to conducting direct extrapolation tests.

3.3 Testing for Underreaction

When testing for underreaction we will first do the opposite of what were done when testing for overreaction: to look at the positive serial correlation in returns for short-term periods. We do this to see if the investors are conservative in their actions or if information is implemented gradually, which indicates that the prices does not reflect the information immediately, which again would infer momentum in returns.

We chose to run a 6 month/6 month strategy, with the same rationale as before: to test the performance six months forward based on the past six months. This gave us a total of 31 observation and test periods. The observation period is the basis of the five quintiles to be tested in the test period, with the same selecting process as before: winners consist of the 20 % best performing stocks while losers consists of the 20 % worst performing stocks, with quintiles Q2, Q3 and Q4 in between.

We will apply $ACAR_p$ here as well, but just the other way around: as an indication as to whether or not there are *positive* autocorrelations in the returns. This would imply momentum, and hence that $ACAR_L$<0 and $ACAR_W$>0 and that an arbitrage portfolio consisting of buying winners and selling losers would earn an abnormal return (i.e. $ACAR_A \neq 0$). Should we find a significant performance pattern, then the abnormal return must be compared relative to the expected return based on the CAPM model and the three-factor model by Fama and French (1993) to assess momentum in our data sample. Apart from momentum (1) as such, two other conditions must be fulfilled in order to empirically prove underreaction:

2) The momentum effect can be linked to firm-specific news.
3) The momentum effect should not be affected by initial overreaction in the short-term if this comes from overvaluation or extreme optimism.

3.4 Why – The Final Puzzle

To our knowledge, there is no published research that focus on the exact issue of *why* over- and underreaction occurs.

Whether this is due to the necessity of providing more robust evidence on the matter, or to circumvent additional complexity and uncertainty, we do not know yet. What we *do* know, however, is that research has lacked a theory on this, and that if we manage to provide such a theory, we deem ourselves successful in this regard.

In order to answer this puzzle, our starting point is the existing models used to test for the presence of over- and underreaction, which we will use as our base going forward. The results derived from the abovementioned models, and commonalities between the different data sets, will finally be compared. If we find similar characteristics between the data sets, we could ultimately isolate these effects to assess their impact on the phenomena´s occurrence.

4 Findings

4.1 Overreaction

Table 1 – Overreaction - CARs

Cumulative Returns for Observation- and Test Periods (1999-2014)					
Portfolio	WINNER	2	3	4	LOSER
Obs 1 (1999-2000)	26 731,81	5 521,23	697,77	-6 001,06	-52 945,36
Test 1 (2001-2002)	19 454,15	-4 784,10	-6 957,31	-12 357,44	-41 744,03
Change 1	**-27,22%**	**-186,65%**	**-1 097,07%**	**-105,92%**	**21,16%**
Obs 2 (2001-2002)	27 334,18	8 448,98	170,21	-18 005,87	-68 244,61
Test 2 (2003-2004)	15 481,86	3 518,58	1 766,78	-23 159,98	-57 502,87
Change 2	**-43,36%**	**-58,36%**	**938,03%**	**-28,62%**	**15,74%**
Obs 3 (2003-2004)	30 526,67	10 619,50	1 105,03	-18 089,30	-87 410,40
Test 3 (2005-2006)	26 006,51	14 622,33	8 823,75	-7 691,45	-67 902,53
Change 3	**-14,81%**	**37,69%**	**698,51%**	**57,48%**	**22,32%**
Obs 4 (2005-2006)	52 955,62	22 485,51	8 244,31	-8 202,45	-89 106,27
Test 4 (2007-2008)	54 417,20	27 436,91	17 698,85	-13 496,12	-92 527,87
Change 4	**2,76%**	**22,02%**	**114,68%**	**-64,54%**	**-3,84%**
Obs 5 (2007-2008)	76 707,26	28 355,50	8 307,07	-14 043,24	-113 958,48
Test 5 (2009-2010)	39 841,74	17 492,28	6 821,64	-33 650,95	-127 880,06
Change 5	**-48,06%**	**-38,31%**	**-17,88%**	**-139,62%**	**-12,22%**
Obs 6 (2009-2010)	73 415,70	23 752,02	2 151,34	-33 201,27	-174 061,11
Test 6 (2011-2012)	55 323,40	17 505,41	-8 906,28	-38 781,30	-164 032,76
Change 6	**-24,64%**	**-26,30%**	**-513,99%**	**-16,81%**	**5,76%**
Obs 7 (2011-2012)	79 012,06	19 068,36	-763,13	-32 382,33	-215 697,16
Test 7 (2013-2014)	73 190,76	16 268,85	-333,39	-35 040,51	-201 345,66
Change 7	**-7,37%**	**-14,68%**	**56,31%**	**-8,21%**	**6,65%**
Average (ACAR)	*-23,24%* *(-0,26)*	*-37,80%* *(-0,64)*	*25,51%* *(0,49)*	*-43,75%* *(-0,72)*	*7,94%* *(0,04)*

"Obs x" shows the cumulative return in observation period x (period of two years), "Test x" shows the cumulative return in test period x (period of two years). The observation periods do not overlap each other (neither do the test periods), but the observations and the tests are overlapping

each other. The formula for change is $(Test - Obs)/Obs$ *if the observation is positive. If the observation is negative, the formula is* $-(Test - Obs)/Obs$.
*T-statistics are reported in parentheses. * denotes statistical significance at the 5 % level.*

Table 1 above presents our main findings and what seems to be quite clear evidence of overreaction occurring on Norwegian stocks within our data sample. The CARs of the five quintiles (including the winner and loser portfolio) are presented for the seven test periods.

The winner portfolio, formed on the basis of its performance the past 24 months, gives an $ACAR_W$ of -23,24 %, whereas the loser portfolio gives an $ACAR_L$ of 7,94 %. This shows that past losers over 24 months outperform past winners over 24 months considering that a contrarian strategy consisting of selling the winners and buying the losers (i.e. buying the arbitrage portfolio) would yield abnormal returns over the next 24-month-period. Unlike DBT (1985), we do not find an asymmetric or stronger effect for losers than for winners.

Table 1A (see appendix) shows the corresponding arbitrage portfolio: it can be seen that the average abnormal return derived from buying the arbitrage portfolio is as much as 31,18 % (t-statistic: 3,67) for our given data sample. Overall, our results seem to be in lines of what were found by DeBondt and Thaler (1985,1987) as well: they found an $ACAR_A$ of 24,6 % over a three-year holding and test period and an $ACAR_A$ of 31,9 % with a five-year holding and test period.[4]

4.1.1 Robustness tests

As stated earlier, the magnitude of the return patterns derived from undertaking a contrarian investment strategy does not accord with market efficiency. However, we will test for robustness by responding to the most recent critics of the Overreaction Hypothesis: Zarowin (1990) and Conrad and Kaul (1993).

[4] Despite $ACAR_W$ and $ACAR_L$ not being statistically significant in its isolated form, the return for the arbitrage portfolio ($ACAR_L$ - $ACAR_W$) *is* statistically significant.

Despite that Chan (1988) and Ball and Kothari (1989) argued that the abnormal return was a manifestation of merely increased risk, and that both CAPM and Fama and French three-factor model is needed to be able to compare the performance patterns; Zarowin and Conrad and Kaul, publishing their articles at a later stage, had time to review the arguments of their earlier peers, and came to the conclusion that the *size effect* and the *January effect* was responsible for the abnormal return derived from the contrarian strategy. Hence, these two robustness tests will be performed in the following.

4.1.2 January effect

Table 2 (see appendix) shows the CARs for the five quintiles and the seven test periods, neglecting the month of January. For the winner portfolio, the $ACAR_W$ is -25,65 % while the loser portfolio yields an $ACAR_L$ of 8,88 %. The arbitrage portfolio is presented in table 2A (see appendix), and shows again a non-zero abnormal return and a corresponding $ACAR_A$ of 34,53 %.

This is in sharp contrast to Zarowin (1990), who argued that the manifestation of overreaction occurs almost exclusively in January. Generally, our finding is supporting what CLR (1992) stated: a substantial proportion of the overreaction (over 50 %) occurs in non-January months. Hence, the seemingly sound evidence of overreaction in our data sample does not vanish when controlling for the January effect.

4.1.3 Size effect

Table 3 (see appendix) presents the CARs of the winner and the loser portfolio, with both quintiles being split in two, based on the median market capitalization[5] of the included firms. The high portfolios (big firms) consist of the firms having a size above the median market capitalization within that quintile, while the low portfolios (small firms) have a size below.

[5] In lines of related literature, we use the median instead of the average simply to ensure that enough companies are within each category.

Doing this, we discovered that many of the firms we included in the general, non-adjusted model had no available market capitalization numbers. Thus, now selecting based on both the trading criteria and an available and reported market capitalization, reduced the number of firms we included in our portfolios. However, we see that whether the included firms are big or small does not matter, considering that the signs for the two quintiles is often the same as the previous, aggregate quintile (e.g. since the winners tend to underperform, both the big winner and the small winner should have a negative ACAR, otherwise firm size may matter).

Additionally, $ACAR_{WB}$ being -40,27 % and $ACAR_{WS}$ being -66,34 %, both numbers are *less* than zero. Whereas $ACAR_{LB}$ is 51,35 % and $ACAR_{LS}$ is 18,22 %, both numbers are *higher* than zero. Hence, since $ACAR_{WB}$ and $ACAR_{WS}$<0 and $ACAR_{LB}$ and $ACAR_{LS}$ >0, firm size does not seem to matter to a significant degree, so we *still* have a mean reversion tendency in the stock returns for our sample.

4.2 Underreaction

Table 4 (see appendix) presents our main findings with respect to underreaction. Surprisingly, we find no clear pattern of positive autocorrelation of stock returns over 6 months for our data sample. For the winner portfolio, we see that there are positive autocorrelations in only 7 out of the 31 test periods. Oppositely, for the worst performing stocks there are a continued decline in performance in only 8 out of 31 test periods. Actually, there are mean reversion tendencies for 22 out of the 31 periods for the winner, and 22 out of 31 periods for the loser portfolio[6]. This gives an $ACAR_W$ of -6,23 % and a $ACAR_L$ of 1,61 % and an $ACAR_A$ of -7,84 %. Hence, utilizing a 6-month momentum strategy does not seem to generate any abnormal returns on OSE for the period 1999-2014 – in fact rather the opposite.

Perhaps by choosing another strategy (i.e. not a 6-month/6-month) we would have seen clearer signs of momentum. This is because that even though the

[6] For the winner portfolio there are two periods with approximately 0 % change, with one for the loser portfolio.

effect for the 6-month/6-month strategy is not nearly as strong as for the 24-month/24-month strategy, both strategies still exhibit mean-reversion tendencies. Due to this, we find it likely that we need to *further* shorten the holding period to potentially detect a momentum effect. However, for the sake of saving space and the likely event that a 4-month/4-month strategy, for example, would not radically alter the outcome, we conclude that we do not find any evidence of underreaction occurring on stocks listed on OSE in the period 1999-2014 in the short term.

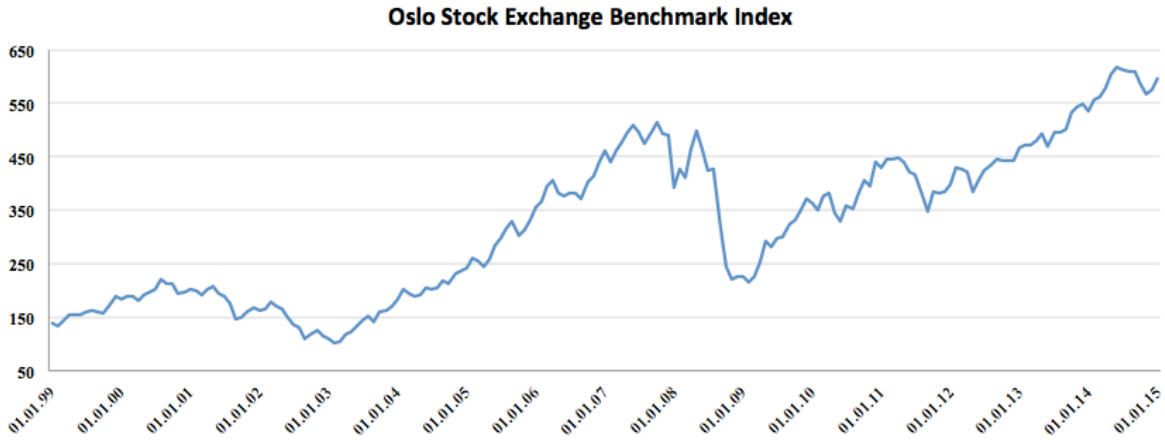
4.2.1 Robustness tests

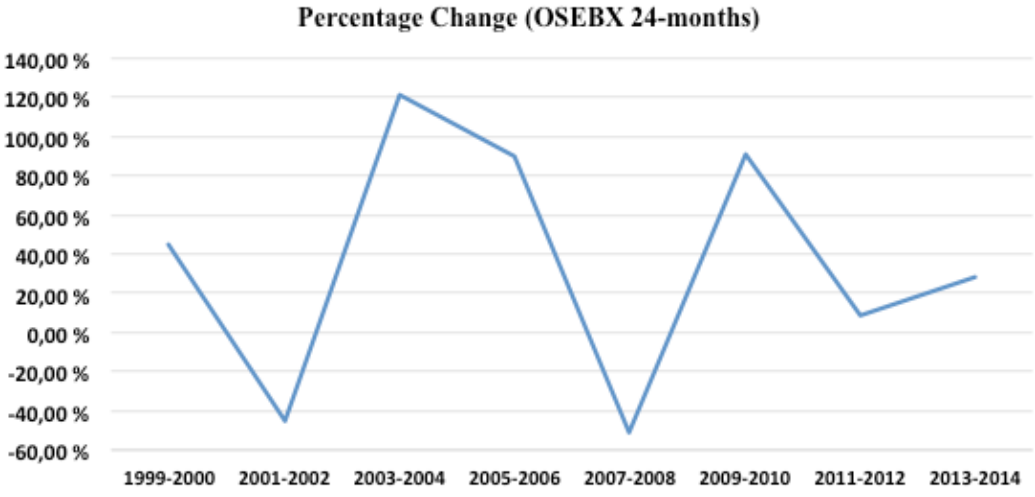
As mentioned earlier, had we found a clear pattern of positive autocorrelation in stock returns six months after portfolio formation, we would have to check for robustness; first, by comparing the abnormal return derived from the arbitrage strategy (of buying winners and selling losers) to the expected return based on the CAPM model and the three-factor model by Fama and French (1993); secondly, we would have had to made sure that the momentum effect could be linked to firm-specific news; and finally, made sure that the momentum effect was not affected by initial overreaction if this came from overvaluation or extreme optimism. However, considering that we found no such momentum tendencies for our sample, a robustness procedure will be redundant and thus skipped.

5 When does it occur?

5.1 The State of the Market

Starting off the analysis, an interesting feature to study is to compare the abnormal returns derived from a contrarian strategy with how the market in general has performed. The charts below show the Oslo Stock Exchange Benchmark Index (OSEBX), a representative selection of all Norwegian stocks, with its respective percentage two-year change.





Comparing OSEBX with our findings, one can see from Table 1 and Table 1A (see appendix) that the only time the arbitrage portfolio (for overreaction) does *not* yield a positive return for our data sample is in our forth test period, being the years of 2007 and 2008. Looking at the chart above, one can clearly see that in 2008 the Norwegian Stock Exchange experienced a sharp decline, and from January 2007 till January 2009, thus including the full 24-month period, the index fell from 460 to 226!

Hence, when the market is bullish or generally in a "normal" state, it seems that overreaction is present. The picture is however not necessarily mirrored when analyzing the bearish tendencies: both in 2001-2002 and in 2007-2008 the market declined significantly, with the dot-com-bubble resulting in an index fall of 45 % and the financial crisis a fall of 51 %, while only the latter having serious consequences for the arbitrage portfolio´s returns. However, since our data set consists of listed firms on OSE *except* the financial institutions, the data set miss out on the possible overvaluation of those firms. Unlike the dot-com-bubble, where all the high-valued IT and Internet firms already were included in the portfolio, the test period of 2007-2008 probably neglects some of the period´s respective growth stocks, and could thus possibly explain why no mean-reversion tendency was found for this period. Using data from the Karachi Stock Exchange (Pakistan), the on-going working paper of Dr. Attiya Javid and Asia Aman strongly support this theory by showing that *during* the global financial crisis, the Overreaction Hypothesis is accepted for the financial sector, whereas for the non-financial sector it is not. Recognizing all this, and despite the enormous repercussions of a market on the decline for example, it seems that a contrarian investment strategy yields significant returns nonetheless. Finally, considering the magnitude of the returns depicted from the arbitrage portfolio, in addition to the fact that whether the market rises or declines does not seem to constitute a significant difference in returns, we argue that investor overreaction (and underreaction) is more of a static phenomenon.

5.2 Portfolio Formation

As stated in DL (2000), most researchers believe overreaction to occur *after* portfolio formation, while some have posited that it occurs before. However, the period before portfolio formation has not been examined in great detail, which thus led the abovementioned authors to conduct an event study on the matter. They divided the returns of the best and worst performing stocks and their fundamentals into two distinct periods: *before* and *after* portfolio formation. They presented clear outperformance of favored versus out-of-favor stocks in the period before portfolio formation, and a sharp reversal thereafter. They found that in the first two years before formation, the winner stocks had their strongest

performance, with only a slight improvement in fundamentals, while the loser stocks displayed an almost mirror image. They conjectured that when coupling this finding to the findings of DBT (1985, 1987) and Abarbanell and Bernard (1992), overreaction could be said to occur before portfolio formation (DL 2000:73).

5.3 Earnings Announcements

There is another element that has yet to be mentioned: Earnings announcement (i.e. news). Howe (1986) and Brown and Harlow (1988) found for instance that overreaction typically occurs in response to bad news (Chen 2008:171). Supporting this view, Ketcher and Jordan (1994) claims that investors react to bad news by driving the company´s share price too low, but when realizing they drove the price too low, they begin buying the stock back – normally within a couple of days. Thus, they argue that overreaction to news (e.g. earnings *surprises*) tends to occur in the short term. On the other hand, Mahani and Poteshman (2008) found that while the stock market does indeed overreact to bad news, it applies to positive news as well, so that in general, the market *overreacts to news*. They also found that in the days leading up to a pre-scheduled release of important information about a firm's prospect, investors increase their share of growth stocks relative to value stocks, and also mistakenly believe that mispriced stocks will deviate further from their intrinsic values at future schedules news releases – thus stating that the prices does *not* mean-revert within a couple of days.

Regarding the underreaction effect, and despite the fact that we found no evidence of it on the Norwegian Stock Exchange, Jagadeesh and Titman (1993) would be the most natural to look at: they found that winning stocks who had outperformed over the last 3-12 months continued to outperform over the next 12-month period, while losers continued to underperform. However, their argument leads to the inclination that investors *underreact* to news. Trying to summarize some earlier work and qualifying the statements, Daniel and Titman (1999) suggested that analysts overweight their own priors when valuing firms, and then underweight new information as it arrives.

Based on our findings in addition to the abovementioned arguments, we concur with the hypothesis posited by DL (2000), in the sense that overreaction most likely occurs *before* portfolio formation, and specifically that the market overreacts to *future* news announcements. *After* portfolio formation, the correction can take several years, implying underreaction. Put simply, investors underreact to new information that contradicts their prior beliefs about a given company, thus allowing the mean-reversion effect to be found both over six months and twenty-four months for our Norwegian sample – as well as up to five years in the DBT (1985) study. The fact that prices have reverted "only" by 18 % after six months compared to 31,18 % after twenty-four months is a clear indication of underreaction post-formation. Finally, we contemplate overreaction to be a rather common trait in the marketplace, given that its occurrence has been well-documented by many researchers, and what seems to matter the most is not whether it is a bull- or a bear-market, but rather how long it takes before the prices revert.

Concluding this section, we believe the following figure and process gives a highly plausible illustration of the two phenomena with regards to *when* they occur:

6 Why does it occur?

This final section will try to address why investors might overreact or underreact in the market, but also more generally: provide suggestions as to what *drives* investors to overreact (underreact). Rephrased, what are the *drivers* of irrational investor behavior?

Gary Antonacci (2015) is one of the few that has actually tried to answer this, and he conjectured that investors overreact due to herding effect, representativeness and overconfidence. Additionally, he stated that underreaction likely comes from anchoring, conservatism and the slow diffusion of information. Thus, starting of this analysis we will dive into these behavioral concepts and try to provide the psychological reasoning behind them.

6.1 Overreaction - Behavioral Biases

Regarding the Herding Effect, Chen, Rui and Xu (2003) found that if domestic investors are more knowledgeable or informed about individual stocks than foreign investors, the latter group is more inclined to herd. Thus, they claim that investors tend to herd when information is scarce or not easily available. Considering that the herding effect is defined as the tendency to mimic other´s actions, it is quite intuitive that this effect is stronger when information is poor. However, if the Herding Effect were to be the reason behind investor overreaction, the Overreaction Hypothesis should not be evident in well-informed markets with low information asymmetry – albeit it could explain overreaction in times of turmoil and uncertainty (e.g. the financial crisis).

When it comes to overconfidence, Tekce and Yilmaz (2015) found that male, young investors, investors with a lower portfolio value, and investors in low income and low education regions typically exhibit more overconfident behavior (Tekce and Yilmaz 2015: 35). Thus, they conjecture that investor overconfidence may depend on individual characteristics. Vissing-Jørgensen (2004) studied this phenomenon using the Index of Investor Optimism by USB/Gallup from 1998-2002 and found that irrational investor behavior decreased with investor wealth and sophistication. Hence, if overreaction were to be explained solely by

overconfidence, the Overreaction Hypothesis should probably not be evident in sophisticated, well-developed markets.

The third and last anomaly provided by Antonacci as an explanation to overreaction is representativeness. First defined by Kahneman and Tversky (1974), the representativeness heuristic is a psychological bias, which means that: "*Under uncertainty, investors are prone to believe that a history of a remarkable performance of a given firm is "representative" of a general performance that the firm will continue to generate into the future"* (Boussaidi, 2013: 9). Trying to study this heuristic´s relationship to the overreaction on the Tunisian Stock Market, Boussaidi (2013) found evidence that partially confirms the representativeness heuristic as a potential explanation to the overreaction phenomenon.

Hence, and although a lot of research is yet to be conducted, we believe that the representativeness bias could possibly explain why investors tend to overreact. Both the Herding Effect and the Overconfidence Bias does not seem to explain why overreaction was found on our sample of Norwegian firms, considering that the OSE represents a well-informed and developed stock market. The Representative Bias, on the other hand, is not constrained to the level of sophistication and information in the market for overreaction to occur. Finally, financial theories does not account for the irrationality or lack of sophistication in the actions of investors (and humans, for that matter), and whenever a representative heuristic is readily available, investors might assume that "winners will be winners, and losers will be losers" – a notion that necessarily explains the mean-reversion tendencies depicted after portfolio formation both in our study and those of others.

6.2 Underreaction – Behavioral Biases

Recall that the anchoring bias is the tendency to anchor ones decisions based on quickly attainable information, and in that regard, possibly overlook fundamentals. Thus, for underreaction or the momentum effect to be explained by the anchoring bias, this "quickly attainable information" should necessarily be

good news for the winning stocks, and bad news for the losing stocks. However, if we assume that overreaction has occurred before portfolio formation, thus resulting in winning stocks being overvalued and losing stocks being undervalued, winning stocks should, on average, exhibit more negative news than its price would call for, and vise versa for the losing stocks. If we then assume that investors just "trade on recent news"[7], a momentum effect post-formation is unlikely to occur. Based on this, our conjecture is that the anchoring bias could not explain underreaction, considering that overreaction before portfolio formation seems quite apparent.

First forwarded by Kahneman and Tversky (1974), the Conservatism Bias[8] is *a "mental process in which people cling to their prior views at the expense of acknowledging new information"* (Pompian, 2006: 119). This is in sharp contrast to the anchoring bias, which would imply that investors cling to the *new* information. Pompian continues by stating that the conservatism bias may cause investors to underreact to new information. Hence, if underreaction were to be explained by the Conservatism Bias, new information would not be as important as the already embedded beliefs in those of the investors, and this could explain why a momentum effect were to occur post-formation, again by assuming that overreaction occurs before portfolio formation.

Finally, Antonacci states underreaction could possibly be explained by the slow diffusion of information. By adopting the same line of reasoning as before, if a momentum effect were to occur post-formation, and overreaction is assumed to occur pre-formation, in addition to assuming that the overvalued winning stocks experiences some negative news to help adjust its biased price, it makes sense that investors cling to their prior beliefs, by slowly diffusing the new set of information. Short after portfolio formation, investors probably neglects new information that contradicts their embedded beliefs, to possibly avoid the psychological repercussions of "admitting defeat". Over time, however, as new information continues to contradict investors´ opinions, the Conservatism Bias is

[7] For clarification, this is not the same as "news watchers" in the Hong and Stein (1999) framework, considering that this group of investors are fundamentalists.
[8] In psychology and cognitive science, this is often termed the "Confirmation Bias".

likely to lose its strength. This is also in accordance with our findings of information being gradually implemented.

7 Critique of methodology

In this section, a few drawbacks of our methodology will be highlighted. Firstly, considering the magnitude of the research question and the fact that our main focus is when and why overreaction and underreaction occurs, the explicit testing for overreaction and underreaction in Norway has been simplified to some degree. For instance, a full-worthy robustness test of all risk factors has not been done. However, given the fact that many prior research papers has found evidence of over- and underreaction in other markets and countries, we believe our simplification is justified due to the likely event that a *full* robustness test would be ”passed” on Norwegian data as well.

When determining which tests to use when examining our findings, we based our “test picking” on relevance, the presence of them in later research, and available data. Newer studies do not include the same type of tests as the ones going back decades, where recent studies are more relevant for our time. This is why some tests have been neglected. Nonetheless, we consider the ones included as the most relevant and important when testing our results for robustness.

Additionally, and as pointed out in Conrad and Kaul (1993), using CARs to assess performance has its drawbacks, because even if the CARs are independently and identically distributed, the CARs: *“like any process which follows a random walk, […] can easily give the appearance of ′significant′ positive or negative drift, when none is present* (Brown and Warner, 1980: 229). However, the CAR framework is still superior and the most used in studies due to its simplicity when examining results, and were thus used in our study as well.

Finally we acknowledge that the workload associated with our research question turned out to be more comprehensive than what was first expected. Our review on when and why over- and underreaction occurs might seem somewhat limited, but given the poor amount of information available, we consider our thesis to include the most relevant and critical aspects of the discussion.

8 Conclusion

Our analysis on overreaction and underreaction, both regarding its occurrence in the Norwegian market, in addition to establishing a theory on when and why it occurs, yields the following results: First, our findings seem to be supportive of the Overreaction Hypothesis. We find a robust mean-reversion tendency in stock returns for our sample of non-financial Norwegian firms.

Our results seem to be in lines of what were found by DeBondt and Thaler (1985,1987): where *we* found an $ACAR_A$ of 31,18% over a two-year holding and test period, *they* found an $ACAR_A$ of 24,6 % over a three-year holding and test period and an $ACAR_A$ of 31,9 % with a five-year holding and test period. In general, the abnormal return derived from buying the arbitrage portfolio is statistically significant (both on non-adjusted and risk-adjusted returns). However, the returns derived from either selling a winning portfolio alone or buying a losing portfolio alone (i.e. $ACAR_W$ and $ACAR_L$) does *not* yield statistical significant results for our sample. Our results are robust to the control of both the January Effect and the Size Effect, despite that many critics state that the abnormal returns derived from undertaking a contrarian investment strategy is simply a compensation of added risk (i.e. the Size Effect) and the January Effect.

As for underreaction, we found no evidence of a Momentum Effect being present on our sample of Norwegian firms. When testing a 6-month/6-month holding and test period, we actually found the opposite (i.e. a mean-reversion tendency). Although a 6-month/6-month strategy is the most common strategy for these types of tests, and thus *should* provide an indication of whether or not there are momentum tendencies in the market, we argue that by choosing another strategy we could possibly end up with a different result.

Regarding *when* the two phenomena could occur, we find that overreaction typically occurs before portfolio formation, and that underreaction typically occurs after. We thus concur with Dreman and Lufkin (2000), who stated that overreaction most likely occurs before portfolio formation, and specifically that the market overreacts to *future* news announcements. We find that after portfolio

formation, a correction can take several years, which necessarily implies underreaction post-formation.

When answering *why* overreaction could occur, we find the Representativeness Heuristic to provide a good explanation: investors probably perceive past performance to be representative for the future, ignoring some of the fundamental aspects. Finally, we believe that underreaction is best explained by the Conservatism Bias: "*a mental process in which people cling to their prior views at the expense of acknowledging new information"* (Pompian, 2006: 119).

Hence, our study shows that once an investment portfolio is made, and although how wrong it may be at the time, humans (and investors) probably have an inherent disability to "admit defeat" and correct its inaccurate estimates. Additionally, our study hopefully serves as a prelude by trying to provide answers on when and why these behavioral anomalies might occur in the marketplace – although the controversy and debate among behavioral explanations to asset mispricing is still going strong, and will continue to do so (eligible or not) for a long time to come.

9 Reference list

Abarbanell, Jeffrey S., and Victor L. Bernard. 1992. "Tests of Analyst´s Overreaction / Underreaction to Earnings Information as an Explanation for Anomalous Stock Price Behavior." *Journal of Finance*, 47: 1181-1207.

Antonacci, Gary. 2015. "Why Does Dual Momentum Outperform?" *Dual Momentum*. *http://www.dualmomentum.net/2015/12/why-does-dual-momentum-outperform.html*.

Ball, Ray and S.P. Kothari. 1989. "Nonstationary Expected Returns: Implications for Tests of Market Efficiency and Serial Correlation in Returns." *Journal of Financial Economics,* 25.1: 51-74.

Bauman, Scott, Mitchell Conover and Robert Miller. 1998. "Growth Versus Value and Large-cap Versus Small-cap Stocks in International Markets." *Financial Analysts Journal,* 54.2: 75-89.

Boussaidi, Ramzi. 2013. "Representativeness Heuristic, Investor Sentiment and Overreaction to Accounting Earnings: The Case of the Tunisian Stock Market". *Procedia – Social and Behavioral Sciences*, Vol. 81: 9-21.

Brown, K.C and W.V. Harlow. 1988. "Market Overreaction: Magnitude and Intensity". *Journal of Portfolio Management*, Vol. 14, No. 2: 6-13.

Brown, Stephen J. and Warner, Jerold B. 1980. "Measuring Security Price Performance". *Journal of Financial Economics*, 8: 228-229.

Chan, K.C. 1988. "On the Contrarian Investment Strategy." *Journal of Business*, 61: 147-163.

Chen, Andrew H. 2008. "Research In Finance". *Emerald*.

Chen, G., O. Rui and Y. Xu. 2003. “When Will Investors Herd? Evidence from the Chinese Stock Markets”. *School of Management*. The University of Texas at Dallas.

Chopra, N., J. Lakonishok and J. Ritter. 1992. "Measuring Abnormal Performance: Do Stocks Overreact?" *Journal of Financial Economics*, 31.2: 235-268.

Clements, A., M. Drew, E. Reedman and M. Veeraraghavan. 2009. ”The Death of the Overreaction Anomaly? A Multifactor Explanation of Contrarian Returns.” *Investment Management and Financial Innovations,* 6: 76-85.

Conrad, J and G. Kaul. 1993. “The Returns to Long Term Winners and Losers: Bid-Ask Biases or Biases in Computed Returns”. *Journal of Finance*, 48: 39-63.

Daniel, Kent, David Hirshleifer and Avanidhar Subrahmanyam. 1997. "A Theory of Overconfidence, Self-Attribution, and Security Market Over-and Underreaction." *Unpublished paper, presented at the NBER–Sage workshop on Behavioral Economics*, Cambridge, MA: 1-57.

Daniel, Kent, David Hirshleifer and Avanidhar Subrahmanyam. 1998. “Investor Psychology and Security Market Under- and Overreactions.” *The Journal of Finance*, Vol, LIII, No 6: 1839-1895.

DeBondt, Werner and Richard Thaler. 1985. “Does The Stock Market Overreact?” *The Journal of Finance*, 40.3: 793-805.

Dreman, David and Eric Lufkin. 2000. “Investor Overreaction: Evidence That Its Basis Is Psychological.” *The Journal of Psychology and Financial Markets*, 1.1: 61-75.

Fama, Eugene. 1970. “The Behavior of Stock Market Prices”. *Journal of Business*, 38: 34-105.

Fama, E. and K. French. 1992. “The Cross-Section of Expected Stock Returns”. *The Journal of Finance*, Vol. XLVII, No. 2: 429.

Fama, E. and K French. 1993. “Common Risk Factors in the Returns of Stocks and Bonds.” *Journal of Financial Economics*, 33: 3-56.

Fama, Eugene. 1970. “Efficient Capital Markets: A Review of Theory and Empirical Work”. *The Journal of Finance,* 25 (2). [American Finance Association, Wiley]: 383–417.

Fama, Eugene. 1998. "Market Efficiency, Long-Term Returns, and Behavioral Finance." *Journal of Financial Economics*, 49.3: 283-306.

Howe, J. 1986. “Evidence on Stock Market Overreaction.” *Financial analysts Journal*, July-August: 27-31.

Ikenberry, David and Sundaresh Ramnath. 2000. “Underreaction”. *Jones Graduate School of Management*. Rice University.

Jagadeesh, N and S. Titman. 1993. “Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency.” *The Journal of Finance*, Vol. 48, No. 1: 65-91.

Javid, Attiya and Aman Asia. On-going. “Global Financial Crisis and Market Reactions: Evidence from the Karachi Stock Exchange, Pakistan. *Working Paper*

Kahneman, Daniel and Amos, Tversky. 1979. ”Prospect Theory: An Analysis Of Decision under Risk.” *Econometrica*, 47(2): 263-291.

Kendall, Maurice. 1953. “The Analysis of Economic Time Series”. *Journal of the Royal Statistical Society*, Series A, 96: 953-1001.

Ketcher, David N. and Bradford D. Jordan. 1994. "Short-Term Price Reversals Following Major Price Innovations: Additional Evidence on Market Overreaction". *Journal of Economics and Business*, 46: 307-323.

Lakonishok, Josef, Andrei Shleifer and Robert Vishny. 1994. "Contrarian Investment, Extrapolation and Risk". *Journal of Finance,* 49: 1541–1578.

Loughran, Tim and Jay Ritter. 1998. "Uniformly Least Powerful Tests of Market Efficiency." *Working Paper*. University of Florida.

Mahani, R and A. Poteshman. 2008. "Overreaction to stock market news and misevaluation of stock prices by unsophisticated investors: Evidence from the option market." *Journal of Empirical Finance*, Vol. 15, No: 4: 635-655.

Michaely, Roni, Richard, Thaler and Kent, Womack. 1995. "Price Reactions to Dividend Initiations and Omissions: Overreaction or Drift?" *The Journal of Finance,* Vol. L, No. 2: 606.

Pompian, Michael. 2006. "Behavioral Finance and Wealth Management: How to Build Optimal Portfolios That Account for Investor Biases". *John Wiley & Sons, Inc*.

Tekce, B and N. Yilmaz. 2015. "Are Individual Stock Investors Overconfident? Evidence from an Emerging Market". *Journal of Behavioral and Experimental Finance*, Vol. 5, March 2015: 35-45.

Thaler, Richard. 2015. "Misbehaving". *Allen Lane*.

Tversky, Amos and Daniel, Kahneman 1974. "Judgement under Uncertainty: Heuristics and Biases". *Science*, New Series, Vol. 185, No. 4157: 1124-1131.

Vissing-Jørgensen, Annette. 2004. "Perspectives on Behavioral Finance: Does "Irrationality" Disappear with Wealth? Evidence from Expectations and Actions". *The National Bureau of Economic Research*, Vol. 18: 139-208.

Zarowin, P. 1990. "Size, Seasonality, and Stock Market Overreaction". *Journal of Financial and Quantitative Analysis*, 25: 113-125.

10 Appendixes

10.1 Table 1A — Overreaction – Arbitrage Portfolio

(*T-statistics are reported in parentheses. * denotes statistical significance at the 5 % level)*

Portfolios	WINNER	LOSER	ARBITRAGE
Obs 1 (1999-2000)	26 731,81	-52 945,36	
Test 1 (2001-2002)	19 454,15	-41 744,03	
Change 1	**-27,22%**	**21,16%**	**48,38%**
Obs 2 (2001-2002)	27 334,18	-68 244,61	
Test 2 (2003-2004)	15 481,86	-57 502,87	
Change 2	**-43,36%**	**15,74%**	**59,10%**
Obs 3 (2003-2004)	30 526,67	-87 410,40	
Test 3 (2005-2006)	26 006,51	-67 902,53	
Change 3	**-14,81%**	**22,32%**	**37,12%**
Obs 4 (2005-2006)	52 955,62	-89 106,27	
Test 4 (2007-2008)	54 417,20	-92 527,87	
Change 4	**2,76%**	**-3,84%**	**-6,60%**
Obs 5 (2007-2008)	76 707,26	-113 958,48	
Test 5 (2009-2010)	39 841,74	-127 880,06	
Change 5	**-48,06%**	**-12,22%**	**35,84%**
Obs 6 (2009-2010)	73 415,70	-174 061,11	
Test 6 (2011-2012)	55 323,40	-164 032,76	
Change 6	**-24,64%**	**5,76%**	**30,41%**
Obs 7 (2011-2012)	79 012,06	-215 697,16	
Test 7 (2013-2014)	73 190,76	-201 345,66	
Change 7	**-7,37%**	**6,65%**	**14,02%**
Average (ACAR)	*-23,24%* *(-0,26)*	*7,94%* *(0,04)*	*31,18%* *(3,67) **

10.2 Table 2 – January Effect – CARs

(*T-statistics are reported in parentheses. * denotes statistical significance at the 5 % level)*

Cumulative Returns for Observation- and Test Periods (1999-2014) without January					
Portfolio	WINNER	2	3	4	LOSER
Obs 1 (1999-2000)	25 768,78	5 487,33	-3 405,62	-4 570,21	-48 687,9
Test 1 (2001-2002)	15 628,29	-2 945,20	-6 098,60	-12 066,90	-38 215,61
Change 1	**-39,35%**	**-153,67%**	**-79,07%**	**-164,03%**	**21,51%**
Obs 2 (2001-2002)	25 173,39	7 776,57	214,23	-16 965,24	-63 703,36
Test 2 (2003-2004)	14 124,02	3 045,42	1 612,09	-21 001,79	-51 990,63
Change 2	**-43,89%**	**-60,84%**	**652,51%**	**-23,79%**	**18,39%**
Obs 3 (2003-2004)	28 151,14	9 874,88	1 375,15	-16 244,33	-80 502,75
Test 3 (2005-2006)	23 711,85	13 577,16	8 148,52	-7 172,19	-61 556,06
Change 3	**-15,77%**	**37,49%**	**492,55%**	**55,85%**	**23,54%**
Obs 4 (2005-2006)	49 659,51	21 060,05	7 867,88	-7 780,35	-82 174,51
Test 4 (2007-2008)	49 674,33	25 721,72	15 818,83	-12 757,33	-85 124,21
Change 4	**0,03%**	**22,14%**	**101,06%**	**-63,97%**	**-3,59%**
Obs 5 (2007-2008)	70 673,34	25 863,05	7 615,03	-13 190,50	-105 543,73
Test 5 (2009-2010)	36 545,02	15 413,80	5 771,62	-29 045,87	-119 822,69
Change 5	**-48,29%**	**-40,40%**	**-24,21%**	**-120,20%**	**-13,53%**
Obs 6 (2009-2010)	67 466,96	21 783,76	1 800,99	-30 630,22	-161 636,67
Test 6 (2011-2012)	50 773,94	11 982,60	-3 790,05	-36 996,80	-149 212,65
Change 6	**-24,74%**	**-44,99%**	**-310,44%**	**-20,79%**	**7,69%**
Obs 7 (2011-2012)	72 796,26	17 445,83	-553,28	-29 830,30	-198 432,28
Test 7 (2013-2014)	67 324,73	15 148,23	38,08	-34 420,85	-182 192,82
Change 7	**-7,52%**	**-13,17%**	**106,88%**	**-15,39%**	**8,18%**
Average (ACAR)	*-25,65%* *(-0,30)*	*-36,21%* *(-0,67)*	*134,18%* *(3,13)*	*-50,33%* *(-0,93)*	*8,88%* *(0,05)*

10.3 Table 2A – January Effect – Arbitrage Portfolio

(*T-statistics are reported in parentheses. * denotes statistical significance at the 5 % level)*

Portfolio	WINNER	LOSER	ARBITRAGE
Obs 1 (1999-2000)	25 768,78	-48 687,9	
Test 1 (2001-2002)	15 628,29	-38 215,61	
Change 1	**-39,35%**	**21,51%**	**60,86%**
Obs 2 (2001-2002)	25 173,39	-63 703,36	
Test 2 (2003-2004)	14 124,02	-51 990,63	
Change 2	**-43,89%**	**18,39%**	**62,28%**
Obs 3 (2003-2004)	28 151,14	-80 502,75	
Test 3 (2005-2006)	23 711,85	-61 556,06	
Change 3	**-15,77%**	**23,54%**	**39.30%**
Obs 4 (2005-2006)	49 659,51	-82 174,51	
Test 4 (2007-2008)	49 674,33	-85 124,21	
Change 4	**0,03%**	**-3,59%**	**-3,62%**
Obs 5 (2007-2008)	70 673,34	-105 543,73	
Test 5 (2009-2010)	36 545,02	-119 822,69	
Change 5	**-48,29%**	**-13,53%**	**34,76%**
Obs 6 (2009-2010)	67 466,96	-161 636,67	
Test 6 (2011-2012)	50 773,94	-149 212,65	
Change 6	**-24,74%**	**7,69%**	**32,43%**
Obs 7 (2011-2012)	72 796,26	-198 432,28	
Test 7 (2013-2014)	67 324,73	-182 192,82	
Change 7	**-7,52%**	**8,18%**	**15,70%**
Average (ACAR)	*-25,65%* *(-0,30)*	*8,88%* *(0,05)*	*34,53%* *(3,93) **

10.4 Table 3 – Size Effect – Winner High, Low Versus Loser High, Low

(*T-statistics are reported in parentheses. * denotes statistical significance at the 5 % level)*

Cumulative Returns for Observation- and Test Periods (1999-2014) splitting Q1 and Q5 into High and Low based on Market Capital			
Portfolio	WINNER	LOSER	ARBITRAGE
Obs 1 High	13 529,38	-30 735,38	
Test 1 High	10 590,60	-22 592,22	
Change	**-21,72%**	**26,49%**	**48,22%**
Obs 1 Low	11 307,93	-21 634,37	
Test 1 Low	2 250,68	-3 673,19	
Change	**-80,10%**	**83,02%**	**163,12%**
Obs 2 High	10 741,25	-25 771,44	
Test 2 High	4 067,61	-9 022,13	
Change	**-62,13%**	**64,99%**	**127,12%**
Obs 2 Low	10 162,05	-27 794,51	
Test 2 Low	-1 636,64	-22 853,95	
Change	**-116,11%**	**17,78%**	**133,88%**
Obs 3 High	9 759,65	-34 835,70	
Test 3 High	5 405,89	602,60	
Change	**-44,61%**	**101,73%**	**146,34%**
Obs 3 Low	7 860,92	-26 240,40	
Test 3 Low	3 283,59	-8 531,63	
Change	**-58,23%**	**67,49%**	**125,72%**
Obs 4 High	15 030,59	-12 042,75	
Test 4 High	13 252,26	-5 553,69	
Change	**-11,83%**	**53,88%**	**65,71%**
Obs 4 Low	22 415,24	-14 498,85	
Test 4 Low	22 972,28	-16 709,28	
Change	**2,49%**	**-15,25%**	**-17,73%**
Obs 5 High	25 862,24	-14 157,28	

Test 5 High	10 328,97	-4 962,10	
Change	**-60,06%**	**64,95%**	**125,01%**
Obs 5 Low	31 629,11	-29 167,13	
Test 5 Low	3 693,13	-44 949,44	
Change	**-88,32%**	**-54,11%**	**34,21%**
Obs 6 High	19 452,22	-39 805,86	
Test 6 High	7 674,32	-38 792,57	
Change	**-60,55%**	**2,55%**	**63,09%**
Obs 6 Low	20 753,16	-61 015,72	
Test 6 Low	5 381,55	-28 204,49	
Change	**-74,07%**	**53,78%**	**127,84%**
Obs 7 High	9 731,74	-68 170,98	
Test 7 High	7 691,69	-37 607,55	
Change	**-20,96%**	**44,83%**	**65,80%**
Obs 7 Low	10 765,58	-40 886,15	
Test 7 Low	5 376,26	-51 179,12	
Change	**-50,06%**	**-25,17%**	**24,89%**
Average (ACAR) Low	*-66,34%* *(-0,43)*	*18,22%* *(0,05)*	*84,56%* *(3,51) **
Average (ACAR) High	*-40,27%* *(-0,95)*	*51,35%* *(0,14)*	*91,61%* *(6,34) **
Average (ACAR) Total	*-53,30%* *(-0,55)*	*34,78%* *(0,11)*	*88,09%* *(5,99) **

10.5 Table 4 – Underreaction – CARs

(*T-statistics are reported in parentheses. * denotes statistical significance at the 5 % level)*

Portfolio	WINNER	2	3	4	LOSER	Periods
Cum. Obs 1	2 996,43	1 342,95	666,78	-270,65	-6 989,08	1999 (1)
Cum. Test 1	4 112,78	2 062,16	519,60	-462,44	-9 253,19	1999 (2)
Change	**37 %**	**54 %**	**-22 %**	**-71 %**	**-32 %**	
Cum. Obs 2	4 719,02	1 836,00	675,72	-819,76	-9 442,93	1999 (2)
Cum. Test 2	3 808,36	1 398,26	594,01	-1 501,68	-7 325,01	2000 (1)
Change	**-19 %**	**-24 %**	**-12 %**	**-83 %**	**22 %**	
Cum. Obs 3	5 900,47	2 152,71	847,26	-1 047,77	-10 171,13	2000 (1)
Cum. Test 3	5 940,57	1 648,71	758,18	-1 880,11	-10 805,63	2000 (2)
Change	**1 %**	**-23 %**	**-11 %**	**-79 %**	**-6 %**	
Cum. Obs 4	6 235,70	2 451,92	659,18	-1 762,29	-12 349,84	2000 (2)
Cum. Test 4	5 934,02	2 738,05	765,77	-4 086,95	-14 645,90	2001 (1)
Change	**-5 %**	**12 %**	**16 %**	**-132 %**	**-19 %**	
Cum. Obs 5	7 908,79	2 559,15	581,21	-3 036,14	-17 825,24	2001 (1)
Cum. Test 5	6 676,79	1 390,11	131,54	-4 776,07	-16 476,47	2001 (2)
Change	**-16 %**	**-46 %**	**-77 %**	**-57 %**	**8 %**	
Cum. Obs 6	7 766,68	2 389,85	95,16	-4 140,09	-19 580,86	2001 (2)
Cum. Test 6	6 079,29	1 892,29	-416,10	-7 668,43	-16 733,04	2002 (1)
Change	**-22 %**	**-21 %**	**-537 %**	**-85 %**	**15 %**	
Cum. Obs 7	7 082,95	2 345,00	-167,97	-5 421,91	-21 399,98	2002 (1)
Cum. Test 7	6 256,91	2 132,31	-1 637,02	-5 990,55	-18 925,79	2002 (2)
Change	**-12 %**	**-9 %**	**-875 %**	**-10 %**	**12 %**	
Cum. Obs 8	6 829,01	2 128,67	-273,53	-5 646,29	-21 416,36	2002 (2)
Cum. Test 8	6 788,66	1 964,02	-626,59	-6 901,66	-20 608,81	2003 (1)
Change	**-1 %**	**-8 %**	**-129 %**	**-22 %**	**4 %**	
Cum. Obs 9	7 272,96	2 610,18	-155,10	-6 488,59	-22 644,54	2003 (1)
Cum. Test 9	7 209,76	2 469,52	-141,86	-5 803,09	-22 244,10	2003 (2)
Change	**-1 %**	**-5 %**	**9 %**	**11 %**	**2 %**	
Cum. Obs 10	7 816,05	2 513,28	12,63	-5 965,02	-22 884,12	2003 (2)
Cum. Test 10	8 330,31	2 712,08	646,07	-3 602,58	-21 977,64	2004 (1)
Change	**7 %**	**8 %**	**5 014 %**	**40 %**	**4 %**	

Cum. Obs 11	9 459,54	3 209,09	1 023,69	-4 084,79	-23 393,61	2004 (1)
Cum. Test 11	8 143,76	3 828,60	1 782,96	-3 654,68	-22 474,46	2004 (2)
Change	**-14 %**	**19 %**	**74 %**	**11 %**	**4 %**	
Cum. Obs 12	8 947,82	3 792,16	1 279,53	-3 842,04	-22 533,93	2004 (2)
Cum. Test 12	7 135,26	3 742,85	1 849,39	-3 862,29	-17 725,26	2005 (1)
Change	**-20 %**	**-1 %**	**45 %**	**-1 %**	**21 %**	
Cum. Obs 13	13 136,05	4 689,19	1 854,58	-2 743,10	-23 460,07	2005 (1)
Cum. Test 13	13 124,85	5 522,83	2 571,41	-2 145,95	-23 259,98	2005 (2)
Change	**0 %**	**18 %**	**39 %**	**22 %**	**1 %**	
Cum. Obs 14	14 123,41	5 644,57	2 376,70	-2 451,97	-23 928,71	2005 (2)
Cum. Test 14	12 344,18	6 874,45	2 474,46	-1 472,29	-22 037,32	2006 (1)
Change	**-13 %**	**22 %**	**4 %**	**40 %**	**8 %**	
Cum. Obs 15	14 916,87	6 726,52	2 693,12	-2 664,84	-24 319,33	2006 (1)
Cum. Test 15	15 876,16	7 241,31	3 413,50	-3 815,41	-24 201,74	2006 (2)
Change	**6 %**	**8 %**	**27 %**	**-43 %**	**0 %**	
Cum. Obs 16	17 530,28	7 167,16	2 817,87	-3 247,39	-25 601,26	2006 (2)
Cum. Test 16	17 736,60	7 188,61	3 760,89	-3 770,27	-24 765,72	2007 (1)
Change	**1 %**	**0 %**	**33 %**	**-16 %**	**3 %**	
Cum. Obs 17	19 566,17	7 705,87	2 730,54	-3 463,62	-26 930,84	2007 (1)
Cum. Test 17	18 045,98	7 302,07	3 248,75	-3 667,37	-25 741,25	2007 (2)
Change	**-8 %**	**-5 %**	**19 %**	**-6 %**	**4 %**	
Cum. Obs 18	19 010,35	7 642,40	2 847,44	-3 768,96	-26 747,84	2007 (2)
Cum. Test 18	17 958,53	6 101,20	2 331,44	-4 671,12	-31 638,04	2008 (1)
Change	**-6 %**	**-20 %**	**-18 %**	**-24 %**	**-18 %**	
Cum. Obs 19	19 911,50	7 034,02	1 691,16	-4 760,25	-33 836,97	2008 (1)
Cum. Test 19	19 609,87	5 882,25	910,57	-5 202,96	-34 267,92	2008 (2)
Change	**-2 %**	**-16 %**	**-46 %**	**-9 %**	**-1 %**	
Cum. Obs 20	21 182,39	6 795,68	1 117,77	-6 637,92	-35 857,55	2008 (2)
Cum. Test 20	17 202,41	4 786,79	1 719,84	-11 436,69	-41 924,22	2009 (1)
Change	**-19 %**	**-30 %**	**54 %**	**-72 %**	**-17 %**	
Cum. Obs 21	20 670,87	6 435,08	537,20	-9 663,02	-48 052,08	2009 (1)
Cum. Test 21	17 983,07	6 655,90	-197,78	-8 489,63	-46 227,64	2009 (2)
Change	**-13 %**	**3 %**	**-137 %**	**12 %**	**4 %**	
Cum. Obs 22	19 534,57	6 152,19	334,59	-9 546,27	-46 718,29	2009 (2)
Cum. Test 22	17 264,49	5 740,02	716,18	-7 693,15	-42 871,71	2010 (1)
Change	**-12 %**	**-7 %**	**114 %**	**19 %**	**8 %**	

Cum. Obs 23	20 821,75	6 490,96	744,97	-7 606,70	-47 524,39	2010 (1)
Cum. Test 23	18 044,74	5 004,49	517,97	-8 242,16	-46 777,91	2010 (2)
Change	**-13 %**	**-23 %**	**-30 %**	**-8 %**	**2 %**	
Cum. Obs 24	19 231,30	5 610,83	127,62	-8 727,41	-47 893,62	2010 (2)
Cum. Test 24	19 354,31	5 186,19	-404,18	-10 132,07	-45 768,41	2011 (1)
Change	**1 %**	**-8 %**	**-417 %**	**-16 %**	**4 %**	
Cum. Obs 25	21 809,84	4 802,69	-50,92	-8 578,53	-51 243,43	2011 (1)
Cum. Test 25	20 646,76	5 192,72	40,85	-8 161,65	-57 112,98	2011 (2)
Change	**-5 %**	**8 %**	**180 %**	**5 %**	**-11 %**	
Cum. Obs 26	21 542,46	5 409,35	296,80	-8 130,69	-58 480,40	2011 (2)
Cum. Test 26	16 666,01	6 437,42	-526,34	-8 837,11	-56 041,03	2012 (1)
Change	**-23 %**	**19 %**	**-277 %**	**-9 %**	**4 %**	
Cum. Obs 27	20 258,49	4 770,11	-232,41	-8 768,29	-58 413,01	2012 (1)
Cum. Test 27	19 790,63	4 909,04	-792,07	-8 711,17	-60 341,77	2012 (2)
Change	**-2 %**	**3 %**	**-241 %**	**1 %**	**-3 %**	
Cum. Obs 28	20 811,75	5 023,17	201,06	-8 412,76	-62 777,04	2012 (2)
Cum. Test 28	18 336,18	5 501,61	374,54	-8 857,47	-62 089,01	2013 (1)
Change	**-12 %**	**10 %**	**86 %**	**-5 %**	**1 %**	
Cum. Obs 29	19 726,20	5 587,52	339,08	-9 202,28	-63 192,24	2013 (1)
Cum. Test 29	19 673,16	6 374,55	874,28	-7 837,40	-53 596,21	2013 (2)
Change	**0 %**	**14 %**	**158 %**	**15 %**	**15 %**	
Cum. Obs 30	21 463,06	6 090,27	920,54	-8 464,89	-54 417,95	2013 (2)
Cum. Test 30	22 113,58	6 148,08	1 079,38	-8 133,16	-52 439,51	2014 (1)
Change	**3 %**	**1 %**	**17 %**	**4 %**	**4 %**	
Cum. Obs 31	24 607,98	6 108,85	845,11	-7 854,72	-55 207,61	2014 (1)
Cum. Test 31	21 983,31	6 113,87	110,59	-7 720,48	-51 469,36	2014 (2)
Change	**-11 %**	**0 %**	**-87 %**	**2 %**	**7 %**	

10.6 Table 4A – Underreaction – Arbitrage Portfolio

*(T-statistics are reported in parentheses. * denotes statistical significance at the 5 % level)*

Portfolio	WINNER	LOSER	ARBITRAGE	Periods
Cum. Obs 1	2 996,43	-6 989,08		1999 (1)
Cum. Test 1	4 112,78	-9 253,19		1999 (2)
Change	**37 %**	**-32 %**	**69%**	
Cum. Obs 2	4 719,02	-9 442,93		1999 (2)
Cum. Test 2	3 808,36	-7 325,01		2000 (1)
Change	**-19 %**	**22 %**	**-41%**	
Cum. Obs 3	5 900,47	-10 171,13		2000 (1)
Cum. Test 3	5 940,57	-10 805,63		2000 (2)
Change	**1 %**	**-6 %**	**7%**	
Cum. Obs 4	6 235,70	-12 349,84		2000 (2)
Cum. Test 4	5 934,02	-14 645,90		2001 (1)
Change	**-5 %**	**-19 %**	**14%**	
Cum. Obs 5	7 908,79	-17 825,24		2001 (1)
Cum. Test 5	6 676,79	-16 476,47		2001 (2)
Change	**-16 %**	**8 %**	**-24%**	
Cum. Obs 6	7 766,68	-19 580,86		2001 (2)
Cum. Test 6	6 079,29	-16 733,04		2002 (1)
Change	**-22 %**	**15 %**	**-37%**	
Cum. Obs 7	7 082,95	-21 399,98		2002 (1)
Cum. Test 7	6 256,91	-18 925,79		2002 (2)
Change	**-12 %**	**12 %**	**-24%**	
Cum. Obs 8	6 829,01	-21 416,36		2002 (2)
Cum. Test 8	6 788,66	-20 608,81		2003 (1)
Change	**-1 %**	**4 %**	**-5%**	
Cum. Obs 9	7 272,96	-22 644,54		2003 (1)
Cum. Test 9	7 209,76	-22 244,10		2003 (2)
Change	**-1 %**	**2 %**	**-3%**	
Cum. Obs 10	7 816,05	-22 884,12		2003 (2)
Cum. Test 10	8 330,31	-21 977,64		2004 (1)
Change	**7 %**	**4 %**	**3%**	

Cum. Obs 11	9 459,54	-23 393,61		2004 (1)
Cum. Test 11	8 143,76	-22 474,46		2004 (2)
Change	**-14 %**	**4 %**	**-18%**	
Cum. Obs 12	8 947,82	-22 533,93		2004 (2)
Cum. Test 12	7 135,26	-17 725,26		2005 (1)
Change	**-20 %**	**21 %**	**-41%**	
Cum. Obs 13	13 136,05	-23 460,07		2005 (1)
Cum. Test 13	13 124,85	-23 259,98		2005 (2)
Change	**0 %**	**1 %**	**-1%**	
Cum. Obs 14	14 123,41	-23 928,71		2005 (2)
Cum. Test 14	12 344,18	-22 037,32		2006 (1)
Change	**-13 %**	**8 %**	**-21%**	
Cum. Obs 15	14 916,87	-24 319,33		2006 (1)
Cum. Test 15	15 876,16	-24 201,74		2006 (2)
Change	**6 %**	**0 %**	**6%**	
Cum. Obs 16	17 530,28	-25 601,26		2006 (2)
Cum. Test 16	17 736,60	-24 765,72		2007 (1)
Change	**1 %**	**3 %**	**-2%**	
Cum. Obs 17	19 566,17	-26 930,84		2007 (1)
Cum. Test 17	18 045,98	-25 741,25		2007 (2)
Change	**-8 %**	**4 %**	**-12%**	
Cum. Obs 18	19 010,35	-26 747,84		2007 (2)
Cum. Test 18	17 958,53	-31 638,04		2008 (1)
Change	**-6 %**	**-18 %**	**12%**	
Cum. Obs 19	19 911,50	-33 836,97		2008 (1)
Cum. Test 19	19 609,87	-34 267,92		2008 (2)
Change	**-2 %**	**-1 %**	**-1%**	
Cum. Obs 20	21 182,39	-35 857,55		2008 (2)
Cum. Test 20	17 202,41	-41 924,22		2009 (1)
Change	**-19 %**	**-17 %**	**-2%**	
Cum. Obs 21	20 670,87	-48 052,08		2009 (1)
Cum. Test 21	17 983,07	-46 227,64		2009 (2)
Change	**-13 %**	**4 %**	**-17%**	

Cum. Obs 22	19 534,57	-46 718,29		2009 (2)
Cum. Test 22	17 264,49	-42 871,71		2010 (1)
Change	**-12 %**	**8 %**	**-20%**	
Cum. Obs 23	20 821,75	-47 524,39		2010 (1)
Cum. Test 23	18 044,74	-46 777,91		2010 (2)
Change	**-13 %**	**2 %**	**-15%**	
Cum. Obs 24	19 231,30	-47 893,62		2010 (2)
Cum. Test 24	19 354,31	-45 768,41		2011 (1)
Change	**1 %**	**4 %**	**-3%**	
Cum. Obs 25	21 809,84	-51 243,43		2011 (1)
Cum. Test 25	20 646,76	-57 112,98		2011 (2)
Change	**-5 %**	**-11 %**	**6%**	
Cum. Obs 26	21 542,46	-58 480,40		2011 (2)
Cum. Test 26	16 666,01	-56 041,03		2012 (1)
Change	**-23 %**	**4 %**	**-27%**	
Cum. Obs 27	20 258,49	-58 413,01		2012 (1)
Cum. Test 27	19 790,63	-60 341,77		2012 (2)
Change	**-2 %**	**-3 %**	**1%**	
Cum. Obs 28	20 811,75	-62 777,04		2012 (2)
Cum. Test 28	18 336,18	-62 089,01		2013 (1)
Change	**-12 %**	**1 %**	**-13%**	
Cum. Obs 29	19 726,20	-63 192,24		2013 (1)
Cum. Test 29	19 673,16	-53 596,21		2013 (2)
Change	**0 %**	**15 %**	**-15%**	
Cum. Obs 30	21 463,06	-54 417,95		2013 (2)
Cum. Test 30	22 113,58	-52 439,51		2014 (1)
Change	**3 %**	**4 %**	**-1%**	
Cum. Obs 31	24 607,98	-55 207,61		2014 (1)
Cum. Test 31	21 983,31	-51 469,36		2014 (2)
Change	**-11 %**	**7 %**	**-18%**	
Average (ACAR)	*-6,14 %*	*1,56 %*	*-7,69 %* *(-1,24)*	