TITLE: 'The Overreaction Hypothesis':
Does it apply to the Norwegian stock market?

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Abstract

This paper tests the overreaction hypothesis in the Norwegian equities market, using monthly stock data over the period 1986 – 2003. Unlike most other studies, no performance reversal is found in loser or winner portfolios, and the returns to the arbitrage portfolio are negative. The results further show that differences in risk as measured by CAPM betas using the Chan (1988) method cannot explain any overreaction effects when three year rank and test periods are employed. However, some return reversal occurs when rank and test periods are expanded to five years and risk is adjusted for. The construction of size portfolios illustrate small firms make up most of the loser portfolio and large firms comprise most of the winner portfolio as suggested by Zarowin (1990). Possible explanations for the continuation behaviour may be differences between national markets or different time periods considered.

Table of Contents

Introduction

1.1 Background

The idea that investors may overreact dates back to Keynes (1936, p. 153-154), who observed that: "day-to-day fluctuations in the profits of existing investments, which are obviously of an ephemeral and nonsignificant character, tend to have an altogether excessive, and even absurd, influence on the market". The notion has been revitalized through DeBondt and Thaler (1985 and 1987). Their papers are based on findings in behavioural psychology that suggest people overreact to striking news events. In contrast to Bayes rule[1] investors assign too much weight to current information instead of past data.

The overreaction hypothesis (ORH) implies the overshooting of prices at regular intervals can be predicted and traded upon. Profits can then be made by following the contrarian strategy, which involve buying stocks that have been earning exceptionally poor returns (losers) and selling stocks that have been earning exceptionally high returns (winners). ORH further implies a break with the efficient market hypothesis (EMH) since the market can not be said to be efficient when securities are not valued at their fundamental values.

[1] The main implication of Bayes rule is that decision makers (investors) update their existing beliefs in light of new evidence.

1.2 Summary of empirical research

The overreaction hypothesis (ORH) is, as mentioned, first studied by DeBondt and Thaler (DBT) (1985)[2]. It is found the portfolio of stocks that performed worst (losers) over a three year period (rank period), performs best over the succeeding three year period (test period). The same phenomenon is observed for the best performing (winner) portfolio, it performs worst over the following three year period. This suggests profits can be made by selling (shorting) winners and buying losers (the contrarian strategy) because investors overreact. Winners are overvalued and losers are undervalued in the rank periods and this is corrected for in the test periods. This finding was a cause of major debate since it implies a break with the efficient market hypothesis (EMH).

Return reversals represent one of the more throughout researched areas in finance. Three alternative explanations to ORH have been come up with in the literature. The first explanation concerns time varying risks. Chan (1988) is one of the first to criticise DBT. In his study he claims changing systematic risk (beta risk) can explain most of the return reversion (labelled overreaction). Ball and Kothari (1989) find negative serial correlation in risk adjusted market returns, which indicate changing relative risks in studies that examines return reversals. Fama and French (1986) arrive at a similar conclusion.

Second, the observed reversals have been seen as a manifestation of the size effect. Papers examining the size effect include Zarowin (1990) and Clare and Thomas (1995). Zarowin (1990) is the first to propose differential sizes as an explanation for

[2] Stocks listed on New York Stock Exchange (NYSE) were used for the study.

the overreaction. He argues the loser portfolio to a great extent contains small firms and that the opposite is true for the winner portfolio. After controlling for size, no significant overreaction is found in his study. The same conclusions are reached by Clare and Thomas (1995) when examining the UK stock market.

The third explanation holds bid-ask biases and infrequent trading[3] as the explanation of the reversals. This effect is nonetheless difficult to correct for in a small equity market such as the Norwegian market. Most stocks in a market of this size trade infrequently. Stocks are also of low market capitalization and have wider spreads than they would in a bigger and more liquid market. Conrad and Kaul (1993) show returns to the contrarian strategy are typically upwards biased. This is due to bid-ask spreads, infrequent trading and price discreteness reflected in single period returns.

However, DeBondt and Thaler (1987) report additional evidence inconsistent with the two alternative hypothesises of firm size and differences in risk as an explanation of the observed reversals. Also Chopra et. al. (1992) and Albert and Henderson (1995) come up with evidence that overreaction persists above what can be explained by differences in risk and size. Chen and Sauer (1997) find the contrarian strategy to be a poor trading strategy, but still report an overreaction when considering different time periods. Dissanaike (1997) examines only the large firms listed on the London Stock Exchange (LSE) and the results show substantial overreaction effects. Lough ran and Ritter (1996) examine the effect of low priced stocks using a different data and methodology from Conrad and Kabul (1993). Evidence is found in support of the

[3] When returns revert from a low base, the returns can seem deceptively large as opposed to when returns revert from a high base. This has been suggested as an explanation for why research often has found greater reversals for the loser portfolios than for the winner portfolios. Cumulating single period returns over longer time periods biases the returns to the contrarian strategy upwards because of bid-ask spreads and infrequent trading.

ORH, but most of the returns to the contrarian strategy are found to accrue in January[4]. Results consistent with overreaction have also been reported for shorter time periods. Bowman and Iverson (1998) report return reversals when considering weekly stock returns on the New Zealand stock market. Chang et. al. (1995) examine the Japanese stock market and find similar results using monthly returns.

1.3 Significance of research paper

Studies testing for overreaction have been performed in several different markets, but no papers have to my knowledge looked at any of the Scandinavian markets. This paper firstly contributes to the literature by being the first to examine the Norwegian equities market. Further, three different returns are calculated: arithmetic returns (cumulative abnormal returns), rebalancing returns and buy and hold returns. As has been suggested in the literature by Roll (1983), different methods for calculating returns result in different returns. Therefore consideration of different return calculation methods should be of high importance. Buy and hold returns are seen as the most realistic method for calculating investor returns, but are often avoided in empirical work. Dissanaike (1994) criticises the arithmetic method of calculating returns and argues multiplication is more reasonable than addition. The buy and hold method is also held to be less sensitive to transaction costs and infrequent trading. Third, the study not only looks at the winner and the loser portfolio, but in addition forms decile portfolios. In this way the full reversal (or momentum) effects can be illustrated from the loser up to the winner portfolio[5]. Fourth, risk adjusted returns are reported and fifth, regressions are carried out when rank and test periods vary in

[4] The January effect holds that returns to the contrarian strategy mostly accrue in January. The effect is not tested for in this study because overreaction would occur regardless of which month most of the return reversal occurs.
[5] Results for the arbitrage portfolio (loser – winner) is reported as well.

length. It can then be seen when the overreaction effect is most significant. Sixth, the size effect is taken into consideration. This is done by reporting regression results for different size portfolios and by portraying size as a function of performance portfolios, different rank/test periods and different months during the rank/test period.

1.4 Outline of dissertation

The layout of the thesis is organised as follows. Section one introduces the thesis by offering a brief précis of past work. The full literature review makes up the second part. Data and methodology is reported in section three and presents the underlying methodology combined with hypothesises. The results are reported in section four and the fifth section concludes the paper.

Literature Review

2.1 Introduction

The overreaction hypothesis has been studied extensively in the finance literature. DeBondt and Thaler (DBT) (1985) are the first to suggest profits can be made by following a contrarian strategy[6]. Evidence of substantial 'overreaction' is found in their first paper and later confirmed by a second paper released two years later. In their second piece of work, test and rank periods are expanded from three to five years, and the restriction of historical return data for 85 months is eased to 61 months. The discovery of losers experiencing high subsequent returns and vice versa, labelled 'the overreaction hypothesis', has however not been without critics. Chan (1988) proposes changing risk structure explains most of the 'overreaction'. Fama and French (1986) and Zarowin (1990) finds the size effect[7] is the main cause of DBT's findings, and Conrad and Kaul (1993) shows returns to the contrarian strategy are typically upward biased due to bid-ask spreads, infrequent trading and price discreteness reflected in single period returns. It has also been argued the arithmetic method for calculating returns is flawed (Dissanaike, 1994) and that the buy and hold method avoids upward biases in returns (Blume and Staumback, 1983). Roll (1983) is the first to suggest different computational methods can yield substantially different results because of negative autocorrelation. Ball and Kothari (1989) reach the same conclusions.

[6] The contrarian strategy involves buying losers and selling (shortselling) winners.
[7] The size effect refers to large firms earning higher returns and small firms earning lower returns. The loser portfolio is in other words comprised mainly by small market capitalization firms and the winner portfolio by high market capitalization firms.

On the other hand 'the overreaction hypothesis' has received much support. Dissanaike (1997) finds overreaction for large firms in the UK. Albert and Henderson (1995), Chopra, Lakonishok and Ritter (1991) and Chen and Sauer (1997) provide further results in favour of return reversion. The effect of low priced stocks is examined by Loughran and Ritter (1996) and it is concluded low priced stocks have the highest returns, but are not solely responsible for long term reversals. Several tests for 'overreaction' have been performed in different countries. Alonso and Rubio (1990), Brailsford (1992), Kryzanowski and Zhang (1992), Da Costa (1994), Clare and Thomas (1995), Bowman and Iverson (1998) and Chang et al. (1995) are some authors that have carried out this research. All the studies, except Kryzanowski and Zhang's (1992) study carried out on the Canadian market, find a reversal effect. It is also worth noting that the New Zealand study completed by Bowman and Iverson (1998) finds return reversal in weekly returns.

2.2 The First Studies

DeBondt and Thaler (1985) publishes the first influential paper in this area of finance titled "Does the stockmarket overreact?" The work is based on research in experimental psychology that suggests most people tend to "overreact" to unexpected or dramatic news events. Overreaction in the stock market implies a break with the efficient market hypothesis (EMH) and that profit can be made by buying losers and selling winners (the contrarian strategy).

Monthly return data from the New York Stock Exchange (NYSE) for common stocks is examined for the period between January 1926 and December 1982. The data is

collected from the Centre for Research in Security Prices (CRSP) and returns are reported based on market-adjusted excess returns. No risk adjustment is made.

For every stock on the CRSP with a return history of at least 85 months, it is reported that a portfolio of US stocks that performs worst (loser) over an initial 3 year period (rank period) performs best in the following 3 year period (test period). They also find a performance reversal for a portfolio of stocks that performs best (winner) over the rank period. The portfolio performs worst in the next period, but the overreaction is less pronounced for winners than for losers. In other words the overreaction effect is found to be asymmetric. For loser portfolios of 35 stocks the market is outperformed by 19.6% on average, whereas for winner portfolios the market is underperformed by only 5.0%. Another important finding is that most of the excess returns (for loser portfolios) are realized in January, a phenomenon that can not be fully explained. Finally the overreaction is found to occur mostly in the second and third year of the test period.

DeBondt and Thaler (1987) reports additional evidence on the overreaction hypothesis. The same data set is used as for the first paper, but the rank and test periods are expanded from three to five years. The restriction of 85 months of historical return data is relaxed to 61 months.

The results of the tests primarily adds evidence to the overreaction hypothesis, but are also inconsistent with two alternative hypothesises that are based on firm size and differences in risk, as measured by CAPM betas. It is found that the winner-loser effect can not be ascribed to changes in risk. The beta of the arbitrage portfolio

(winner – loser) has a positive beta, but not significantly large to explain the average annual test period return. It is also found that the winner-loser effect is not primarily a size effect.

The differences in the computational methods of means are examined by Roll (1983). It is found that because of the serial correlation within stock data, the different methods for computing means can differ substantially. The buy and hold method is seen as the best method for imitating investment experience, and it produces way smaller returns than the rebalancing and arithmetic methods. The small firm premium represents the compensation in returns for investing in smaller and riskier firms, and it is found to be only half as large as by using the rebalancing and arithmetic methods, when using a buy and hold methodology. The small firm premium is measured as the difference between the mean returns of New York Stock Exchange (NYSE) and American Stock Exchange (AMEX). Results of 7.5% per annum eventuate when using the buy and hold method and 14% using the latter two methods. The buy and hold method is often avoided in empirical work because it is more complicated to use.

Negative serial correlation in stock returns is confirmed by Ball and Kothari (1989). It is shown that not only does it exist in raw market returns, but also in risk adjusted market returns. There are two possible solutions for the serial correlation. The first explanation is changing expected returns and the other systematic market misprising. The results indicate changing relative risks and thereby changing expected returns as the cause for the negative serial correlation.

2.3 Criticisms of the "Overreaction" theory

Some of the early criticisms of the overreaction hypothesis are proposed by Fama and French (1986) and by Chan (1988). While the size effect is seen as the reason for the mean reversal in the first paper, Chan claimed non constant risks are the main cause. The data set used in Chan's sample is the same as applied by DeBondt and Thaler (1985). However, regressions based on the Capital Asset Pricing Model (CAPM) are run both when winner and loser portfolios of 35 stocks are created, as in the seminal work of DBT and when decile portfolios are formed. The results from the two regression outputs are largely consistent with each other.

Chan (1988), using the DBT sample, finds the betas of the winner portfolio decreases from rank to test period in 16 out of 18 cases, where the majority of 'drops' are significant at the 95% level. The average decline in beta is measured to .222. For loser portfolios, the betas increase from the rank period to the test period, and the average increase is .231. The arbitrage beta increases by .453 on average. The abnormal returns found were small and controlling for transaction costs would probably have been insignificant. This is viewed as consistent with changing risks as an explanation of mean reversal.

Previous studies by Blume and Staumback (1983) find that by using the buy and hold method for calculating portfolio returns, upward biases can be avoided. This is due to a 'diversification effect'. This differs from the use of portfolio rebalancing or arithmetic returns, which clearly biases the returns upwards.

Based on buy and hold returns, the size effect (large firms earning greater returns) for a year only turns out to be half of previously estimated, and all of the full year effect is due to the month of January.

Dissanaike (1994) provides another criticism of the original evidence on 'the Overreaction Hypothesis'. He argues the arithmetic method for calculating cumulative portfolio returns is flawed. The first problem with the arithmetic method is that it simply summarizes the single period returns accrued to an investor to get multi period returns. This is an unrealistic strategy and multiplication provides a much more realistic measure. Secondly, the method biases the measurement of rank returns, something that affects the composition of portfolios. Because of these flaws there appears to be little justification for using the arithmetic method of return calculation, except for the fact that it is the simplest method. Thirdly, the buy and hold returns (BHRS) method is also a better method because it is less exposed to transaction costs and problems with infrequent trading.

To compare the cumulative abnormal returns (CARS) method with its multiplicative counter parts the rebalancing returns method (RBRS) and the buy and hold returns method (BHRS), monthly returns are obtained for stock prices on the London Stock Exchange (LSX)[8] as at 1/1/84 and 1/1/85. Three year rank periods are constructed with five year test periods. Rank period returns are calculated based on the arithmetic method.

[8] Returns are obtained from the London Share Price Database (LSPD) for all constituents of the FT500 index. 462 companies met this criterion for 1/1/84 and 450 for 1/1/85.

In the first test period neither of the CARS or the RBRS results shows any signs of overreaction, but the CARS method has far less positive returns (winner – loser) than the RBRS method. The average cumulative abnormal returns (ACARS) after 36 months are 40% versus 84% respectively for the two methods. In the second test period based on portfolios formed on the 1/1/85 the results are contrasting. Both methods produced an overreaction effect, but the CARS method 'underestimated' it considerably. The returns this time are -52.7% for RBRS and -24.4% for the CARS method. When using a multiplicative method for calculating rank period returns, evidence in favour of the overreaction hypothesis is found. For the RBRS method the differential between the winner and loser portfolio is -26.6% and for the BHRS method the number is -30.4%. However, the difference between the two numbers is found to be insignificant.

Zarowin (1990) argues the overreaction effect found in many prior studies is a size effect. In his study, seventeen nonoverlapping three year test periods are constructed beginning in January 1930. The data set contains companies listed on NYSE and starts in January 1927[9]. Zarowin (1989) find that rank period losers significantly outperform winners in subsequent 36 months periods, but losers are also usually much smaller than winners.

In this paper stock market overreaction is tested controlling for size differences. The results point out that size and January effects are responsible for the return reversal observed. Because losers are generally smaller firms than winners they outperform winners in test periods. When comparing losers and winners of equal size, no return

[9] Data are extracted from the CRSP tapes. Formation periods are also three years of length in line with the D&T seminal work.

reversal is observed except for in the month of January. This can be attributed to the tax loss selling effect, but overreaction should not be ruled out since January is the first month of the trading strategy. Further when losers are smaller than winners, losers outperform winners in the subsequent period, but when the opposite is true, winners beat losers.

Conrad and Kaul (1993) shows returns to the contrarian strategy are typically upwards biased. This is due to bid-ask spreads, infrequent trading and price discreteness reflected in single period returns. Cumulating single period returns over long time intervals can thus change results dramatically and give an impression of overreaction when there is none. Loser firms are generally low priced compared to winner firms, which will create an upward bias in single period returns substantially greater than the downwards bias in winner firms. Profits of the contrarian strategy will then look greater then what they actually are.

It is also argued the use of the CARS method for calculating returns implicitly assumes rebalancing loser and winner portfolios to equal weights each month. The better measure would be BHRS. When 'true' returns are cumulated no evidence in favour of overreaction is found.

Fama (1998) provides an overview of the overreaction literature. He emphasizes that the evidence against the efficient market hypothesis from long term return studies is weak. Because post event momentum has been as frequent as post event reversal and underreaction as common as overreaction, the long term return anomalies can be seen as chance results. If the long term reversals are so large they can not be attributed to

chance, a fifty-fifty split between under and overreaction would imply the market is efficient.

Another point noted is the disappearance of an anomaly when methodology is changed. Most anomalies fall into this category, including the overreaction hypothesis. Value weighting portfolio returns generally reduces anomalies substantially in size, something that limits anomalies to small stocks. The smaller stocks on the other hand are most often subject to bad model problems. In the overreaction case this can be due to bid-ask spreads or infrequent trading.

2.4 Tests in different markets

The overreaction hypothesis has been tested in several different stock markets. To date evidence has been published for markets in Australia, Brazil, Canada, England, Japan and Spain[10]. Da Costa (1994) examines a Brazilian data set over the period 1970 to 1989[11]. Two year formation periods and two year test periods are formed for the periods 1972/73 until 1988/89. The returns reported are market adjusted returns. In comparison to DBT's US results, the magnitude of the reversal effect appears to be larger in the Brazilian data set.

Tests are also carried out to test whether changes in risk composition can explain the results and if the reversals are symmetric. The model used to test for risk changes is given as: $R(w) = \alpha + \beta(R(m) - R(f)) + e$. The average Jensen performance index (α) is found to be 0.0150 with an average t–statistic of 3.04. Risk changes can therefore not

[10] Alonso and Rubio (1990), Brailsford (1992), Chang et al. (1995), Clare and Thomas (1995), DaCosta (1994), Gaunt (2000), Kryzanowski and Zhang (1992) and Lehenkari and Perttunen (2003)
[11] The data includes a sample of 121 stocks that belongs to the BOVESPA index (IBOVESPA) for at least four years during the total period. IBOVESPA is the official index of Sao Paulo stock exchange.

explain the results. Reversals are further found to be symmetric. In other words the absolute value of the average abnormal return for the loser portfolio is similar to the average abnormal return for the winner portfolio. These results contrast with DBT's findings, where the loser portfolios revert more than the winner portfolios.

In the Canadian markets the winner-loser anomaly is tested by Kryzanowski and Zhang (1992). Monthly returns from Toronto Stock Exchange over the period 1950-1988 are used, with formation and test periods ranging from twelve months up to three years. In contrast to most research on the contrarian strategy, no reversal effect in the Canadian markets is identified[11]. While reversal behaviour is found for the longer test periods, the effect is not found to be significant at conventional levels. This applies to all three performance measures used, respectively cumulative abnormal returns, Jensen's alpha and the Sharpe ratio.

Changes in risks are furthermore controlled for by measuring changes in betas. While betas of winners drop significantly from formation to test periods, betas of losers do not increase significantly. For the arbitrage portfolio the results are found to be significant only for the period of 36 months. However, compared to the 45.3 percent increase found by Chan (1988)[12] the increase of 27.21 percent is small.

Further, both the January effect and the size effect are tested for. The differences in returns for January portfolios and February – December portfolios are measured by alphas (α). For winner portfolios only the alpha for T-periods of 12, 24 and 36 months are significant. For loser portfolios only the alpha for the T-period of 120 is

[11] The TSE/Western database is employed for data collection. Most of the Canadian companies are of much smaller market capitalization than their US counterparts.
[12] Chan (1988) presents the first evidence of risk changes as an explanation of return reversals.

significant. Therefore the initial result of no overreaction is found to be robust to the January effect. The differences in mean and median CARs are not statistically significant at the 0.05 level for size based portfolios. No statistical evidence is thus found for the size effect.

Moreover tests have been performed in the New Zealand Stock market. Bowman and Iverson (1998) examine weekly returns on the New Zealand Stock Exchange (NZSE) from the period 1967 to 1986[13]. This is the first non US study on the short run reversal effects.

The behaviour of stock prices is examined after dramatic weekly changes in price. All cases where stocks changes in value by more then 10% during a week are identified. Stocks with large price increases are identified as winners whereas stocks with large price declines are identified as losers. Limits of three stocks of each group per week (winners or losers) are further imposed to ensure price changes are not common. The results found are interpreted as overreaction, where the degrees of reversals are more than two times greater for losers than for winners. Abnormal returns are 15.1% for the winner portfolio in week 0 and -1.5% in week 1. For the loser portfolio, abnormal returns are -11.0% in week 0 and 2.4% in week 1.

Since price movements in low price stocks can give an appearance of overreaction, the sample is divided into two subsamples. One sample is constructed for less than a dollar stocks (penny sample) and one for more than a dollar stocks. The size of the event period abnormal return is found to be larger for penny stocks, but not

[13] Data are obtained from the University of Auckland Weekly Share Price Database.

substantially. It is concluded the results of the main test are not driven by higher returns of low priced stocks. The magnitude effect is described as the relationship between an extreme initial price change and an extreme subsequent reversal. In other words the greater the initial price change, the greater the subsequent reversal will be. A test on this effect is carried out by partitioning the sample according to size of the initial price change. It is found evidence for the effect for losers, but for winners with initial price changes of more than 30%, the reversal pattern do not seem to hold. Nevertheless, this result is not significant. The losers are further found to display a greater reversal in returns than winners.

Additional tests are also performed on their main findings based on time period stability, risk, seasonality, size and movements within the bid – ask spread. Substantial support for either of the explanations is not found. Return reversals are discovered in subperiods and for the total period, which indicates overreaction is present over different time periods. When stock price is used as a proxy for size, results do not vary. Further, the results found for the bid – ask spread can not explain the overreaction results from the main test.

Gaunt (2000) tests the winner-loser anomaly in the Australian equity market over the time period 1974-1997.[14] Three year rank and test periods are formed and substantial return reversal is found when the portfolios are rebalanced monthly. Both the rank period loser and winner portfolios experience performance reversal, and there are positive abnormal returns to the arbitrage portfolio. However, the effect disappears when a buy and hold methodology is applied.

[14] Data is gathered from the Centre for Research in Finance (CRIF) at the Australian Graduate School of Management. Price relative files are employed for the study.

When changing risks are controlled for, the performance reversal experienced by the loser portfolio is significantly reduced, but there are still positive abnormal returns to the contrarian strategy when a rebalancing approach is used. Conversely, when the buy and hold method is applied for calculations, the abnormal returns become negative. It is also revealed the loser portfolio largely consists of small firms, while the winner portfolio consists of large firms. This is consistent with Zarowin (1990) who suggests returns to the arbitrage portfolio are largely driven by small firms (the small firm effect).

Two earlier Australian studies are carried out by Brailsford (1992) and Allen and Prince (1995). Brailsford covers the entire period from 1958 until 1987[15] and finds no overreaction effect when employing the same methodology as DeBondt and Thaler (1985). Allen and Prince examine the period from 1974-1991 and reach a similar conclusion. A slight reversal is observed when raw returns are examined, but after adjusting for risk, losers continue to be losers and winners continue to be winners. The contrarian investment strategy is therefore argued to be invalid, unless compensation is made for changing risk premiums. Brailsford's results are for the most part consistent with Gaunt's studies. An overreaction effect is found when portfolios are rebalanced monthly to equal weights, but disappears when the buy and hold method is used for calculations.

2.5 Further evidence in favour of 'Overreaction"

Evidence in favour of overreaction is also found by Chopra, Lakonishok and Ritter (1991). Three methodological innovations are employed in their study on US stocks

[15] Data is gathered from Centre for Research in Finance (CRIF) for both studies

listed on New York Stock Exchange (NYSE) over the period 1926 to 1986. Firstly, time varying betas are estimated, but the restrictions of the Sharpe-Lintner CAPM are not used in the computation of abnormal returns. CAPM assumes compensation per unit of beta risk is about 14-15% per year and can explain a substantial proportion of the overreaction effect. Instead the much smaller market compensation per unit of beta risk is relied on. Secondly, abnormal returns are calculated adjusting for size and thirdly, only abnormal returns over short periods of time is examined as returns calculated over longer time periods are sensitive to benchmarks used.

Results indicate losers outperform winners by 6.5% per year using annual return intervals and 9.5% per year using monthly return intervals[16]. It is also shown that in contrast to Zarowin (1990) the overreaction effect is not just a manifestation of the size effect. An overreaction effect is found even after adjusting for beta and size. Multiple regression results using size, prior return and beta as variables results in an economically significant overreaction effect of 5% per year.

Moreover a strong January seasonal is found in the return patterns, but this is not interpreted as being caused solely because of tax loss selling. The overreaction effect is also found to be stronger for smaller firms than for larger firms. Since small firms are mainly held by private investors the result was interpreted as overreaction in this group. Large firms are mainly held by institutional investors and the return reversal is found to be small in this group.

[16] Portfolios are formed based on rank periods of five years. Test periods are five years of length.

Chen and Sauer (1997) reports additional results consistent with overreaction. Their study differs to prior research in that the time series properties of loser and winner portfolios are examined. In line with Chopra, Lakonishok and Ritter (1992) data from the CRSP tape are extracted for the time period 1926 to 1992. Twenty portfolios are formed and both formation and test periods are five years of length. Results for the full time period shows that the loser portfolio outperforms the winner portfolio by 11 percent annually, which is slightly lower than what is found for the CLR study.

The full sample is divided into four periods: The pre-war period (1926-42), post-war period (43-55), pre energy crisis (56-70) and post energy crisis period (71-83). It is found that overreaction is not consistent over time and it is therefore argued that the contrarian strategy is not a good trading strategy. The return reversals seem to be greatest during the pre-war period and the pre energy crisis period. For the two remaining periods the contrarian strategy earns poor returns.

Regression is also run where returns are regressed on standard deviation and where returns and returns squared are regressed on standard deviation. When the latter method is used the regression R^2 is significantly improved. It is therefore concluded that the standard deviations follows a U-shape for the twenty portfolios. In other words both the winner and the loser portfolios are more risky than an intermediate portfolio because the relationship between risk and return is best described when including a squared term. Chen and Sauer in addition find a positive relationship between the arbitrage portfolio and market risk premiums. Hence, overreaction follows the business cycle. The explanation for this is that losers are more sensitive to economic upturns and downturns.

The effect of low priced stocks is examined by Loughran and Ritter (1996) employing different data and methodology from Conrad and Kaul (1993). Starting in 1929 and ending in 1988, 58 non overlapping three year periods are constructed.[17] Evidence is found in favour of the overreaction hypothesis. When employing the CARS method for calculating rank period returns, 3-year test period holding period returns (HPRS) of 42.8% and 3-year CARS of 37.5% are found. When the BHRS method is used the numbers are 55.1% and 55.7% respectively. Most of these returns accrue in January.

Because the difference between the two methods for return calculation is small, Loughran and Ritter conclude that DBT's main finding is not driven by the use of CARS instead of BHRS. While low priced stock returns are biased upwards because of the bid ask spreads when applying CARS, they do not receive the benefits of compounding as when the BHRS method is used. When the BHRS method is applied to form winner and loser portfolios, greater difference in price, market capitalization and rank period 3-year returns are found.

In comparison to Conrad and Kaul (1993) price is found to be much less correlated with prior returns in cross sectional regressions. This is attributed both to the survivorship bias introduced with the restriction of listing over the three year rank period and to the fact CS-TS regressions are not believed to provide good estimates. Further, Loughran and Ritter (1996) find that low priced stocks have the highest returns, but are not solely responsible for long term reversals.

[17] Stock price data are obtained from the Centre for Research in Security Prices (CRSP) tapes for NYSE and AMEX listed firms.

Albert and Henderson (1995) criticise Zarowin's (1990) work for producing biased results. They argue stratifying winner and loser portfolios after size does not ensure winners and losers are size and performance ranked. When a different control is applied, an overreaction effect that is different from the size effect is found.

Data is collected for firms listed on NYSE and on the Compustat tapes for the period 1963 until 1989[18], and a three part methodology is followed in the research. Firstly, DBT's study is replicated and secondly, Zarowin's study is simulated. The results obtained are very similar to DBT's and Zarowin's results even though time periods differ. The extreme 35 losers are found to outperform the extreme 35 winners by 27.5 percent in comparison to DBT's 24.6%. Thirdly, DBT's portfolios are compared to more correctly matched portfolios to see if there is an overreaction effect in the data different from the size effect.

In order to distinguish between the size effect and the overreaction effect, both size and rank period performance are controlled for. The size effect means the portfolios with the largest size differentials should have the largest test period return differentials. In contrast, it is found the quartile of smallest size matched winners and losers have the greatest test period return differentials. An overreaction effect different from the size effect is therefore concluded to exist. Evidence of a diminishing overreaction effect is besides added. A possible explanation is that investors have become more aware of the phenomenon and changed their trading strategies.

[18] Return data are gathered from the CRSP tapes and size data from the Compustat tapes.

Return reversal in United Kingdom is examined by Dissanaike (1997). Using both the buy and hold method and the rebalancing method for calculating returns he finds evidence of an overreaction effect. Dissanaike wrote that three alternative explanations to the overreaction hypothesis have been proposed in the literature. The first explanation is Zarowin's (1990) size effect. Then, bid-ask spreads and infrequent trading (Conrad and Kaul, 1993) have been suggested. Finally, time varying risks as set out by Chan (1988) have been cited.

The paper of Dissanaike (1997) distinguishes itself from other papers in this area of finance in that the data is limited to 1000 large, better known companies listed on the London Stock Exchange (LSX)[19]. This restriction eliminates two of the three alternative explanations. Firstly, shares of large companies are normally traded more often and have tight bid-ask spreads. Secondly, the size explanation becomes much less prominent as all companies are large.

Using the BHRS method it is found the loser portfolio, on average, outperforms the winner portfolio by nearly 100% four years after portfolio formation. The equivalent result from the RBRS method is 137%. These magnitudes are actually larger than what is found in American studies and rules out transaction costs as an explanation of the return reversals. Another interesting characteristic of the results is the asymmetric overreaction. Losers revert more than winners. However, this might be because losers

[19] All companies that have been listed on the FTA Index (FTA 500 Index) over some time period during the years 1975 until 1995 are considered. 925 companies are found to have been members of the index during this period. Data is collected from the London Share Price Database (LSPD) Monthly Returns File.

revert from a lower base than winners. Tax loss effects are also ruled out as an explanation of the January effect because the British tax year starts in April[20].

When examining changing risk as an explanation of return reversals, the beta of the winner and loser portfolios contrasts to Chan's (1988) result. In contrast to Chan, the beta of the winner portfolio is found to be smaller than the beta of the loser portfolio. This shows that different betas can not explain the observed return patterns.

2.6 Summary

The review of literature above examines research on "the overreaction hypothesis' and related work. Results of studies have been mixed and different results have been obtained in different countries and markets. However, the consensus of the studies indicates the existence of an overreaction effect. This paper provides another piece to the puzzle by examining the hypothesis on the Norwegian equities market.

[20] As in US studies a strong January seasonal is found in this study.

Data and Methodology

3.1 Raw returns

The data employed in this study covers the period from 1986 to 2003. Both stock prices and market capitalization values are obtained for companies listed on the Oslo Stock Exchange (OSE). The data are obtained from DataStream ^{TM} at Curtin University of Technology.

Because the methodology employed for the study requires a three year ranking period and a three year test period, only companies with returns over at least six years can be considered. This introduces a bias in the sample towards companies of higher market capitalization, since mature firms are normally larger firms (Zarowin, 1990). Further, this bias is increased as data on delisted companies was unattainable and hence not included in the analysis. The methodology employed in this paper is based on the methodology utilized by Clive (2000).

Using stock prices, returns are calculated for all stocks using the formula for continuously compounded returns. $P_{i,t}$ represents the stock price in the current period while $P_{i,t-1}$ is the stock price from the previous period. $R_{i,t}$ is the continuously compounded return for stock i in month t.

$$R_{i,t} = \ln(P_{i,t} / P_{i,t-1}) \quad (1)$$

The market adjusted abnormal return for stock i in month t is then calculated. $R_{m,t}$ represents the return on the market index (m) in month t. An equally weighted Norwegian market index is used covering all the major 50 stocks[21].

$$\mu_{i,t} = R_{i,t} - R_{m,t} \tag{2}$$

Companies are then ranked in order of cumulative abnormal return (CAR) over the rank period.

$$CAR_i = \sum_{t=-36}^{0} \mu_{i,t} \tag{3}$$

CAR_i is the cumulative market adjusted abnormal return for stock i over the period from 36 months prior to the start of the test period.

Based on the CARs, decile portfolios are formed where the winner portfolio comprises the best performing 10% of stocks and the loser portfolio comprises the lowest performing 10% of stocks. All intermediate portfolios are included in the study. In the 1986-88 rank period the portfolios include only 3 stocks, but in the 1998-00 rank period the portfolios include 12 stocks each. A total of 115 stocks are examined. When a rank period includes a number that is not divisible by ten, the additional stocks over the highest number in the sample divisible by ten are included in the lower decile portfolios. E.g. For the 1998-00 rank period there are 115 stocks. Eleven

[21] The 50 firms comprise 85% of the market capitalization of the Norwegian equities market.

stocks are then included in the five lower decile portfolios, while twelve stocks are included in the higher decile portfolios.

The performances of the portfolios are then tracked over the test periods of 36 months applying the following formula.

$$CAR_{p,z,t} = \sum_{t}\left[(1/N)\sum_{i=1}^{N}\mu_{i,t}\right] \tag{4}$$

$CAR_{p,z,t}$ is the cumulative market adjusted abnormal return in month t over test period z for portfolio p. N is the number of stocks in each portfolio.

The procedure outlined is followed for all different rank and test periods. Rank periods are 1986-88, 89-91, 92-94, 95-97 and 98-00. Matching test periods are 1989-91, 92-94, 95-97, 98-00 and 01-03. Portfolio CARS are then averaged across all test periods to attain average cumulative returns (ACARS).

$$ACAR_{p,t} = \frac{\sum_{z=1}^{Z} CAR_{p,z,t}}{Z} \tag{5}$$

$ACAR_{p,t}$ is the average CAR across all the Z(5) test periods for each portfolio p over each month t.

Three hypothesises are put in order to test the profitability of the contrarian strategy:

H1: $ACAR_{L,t} = 0$ where t = 1 …36

H2: $ACAR_{W,t} = 0$ where t = 1 …36

H3: $ACAR_{L-W,t} = 0$ where t = 1 …36

Hypothesis one and two are tested using the following test statistic (Winner and Loser portfolio test statistic):

$$t_{p,t} = \frac{ACAR_{p,t}}{S_p / \sqrt{Z}}$$

A t-test is calculated on the mean ACAR with unknown population variance. S_p is the sample standard deviation of portfolio p, where p is set to L to test H1 and W to test H2.

For hypothesis three a different test statistic (arbitrage portfolio test statistic) is used:

$$t_{L-W,t} = \frac{(ACAR_{L,t} - ACAR_{W,t})}{\sqrt{2S_t^2} / N} \tag{7}$$

The population variance is given by:

$$S_t^2 = \frac{\sum_{z=1}^{Z}(CAR_{W,z,t} - ACAR_{W,t})^2 + \sum_{z=1}^{Z}(CAR_{L,z,t} - ACAR_{L,t})^2}{2(Z-1)} \tag{8}$$

The method outlined above (Eq. 1-8) is not consistent with rebalancing and can be referred to as the arithmetic method for calculating returns. A realistic calculation of long term portfolio performance where monthly rebalancing is assumed is given by:

$$CAR_{p,z,t} = \prod_{i=0}^{T}\left(\sum_{i}^{N}\frac{R_{i,t}}{N}\right) - \prod_{i=0}^{T} R_{m,t} \tag{9}$$

$R_{i,\,t}$ is the price relative of security i in month t and $R_{m,\,t}$ is the return on the index m in month t. This method is referred to as the rebalancing (RB) method.

To calculate test period returns assuming a buy and hold strategy (BH), the subsequent formula is applied:

$$CAR_{p,z,t} = \frac{1}{N}\sum_{i=1}^{N}\left(\prod_{t=1}^{T} R_{i,t} - \prod_{t=1}^{T} R_{m,t}\right) \tag{10}$$

The cumulative abnormal return during the rank period is calculated by:

$$CAR_{p,z,t} = \prod_{t=-35}^{0} R_{i,t} - \prod_{t=1}^{T} R_{m,t} \tag{11}$$

This is the case both for rebalancing returns and for buy and hold returns.

3.2 Risk adjusted returns

Risk adjusted returns (regression results) are also reported both with and without adjusting for size. It is assumed expected returns are generated from the Sharpe-Lindtner CAPM. Abnormal returns can then be found be looking at the value of α in the following equation:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i (r_{m,t} - r_{f,t}) + \varepsilon_{i,t} \tag{12}$$

The equation is then modified to:

$$r_{i,t} - r_{f,t} = \alpha_{1i}(1 - D_t) + \alpha_{2,i} D_t + \beta_i (r_{m,t} - r_{f,t}) + \beta_{iD} (r_{m,t} - r_{f,t}) D_t + \varepsilon_{i,t} \tag{13}$$

where t = 1 to 72. From the above equation it can be observed whether the abnormal returns and the risk (beta) have changed from the rank period to the test period. $\hat{\alpha}_{1i}$ signifies the rank period return, $\hat{\alpha}_{2i}$ represents the test period return, $\hat{\beta}_i$ is the rank period beta and $\hat{\beta}_{iD}$ is the change in beta from rank to test period. The test period beta is given by $\hat{\beta}_i + \hat{\beta}_{iD}$. The continuously compounded return on portfolio i at time t is given by $r_{i,t}$, the equally weighted market index (DS-market) is given by $r_{m,t}$[22], the risk free rate is r_f[23] and D_t represents a dummy variable which is zero in the rank period (t < 37) and one in the test period (t > 36). Ordinary least squares (OLS) estimation is applied to estimate the parameters.

[22] The DS market represents the 50 biggest stocks by market capitalization. Together they account for 85% of the market.
[23] The long term government bond rate is used as a risk free rate.

The aggregate regression coefficients are given by the weighted averages of the individual test period coefficients. In this paper all test periods are 36 months in length. Thus it is not necessary to weight proportionally to the individual test periods, as was done by Chan (1988). The aggregate t-statistic is represented by:

$$T - stat = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} t_i \sqrt{(T_i - 3)/(T_i - 1)} \qquad (14)$$

T is the number of observations (36), N is the number of test periods (5) and t_i is the individual test period t-statistic.

Results

4.1 Cumulative abnormal returns method (Arithmetic - CARS)

The results from table 1 are not consistent with return reversal. [24] At the end of the test period, the loser portfolio is still displaying negative returns. The returns are even more negative after 36 months than after 6 months. The returns are -0.15 and -0.04 respectively, and both numbers are insignificant at the 5% level. [25] The winner portfolio also displays more of a momentum effect, as returns become more and more positive during the test period. The insignificant returns increase from -0.07 after 6 months to 0.14 after 36 months. The returns to the arbitrage portfolio are all negative except for in the first period, and neither of the returns are significant. Further, none of the intermediate portfolios show any signs of return reversal.

4.2 Buy and hold method (BHRS)

Employing buy and hold returns (Eq.10) gives different results than CARS, but only for periods of 6 to 24 months. The "overreaction effect" tends to disappear for the longest two test periods. Selling winners and buying losers gives a profit for the two first years of the test period. The return to the strategy is highest after 18 months with a return of 0.33, which is significant at the 99% confidence level. After 36 months returns have turned negative to -0.42 (significant at 1% level).

While the loser portfolio shows positive returns for test period lengths between 6 and 18 months, it displays negative returns for test periods of 30 and 36 months of length.

[24] The Cumulative abnormal returns method is represented by Eq.4 and Eq.5 from the Data and Methodology section.
[25] Unless otherwise stated, significant refers to the 5% significance level.

Table 1

Cumulative Abnormal Returns Method (Arithmetic) – Test period performance

The Norwegian stocks with a full set of returns through both the first rank and test period (1986-91) are all identified. The stocks that have been delisted in subsequent periods are not included in the calculations. Monthly market adjusted abnormal returns are then calculated for every stock in the rank period (1986-88), and these returns are again summarised for each stock to get cumulative abnormal returns (CARS). Stocks are then ranked after rank period performance and placed into decile portfolios. The worst performing 10% of the stocks constitute the Loser (L) portfolio and the best performing 10% make up the Winner (W) portfolio. Test period performance is calculated by following the same procedure for return calculations as outlined above. The entire process is repeated for all other four rank/test periods. The results are then averaged across the five test periods for all ten decile portfolios as well as the arbitrage portfolio (L-W). The return calculations are performed applying the Cumulative Abnormal Returns (Arithmetic) (CARS) method. The method is detailed in the data and methodology section in equation (1)-(8) and t-statistics are given in parenthesis. The table presents average cumulative abnormal returns (ACARS) for different periods in test periods, across all ten decile portfolios and for the arbitrage portfolio.

CARS	L	2	3	4	5	6	7	8	9	W	L-W
ACAR 6	-0.04	-0.14	-0.01	-0.06	-0.14	-0.07	0.06	0.04	-0.04	-0.07	0.03
T-STAT 6	(-0.23)	(-1.31)	(-0.1)	(-0.54)	(-1.79)	(-0.93)	(-0.52)	(-0.53)	(-0.39)	(-0.43)	(-1.53)
ACAR 12	0.13	0.19	0.40	0.31	0.26	0.20	0.44	0.22	0.28	0.28	-0.15
T-STAT 12	(-0.41)	(-1.25)	(-1.89)	(-1.54)	(-2.79)[a]	(-1.14)	(-2.53)[b]	(-1.42)	(-1.7)	(-0.99)	(-1.19)
ACAR 18	0.12	0.31	0.31	0.33	0.21	0.15	0.50	0.21	0.34	0.29	-0.17
T-STAT 18	(-0.39)	(-1.81)	(-1.12)	(-1.23)	(-1.54)	(-0.59)	(-2.62)[b]	(-1.2)	(-2.01)	(-0.99)	(-1.17)
ACAR 24	-0.07	0.12	0.22	0.25	0.19	0.12	0.49	0.14	0.32	0.16	-0.23
T-STAT 24	(-0.18)	(-0.59)	(-0.65)	(-0.97)	(-1.03)	(-0.42)	(-2.46)[b]	(-0.75)	(-1.37)	(-0.39)	(-1.32)
ACAR 30	-0.08	0.12	0.19	0.20	0.17	0.08	0.45	0.08	0.30	0.16	-0.24
T-STAT 30	(-0.2)	(-0.54)	(-0.55)	(-0.61)	(-0.99)	(-0.27)	(-2.21)[b]	(-0.46)	(-0.95)	(-0.35)	(-1.38)
ACAR 36	-0.15	0.12	0.22	0.18	0.23	0.11	0.43	-0.03	0.25	0.14	-0.29
T-STAT 36	(-0.35)	(-0.45)	(-0.63)	(-0.5)	(-0.99)	(-0.33)	(-1.59)	(-0.13)	(-0.79)	(-0.27)	(-1.71)

[a] Significant at the 1% level using a two tailed test

[b] Significant at the 5% level using a two tailed test

Table 2

Buy and Hold Method – Test period performance

The Norwegian stocks with a full set of returns through both the first rank and test period (1986-91) are all identified. The stocks that have been delisted in subsequent periods are not included in the calculations. Continuous monthly returns are then calculated for every stock in the rank period (1986-88), and these returns are again multiplied for each stock to get buy and hold returns (BHRS). Stocks are then ranked according to rank period performance and placed into decile portfolios. The worst performing 10% of the stocks constitute the Loser (L) portfolio and the best performing 10% make up the Winner (W) portfolio. Test period performance is calculated by following the same procedure for return calculations as outlined above. The entire process is repeated for all other four rank/test periods. The results are then averaged across the five test periods for all ten decile portfolios as well as the arbitrage portfolio (L-W). The return calculations are performed applying the Buy and Hold method (BHRS). The method is detailed in the data and methodology section in equation (10)-(11) and t-statistics are given in parenthesis. The table presents average buy and hold returns (ABHRS) for different periods in test periods, across all ten decile portfolios and for the arbitrage portfolio.

BHRS	L	2	3	4	5	6	7	8	9	W	L-W
ABHRP 6	-0.06	-0.06	0.01	-0.08	-0.04	-0.05	-0.03	-0.07	-0.03	-0.11	0.05
T-STAT 6	(-0.28)	(-0.55)	(-0.1)	(-0.82)	(-0.34)	(-0.65)	(-0.34)	(-0.88)	(-0.34)	(-0.87)	(-2.48)[b]
ABHRP 12	0.07	-0.04	0.02	0.02	-0.11	0.06	0.06	0.02	0.02	-0.09	0.16
T-STAT 12	(-0.16)	(-0.25)	(-0.07)	(-0.14)	(-1.3)	(-0.39)	(-0.39)	(-0.11)	(-0.08)	(-0.5)	(-3.61)[a]
ABHRP 18	0.24	0.09	0.03	-0.05	-0.17	0.02	0.04	0.04	0.06	-0.09	0.33
T-STAT 18	(-0.43)	(-0.38)	(-0.09)	(-0.22)	(-2.15)[b]	(-0.11)	(-0.2)	(-0.24)	(-0.25)	(-0.34)	(-4.85)[a]
ABHRP 24	0.01	0.31	0.09	-0.15	-0.19	-0.12	-0.11	0.00	0.02	-0.07	0.09
T-STAT 24	(-0.03)	(-1.05)	(-0.2)	(-0.45)	(-2.17)[b]	(-0.79)	(-0.85)	(-0.01)	(-0.07)	(-0.24)	(-1.61)
ABHRP 30	-0.09	0.40	0.38	-0.07	-0.19	-0.11	-0.08	-0.07	0.18	-0.05	-0.04
T-STAT 30	(-0.25)	(-1.26)	(-0.53)	(-0.15)	(-1.65)	(-0.67)	(-0.51)	(-0.47)	(-0.44)	(-0.16)	(-0.63)
ABHRP 36	-0.36	0.51	1.06	-0.14	-0.18	-0.11	-0.08	-0.07	0.31	0.05	-0.42
T-STAT 36	(-1.32)	(-1.22)	(-0.76)	(-0.25)	(-0.98)	(-0.57)	(-0.41)	(-0.45)	(-0.44)	(-0.12)	(-8.28)[a]

[a] Significant at the 1% level using a two tailed test

[b] Significant at the 5% level using a two tailed test

For the winner portfolio the situation is the opposite. The returns start off negative for the 6 month test period and end up positive at 0.05 for the 36 month period. However, all test statistics for the loser and winner portfolios are insignificant. It is also worth noting the second and third decile portfolios display patterns of return reversal. Returns increase and are all positive when test periods are increased, but none of the returns are significant.

4.3 Rebalancing method (RBRS)

The rebalancing method (Eq.9) assumes rebalancing the portfolios to equal weights after each month. [26]The results from the strategy are similar to the buy and hold results, but a bit less pronounced. After comparing the arbitrage portfolios, it can be seen both methods result in negative and significant returns at the 1% level for the 36 month test period. The returns are -0.21 for the RBRS and -0.42 for the BHRS. When considering the test periods between one and two years the BHRS tend to be larger and more significant than the RBRS, but there are still gains to be made from following the contrarian strategy (excluding transaction costs) for test periods up to two and a half years, when rebalancing the portfolios.

The loser portfolio follows a similar pattern to the BHRS loser portfolio over the various test periods. The returns start off negative for the shortest test periods, become positive for medium length periods and turns negative (-0.32) for the three year test period. The winner portfolio returns stay negative, but not significantly, over all test periods, thus some signs of return reversals are present. As is the case when the buy and hold methodology is followed, there is a significant return reversal for the second

[26] It is assumed delisted companies are reinvested to equal weight when delisted, but since delisted companies are not considered in this paper, this can be ignored.

Table 3

Rebalancing method – Test period performance

The Norwegian stocks with a full set of returns through both the first rank and test period (1986-91) are all identified. The stocks that have been delisted in subsequent periods are not included in the calculations. Monthly continuous returns are then calculated for every stock in the rank period (1986-88), and these returns are again multiplied for each stock to get rebalancing returns (RBRS). Stocks are then ranked according to rank period performance and placed into decile portfolios. The worst performing 10% of the stocks constitute the Loser (L) portfolio and the best performing 10% make up the Winner (W) portfolio. Test period performance is calculated by first calculating all monthly portfolio returns and then multiplying monthly returns into six, monthly returns for all portfolios. The entire process is repeated for all other four rank/test periods. The results are then averaged across the five test periods for all ten decile portfolios as well as the arbitrage portfolio (L-W). The return calculations are performed applying the Rebalancing (RBRS) method. The method is detailed in the data and methodology section in equation (9) and (11) and t-statistics are given in parenthesis. The table presents average rebalancing returns (ARBRS) for different periods in test periods, across all ten decile portfolios and for the arbitrage portfolio.

RBRS	L	2	3	4	5	6	7	8	9	W	L-W
ARBRP 6	-0.06	-0.06	0.27	-0.07	-0.03	-0.05	-0.02	-0.07	-0.01	-0.14	0.08
T-STAT 6	(-0.28)	(-0.53)	(-2.38)[b]	(-0.72)	(-0.29)	(-0.66)	(-0.26)	(-0.88)	(-0.17)	(-1.1)	(-3.88)[a]
ARBRP 12	-0.10	-0.05	0.44	0.03	-0.08	0.04	0.05	0.00	0.01	-0.12	0.01
T-STAT 12	(-0.24)	(-0.31)	(-1.93)	(-0.18)	(-0.86)	(-0.28)	(-0.36)	(-0.02)	(-0.03)	(-0.65)	(-0.31)
ARBRP 18	0.13	0.10	1.12	-0.09	-0.12	0.00	0.04	0.04	0.05	-0.12	0.25
T-STAT 18	(-0.24)	(-0.41)	(-3.35)[a]	(-0.38)	(-1.46)	(-0.02)	(-0.22)	(-0.29)	(-0.22)	(-0.45)	(-3.68)[a]
ARBRP 24	0.01	0.32	2.69	-0.26	-0.12	-0.10	-0.06	0.00	-0.02	-0.14	0.14
T-STAT 24	(-0.02)	(-1.07)	(-5.85)[a]	(-0.78)	(-1.41)	(-0.67)	(-0.49)	(-0.01)	(-0.06)	(-0.44)	(-2.66)[b]
ARBRP 30	-0.04	0.45	4.57	-0.25	-0.11	-0.08	-0.02	-0.08	0.10	-0.13	0.08
T-STAT 30	(-0.12)	(-1.43)	(-6.27)[a]	(-0.56)	(-1)	(-0.48)	(-0.15)	(-0.48)	(-0.24)	(-0.38)	(-1.52)
ARBRP 36	-0.32	0.49	7.81	-0.35	-0.14	-0.08	-0.04	-0.06	-0.02	-0.11	-0.21
T-STAT 36	(-1.16)	(-1.17)	(-5.58)[a]	(-0.65)	(-0.76)	(-0.41)	(-0.21)	(-0.37)	(-0.02)	(-0.23)	(-4.23)[a]

[a] Significant at the 1% level using a two tailed test

[b] Significant at the 5% level using a two tailed test

Table 4

Rebalancing method – Performance over different test periods

The Norwegian stocks with a full set of returns through both the first rank and test period (1986-91) are all identified. The stocks that have been delisted in subsequent periods are not included in the calculations. Monthly continuous returns are then calculated for every stock in the rank period (1986-88), and these returns are again multiplied for each stock to get rebalancing returns (RBRS). Stocks are then ranked according to rank period performance and placed into decile portfolios. The worst performing 10% of the stocks constitute the Loser (L) portfolio and the best performing 10% make up the Winner (W) portfolio. Test period performance is calculated by first calculating all monthly portfolio returns and then multiplying monthly returns into six, monthly returns for all portfolios. The entire process is repeated for all other four rank/test periods. The results are then averaged across the five test periods for all ten decile portfolios as well as the arbitrage portfolio (L-W). The return calculations are performed applying the Rebalancing (RBRS) method. The method is detailed in the data and methodology section in equation (9) and (11). This table presents the rebalancing returns (RBRS) at the end of the test periods for all five test periods as well as the mean. The results are shown for all ten decile portfolios.

Rank Period	Portfolio size	L	2	3	4	5	6	7	8	9	W	L-W
1986-1988	27	-0.05	0.34	-0.46	-0.13	-0.75	0.39	0.04	0.49	-0.28	0.46	-0.51
1989-1991	31	-0.42	2.15	-0.32	-1.33	0.08	-0.48	-0.54	-0.07	-0.70	-0.38	-0.04
1992-1994	40	-0.08	0.41	1.70	-0.01	0.24	-0.26	-0.06	-0.47	1.33	0.13	-0.21
1995-1997	63	-0.33	-0.03	38.25	-0.06	-0.15	-0.27	-0.08	-0.50	-0.40	-0.23	-0.09
1998-2000	115	-0.72	-0.42	-0.11	-0.20	-0.14	0.23	0.44	0.25	-0.03	-0.50	-0.22
ACAR		-0.32	0.49	7.81	-0.35	-0.14	-0.08	-0.04	-0.06	-0.02	-0.11	-0.21

and third decile portfolios. For the 36 month test period the return to the third decile portfolio is a significant at the 1% level, 7.81 (5.58).

Table 4 represents returns for the three year test periods at the end of the test periods. Results are reported across all ten decile portfolios and for all time periods considered. The returns to the arbitrage portfolio are all negative, but least negative with a return of -0.04 for the 1989-91 period. The returns to the loser portfolios are all negative over the time periods. Thus, the losers have continued to perform badly. On the contrary, returns of the winner portfolios show some signs of reversal. For three of the time periods considered, the returns to the portfolio are negative. For the 1998-00 rank period, the test period return is -0.50. From these results it may be concluded that following a contrarian investment strategy in the Norwegian equities market is not recommended. The same findings have been reached using raw returns in the Canadian market (Kryzanowski and Zhang, 1992) and in the Australian market ((Brailsford, 1992) and (Allen and Prince, 1995)) as well.

4.4 Risk Adjustment

The results reported above are raw returns. In order to ensure that the changes in returns from the rank to the test periods are not due to changes in the risk composition (systematic risk) of the portfolios as suggested by Chan (1988) and Ball and Kothari (1989), risk must be controlled for. It is assumed expected returns are generated from the Sharpe-Lindtner CAPM, and the regression equations are outlined in the Data and Methodology section.

Rank period mean abnormal return ($\hat{\alpha}_{1i}$) is expected from the methodology to be negative for the loser portfolio; however it turns out to be positive 0.13 (Table 5), but not significantly. This seems to be due to the period of 1986-88 (rank period), which

Table 5

Rebalancing method with risk adjustment – Performance over different test periods

The Norwegian stocks with a full set of returns through both the first rank and test period (1986-91) are all identified. The stocks that have been delisted in subsequent periods are not included in the calculations. Monthly continuous returns are then calculated for every stock in the rank period (1986-88), and these returns are again multiplied for each stock to get rebalancing returns (RBRS). Stocks are then ranked according to rank period performance and placed into decile portfolios. The worst performing 10% of the stocks constitute the Loser (L) portfolio and the best performing 10% make up the Winner (W) portfolio. Regression is then run, of the form:

$$r_{i,t} - r_{f,t} = \alpha_{1i}(1 - D_t) + \alpha_{2,i} D_t + \beta_i (r_{m,t} - r_{f,t}) + \beta_{iD} (r_{m,t} - r_{f,t}) D_t + \varepsilon_{i,t}$$

where t = 1 to 72. $\hat{\alpha}_{1i}$ signifies the rank period return, $\hat{\alpha}_{2i}$ represents the test period return, $\hat{\beta}_i$ is the rank period beta and $\hat{\beta}_{iD}$ is the change in beta from rank to test period. The test period beta is given by $\hat{\beta}_i + \hat{\beta}_{iD}$. The continuously compounded return on portfolio i at time t is given by $r_{i,t}$, the equally weighted market index (DS-market) is given by $r_{m,t}$, the risk free rate is r_f and D_t represents a dummy variable which is zero in the rank period (t < 37) and one in the test period (t > 36). Ordinary least squares (OLS) estimation is applied to estimate the parameters. The aggregate regression coefficients are given by the weighted averages of the individual test period coefficients. The return calculations are performed applying the Rebalancing (RBRS) method, which is detailed in the data and methodology section in equation (9) and (11). The entire process is repeated for all other four rank/test periods. The results are then averaged across the five test periods to obtain aggregate results. Results for the loser, winner and the arbitrage portfolio (L-W) for all five rank periods are reported here in addition to aggregate results.

Rank Period	Loser				Winner				Loser - Winner			
	α_{1i}	α_{2i}	β_i	β_{id}	α_{1i}	α_{2i}	β_i	β_{id}	α_{1i}	α_{2i}	β_i	β_{id}
1986-88	0.6028	0.1851	0.2548	0.5398	0.1728	0.7226	0.8176	-0.6096	0.2798	-0.6373	-0.5412	1.1224
t - stat	(-3.07)[a]	(-0.75)	(-1.15)	(-1.54)	(-1.68)	(-5.59)[a]	(-7.08)[a]	(-3.31)[a]	(-1.37)	(-2.47)[b]	(-2.35)[b]	(-3.06)[a]
1989-91	-0.0961	-0.0322	1.0719	-0.0413	0.2442	0.2856	0.7508	-0.0648	-0.4406	-0.5083	0.3165	0.1493
t - stat	(-0.63)	(-0.19)	(-6.4)[a]	(-0.17)	(-2.43)[b]	(-2.56)[b]	(-6.78)[a]	(-0.4)	(-2.62)[b]	(-2.73)[b]	(-1.71)	(-0.55)
1992-94	-0.0066	-0.28	0.9636	0.3327	0.21	0.5592	0.7901	-0.3718	-0.4078	-0.9735	0.2924	0.6649
t - stat	(-0.03)	(-0.56)	(-3.55)[a]	(-0.57)	(-2.28)[b]	(-3.05)[a]	(-7.93)[a]	(-1.72)	(-1.61)	(-1.96)	(-1.08)	(-1.14)

1995-97	0.2359	0.4717	0.7259	-0.2382	0.1673	-0.0569	0.8767	0.1769	-0.0684	0.4592	-0.0687	-0.4845
t - stat	(-1.28)	(-5.03)[a]	(-3.78)[a]	(-1.1)	(-0.77)	(-0.52)	(-3.88)[a]	(-0.7)	(-0.26)	(-3.4)[a]	(-0.25)	(-1.55)
1998-2000	-0.0861	-0.4685	1.046	0.3995	0.4552	0.0695	0.5417	0.3591	-0.6096	-0.664	0.5157	0.1032
t - stat	(-0.4)	(-1.81)	(-4.62)[a]	(-1.12)	(-4.65)[a]	(-0.59)	(-5.25)[a]	(-2.21)[b]	(-2.94)[a]	(-2.66)[b]	(-2.36)[b]	(-0.3)
Aggregate	0.13	-0.0248	0.8124	0.1985	0.2504	0.316	0.7554	-0.1021	-0.2493	-0.4648	0.1029	0.311
t - stat	(-1.43)	(-1.4)	(-8.47)[a]	(-0.85)	(-5.13)[a]	(-4.9)[a]	(13.43)[a]	(-1.1)	(-2.63)[b]	(-2.79)[a]	(-1.11)	(-1.51)

[a] Significant at the 1% level using a two tailed test

[b] Significant at the 5% level using a two tailed test

strongly biases the aggregate results upwards. Of the five periods considered, three of them have negative signs on the coefficient ($\hat{\alpha}_{1i}$). The coefficient is however positive and significant 0.25 (at the 1% level), for the winner portfolio.

The test period mean abnormal return ($\hat{\alpha}_{2i}$), turns out to be insignificantly negative for the loser portfolio. On the other hand, the parameter for the winner portfolio is even more positive than for the rank period and significant at the 1% level. This suggests that when adjusting for risk, in contrast to 'overreaction', 'underreaction' exists. It seems like losers get lower and lower returns and winners get higher and higher returns on average. This can also be seen, judging by the arbitrage portfolios which have negative return in all the test periods except the test period corresponding to the 1995-97 rank period.

Chan (1988) argues high return stocks are accompanied by high risk. According to this theory, beta risk should drop from rank to test period for the loser portfolio and increase for the winner portfolio. What is observed from the results is that the loser portfolio is actually of higher risk than the winner portfolio for the rank period. The risk changes from the rank to test periods are besides of different signs than what could be expected, even though the risk changes are insignificant. When considering results from individual test periods, there are some deviations from the aggregate trend that would support Chan. However in most cases low returns go together with high systematic risk. Most of the rank period betas are besides less than one.[27]

[27] The beta of a security will have a value of less than one if the returns of the firm are less volatile than the market. If the opposite is true the security will have a beta of more than one.

The result is generally robust to different rank/test periods. Table 6 reports results when rank/test periods are allowed to vary from two to five years. Returns to the loser – winner portfolio is negative for periods of two to four years, but only significant (at the 1% level) for the three year case. When expanding rank and test periods to five years the contrarian strategy seems to pay off more. From the various loser portfolios it can be seen all mean abnormal returns ($\hat{\alpha}_{1i}$) are positive and for periods of four and five years, the returns revert (increase). For the winner portfolios, the rank period returns are all positive and significant at the 1% level, but only the when rank and test periods of three years are used do the returns increase from rank to test period. In all other cases they decrease and for the five year period test period return becomes insignificantly negative.

Further, the loser portfolios are riskier than the winner portfolios over all periods except for rank/test periods of four years. It can also be noted that when studying short periods (two to three years) low returns tend to go together with high beta risk, while for longer periods (four to five) years, low returns go together with low risk. Change in beta from rank to test period ($\hat{\beta}_{iD}$) is negative.

4.5 Size

The size effect posits the reason why losers tend to outperform winners in many previous studies is not an overreaction effect. According to Zarowin (1990), losers tend to be small firms and winners tend to be large firms, thus the tendency is merely a manifestation of differences in size.

Table 6

Rebalancing method with risk adjustment – different rank/test period lengths

The Norwegian stocks with a full set of returns over different rank/test periods of a total of 4 (2/2) to 10 (5/5) years are all identified. The stocks that have been delisted in subsequent periods are not included in the calculations. Monthly continuous returns are then calculated for every stock in the rank period (1986-88), and these returns are again multiplied for each stock to get rebalancing returns (RBRS). Stocks are then ranked according to rank period performance and placed into decile portfolios. The worst performing 10% of the stocks constitute the Loser (L) portfolio and the best performing 10% make up the Winner (W) portfolio. Regression is then run, of the form:

$$r_{i,t} - r_{f,t} = \alpha_{1i}(1 - D_t) + \alpha_{2,i} D_t + \beta_i (r_{m,t} - r_{f,t}) + \beta_{iD} (r_{m,t} - r_{f,t}) D_t + \varepsilon_{i,t}$$

where t = 1 to N. $\hat{\alpha}_{1i}$ signifies the rank period return, $\hat{\alpha}_{2i}$ represents the test period return, $\hat{\beta}_i$ is the rank period beta and $\hat{\beta}_{iD}$ is the change in beta from rank to test period. The test period beta is given by $\hat{\beta}_i + \hat{\beta}_{iD}$. The continuously compounded return on portfolio i at time t is given by $r_{i,t}$, the equally weighted market index (DS-market) is given by $r_{m,t}$, the risk free rate is r_f and D_t represents a dummy variable which is zero in the rank period ($t < N/2 + 1$) and one in the test period ($t > N/2$). Ordinary least squares (OLS) estimation is applied to estimate the parameters. The aggregate regression coefficients for each rank/test period length of between 4 and 10 years (represented in the table by rank period) are given by the weighted averages of the individual test period coefficients. The return calculations are performed applying the Rebalancing (RBRS) method, which is detailed in the data and methodology section in equation (9) and (11). The entire process is repeated for all other rank/test periods. Results for the loser, winner and the arbitrage portfolio (L-W) for all rank/test periods are reported here, by rank period.

Rank Period (Year)	**Loser**				**Winner**				**Loser - Winner**			
	α_{1i}	**α_{2i}**	**β_i**	**β_{id}**	**α_{1i}**	**α_{2i}**	**β_i**	**β_{id}**	**α_{1i}**	**α_{2i}**	**β_i**	**β_{id}**
2	0.1010	-0.0323	0.8280	0.1930	0.3590	0.0768	0.6419	0.2673	-0.3793	-0.2234	0.2255	-0.0713
t - stat	(-0.6)	(-0.23)	(-2.59)[b]	(-0.49)	(-2.21)[b]	(-0.34)	(-3.36)[a]	(-0.93)	(-1.13)	(-0.4)	(-0.56)	0.00

3	0.1300	-0.0248	0.8124	0.1985	0.2504	0.3160	0.7554	-0.1021	-0.2493	-0.4648	0.1029	0.3110
t - stat	(-1.43)	(-1.4)	(-8.47)[a]	(-0.85)	(-5.13)[a]	(-4.9)[a]	(13.43)[a]	(-1.1)	(-2.63)[b]	(-2.79)[a]	(-1.11)	(-1.51)
4	0.3493	0.4270	0.5779	-0.0306	0.3445	0.3123	0.6531	0.0151	-0.1545	-0.0011	-0.0037	-0.0682
t - stat	(-2.09)[b]	(-2.63)[b]	(-3.52)[a]	(-0.13)	(-2.67)[b]	(-2.28)[b]	(-4.54)[a]	(-0.01)	(-0.8)	(-0.11)	(-0.03)	(-0.23)
5	0.0968	0.2118	0.8550	-0.0828	0.2429	-0.0365	0.7516	0.2787	-0.3060	0.1276	0.1680	-0.3692
t - stat	(-0.53)	(-1.16)	(-5.57)[a]	(-0.37)	(-2.27)[b]	(-0.03)	(-6)[a]	(-1.4)	(-1.67)	(-0.61)	(-0.84)	(-1.22)

[a] Significant at the 1% level using a two tailed test

[b] Significant at the 5% level using a two tailed test

Table 7 presents the market capitalization of the companies in the ten decile portfolios over different months in the rank/test periods. As expected, the loser portfolio consists of the firms that lose most size over the rank period, whereas the winner portfolio consists of the firms that grow most over the rank period. The size of the loser portfolio increases slightly over the test period, from 510.88 to 633.66. [28] The winner portfolio, in contrast to all other portfolios, declines slightly, from 2440.94 to 2394.95.

Table 8 gives market capitalizations for month 36 of the different rank periods, for all ten portfolios. There is no doubt that size increases the better the performance of the portfolio (mean size loser = 510.88 and mean size winner = 2440.94). However, the eight and ninth decile portfolios are the largest portfolios over most of the periods. For the early periods (1986-88 and 1989-91) the second and third decile portfolios are very small and the loser portfolio is actually bigger. Nevertheless, this trend changes for the last three test periods where the second and third decile portfolios contain firms of much larger size than the loser portfolio.

To filter out the size effect, portfolios are ranked by both performance and size. First, the stocks for each rank period are divided into ten decile portfolios, based on rank period return, but only the results for the winner, loser and the arbitrage portfolio are reported. [29] Each portfolio is then divided into a smaller size portfolio. [30] There are three different size portfolios: small, medium and large, and they account for the three one-

[28] All numbers are given in millions of Norwegian Kroner (NOK).
[29] The rebalancing/buy and hold approach is used to calculate rank period return (Eq. 11).
[30] This procedure results in some portfolios with very few stocks. In some cases there have only been one security in one aggregate size portfolio, and results (Table 10) should therefore be interpreted with some scepticism.

Table 7

Mean size of companies (Million NOK) at different times of the rank/test periods

The Norwegian stocks with a full set of returns through both the first rank and test period (1986-91) are all identified. The stocks that have been delisted in subsequent periods are not included in the calculations. Monthly continuous returns are then calculated for every stock in the rank period (1986-88), and these returns are again multiplied for each stock to get rebalancing returns (RBRS). Stocks are then ranked according to rank period performance and placed into decile portfolios. The worst performing 10% of the stocks constitute the Loser (L) portfolio and the best performing 10% make up the Winner (W) portfolio. Test period performance is calculated by first calculating all monthly portfolio returns and then multiplying monthly returns into six, monthly returns for all portfolios. The entire process is repeated for all other four rank/test periods. The results are then averaged across the five test periods for all ten decile portfolios. Mean market capitalization (NOK'000) is reported at 12 month intervals throughout the rank and test periods.

Portfolio	L	2	3	4	5	6	7	8	9	W
MV 1	978.09	1294.27	3243.67	1497.21	2757.51	1692.58	2032.04	3221.76	2776.41	974.78
MV 12	670.93	1021.51	2843.41	1564.26	3021.17	1616.45	2242.47	3091.65	2951.25	973.07
MV 24	588.40	1296.86	3527.35	1682.71	3760.95	2166.66	3229.83	3996.56	4118.48	1517.24
MV 36	510.88	1324.32	3851.72	1626.84	3265.57	2295.92	3290.71	5043.23	5462.84	2440.94
MV 48	331.31	1422.47	2746.32	1941.70	3528.99	2649.26	4086.75	4885.47	5152.32	2086.49
MV 60	594.98	1799.09	3737.69	1665.38	4483.24	2972.23	5015.05	5263.67	6125.92	2116.64
MV 72	633.66	2323.89	4318.31	1757.42	5889.88	3205.11	4843.37	6930.56	6558.65	2394.95

Table 8

Mean size of companies (Million NOK) at the last month of the rank period

The Norwegian stocks with a full set of returns through both the first rank and test period (1986-91) are all identified. The stocks that have been delisted in subsequent periods are not included in the calculations. Monthly continuous returns are then calculated for every stock in the rank period (1986-88), and these returns are again multiplied for each stock to get rebalancing returns (RBRS). Stocks are then ranked according to rank period performance and placed into decile portfolios. The worst performing 10% of the stocks constitute the Loser (L) portfolio and the best performing 10% make up the Winner (W) portfolio. The entire process is repeated for all other four rank/test periods. Average market capitalization (NOK'000) is reported at the end of the rank period for all individual rank period portfolios and for the aggregate (mean) portfolio.

Portfolio	L	2	3	4	5	6	7	8	9	W	Mean
1/12/1988	101.60	64.92	163.47	621.56	1246.24	1037.13	7467.35	1304.60	703.77	2564.23	1527.49
1/12/1991	390.58	75.65	542.95	790.69	8744.29	4919.86	228.29	1657.85	1102.40	704.57	1915.71
1/12/1994	143.39	1897.91	374.31	2777.11	377.71	2945.10	3513.77	892.11	15290.92	668.47	2888.08
1/12/1997	779.29	2753.85	16868.64	2420.32	3605.03	1586.36	1439.96	8039.65	3919.70	2448.40	4386.12
1/12/2000	1139.54	1829.25	1309.24	1524.54	2354.56	991.13	3804.19	13321.93	6297.41	5819.05	3839.08
Mean	510.88	1324.32	3851.72	1626.84	3265.57	2295.92	3290.71	5043.23	5462.84	2440.94	2911.30

thirds of size, from the smallest to the biggest firms, based on market capitalization at the end of each rank period.

The percentage of small, medium and large firms in each of the ten decile portfolios is given in table 9. It can be observed from the results that winners are normally bigger firms, while losers are most likely small. The percentage of big firms in the loser portfolio is only 3.6%. The percentage of medium sized firms is quite stable across the ten rank period return portfolios. Bigger firms tend to be clustered in the best performing portfolios and smaller firms at the opposite end of the scale with 20.2% in the winner portfolio.

From the regression output in table 10, it can be seen both the rank period returns ($\hat{\alpha}_{1i}$) from the loser and the winner portfolios are positive and highly significant (1% level). For the winner portfolio, this in line with theory, whilst for the loser portfolio, the result is similar to the result from the 'risk adjustment' section. However, the returns to the winner portfolio are on average higher than those for the loser. Returns are besides higher for the larger size portfolios. This is expected since performance and market capitalization give the impression of being correlated. The test period abnormal returns ($\hat{\alpha}_{2i}$) are generally higher than for the rank periods. For the winner portfolio this is similar to previous risk adjusted results (non- size adjusted). For the loser portfolio, the increase in return for small and medium sized firms implies return reversion. The test period return for the arbitrage portfolio is positive 0.1536, but insignificant for small firms. This confirms there is some 'overreaction' effect beyond risk and size effects present. The finding is also consistent with Chopra, Lakonishok and Ritter (1991), which find the overreaction effect to be stronger for smaller firms

than for larger firms. They reason this is because small firms are mainly held by private investors, while large firms are mainly held by institutional investors. The coefficients for beta risk ($\hat{\beta}_i$) and beta risk change ($\hat{\beta}_{iD}$) are rarely significant.

Some trends can be observed from these numbers. First of all, the portfolios do not contain a lot of market risk. Second, small firms are usually less risky (in contrast to our previous results). Third, risk changes from rank to test periods are positive for all three performance portfolios. Lastly smaller firms have a greater change in risk, something that could be connected with the low risk from the rank periods.

Table 9

Percentage of small, medium and large firms for all ten decile portfolios

The Norwegian stocks with a full set of returns through both the first rank and test period (1986-91) are all identified. The stocks that have been delisted in subsequent periods are not included in the calculations. Monthly continuous returns are then calculated for every stock in the rank period (1986-88), and these returns are again multiplied for each stock to get rebalancing returns (RBRS). Stocks are then ranked according to rank period performance and placed into decile portfolios. The worst performing 10% of the stocks constitute the Loser (L) portfolio and the best performing 10% make up the Winner (W) portfolio. The entire process is repeated for all other four rank/test periods and then averaged. The securities from all the ten decile portfolios are then ranked based on market capitalisation in the last month of the rank period. The performance portfolios are divided into three smaller size portfolios of equal weight (small, medium and large). Percentage of small, medium and large firms is reported here for the ten decile portfolios.

Mean	L	2	3	4	5	6	7	8	9	W
S (%)	53.7%	65.7%	38.9%	25.0%	33.7%	17.3%	37.1%	13.6%	27.0%	20.2%
M (%)	42.7%	12.4%	48.9%	40.0%	35.7%	30.8%	27.6%	28.9%	32.1%	38.9%
B (%)	3.6%	21.9%	12.1%	35.0%	30.7%	52.0%	35.3%	57.4%	40.9%	40.9%

Table 10

Rebalancing method with risk adjustment – Performance for different size portfolios

The Norwegian stocks with a full set of returns through both the first rank and test period (1986-91) are all identified. The stocks that have been delisted in subsequent periods are not included in the calculations. Monthly continuous returns are then calculated for every stock in the rank period (1986-88), and these returns are again multiplied for each stock to get rebalancing returns (RBRS). Stocks are then ranked according to rank period performance and placed into decile portfolios. The worst performing 10% of the stocks constitute the Loser (L) portfolio and the best performing 10% make up the Winner (W) portfolio. The securities from the loser, winner and the arbitrage portfolio, are then ranked based on market capitalisation. The performance portfolios are divided into three smaller size portfolios (small, medium and large). Regression is then run for the size portfolios, of the form:

$$r_{i,t} - r_{f,t} = \alpha_{1i}(1 - D_t) + \alpha_{2,i} D_t + \beta_i (r_{m,t} - r_{f,t}) + \beta_{iD} (r_{m,t} - r_{f,t}) D_t + \varepsilon_{i,t}$$

where t = 1 to 72. $\hat{\alpha}_{1i}$ signifies the rank period return, $\hat{\alpha}_{2i}$ represents the test period return, $\hat{\beta}_i$ is the

rank period beta and $\hat{\beta}_{iD}$ is the change in beta from rank to test period. The test period beta is given by $\hat{\beta}_i + \hat{\beta}_{iD}$. The continuously compounded return on portfolio i at time t is given by $r_{i,t}$, the equally weighted market index (DS-market) is given by $r_{m,t}$, the risk free rate is r_f and D_t represents a dummy variable which is zero in the rank period ($t < 37$) and one in the test period ($t > 36$). Ordinary least squares (OLS) estimation is applied to estimate the parameters. The return calculations are performed applying the Rebalancing (RBRS) method, which is detailed in the data and methodology section in equation (9) and (11). The entire process is repeated for all other four rank/test periods. The results are then averaged across the five test periods to obtain aggregate results. Results for the loser, winner and the arbitrage portfolio (L-W) are reported here for each of the size portfolios (small, medium and large).

Rank Period (Year)	**Loser**				**Winner**				**Loser - Winner**			
	α_{1i}	α_{2i}	β_i	β_{id}	α_{1i}	α_{2i}	β_i	β_{id}	α_{1i}	α_{2i}	β_i	β_{id}
S	0.4212	0.9672	-0.1213	0.3367	0.7203	0.7403	-0.0420	0.2792	-0.4349	0.1536	-0.1340	0.1264
t-stat	(39.19)[a]	(27.57)[a]	(-3.35)[a]	(-0.1)	(64.71)[a]	(-31.9)[a]	(-4.17)[a]	(-0.74)	(-6.21)[a]	(-0.07)	(-0.65)	(-0.6)
M	0.8271	0.9193	0.0406	0.0848	0.4775	1.0375	0.1814	0.2027	-0.2388	-0.1866	-0.1919	0.3477
t-stat	(40.05)[a]	(25.19)[a]	(-0.8)	(-0.01)	(10.35)[a]	(51.33)[a]	(13.99)[a]	(-1.56)	(-3.98)[a]	(-3.22)[a]	(-0.81)	(-0.91)
B	0.9159	0.7810	0.6326	-0.5804	0.9622	0.9394	0.0527	0.0670	-0.1190	-0.1338	0.3783	-0.3530
t-stat	(26.56)[a]	(16.56)[a]	(-1.84)	(-1.69)	(46.95)[a]	(32.78)[a]	(-0.21)	(-0.14)	(-3.79)[a]	(-3.12)[a]	(-1.21)	(-1.13)

[a] Significant at the 1% level using a two tailed test

[b] Significant at the 5% level using a two tailed test

Conclusion

5.1 Summary of Results

Results from overreaction studies have been mixed. DeBondt and Thaler (1985), (1987), Chopra et. al. (1992), Dissanaike (1997) and several other studies find that prior losers outperform prior winners significantly three years after portfolio formation. In contrast, Chan (1988) and Ball and Kothari (1989) find intertemporal changes in systematic risks explain most of the return reversals. Fama and French (1986) and Zarowin (1989), (1990) find the overreaction effect to be just another appearance of the size effect. Moreover, many non American studies have found continuation behaviour instead of return reversals. These include Kryzanowski and Zhang (1992) (Canada) and Brailsford (1992) and Allen and Prince (1995) (Australia).

The results of this study are generally inconsistent with the overreaction hypothesis. Instead of return reversal, return continuation is observed when three year rank and test periods are examined. This is consistent with the results of the Canadian and Australian studies mentioned above. The results for the raw returns show the returns to the arbitrage portfolio to be significantly negative, but most negative when a buy and hold method is employed. No reversal is found for either rank period losers or winners, and these results appear to be robust across different time periods.

After adjusting returns for risk, equivalent results are arrived at. Returns to the arbitrage portfolio are negative. Test period returns for the loser portfolio are also negative, while for the winner portfolio they are positive. However, when rank and test periods are allowed to vary, some overreaction effects are found for the longer

time periods of four and five years. In contrast to Chan (1988) and Dissanaike (1997), systematic risk in most cases actually increases when returns decrease. This suggests that bigger firms are less risky than their smaller rivals.

Tests for size differences confirm the results of Fama and French (1986) and Zarowin (1989), (1990). It is found the loser portfolio is made up by significantly smaller firms than the winner portfolio for all time periods. The medium and large firms regression output show the same momentum pattern as previous risk adjusted results. The small firm portfolio on the other hand gives a positive test period return to the arbitrage portfolio, which seems to be due to the reversal of the loser portfolio. Firms of low market capitalization are nevertheless lower priced than bigger firms and therefore revert from a lower base yielding misleading results. Thus, it can be concluded the return continuations are consistent when adjusting both for risk and size, except for small firms where some reversal is displayed. When adding transaction costs into the equation after analysing proposed explanations for the return reversals, it appears as if the contrarian strategy is a poor investment strategy.

Most of the research on ORH has been done in the US, and the original DBT methodology has been applied in numerous papers. The consensus from the research displays clear reversals of returns when raw returns are utilized. The tests performed in other markets have on the contrary not all been in favour of the overreaction effect. For this reason it could appear as if the return reversals are not robust from country to country, and that some countries exhibit return reversals and others return continuation. Further, the time periods tested in this study are relatively short.

Whereas the period in this study only ranges from 1986-00, DBT examine the time full period of 1926-1984.

5.2 Limitations and Future Research

Testing for overreaction in a small, illiquid market such as the Norwegian equities market imposes some limitations by itself. Wide bid-ask spreads and infrequent trading are difficult factors to adjust for in such a market. Apart from this, data for delisted companies could not be obtained. This could possibly introduce a survivorship bias.

Future research should examine large stocks in order to eliminate the biases of bid-ask spreads and infrequent trading as well as the size effect. In addition, studies should expand their rank and test periods to five years or more, as return reversals could occur over longer time periods.

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Appendix

Table 11

Table of overreaction findings

Themes relevant to "Overreaction" studies	**Research Findings supporting "overreaction"**	**Research findings not supporting "overreaction"**
Raw Returns:	*DeBondt and Thaler (1985)*	
Risk Adjusted Returns:		*Chan (1988)* *Ball and Kothari (1989)*
Size Adjusted Returns:		*Fama and French (1986)* *Zarowin (1990)* *Clare and Thomas (1995) - UK*
Risk and Size Adjusted Returns:	*DeBondt and Thaler (1987)* *Chopra et. al. (1992)* *Albert and Henderson (1995)* *Chen and Sauer (1997)* *Dissanaike (1997) - UK*	
Bid-ask spreads and infrequent trading:	*Loughran and Ritter (1996)*	*Conrad and Kaul (1993)*
International studies:	*DaCosta (1994) – Brazil* *Alonso and Rubio (1990) – Spain* *Gaunt (2000) – Australia* *Leung and Li (1998) - Japan*	*Kryzanowski and Zhang (1992) – Canada* *Brailsford (1992) – Australia* *Allen and Prince (1995) - Australia*
International studies – Shorter periods:	*Bowman and Iverson (1998) - NZ* *Chang et. al. (1995) - China*	