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# EXPLOITING THE INDEX EFFECT TO EXTRACT ALPHA

***Master Thesis in Financial Economics***

BOREA ASSET MANAGEMENT

**IN COLLABORATION WITH:** BOREA ASSET MANAGEMENT

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# Abstract

This thesis aims to provide a better understanding of the index effect on the Oslo Stock Exchange Benchmark Index (OSEBX) and generate potential trading strategies for Borea Asset Management. The exploitation of the index effect anomaly has been discussed since the earliest studies of index revisions on S&P 500 dating back to the 1980s. This paper examines the index effect indirectly by observing returns on various CAR interval within the event window. By using the standard event-study methodology and the market model to calculate abnormal returns, we find that Borea can exploit the index effect by going long-short on inclusions and exclusions, respectively, within the grace period. More specifically, Borea should apply this strategy on the announcement day and cancel out the positions the day before the effective date. Moreover, we find a strong reversal effect already on the effective date. The mean reversal reinforces the belief that the index funds must rebalance their holdings with index revisions, and thus creates a price pressure and consequently a change in demand. Thus, we find support for the Price Pressure Hypothesis to explain the index anomaly. Ultimately, Borea can combine a trading strategy that exploits both the index effect in the grace period and the subsequent mean reversal after the effective date. In sum, we have revealed several exciting trading opportunities before and after the effective date.

# Preface

The field of finance is a relatively new research area aiming to explain the financial markets and the behaviour of the market participants. Established theories such as the efficient market hypothesis has played an important role for understanding financial markets. Yet, practical finance still deviates from financial theories, and markets have seen several anomalies. Financial research wants to close this gap and gain better knowledge of why deviations from the real-world and financial theories exists. One such anomaly is the observed price effect on inclusions and exclusions from stock indexes, also known as the index effect. We found this research area particularly interesting.

When Borea Asset Management proposed a master thesis collaboration we were unhesitant to apply for this privilege. As Borea is an active mutual fund located in Bergen with specialization in the Nordic countries, we couldn't wait to gain deeper knowledge of asset management. Specifically, we were excited to study the circuit of Oslo Stock Exchange and investigate if Borea could exploit the index effect to earn abnormal returns.

We want to thank our supervisor Professor Thorsten Hens for valuable guidance throughout the writing process. He has been extremely flexible and supportive. Lastly, we would want to express our gratitude towards Finans Bergen and Borea Asset Management for giving us the opportunity to write about such an interesting and applicable subject.

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# 1. Introduction

Active and passive management are the two main strategies for an investor to generate portfolio returns. Active management focuses on outperforming the market compared to a specific benchmark while passive management aims to replicate the composition of a market index. An actively managed investment fund believe that they can beat the market with the right expertise, in-depth research, market forecasting and experience of the management team with the underlying assumption that the market is inefficient. On the other hand, a passively managed fund aims to track the returns of a particular market index to generate the same return as the index rather than outperforming it.

The distinction between active and passive management hinge on the assumption of market efficiency. In short, the Efficient Market Hypothesis states that asset prices quickly adjust to new information and is therefore always reasonably priced. Active management is formed based on the belief that markets are imperfect; one can exploit the mispricing of securities with superior skills in stock picking and market timing. Hence, active managers believe that they can earn a higher average return over a low-cost index fund. On the contrary, passive management believes that it is impossible to beat the market systematically. A better alternative would be to invest in an index as it offers good diversification, low turnover- and management fees.

Studies have shown that passive management has strong empirical support. Consequently, index funds have expanded rapidly in popularity over the recent years (Furuseth 2015). Globally, index funds have grown in market share from 12 percentage in August 2010 to 18 percentage in July 2015 (ibid). Thus, the increased popularity of using indices as benchmarks has given rise to the "index effect."

## 1.1 Index Definition

An index is a statistical means of calculating a change in the economy or a market. The index is typically a weighted average representative sample of a market. The most popular index is the Standard and Poor 500 and is used as a proxy for the US stock market. Each stock index has its calculation methodology. Indices are generally classified as broad- or narrow-based regarding the diversity of the underlying securities and the markets they cover. A broad-based index is designed to represent the performance of an entire stock market such as the S&P 500 and OSEBX. A narrow-based index tracks the performance of stocks with similar characteristics. It could be particular industries they operate in or the size of the firms measured

by the market capitalisation. One example is the Oslo Seafood Index which consists of firms that operate in the seafood sector.

There are two popular ways to calculate the composite value of an index, and this affects how the index behaves in response to the movement of the prices of its component stocks. The first method is called the market value-weighted index. The price-weighted index method is calculated based on the price of the component stocks.

### 1.1.1 Index Tracking Funds

Index funds mirror various indices. The first index funds appeared in 1973 (Arnott 2018). Time revealed that index-tracking funds offered low transactions costs for investors and thus grew in popularity. The interest in index funds arose by the escalating evidence that active funds underperformed the broad market index, net of fees and trading costs (ibid). Today, the most popular indexes for the U.S market exposure include the S&P 500, Dow Jones Industrial Average and the Nasdaq Composite. For S&P 500, the popular tracking fund SPDR S&P 500 ETF has $275.4 billion in assets under management as of February 2018 (Arnott et al. 2018)

Trading costs associated with index funds are far from zero. In general, indices rebalance their holdings according to a set of criteria's such as liquidity, minimum float, and market capitalisation. These index changes are based on the guidelines outlined by their respective Stock Exchange. A stock that fulfils (fail to fulfil) the criterions are consequently added (deleted) into (from) the Stock Exchange. The index tracking funds aim is to replicate the index and to minimise the tracking error. A tracking error is the difference between a portfolio's return and the benchmark or index it is mimicking (Ang 2014). As a result, the index funds must buy and sell the added and deleted stocks whenever the index rebalance their holdings. Typically, index funds trade in large quantities and increases the trading costs (ibid).

Both Standard and Poor 500 and Oslo Stock Exchange pre-announce (announcement date) the index changes before the actual rebalancing date (effective date). The announcement date can range from a few days to weeks before the effective date. The implementation of the index changes occurs on the effective date. Moreover, the time between announcement- and the effective date is called the "grace period" where index fund managers must change their portfolio holdings to mimic the index (Ang 2014). This grace period gives index fund managers time to rebalance their holdings and may help to reduce tracking error and trading costs (ibid). Inclusions and exclusions should not affect the stock price according to the EMH. However, studies have shown otherwise (Ang 2014).

### 1.1.2 Definition of Alpha

Alpha is the average return in excess of a benchmark (Ang 2014). Thus, the concept of alpha requires a benchmark to be measured against.

$$r^{ex}{}_t = r_t - r^{bmk}{}_t$$

Where $r_t$ is the return of an asset, and the $r_{bmk}$ is the return of the benchmark. The excess return and benchmark return are often called active and passive returns, respectively. The benchmark return is passive and can be produced without human intervention (ibid). Two important concepts concerning alpha are the tracking error and information ratio. The tracking error is the standard deviation of the excess return (Ang 2014). It measures how disperse the manager's return are relative to that of the benchmark. Typically, managers tracking an index wish to minimise this tracking error. Moreover, the information ratio is the ratio of alpha to tracking error and is called the average excess return per unit of risk (ibid).

## 1.2 Standard & Poor 500

The S&P 500 index was created in 1957 to measure the performance of the stock market in the US (S&P 500 2018). It is composed of 500 constituent companies (ibid). It is a large-cap index and is a measure of the overall U.S. economy. The S&P is a broad-based index, and constituent weights are based on float-adjusted market capitalisation (ibid). Our interest of study in this paper is the OSEBX. The Norwegian stock market is much smaller and has been subjected to fewer studies. The reason behind is the significant difference in the invested capital indexed to the S&P 500 and OSEBX. Since most of the studies on the index effect are based on the S&P 500; it is worth discussing the characteristics of the two markets.

The S&P 500 index is rebalanced annually in June, but the composition can change throughout the year due to changes in eligibility. The announcement date has varied and ranges from one to five days before the effective date (S&P 500 2018). When the index constituents are changed, it does so according to the following criteria: Market capitalisation, liquidity, domicile, public float, sector classification, financial viability and treatment of IPOs. For further details, one can take a closer look at the S&P 500 index methodology.

## 1.3 Oslo Stock Exchange Benchmark (OSEBX)

The OSEBX is the most popular benchmark for index funds in the Norwegian stock market. OSEBX is a total return index that functions as an indicator of the overall performance of the Oslo Stock Exchange (Oslo Børs 2017). It aims to be an investable index, containing a representative selection of all listed shares on OSE and periodic stability of the index

composition. Also, OSEBX wishes to reduce administrative costs and secure tradability of the index constituents (ibid). To fulfil this object, OSEBX follows an Index Methodology outlined by Oslo Stock Exchange.

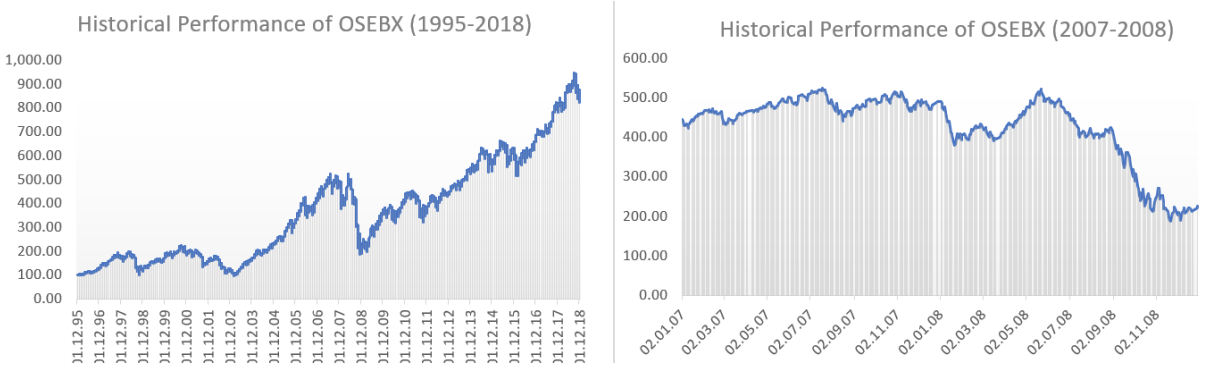


*Figure 1. Historical Performance of the OSEBX from 1995-2018 and 2007-2008*

The index was introduced on 23rd of May in 2001 with a start date of December 31 in 1995 with a base value of 100 points (Oslo Børs 2017). Per 24.09.2018 the value of the index peaked at 900 points. Historically, the index has been fluctuating around an increasing mean. However, the index has seen a sharp decrease during the dot-com bubble in the early 2000s and the financial crisis from mid-2008. Originally, the crisis began in the subprime mortgage market in the U.S. in 2007 and escalated to a full-fledged international banking crisis where Wall Street bank Lehman Brothers filed for bankruptcy on September 2008 (Kingsley 2012). The Norwegian Stock market was volatile in the second half of 2007 and got hit hard in 2008 where the value of the shares listed on OSE were more than halved from the end of May to the beginning of October (Eikrem 2008). Most companies' shares declined 50-70% in value (ibid).

### 1.3.1 OSEBX Index Methodology Guidelines

The OSEBX is rebalanced semi-annually based on a liquidity, industry target and free float criteria. The index changes are implemented the first trading day of June and December, and rebalancing will be undertaken based on the closing prices the day before implementation (Oslo Børs 2017). However, from January 2003 to 2009 the effective date was the first trading day of January and July. The announcement date has varied throughout the years due to weekends or holidays but also methodology changes executed by OSE. The table below gives the reader an overview of the average AD of various horizons. Since the AD varies throughout the sample, we have calculated the median between AD and ED in the sample period to get an accurate estimation of the average announcement date over the full sample as well as sub-samples.

| Period | Announcement Date |
|---|---|
| **2003-2007** | 15 days before ED |
| **2009-2018** | 11 days before ED |
| **Full sample** | 12 days before ED |

*Table 1. Historical Announcement Dates over Various Horizons*

#### *1.3.1.1 Liquidity and Industry Target Criteria*

The following four-step process describes how OSE selects securities that constitute the index. Oslo Stock Exchange (2017) states the following:

(i) All eligible securities listed on Oslo Børs are ranked according to the previous 12 months official turnover. The 12 days with the highest turnover for each security are excluded from the calculation.

(ii) Securities with the lowest turnover according to (i) corresponding to 40% in number are deemed ineligible. Existing constituents are deemed ineligible when ranked at 35% or below.

(iii) The 30 highest ranked securities according to (i) are deemed to qualify for inclusion. Existing constituents are deemed to qualify if ranked at 35 or above.

(iv) Within each industry group (GICS level 2), securities are ranked according to their free float-adjusted market cap from largest to smallest, and selected top-down until at least 80% of the industry group's free float-adjusted market cap is reached. Existing constituents are selected unless they are ranked below 90% of the industry group's free float-adjusted market cap.

Securities deemed to qualify according to (iii) are added. Securities deemed ineligible according to (ii) are removed. Consequently, the target of at least 80% of each industry group's free float-adjusted market cap may not be reached (ibid)

#### *1.3.3.2 Free Float Criteria*

The free float criteria are the portion of the outstanding shares of a company, which is freely available in the market (Oslo Børs 2017). The level of free float is measured with data about the ownership stake of the top ten investors in a company from the first two weeks of April and October, respectively. The goal of free float is to improve the pricing of the securities and the index's overall investability (ibid). The following ownership restricts free float and prohibits securities to be included in OSEBX:

| | |
|---|---|
| **Government holdings** | Shareholders held by governments, municipality excluded. |
| **Controlling shareholders** | Ownership stakes defined as non-free float:<br>I. Ownership stake > 30%<br>II. One ownership stake of 10% combined with other ownership stakes exceeding 40%<br>III. Three or more ownership stakes all higher than 10% exceeding 50%<br>IV. Shareholdings owned by a firm in the same industry group exceeding 10% |
| **Company Insider stakes** | Shares owned by persons included in the list of Financial Supervisory Authority. |
| **Cross-holdings** | Shares owned by an index constituent or a non-constituent. Classified as non-free float only if both companies own shares of each other. |

*Table 2. Ownership Restrictions Outlined by The OSE*

Any security with a free float greater than 15% will be included in the index rounded up to the closest 5%. Securities failing to exceed 15% will be included in the index rounded down to the nearest percentage (ibid). The constituent's free float is rarely changed between the review dates, unless if there have been abnormal market changes related to corporate events.

#### *1.3.3.3 Other Considerations*

Liquidity criteria

Even if security fulfils the criteria of being the top 30/35 with the highest turnover, OSE might decide that the security is ineligible if the security has experienced days with limited or no transactions. Typically, securities that have been traded less than 90% of the (listed) period's trading days will typically be convicted ineligible (Oslo Børs 2017).

Corporate events

If any M&A activity occurs between the last trading date of April/October and the publishing of the preliminary index composition the acquisition/merger will not be included in the selection process. OSE considers an acquisition to be complete when the acquirer controls more than 90% of the outstanding shares of the target (Oslo Børs 2017).

OSEBX is uncapped

The uncapped OSEBX can be an unfavourable choice of benchmark if one or more of the constituents dominates the index. The security or the industry can be over-represented, skew the index performance, and thus not correctly represent the investment universe of all stocks listed on OSE. Consequently, the index may no longer be investable for investors who benchmark against the index due to investment restrictions (Oslo Børs 2017).

## 1.4 Comparison Between S&P 500 and OSEBX

The index effect on S&P 500 is a well-researched phenomenon, contrary to the OSEBX which does not have the same coverage. Both indices are broad-based aiming to represent the performance of the US and Norwegian stock markets respectively. Moreover, the indices are market capitalisation weighted where each stock's price times the shares outstanding decides the influence each stock have on the overall index. The main difference between the two indices is that they represent two very different markets, both in size and composition. Furthermore, the capital invested in index funds in Norway is much smaller compared to the US market. In 2017, the number of mutual funds in Norway and USA were 398 and 9356 respectively (Statistisk Sentralbyrå 2018).

Both indices have straightforward selection criteria which make changes in the index constituents predictable. Specifically, the S&P 500 and OSEBX both have an announcement date and effective date; which allows us to study the price movements on additions and deletions during this "grace" period and compare the results on previous studies on S&P 500 to our findings on the OSEBX. Moreover, it will be interesting to investigate the index effect between a heavily tracked multinational index (S&P 500) and a less popular national index (OSEBX).

# 2. The Index Effect and Earlier Studies

There have been several studies researching the index effect, and the result is ambivalent. Shleifer (1986) was the first to study the index effect on the S&P 500. He found stocks that were newly included in the S&P 500 index earned an abnormal return on the announcement of the inclusion. This abnormal return was linked to buying pressure by the index funds. Another study, Jain (1986) argued that an increase in the price itself was not enough evidence of a price pressure effect. After controlling for the price performance of a supplemental index, the study rejects the hypothesis of a price pressure effect on the S&P 500. However, Jain (1986) found strong evidence that S&P 500 inclusions had information content. Furthermore, Lynch and Mendenhall (1997) explained their results considering the violation of the efficient market hypothesis and how risk arbitrageurs could exploit it.

## 2.1 Efficient Market Hypothesis

The EMH is a pillar of modern finance theory. The notion that stocks already reflect all available information is referred to as the efficient market hypothesis (Bodie et al. 2012). According to the EMH, stock returns follow a random walk and is therefore not predictable. So why do investors have the incentive to spend both time and resources to uncover new information? It boils down to the investor's belief of how efficient the market is (ibid).

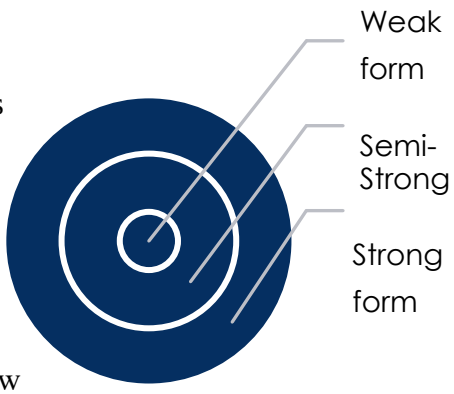


*Figure 2. Efficient Market Hypothesis*

The weak-form hypothesis states that stock prices already reflect all information that can be derived by examining market trading data such as historical price- and trading volume (ibid). This data is publicly available and is cost less to obtain. It claims that all past prices of a stock are reflected in today's price (Bodie et al. 2012). Semi-strong efficiency argues that current stock prices adjust quickly to the release of new information. Such information includes (in addition to past prices) fundamental data of a firm's current product line, quality of management, earnings forecasts and balance sheet composition (ibid). If investors can access this information from public data, one would expect the stock price to reflect information of a firm's current prospects and past prices (Bodie et al. 2012). The strong-form efficiency claims that the stock price reflects all information relevant to the firm, including inside information (ibid).

### 2.1.1 The Market Portfolio

If we ought to believe that the efficient market hypothesis holds, then the effort performed by active management is pointless. The EMH does not arouse enthusiasm among the community

of professional portfolio managers (Bodie et al. 2012). The activity performed by the portfolio managers may be harmful to clients as they get charged a management fee and less-diversified portfolios. However, security analysts disagree. They believe that the combination of superior skills, unique techniques and a substantial amount of capital can indeed beat the market. Those who are in favour of the market efficiency, the passive managers, believe that stock prices are at fair levels, given all available information, and so buying and selling securities at a high frequency results in substantial trading costs without increasing returns (Bodie et al. 2012).

The move towards indexation was supported by the Efficient Market Hypothesis and the Capital Asset Pricing Model (CAPM), both gaining enormous attention in academic circles (Arnott 2018). Notably, CAPM conclusions of the market portfolio as being mean-variance efficient for every investor gained much support (ibid). In other words, CAPM argued that the market portfolio is unbeatable except by luck. Empirical evidence revealed later that it existed inefficiencies in the markets (ibid). Roll (1977) studied the CAPM and questioned if there were such thing as a truly diversified market portfolio.

Theoretically, the market portfolio consists of all the investments individuals hold as a global community, including human capital, real estate, obligations and illiquid markets such as venture capital (Arnott 2018). Investors who have their capital tied up to index-tracking funds may believe that they are invested in the market portfolio. This is far from the truth. The S&P 500 represented 80% of the US equity market and 40% of the global equity market from 1985 to 2017 (ibid). In other words, S&P 500 and other indices are not perfect substitutes for the market portfolio.

### 2.1.2 Weak-form Tests

Early tests of efficient markets were conducted measuring serial correlations of stock market returns (Bodie et al. 2012). Serial correlation is the tendency of past returns being a predictor of future returns. A negative (positive) serial correlation means that negative (positive) returns follow positive returns. Several studies found a weak price trend over short periods in broad indices, but no clear-cut evidence of trading opportunities (ibid). Besides, studies have shown that there has been a strong momentum effect in the short-run in both the aggregate and cross-sectional market (across particular stocks).

On a long-term basis, Fama et al. (1988) found that long-horizon returns have experienced negative serial correlation in the performance of the aggregate stock market (ibid). One explanation is the stock market's overreaction to relevant news. First, there will be a subsequent

positive serial correlation over the short term. This overreaction leads to poor performance over in the subsequent periods. Lastly, Fama and French (1988) found that readily observed variables such as dividend to price ratio could predict market returns. One take is that these variables could predict abnormal stock returns and violate the EMH. More plausible, however, is that these predictors are just a proxy for some market risk.

### 2.1.3 Semi-strong Tests

To test if asset returns are predictable using past and current publicly available information, one must use fundamental analysis. The fundamental analysis aims to evaluate a security to assess its intrinsic value, by examining related economic, financial and other qualitative and quantitative factors (Investopedia 2018). Thus, investigating the credibility of the fundamental analysis is simultaneously a test of the semi-strong form (Bodie et al. 2012).

The difficulty of interpreting these tests are the choice of benchmark to adjust for portfolio risk when performing an event study (ibid). The general approach starts with choosing a proxy for what the stock return would have been in the absence of the event (benchmark). The abnormal return is calculated as the difference between the stocks actual return and the benchmark's return (ibid). If the benchmark is unable to capture the market risk premiums, one can end up recommending unfeasible investment strategies that seemingly offer superior returns.

Studies have revealed several anomalies. Banz (1981) found that small firm portfolios gave on average 8.52% higher annual return than large firm portfolios between 1926-2011. Generally, smaller firms contain more risk. However, adjusting for risk using CAPM, there was still a premium to collect for investing in smaller-sized portfolios. Later studies found that this effect is prominent in the first two weeks of January (Bodie et al. 2012). However, some studies argue that the January effect is due to information. Since institutional traders tend to neglect smaller firms, information is, therefore, less available. The January effect may represent a risk associated with limited information rather than abnormal returns.

Fama and French (1992) found that high-book-to-market firms tend to outperform low-book-to-market firms. Lastly, Ball and Brown (1968) found a sluggish response to news announcements. It does not coincide with the EMH which states that efficient markets react quickly to new information. One of the findings was a positive drift after the announcement of good news, also called the momentum effect. Thus, a trader could earn abnormal profits by merely purchasing a stock portfolio of positive-earnings-surprise companies and capture the momentum effect (Bodie et al. 2012).

### 2.1.4 Interpreting the Anomalies

Are anomalies such as price-earnings, small-firm, market-to-book, momentum, and long-term reversals risk premiums that traders need to be compensated for, or simply inefficiencies to be exploited? Fama and French (1993) claim that these effects are compensation for risk. In other words, they argue that these patterns of returns are consistent with the EMH, compensating traders for additional risk taking. On the contrary, Lakonishbok et al. (1995) argue that these phenomena's are a result of market inefficiencies. They believe that market analysts extrapolate past performance too far into the future. Consequently, firms with recent good (bad) performance are overpriced (under-priced). When market players discover these errors, price reversals commence.

To conclude, the view that we live in perfectly efficient markets are unrealistic. There are enough anomalies in the academic literature that suggest that research effort can be justified (Bodie et al. 2012). The pursuit of under-priced securities is not without reason. However, most studies suggest that investment strategies offering superior return by exploiting anomalies, should be taken with a grain of salt. The market is heavily competitive, and only those who possess superior information or insight will earn money (ibid).

## 2.2 The Index Effect Anomaly

The index effect is the phenomenon of abnormal returns and trading volume that stocks may experience in the event of being included or excluded from an index (Blomstrand & Safstrand 2010). An index effect is a violation of the EMH, as revisions of indices based purely on price and trading volume should not affect the stock returns as it does not reveal any new information. In efficient markets, the return is justified for its risk, and any mispricing would quickly adjust as arbitrageurs would exploit such mispricing.

### 2.2.1 Indices as Benchmarks

The idiosyncratic and systematic risk is what separates fluctuations of a stock's return (Berk & DeMarzo 2014). Idiosyncratic risk is firm-specific and unrelated across stocks. On the other hand, systematic risk is macro events that affect all stocks. Hence, the systematic risk is non-diversifiable and must be fairly compensated for (ibid). When one combines many stocks in a broad portfolio, the idiosyncratic risk for each stock will average out and be diversified (Berk & De Marzo 2014). Financial theory suggests that any investor should in equilibrium hold the market portfolio (ibid). A near-substitute for the market portfolio can be a broad market index. Therefore, mutual funds have found it convenient to use indices as benchmarks, and thus the index effect anomaly has blossomed.

### 2.2.2 The Price Pressure Hypothesis

The price-pressure hypothesis introduced by Schleifer (1986), argues that demand and supply shocks lead to abnormal returns, seeing as the market is incapable of absorbing the orders at the current price level. According to EMH, asset prices should only change in response to news about fundamentals, not the number of shares demanded. However, in the real world, security prices fluctuate continuously (Foucault 2013). PPH predicts that shocks will have a temporary effect on prices caused by market frictions. If a stock is included in an index, there will be an outward shift of the demand curve for the stock, consequently affecting the price (Schleifer 1986). On condition that the supply- and demand curve being constant and downward sloping, respectively. When faced with block trades in the marketplace, suppliers of liquidity will demand a premium for providing liquidity in order to absorb the shock. These price fluctuations are temporary and inconsistent with the strict interpretation of the EHM.

Harris and Gurel (1986) studied inclusions to the S&P 500 index and found that stock prices reverted to their pre-event levels within two weeks and that the trading volume increased around the announcement day. Similarly, Elliott and Warr (2003) found evidence of the Price Pressure Hypothesis, but only on the effective date. Shleifer (1986) found stock price increases for additions on the S&P 500 but attributed the increase to another hypothesis called the imperfect substitute hypothesis.

### 2.2.3 The Imperfect Substitute Hypothesis

The imperfect-substitute hypothesis states that the stock price is of a more permanent nature if different stocks are imperfect substitutes (Bechmann 2004). Thus, the long run demand curve slopes downwards. To tackle the demand shock, stock prices must increase to eliminate any excess demand caused by an index inclusion (ibid). Consequently, the price effect is permanent as long as the stock is included in the index. The trading volume can, however, be short term or long term depending on the behaviour of the traders causing the demand shock (Bechmann 2004). If a trader has a buy and hold strategy, the trading volume would be temporary. On the contrary, if an index inclusion increases the popularity of the stock; the increased trading volume will persist as long as the stock is in the index (ibid). Wurgler (2002) found that stocks without close substitutes experienced higher price jumps upon inclusion into the S&P 500.

### 2.2.4 The Information Costs / Liquidity Hypothesis

The fourth hypothesis is the information costs/liquidity hypothesis. The general idea is that trading costs arise from the illiquidity of the market. All else equal, an inclusion increases the trading volume and consequently the liquidity. Thus, the quoted bid-ask spread is negatively

correlated with market liquidity (Foucault 2013). Bear in mind, that trading volume tends to increase when new information hits the market, which is also a time for high volatility and wide bid-ask spreads. Lastly, several studies argue that index inclusions have both an informational content and attention drawing effect.

Dhillon and Johnson (1991) found evidence supporting the information costs/liquidity explanation and casted doubt upon the price pressure and imperfect substitutes hypothesis. They argued that listings indeed conveys information to the market. Moreover, they analysed the options market at the S&P 500 and found that call prices increased on the announcement date, while put prices declined (ibid). What is more, the stock price did not return to pre-announcement levels. The evidence supported the information hypothesis and that stocks, bonds, calls, and puts were close substitutes. Hence, they argue that the EMH holds.

### 2.2.5 The Attention Hypothesis

The attention bias stresses the idea that an investor has limited attention and will therefore only extract the information they consider essential for solving a specific task (Hens & Bachmann 2018). Moreover, investors are exposed to news through media, and increased market attention of a firm can lead to a permanent stock appreciation. After an index inclusion, a larger pool of investors draw attention to the stock which leads to a permanent price appreciation, and vice versa. However, stocks that have previously been excluded from specific indices and been included in another index should not experience the same price jump as first-time inclusions.

### 2.2.6 The Information Signalling Hypothesis

The information signalling hypothesis was studied by Mikkelson (1981), Harris & Raviv (1985) and Smith (1986). This hypothesis looks at how inclusion and exclusion of a stock function as a proxy for good and bad news respectively. To illustrate, the inclusion of a firm's stock has convinced the committee’s opinion of the firm’s longevity and future cash flows (Bechmann 2004). Jain (1987) finds evidence of a permanent stock price effect of S&P 500 revisions and suggest the reason is new information revealed by announcements (ibid).

## 2.3 Is There an Index Effect on OSEBX?

Several hypotheses can help explain the index effect. We have examined some recent studies on the matter to see if there is any support for these theories. A study on the capped version (OSEFX) done by Knutsen (2014) shows a significant price pressure effect on inclusions. This study concludes that the effects are mainly related to The Price Pressure Hypothesis. A similar study conducted by Mæhle & Sandberg (2015) supported these findings, emphasising the importance of the price pressure hypothesis as a possible explanation for the abnormal returns observed around announcement date and effective date. Both studies indicate positive abnormal returns for inclusions. Mæhle & Sandberg (2015) finds a Cumulative Abnormal Return (CAR) of 8.32% in the period ED-60 to ED-1, while Knutsen's (2014) findings are more conservative with a CAR of 2.69% in the same period. Both studies look at different hypothesises that try to explain the index effect and both papers make conclusions on how their results can be consistent or not consistent with the proposed hypotheses outlined in sub-chapter 2.2. The table below summarises the results of both studies.

| | Knutsen (OSEFX) | Mæhle & Sandberg (OSEBX) |
|---|---|---|
| **Hypothesis** | | |
| Price Pressure Hypothesis | Consistent | Consistent |
| Imperfect Substitutes Hypothesis | Not consistent | Not consistent |
| Liquidity/Information Cost Hypothesis | Not consistent | Not consistent |
| Attention Hypothesis | Consistent | Consistent |
| Information Signalling Hypothesis | Not consistent | Not consistent |

*Table 3. Main Results from Knutsen (2014) and Mæhle & Sandberg (2015) on The Index Effect*

Both Knutsen (2014) and Mæhle & Sandberg (2015) research on the capped (OSEFX) and uncapped (OSEBX) benchmark indexes are consistent with each other. Both papers state that there is a presence of an index effect on OSEFX and OSEBX and that their results can be explained by the price pressure hypothesis and the attention hypothesis. Our research aims to propose a trading strategy for Borea to exploit the index effect. Therefore, we are more interested in finding the CAR intervals that maximise the return on our proposed trading strategy rather than going in depth of which hypotheses that is the underlying factor creating the index anomaly. The table below summarises the (cumulative) abnormal returns for both Knutsen (2014) and Mæhle & Sandberg (2015).

| | Knutsen (OSEFX) | Mæhle & Sandberg (OSEBX) | Mæhle & Sandberg (OSEBX) |
|---|---|---|---|
| Timeline | Inclusions | Inclusions | Exclusions |
| AR AD-1 | -0.13 % | 0.16 % | -0.06 % |
| AR AD | 0.39 % | 0.76 % | -0.84 % |
| AR AD+1 | 0.67 % | 0.18 % | -0.16 % |
| AR ED-1 | 2.48 % | 2.51 % | -2.86 % |
| AR ED | -0.64 % | -0.48 % | 1.93 % |
| AR ED+1 | 0.21 % | -0.03 % | 0.56 % |
| CAR ED-51 to -1 | 2.69 % | | |
| CAR ED+1 to +36 | -1.73 % | | |
| CAR ED-60 to -1 | | 8.32 % | -9.86 % |
| CAR ED+1 to +100 | | -2.94 % | 8.57 % |

*Table 4. Knutsen (2014) and Mæhle & Sandberg's (2015) AR/CAR findings in Their Respective Studies*

Both studies show high and significant abnormal returns around the rebalancing date for inclusions. Also, Mæhle & Sandberg find significant negative returns for exclusions on ED-1 and ED-60 to ED-1 of -2.86% and -9.86%, respectively. Both studies examine the traded volume in the period to explain the abnormal returns. The spike in volume that occurs around AD and ED is statistically significant at one per cent level. Furthermore, an exciting feature of these findings is the reversal effect that starts immediately at the rebalancing date. Mæhle & Sandberg finds strong and significant negative abnormal returns for inclusions and positive for exclusions at ED. This effect is still observed 100 days post-effective date as we see inclusions have a negative cumulative abnormal return of -2.94% and positive 8.57% for exclusions. Knutsen does not have the same length on his event window but can also confirm the same effect for inclusions 36 days after rebalancing.

Both studies give indications of a stronger index effect after the financial crisis of 07-08. We believe that the stronger index effect is mainly driven by the increased popularity (and number) of index-tracking funds and thus reinforce the price pressure hypothesis as more mutual funds rebalance their holdings. The reason why index-tracking funds have grown in popularity could be the increased risk-aversion among investors. Moreover, diversification combined with low to zero management fees makes index-funds an attractive option for investors. In sum, the findings of both studies leave us with the conclusion that an index effect is present on the Oslo Stock Exchange. Furthermore, we believe that the Price Pressure Hypothesis is the primary driver for the index effect and the increasing popularity of index-tracking funds will sustain the index effect for years to come. Also, the strong mean reversals of both studies confirm that the index effect is temporary and thus amplifies the price pressure effect.

# 3. Data Selection

This study aims to identify and exploit the index effect through a long-short portfolio of inclusions and exclusions on the OSEBX. Thus, there are two dates of interest for every inclusion and exclusion; the announcement- and effective date. OSE reviews the index semi-annually, and the rebalancing is implemented on the first trading day of June and December. On the announcement day, market participants can forecast the final revision on the effective date. Not only is the information publicly available for all market participants, but the selection criterions for the OSEBX is straightforward and predictable.

We have studied index revisions for OSEBX between January 2003 and June 2018. The data was divided into four sub-samples; the full sample (2003-2018) and pre (2003-2007), during (2008) and after the financial crisis of 2008 (2009-2018). Every inclusion and exclusion are defined as an individual event. DataStream has been used to extract daily returns for securities that have been subject to either an inclusion or exclusion on OSEBX. To adjust for stock splits, dividends and corporate actions we have applied adjusted closing prices. Moreover, we have retrieved daily returns for a suitable benchmark in the same respective period. Our choice of benchmark fell on OSEAX, as it in our opinion, represent the overall Norwegian stock market.

Our analysis consists of 362 events in total where 203 of them being inclusions while the rest being exclusions. We could not use all the actual events in our data. Firstly, restrictions on data availability. Some inclusions and exclusions were omitted due to little or no trading days in the event window. Secondly, corporate events such as M&A, divestitures and name changes are excluded from our data. These are all examples of events that can give misleading results and cause abnormal returns independent of the index effect. As a result, these observations have been removed from our dataset.

In sum, we have studied the performance of inclusions and exclusions relative to the market (OSEAX) over the event window [T-30, T+30], where T is the effective date since the change is implemented on the effective date. A separation of the inclusions and exclusions have been made to capture and isolate the different characteristics of the two events. Furthermore, the reduced sample size was necessary but posed implications for our initial data set. However, for obtaining interpretable results, we had no choice but to remove data to mitigate aggravating factors that could not be attributed to the index effect. Moreover, there may be some bias in our dataset due to spin-off and merger activities around the announcement day that have not been detected.

# 4. Event Study Methodology

MacKinlay (1997) argue that an event study is feasible for measuring the effects on an economic event. Given a rational marketplace, the effects of an event can be observed in the security prices over a relatively short time span (ibid). The event study has been a popular tool to study firm-specific and economy-wide events. In economics and finance, some examples include mergers and acquisitions and earnings announcements. Using the event study methodology outlined by MacKinlay (1997), we will study the effect on security prices to measure the impact of an index inclusion or exclusion.

## 4.1 The Event Window

The event window is the period over which the security prices of the firms involved in this event will be examined (MacKinlay 1997). The period of interest where we will observe abnormal returns is set around the announcement- and effective date. As Oslo Stock Exchange pre-announce changes to the index along with the effective date, we expect the index effect to be visible in the grace period. Likewise, the index funds will accept some tracking error to begin early purchasing of stocks that will be subject to a potential inclusion/deletion. The causality of this is that index funds wish to trickle the orders slowly into the market to get better prices. Moreover, we expect that market participants will make educated guesses to index changes even before the announcement date due to the predictability of the OSE selection criterions. As a result, we have set our event window to start 30 trading days before the effective date.

Previous research suggests that the price effects after an inclusion/exclusion will be fully reversed within a few weeks after the effective date. Thus, we have chosen to set the event window thirty days after the effective date to capture any reversals. We have chosen the event date (t=0) to represent the effective date. As mentioned in subchapter 1.3.1, the announcement date has varied in relation to the ED. Thus, the AD in our analysis represents an estimation as we have taken the median between AD and ED over the full sample. Historically, OSEBX has experienced an announcement date that ranges from 9-16 days before the effective date.

## 4.2 Model Selection

A substantial feature of an event study is the choice of an appropriate normal return model. The abnormal return is essential to evaluate the event's impact. The subtraction of the actual ex-post return from a benchmark is the abnormal return. The benchmark is the expected return the security otherwise would experience if the event did not occur (MacKinlay 1997). For firm i and event date $\tau$ the abnormal return is

$$AR_{i,\tau} = R_{i,\tau} - E\left[R_{i,\tau} \mid X_{\tau}\right] \qquad (1)$$

Where $AR_{i\tau}$, $R_{i\tau}$, and $E[Ri\tau|X\tau]$ is the abnormal return, actual return, and the benchmark (or normal) return respectively in time period $\tau$. $X_{\tau}$ is the conditional information for the normal return model (MacKinlay 1997). There are two prevalent statistical models for calculating the normal return; the constant mean return model where $X_{\tau}$ is a constant, and the market model where $X_{\tau}$ is the market return. The constant mean model assumes that the mean return for any given security is constant through time (MacKinlay 1997). The market model argues that there is a linear relationship between the security's return and the market return (ibid). The constant mean model does not account for market changes so the results may be biased. It is simple and highly restrictive compared to other models. A more sophisticated choice would be the market model as it has proven to give more robust results. Consequently, the calculations are more complicated but worth the effort. Thus, our choice of an appropriate normal return model is the market model.

### 4.2.1 Other Statistical Models

Researchers for modelling the normal return have used several other statistical models. The most general model is the factor model. This model aims to reduce the variance of the abnormal return by explaining more of the variation in the return of the expected return. Usually, the factors are portfolios of traded securities. The market model is an example of a one-factor model. A popular multifactor model used and endorsed by many researchers is the Fama French Three-Factor Model (FF3F). The FF3F model is an extension of the CAPM by adding size risk and value risk factors to the market risk factor defined by the CAPM. The main findings in this study was that small-cap stocks systematically beat the market. In this multifactor model, one calculates the abnormal return by taking the difference between the actual return and a portfolio of firms with similar size; measured by the market capitalisation (MacKinlay 1997).

Generally, the gains of adding multiple factors for event studies can have limited benefits (ibid). In an econometric perspective, the added factors have shown to have limited explanatory power to the simple one-factor model such as the market model. Consequently, the multi-factor model offers a little reduction of the variance in the abnormal return (ibid).

### 4.2.2 Economic Models

The two most popular economic models applied in event studies is the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT). The CAPM is an equilibrium theory where the covariance with the market portfolio determines the expected return of a given

security. The APT is an asset pricing theory which states that the expected return of a security is a linear combination of multiple risk factors (MacKinlay 1997).

The CAPM was popular in the 1970s in event studies but revealed flaws on the restrictions imposed by the CAPM on the market model (MacKinlay 1997). Campbell et al. (1997) found that the CAPM estimates deviated significantly from actual observations. Likewise, other studies have applied multifactor models to the market model motivated by the ATP (ibid). Researches have revealed that the most critical factor is the market factor while additional power adds little explanatory power (ibid). Thus, the difference between the APT model and the market model is small and insignificant. Finally, the statistical models eliminate the biases posed by the CAPM. To this day, statistical models dominate the event studies.

## 4.3 Estimation Window

The next step in the event-study methodology is to define the estimation window. The estimation window calculates the hypothetical return that would have occurred in the absence of the event. Specifically, the estimation window is set before the event window to calculate the expected return for each asset and every event. Given the market model as our model selection ($X_\tau$), the estimation window estimates the market mean return over a given period. The duration of the estimation window has no "one-size-fits-all" solution. Yet, the estimators should be as unbiased as possible and the event period itself should not be included in the estimation period as it can prevent the event from influencing the normal performance model parameters (MacKinlay 1997).

There is no consensus concerning the length of the event window nor the estimation window. MacKinlay (1997) suggests that an event study using daily returns should estimate the market model parameters over 120 days before the event. Moreover, Carow and Kane (2002) suggest 200 days and Litvak (2007) use 500 days before the event window. To maximise the predictive power of the market model we have applied an estimation window that starts 200 trading days ex-ante the effective date. In order to decide an appropriate end date of the estimation window; one must take the likelihood of information leak into account. In our research setting, we have chosen the end date of the estimation window to be one day before the start of the event window. We believe that the predictability of OSE methodology guidelines increases the risk of informed market participants, and thus have chosen a relatively large event window, starting 30 days before the ED to cover any information leakage.

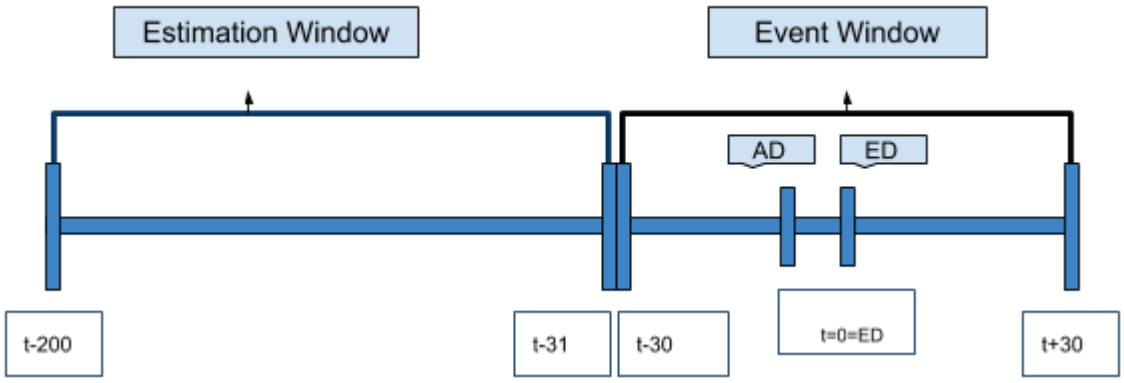


*Figure 3. Event and Estimation Window*

The figure above illustrates the length of the event- and estimation window. As illustrated, the estimation window starts 200 trading days before the effective date and ends 31 observations before the effective date; [t-200, t-31]. T denotes the effective date. Since AD varies throughout the period, it has no notation. Moreover, quantities with the subscript $\tau$ refer to calculations within the event window, and *t* refers to the calculations in the estimation window. Finally, the estimation window lays the foundation of the parameter estimates used in our market model to calculate the abnormal returns.

## 4.4 The Market Model

The market model is a statistical model which relates any security's return to the return of the market portfolio (MacKinlay 1997). The model's linear specification is built on the foundation of assumed joint normality of asset returns. For any security *i* the market model is

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \qquad (2)$$

$$E(\varepsilon_{it} = 0) \qquad var(\varepsilon_{it}) = \sigma^2{}_{\varepsilon_i}$$

Where $R_{it}$, $R_{mt}$ is the period (t) returns on security *i* and the market portfolio respectively. The actual stock return is the lognormal change in the closing price of the day before. $\alpha_i, \beta_i,$ and $\sigma^2{}_{\varepsilon_i}$ are the parameters of the market model to be estimated. Furthermore, $\varepsilon_{it}$ is the residual for security *i* at time t.

A proxy for the market portfolio (and therefore $R_{mt}$) is a world-wide market index. However, there are trends in the local markets that are not captured by a worldwide market index. By not including these local market factors, can lead to a biased estimation of $R_{mt}$. Thus, we have chosen to include an index that represents the overall Norwegian stock market; namely the Oslo

Stock Exchange All-Share Index (OSEAX). The OSEAX consists of all shares listed on the OSE and is adjusted for corporate actions, dividends payments, and stock splits. For each security, we estimate the model parameters applying the ordinary least squares (OLS) based on the estimation-window observations.

$$R_{it} = \alpha_i + \beta_i R_{OSEAX\ AllShare,t} + \varepsilon_{it} \qquad (3)$$

The OLS estimator chooses the regression coefficient so that the estimated regression line is as close as possible to the observed values. The intercept $\hat{\alpha}_i$ and the OLS estimator $\hat{\beta}_i$ can then be used to calculate the expected returns in the event window.

$$E(R_{it}) = \hat{\alpha}_i + \hat{\beta}_i R_{OSEAX\ AllShare,t} \qquad (4)$$

The market model represents a potential advantage over the constant mean return model (MacKinlay 1997). The model removes the portion of the security's return that is related to the variation in the market's return, thereby reducing the variance of the abnormal return (ibid). Implicitly, this can increase the model's ability to reveal event effects. Furthermore, the benefit of the market model depends on the values of $R^2$ (ibid). The higher the $R^2$, the higher is the variance reduction of the abnormal return's, and the better fit of the OLS estimators. Moreover, using the market adjusted returns as given by the market model, minimises the impact of the breakdowns experienced in our period (dotcom bubble and the financial crisis).

## 4.5 Abnormal Return Calculations

The abnormal return is the difference between the actual return and the normal return (expected return) when applying the market model.

$$AR_{i,\tau} = R_{i,\tau} - E(R_{i,\tau}) \qquad (5)$$

Where $AR_{i,\tau}$ is the abnormal return for security *i* at time $\tau$. To recap, $\tau$ denotes the calculation within the event window. To study the index effect associated with the index revision, we must look at the abnormal return in the time period when the securities are included or excluded from the index. We apply the arithmetic mean of the abnormal return for all securities on the same day in the respective event window. Moreover, we investigate the inclusions and exclusions separately.

$$\overline{AR_\tau} = \frac{1}{N}\sum_{i=1}^{N} AR_{i,\tau} \qquad (6)$$

$\overline{AR_\tau}$ is the abnormal arithmetic return at time $\tau$ and N denotes the number of inclusions/exclusions in the observed sample. By combining the expected return derived from the market model and actual returns; we will be able to calculate the abnormal return within the event window. After determining these abnormal returns in the event window, we will proceed to investigate if there are specific trading days when the abnormal returns are at its highest. Specifically, when is a long-short portfolio of inclusions and exclusions most profitable within the event window? To perform such an analysis, we must aggregate the abnormal returns to draw interferences on the event of study.

Since the OSE selection criterions for inclusions and exclusions are predictable for market participants; we expect to capture an index effect trading days before the announcement and after the effective date.

$$\overline{CAR}_{\tau_1,\tau_2} = \sum_{t=t1}^{t2} \overline{AR_\tau} \qquad (7)$$

Where $\overline{CAR}$ is the cumulative arithmetic mean abnormal return for all N securities between day $\tau_1$, $\tau_2$. The period $[\tau_1, \tau_2]$ can be many different time intervals within the event window. We are interested in examining the CAR over the whole event window to identify the interval that gives the highest CAR. Moreover, researchers have found evidence of the index effect being stronger post the financial crisis of 2008. Thus, we will perform several sub-samples into a pre-crisis-, during crisis-, after crisis sub sample.

## 4.6 Hypothesis Testing and Statistical Interference

The last step is to test whether the abnormal returns (ARs and CARs) are significantly different from zero on a statistical basis. We have performed a hypothesis test to determine if the abnormal effects on individual events or samples of events are significant. The general principle of this assessment is to test if the abnormal returns are significantly different from zero (Muller 2018). We test the null hypothesis (H0) against the alternative hypothesis (H1) as follows:

$$H\,0: \mu = 0 \quad v \quad H1: \mu \neq 0 \qquad (8)$$

If we fail to reject the null hypothesis, there are no abnormal returns within the event window. On the contrary, if we reject the null hypothesis, then there is a presence of ARs. For each level of calculations, both ARs and CARs, significance tests must be performed:

$$H0: AR = 0 \quad v \quad H1: AR \neq 0 \qquad (9)$$

$$H0: CAR = 0 \quad v \quad H1: CAR \neq 0 \qquad (10)$$

To sum up, our event study focuses on the mean distribution of abnormal returns (Khotari 2006). The specific null hypothesis test whether the mean abnormal return at time t is different from zero (AR=0). Thus, our event study wants to examine if the event, on average, is associated with a change in shareholder wealth. What's more, we want to see if there are specific periods around the event date that deliver abnormal returns. As the index revison is partially anticipated, we expect to see the index effect before ED. Thus, we wish to measure the performance over multi-period intervals (CAR=0).

The literature of significance testing has been rich, and researchers have proposed a range of test statistics. Patell (1976) developed a popular t-test that took a standardised abnormal return approach and estimated a separate standard error for each security event and assumes cross-sectional independence. However, one of the greatest challenges of event studies on asset prices is the problem with the event-date clustering (Kolari and Pynnonen 2010). Clustering leads to a cross-sectional correlation of abnormal returns and distortions from event-study induced volatility changes (ibid). Thus, clustering leads to a downward bias in the standard deviation and overstate the t-statistic; leading to an over-rejection of the null hypothesis (Kolari and Pynnonen 2010). Put differently, the i.i.d assumption does not hold when there is a cross-correlation between residuals of stocks because of event day clustering. However, the OLS estimators are unbiased while the OLS standard errors are biased. Kolari and Pynnonen (2010) has developed a new test statistic to modify the original t-statistic by Patell (1976) by taking cross-sectional correlation into account

A common assumption in traditional event study methodology is that the abnormal returns are cross-serially uncorrelated. This assumption holds if the event day is unknown for the firms (Kolari & Pynnonen 2010). As stock returns are typically positively correlated, applying a t-statistics relying on independence understate the standard error and may lead to severe over-rejection of the null hypothesis of no event effect (ibid). Below we will apply Kolari and Pytnnonen (2010) framework for a t-statistics with the cross-sectional correlation between observations.

### 4.6.1 Single Common Event Day

Let $\sigma^2_A$ represent the population variance of the standardised abnormal returns, and $\sigma^2_{ij}$ denote the population covariance of standardised abnormal returns for securities i and j. Using simple algebra, the variance of the mean of the standardised abnormal returns over n firms.

$$\sigma^2_{\bar{A}} = \frac{1}{n}\,\sigma^2_A + \frac{1}{n^2}\sum_{i=1}^{n}\sum_{j\neq i}\sigma_{ij} \qquad (11)$$

Since the variance is the same for all standardised abnormal return then $\sigma^2_i = \sigma^2_j = \sigma^2_A$. The covariance can be written as

$$\sigma_{ij} = \sigma_i\sigma_j p_{ij} = \sigma^2_A p_{ij} \qquad (12)$$

Where $p_{ij}$ is the correlation of the abnormal returns of stock i and j. With this, we can rewrite equation (11) as

$$\sigma^2_{\bar{A}} = \sigma^2_A\left(\frac{1}{n} + \frac{1}{n^2}\sum_{i=1}^{n}\sum_{j\neq i} p_{ij}\right) = \frac{\sigma^2_A}{n}(1 + (n-1)\bar{p}\ ) \qquad (13)$$

Where $\bar{p}$ is the average correlation of the abnormal returns. Notably, the return correlations cannot be highly negative on average for equation (13) to hold. Accordingly, using equation (13) a correlation adjusted t-statistics becomes

$$t_{KP1} = \frac{\bar{A}\sqrt{n}}{\sqrt{\frac{m-2}{m-4}} * \sqrt{1+(n-1)\bar{r}}} = \frac{\frac{\bar{A}\sqrt{n}}{\sqrt{\frac{m-2}{m-4}}}}{1+(n-1)\bar{r}} \qquad (14)$$

Where $\bar{r}$ is the average of the sample correlations of estimation period residuals, n is the number of firms and m is the number of observations in the estimation period. Equation (14) highlights the severity of cross-correlation through the average correlation and the number of firms. Kolari and Pytnnonen (2010) studied a sample of 100 firms with an average correlation of only 0.05. If this correlation were not considered, the null hypothesis would be falsely rejected with more than 40 % (25%) probability in the two-sided (one-sided) test. Even though the market model can capture a large share of the return correlation, any researcher would aim to choose a procedure that properly accounts for the correlation to a minimum. Cross-correlation weakens a testing procedure by decreasing power, as correlation implies overlapping information (Kolari and Pynnonen 2010).

### 4.6.2 Clustered Common Event Days

Suppose we have q groupings of the event days, where each corresponding firms within the grouping have the same event day (Kolari and Pynnonen 2010). Then the correlations of the non-overlapping event-day groups are zero, and the covariance matrix becomes block-diagonal. Put differently, if we have q industries where all industries have the same event day, but the between industry correlation is zero (ibid). The kth block corresponds to the covariance matrix of the firms belonging to the kth group with covariance matrix $\sum_k$, k=1,…q.

Patell (1976) argue that scaled abnormal returns should be used for statistical tests. Standardised weights should only be used for statistical testing purposes only as they have proven to exhibit better statistical purposes. However, raw returns should be used to interpret economic information. The average standardised abnormal return is $\bar{A} = \frac{1}{n}\sum_{k=1}^{q} n_k \overline{A_k}$ where $\overline{A_k}$ is the average standardised abnormal return in subgroup k, and $n_k$ is the number of firms within subgroup k. Again, within each subgroup, the variances of the standardised returns are the same. As a result, the variance of the average abnormal returns over all n firms becomes

$$\sigma^2{}_{\bar{A}} = \frac{1}{n^2}\sum_{k=1}^{q} n^2{}_k \, \sigma^2{}_{\bar{A}k} = \frac{1}{n^2}\sum_{k=1}^{q} n_k * \sigma^2{}_k(1 + (n_k - 1)\overline{p_k}) \qquad (15)$$

Where $\sigma^2{}_{\bar{A}k}$ is the variance of the average abnormal returns in group k, $\sigma^2{}_k$ is the variance of the standardised abnormal return in group k and $\overline{p_k}$ is the average return correlation in group k. Since the estimation period is the same for all firms then $\sigma^2{}_k = (m-2)/(m-4)$ for all k = 1,…,q. The average of the cross-sectional sample correlations of residuals $\overline{r_k}$ for group k is defined as

$$\overline{r_k} = \frac{1}{n_k(n_k - 1)} \sum_{i=1}^{nk} \sum_{\substack{j=1 \\ j \neq i}}^{nk} \bar{r}_{ij,k} \qquad (16)$$

Where $\bar{r}_{ij,k}$ is the sample correlation of the market model residuals of returns i and j in group k calculated over the sample period. Replacing $\overline{pk}$ in equation (15) by the estimator in (16) leaves us with a t-stat

$$t_{KP2} = \sqrt{\frac{n}{\sum_{k=1}^{q} n_k(1 + (n_k - 1)\overline{r_k})}} \qquad (17)$$

The t-stat can be further simplified with

$$t_{KP2} = n(1 + (n-1)\bar{\bar{r}}) \qquad (18)$$

Where

$$\bar{\bar{r}} = \frac{1}{n(n-1)} \sum_{k=1}^{q} (n_k - 1)\, \overline{r_k} \qquad (19)$$

Thus, $\bar{\bar{r}}$ is the average sample correlations over the whole (block) correlation matrix with between block sample correlations set to zero and the t stat can be similarly written as equation (14):

$$t_{KP2} = \frac{\bar{A}\sqrt{n}}{\sqrt{\frac{m-2}{m-4}} * \sqrt{1 + (n-1)\bar{\bar{r}}}} = \frac{\frac{\bar{A}\sqrt{n}}{\sqrt{\frac{m-2}{m-4}}}}{1 + (n-1)\bar{\bar{r}}} \qquad (20)$$

The only difference between equation (14) and (20) is that the unrestricted average correlation estimator is replaced with the restricted average correlation estimator $\bar{\bar{r}}$ defined in equation (19). To calculate the modified t-statistic developed by Kolari and Pynnonen (2010) , we will use a software package called Event Study Metric.

### 4.6.3 Summary

The main problem with event study testing is the issue of cross-serial correlation. Even a relatively low cross-correlation among abnormal returns can make us over-reject the null hypothesis of zero average abnormal returns. Bear in mind, that the scaled returns are applied in the statistical testing only; while the raw returns (Equation 5,6 and 7) calculated in the market model are non-scaled. To address this problem, the abnormal returns must be scaled; and Kolari and Pynnonen (2010) propose a t-stat that take cross-correlation into account. Thus, applying this t-stat avoids the downward bias in the standard deviation and thereby avoids rejecting the null hypothesis when it is true. To summarise, we are confident with our choice of t-statistics as it overcomes the event-date clustering problem.

## 4.7 Other Statistical Interferences

Other issues arise when conducting an event study. These issues involve inferences with non-normality, the sampling interval and days with no trading.

The market model assumes that the abnormal returns are normally distributed. The distribution of daily data is often skewed (MacKinlay 1997). A response to this possible shortcoming is to take the mean across abnormal returns and simultaneously increase the sample size (Brown and Warner 1985).

Stock return data offer a different sampling interval. Typically, researchers may apply daily or monthly observations of stock returns. Researchers have found that there is a definite advantage to choose daily- over monthly data. There is a significant decrease in the power of the tests when monthly data is applied. MacKinlay (1997) and Dale Morse (1984) argue for the benefits of reducing the sampling interval with observations of higher frequency. Using observation intervals that are less than one day may cause implications where other complications are introduced (MacKinlay 1997). On the contrary, other researchers claim that monthly observations are more normally distributed than that of daily returns.

Days, when no trading occurs for any security, can introduce bias. In our study, daily prices are based on the closing price (prices where the last transaction of the securities occurred during the trading day). These closing prices do not occur at the same time each day, but by calling them daily prices, we wrongly assume that they are equally spaced between a 24 hours interval (MacKinlay 1997). This assumption results in a nontrading bias at the moment and co-moment of returns (ibid). This influence of the nontrading effect affects the market model's beta, as the nontrading effect affects the variance of the individual stocks. However, MacKinlay (1997) argue that for actively traded securities the problem is small.

# 5. Expected Findings

It is plausible to assume that the index effect is present at the OSEBX, since the study of Knutsen (2014) and Mæhle & Sandberg (2015) has confirmed abnormal returns and trading volumes in the grace period. Thus, we want to exploit the index effect anomaly by constructing an optimal trading strategy for Borea Asset Management. Based on our empirical findings, we expect to identify abnormal returns within the grace period. Specifically, we would like to identify where the CAR is highest. Moreover, we would like to construct a long-short portfolio that exploit the highest CAR in the grace period and reverse the positions after the ED to capture any reversal effects ex-post the event.

The increased attention and popularity of indices over the past years has led many researches to believe that the index effect has been stronger post the financial crisis in 2007-2008. Consequently, we would like to isolate and study the index effect pre- and post-crisis. We believe that the index tracking funds will continue to grow in popularity. Therefore, we believe that the index effect may be downward biased when looking at the whole sample; as the sub-sample post the financial crisis will be more representable for the future.

The fact that OSEBX is exposed to a time-period between the AD and ED (the grace period), the index-tracking funds have time to rebalance their holdings before the effective date. Thus, we expect to see the index effect before ED. Moreover, due to the predictability of the OSEBX revisions; we believe that arbitrageurs will start purchasing inclusions before the AD. The presence of arbitrageurs and the predictability of the event should make the alpha opportunities limited. Below are our hypotheses presented:

| Hypotheses |
| --- |
| **H1.** In the short term, stocks of companies entering the OSEBX will experience abnormal returns. Conversely, a deleted company's stock will experience negative abnormal returns |
| **H2.** There is a stronger index effect ex-post the financial crisis of 2008 |
| **H3.** We will observe the index effect already before the announcement day and in-between the grace period |
| **H4.** Executing a long-short strategy of inclusions and exclusions within the grace period will outperform the market |
| **H5.** Borea Asset Management can further increase the return on their trading strategy by betting on reversals after the effective date |

*Table 5. Own Constructed Hypotheses*

# 6. Empirical Analysis

Our analysis revolves around the grace period between the announcement of index constituent changes and their effective date. We will investigate the hypotheses outlined in the previous section and identify the highest CAR interval and any mean reversions. If there is a presence of mean reversals shortly after the event, then there is a significant temporary stock-price effect. Thus, the presence of heavy index-fund trading around the time of the change will temporarily move the stock prices away from its fundamental value.

When studying the price effects, we applied the adjusted market model to capture economic events in order to isolate the eventual effects. Our sample of the OSEBX historical component changes consists of 203 inclusions and 159 exclusions from January 2003 to June 2018. As researchers have found evidence of a stronger index effect ex-post the financial crisis in 2008, we found it convenient to divide the total sample into three sub-periods: Pre-crisis (2003-2007), during-crisis (2008) and post-crisis (2009-2018). If we find a significantly higher alpha ex-post the financial crisis, we ought to believe that the growing popularity of index-tracking funds drives the abnormal returns. Finally, a more accurate estimate of the AD occurs as Oslo Stock Exchange had a relatively stable AD within the three subperiods (sub-chapter 1.3.1).

| Date | Inclusions | Exclusions | Total Events |
|---|---|---|---|
| Pre Crisis (2003-2007) | 97 | 60 | 157 |
| During Crisis (2008) | 12 | 23 | 35 |
| Post Crisis (2009-2018) | 76 | 94 | 170 |
| Total | 203 | 159 | **362** |

*Table 6. Events Used in our Sample Divided into Pre-, During- and Post-Crisis*

## 6.1 CAR over Various Horizons in the Event Window

The guidelines outlined by the OSE determines any inclusions or exclusions on OSEBX. These guidelines include liquidity, industry target and free float criteria. Coupled with the credibility of various index effect theories, we expect stocks of companies entering the portfolio will experience an increase in price. By contrast, the exclusion of a company's stock will have a decrease in price.

We examined the pre-announcement performance of inclusions and exclusions relative to the market before the announcement date, between the announcement- and effective date (the grace period) and after the effective date over the whole sample. As reported in table 7, we observe that exclusions underperform relative to the market over the whole period ex-ante AD. Surprisingly, the inclusions also experience a negative return relative to the market over the same time interval. In comparison, Arnott et al. (2018) found that inclusions on the S&P 500

experienced a positive return in excess of the market return ex-ante the AD. However, Arnott et al. (2018) found that the positive return of the additions was highest one year and six months before the AD, with a cumulative return of 36.17% and 13.84% respectively.

| Trading Days Before AD | Inclusions | Exclusions | Inclusions minus Exclusions |
|---|---|---|---|
| 17 days | -1.67% | -0.78% | -0.89% |
| 15 days | -1.92% | -0.88% | -1.04% |
| 10 days | -1.88% | -2.20% | 0.32% |
| 5 days | -1.08% | -0.50% | -0.58% |
| 3 days | -0.59% | -0.79% | 0.20% |
| 1 day | -0.32% | -0.85% | 0.53% |
| AD | -0.12% | -0.69% | 0.57% |
| CAR between AD and ED | | | |
| Exclusive of ED | 2.24% | -3.00% | 5.24% |
| Inclusive of ED | 1.35% | -1.43% | 2.78% |
| Trading Days after ED | | | |
| ED | -0.89% | 1.58% | -2.47% |
| 1 day | -1.37% | 2.08% | -3.45% |
| 3 days | -1.82% | 2.90% | -4.72% |
| 5 days | -2.79% | 4.38% | -7.17% |
| 10 days | -3.91% | 6.72% | -10.63% |
| 15 days | -5.43% | 7.40% | -12.83% |
| 20 days | -5.79% | 8.96% | -14.75% |
| 25 days | -6.04% | 10.69% | -16.73% |
| 30 days | -6.11% | 11.40% | -17.51% |

*Table 7. Average Cumulative Return Relative to Market over Various Horizons, Jan 2003 – June 2018*

The grace period shows significant and exciting results. The cumulative abnormal return between the AD and ED, *exclusive of ED*, reports that inclusions (on average) appreciate by 2.24% over the market. Conversely, exclusions underperform by -3.00%. This produces a performance gap of 5.24%. This strong effect can be explained by index funds accepting some tracking error to begin the early purchasing and selling of stocks that are about to enter or leave the OSEBX. The price moves can also be attributed to other sources such as increase market coverage.

Notably, the grace period inclusive of the effective date produces a lower CAR than exclusive of ED. The inclusions beat the market by 1.35%, while the exclusions underperform the market with -1.43%; resulting in a performance gap of 2.78%. A plausible explanation would be that the stock prices have already incorporated the rebalancing changes before the ED. Thus, index tracking funds have already purchased the inclusions and sold off the exclusions. To summarise, it looks like mutual funds tracking the index completed their trades on inclusions and exclusions before the ED.

We find a sharp reversal on the performance of the inclusions and exclusions on and ex-post the ED. Our analysis suggests that there is a larger alpha by betting on reversals rather than the actual event date, with an astonishing return of 17.51% with a long-short portfolio of exclusions and inclusions, respectively, 30 days ex-post the ED. A possible explanation can be a combination of a value effect and mean reversion. Thus, investors may overreact to the event, and therefore mispricing occurs that the investors can exploit after the effective date. This overreaction can lead to valuation errors and could be further investigated by looking at various valuation multiples for the included and deleted stocks relative to the market. Arnott et al. (2018) found that the valuation ratios for inclusions (exclusions) were significantly overpriced (cheaper) relative to the market. According to our analysis, the significant performance gap in the grace period should be exploited by Borea, as illustrated in figure 4.

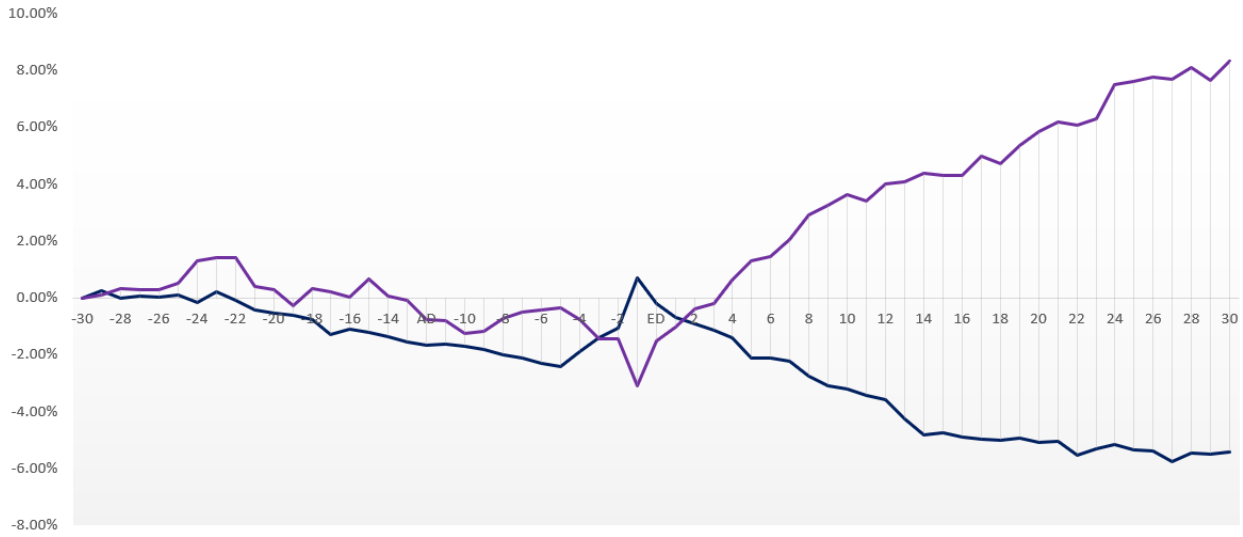


*Figure 4. CAR Return Relative to Market for Inclusions and Exclusions, Jan 2003 – June 2018*

We performed the exact same analysis for the period before and after the crisis. As predicted, the CAR was higher ex-post the financial crisis (Appendix G). Similarly, the CAR was highest in the grace period exclusive of ED but experienced a CAR of 8.46% compared to the whole sample of 5.24%. The CAR for the period after the financial crisis is summarised in the figure below.

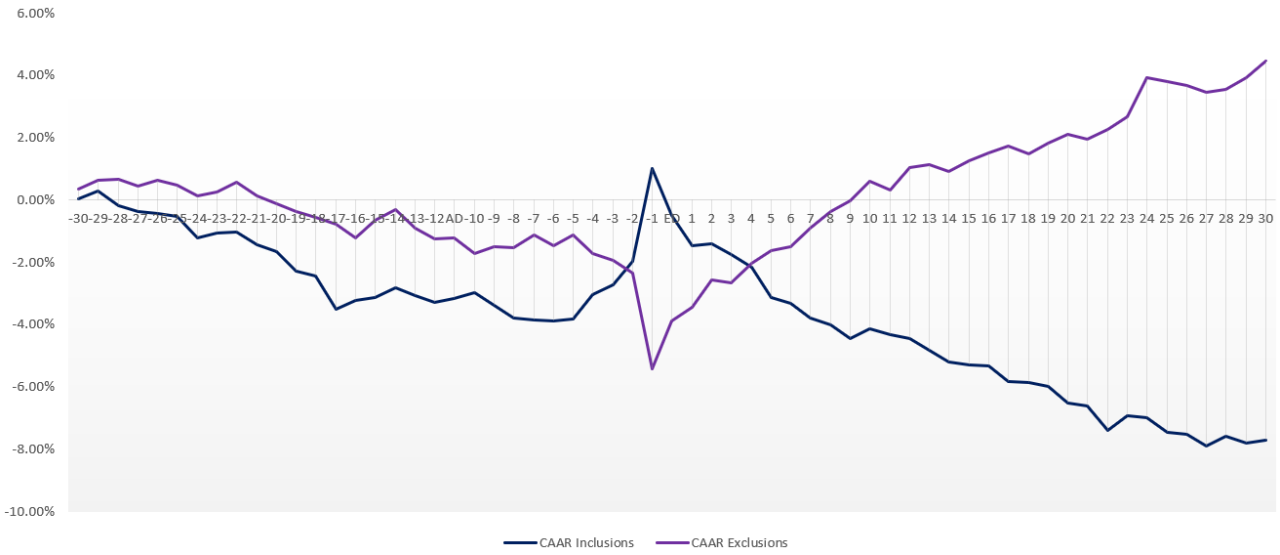


*Figure 5. CAR Return Relative to Market for Inclusions and Exclusions, June 2009 – June 2018*

The sub-sample prior to the financial crisis shows another picture. The index effect is non - existent! The CAR in the grace period, exclusive of ED, returns a value of -0.93% (Appendix F). In the pre-crisis sample, the CAR on inclusions is positive in the interval AD-5 to AD and negative from there on. On the contrary, the exclusions return a positive CAR over the complete subsample, with a few exceptions. As figure 6 highlights, the inclusions and exclusions are negatively correlated pre-AD and after ED. Conversely, in the grace period, there is no presence of an index effect. The results can be found in Appendix F.

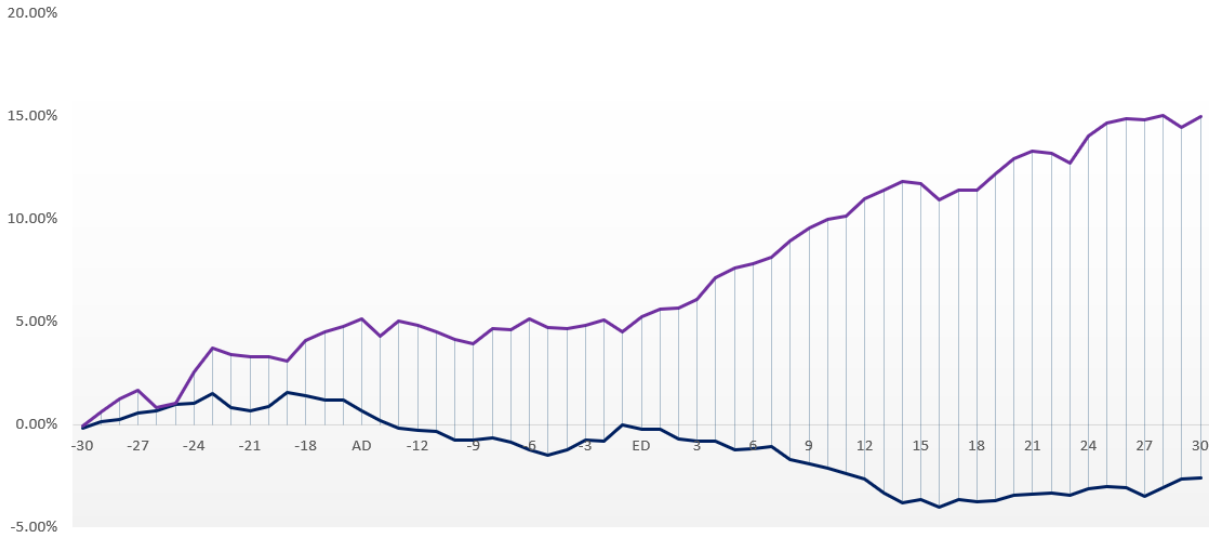


*Figure 6. CAR Return Relative to Market for Inclusions and Exclusions, Jan 2003 – July 2007*

We find it puzzling that the exclusions experience such substantial momentum for the pre-crisis period. The exclusions over-perform 10.49% over the market thirty days after ED. This

overperformance of exclusions pre-crisis has affected the result on the whole-sample (2003-2017) with the return of 11.40% on exclusions 30 days post-ED. As no previous theories nor empirical evidence can support the puzzling results of the inclusions and exclusions ex-ante the financial crisis, we find it more reliable to further investigate the sub-sample post the financial crisis to grasp the nature of the index anomaly. Moreover, we believe that the increased number of index tracking funds post the financial crisis is expected to persist and therefore represent a better picture of the future. Since our analysis reveals a strong reversal effect post-crisis, we ought to believe that the presence of an increased number of index tracking funds is the primary driver of the index effect.

## 6.2 Proposed Trading Strategies

The next step is to propose potential trading strategies for Borea. We have initially combined a portfolio by going long on inclusions and short on exclusions within the grace period. Our results show a clear tendency of positive returns between AD end ED before the effect is reversed after the event date (ED). If we look at the total sample, the strategy gives a CAR of 5.24% as shown in table 7. On the other hand, if we look at the sub-sample ex-post financial crisis, we earn a CAR of 8.46% over the same period (Appendix G). This is consistent with the belief that the index effect is more dominant after the financial crisis due to the increased popularity of index funds. The results are illustrated in the figure below.

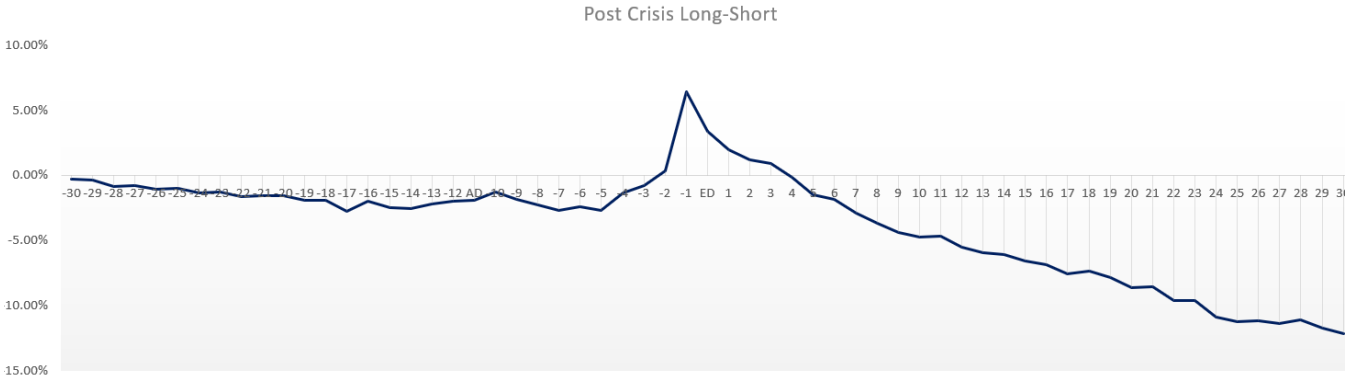


*Figure 7. Return of a Long-Short Portfolio within The Event Window, Post Crisis sample*

The strategy of buying inclusions and shorting exclusions at the AD, and cancelling out the positions the day before ED, gives the highest return within the grace period. This is a relatively short-term strategy, as the reversal effect is already evened out seven days after ED. Since the sample gives a clear indication of a reversal effect after ED, we also looked at the possibility of a trading strategy that exploits this. Abnormal returns for both inclusions and exclusions starts to reverse at the ED. That is to say; inclusions seem to underperform relative to the market while exclusions outperform the market post the ED. This gives us an opportunity to not only

bet on the rebalancing but also the reversal effect. As we can see from figure 8, by going long exclusions and short inclusions we can obtain a cumulative abnormal return of 18.62% with a holding period of 30 days after ED in the post-crisis sample.

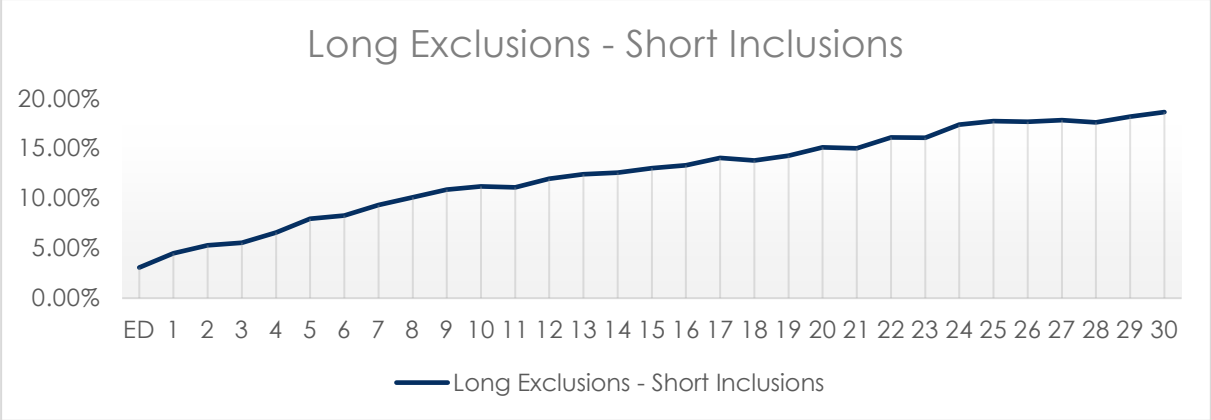


*Figure 8. Cumulative Abnormal Return with Reversal, Post Crisis sample*

We see a possibility of combining the two strategies to maximise abnormal returns in the event window. By initially going long-short between AD and ED, one could exploit the reversal effect by undoing the initial position at the end of ED-1 and switching to a long exclusions and short inclusions position. Furthermore, our research indicates a total CAR of such a strategy to be 25.06% over a holding period stretching from AD+1 to ED+30. The combination of the two trading strategies outperforms the originally proposed strategy by almost 17%, where trading costs are not considered. To bet on the index effect, Borea Asset Management should go long-short in inclusions and exclusions on the AD and cancel out the positions ED-1. Another strategy would be to short inclusions and buy exclusions on ED and cancel the position thirty days after ED. Borea could also execute a strategy that combines both the index effect in the grace period and the reversal effect. Since all the three strategies have event windows after the AD, Borea do not have to forecast index revisions prior to AD. These strategies are all based on publicly available information. The figure below gives the reader a visualisation of the beneficial properties by going long-short with reversals.

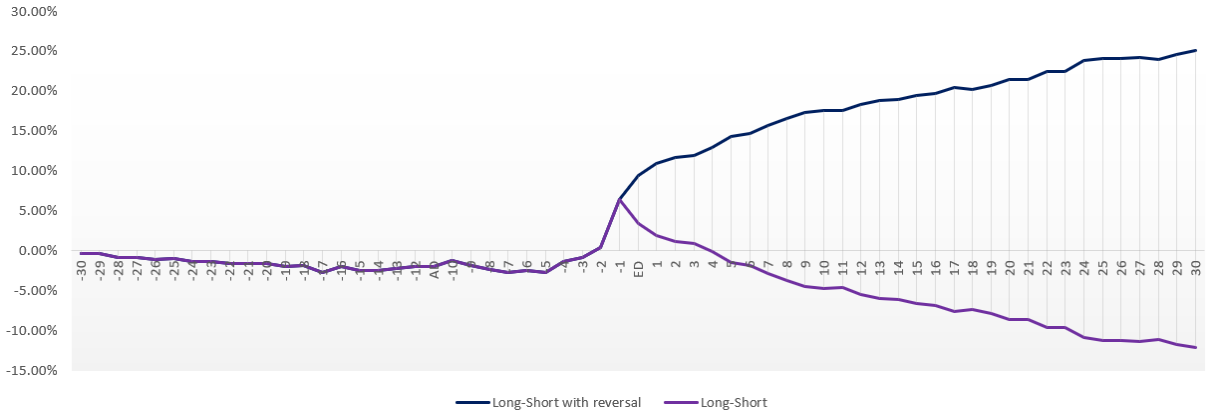


*Figure 9. Comparison Between The CAR With and Without Reversal, Post Crisis sample*

## 6.3 Statistical Results

To measure the significance level of the performance measure CAR, we have applied the standard t-stat of Patell (1976) and the Kolari and Pynnonen (2010) that takes cross-correlation into account. The t-stat is compared to its assumed distribution (normal) under the null hypothesis that means abnormal performance equals zero. The null hypothesis is rejected if the t-stat exceeds a critical value corresponding to the 5% tail region (Khotari 2006). The tables below provide the CAR for both inclusions and exclusions and the t-statistics associated with the means over the full sample as well as the post-crisis sample. Notably, the fact that the correlation of stock returns is often positive reveals itself in our t-stat output as Kolari & Pynnonen (2010) has overall a slightly smaller significance level than the t-stat of Patell (1976).

Our analysis rejects the null hypothesis of CAR=0 within the grace period for both the full and post-sample. Notably, the null hypothesis of CAR, *exclusive of ED*, is rejected on a 1% significance level for both the full and post-crisis sample. Given our choice of model and input parameters we recommend Borea Asset Management to exploit this index anomaly by buying and selling inclusions and exclusions respectively, on the AD and cancel out the positions the day ex-ante the ED. This will overall give Borea a return of 5.24% (full sample) and 8.46% (post-crisis sample). Furthermore, the period right before AD we find that inclusions and exclusions are both negative. However, most of the t-stats are not significant. The most noteworthy, however, is the enormous returns that can be extracted by betting on reversals ex-post the event date. For both inclusions and exclusions, the null hypothesis is rejected on a 1% significance level and seemingly offers a superior return of betting on reversals.

| Trading Days Before AD | CAR Inclusions | T-test cross sectional | Prob. | Patell Z | Prob. | CAR Exclusions | T-test cross sectional | Prob. | Patell Z | Prob. |
|---|---|---|---|---|---|---|---|---|---|---|
| 17 days | -1.67% | -1.634 | 0.1023 | -0.4879 | 0.6256 | -0.78% | -0.4883 | 0.6253 | -0.1078 | 0.9141 |
| 15 days | -1.92% | -1.9548 | 0.0506 | -0.943 | 0.3457 | -0.88% | -0.5825 | 0.5602 | -0.0778 | 0.938 |
| 10 days | -1.88% | -2.502 | 0.0124 | -1.9093 | 0.0562 | -2.20% | -1.6727 | 0.0944 | -1.746 | 0.0808 |
| 5 days | -1.08% | -2.0237 | 0.043 | -1.1417 | 0.2536 | -0.50% | -0.569 | 0.5694 | -0.8585 | 0.3906 |
| 3 days | -0.59% | -1.3821 | 0.167 | -0.4751 | 0.6347 | -0.79% | -1.3165 | 0.188 | -1.4875 | 0.1369 |
| 1 day | -0.32% | -0.9495 | 0.3423 | -1.0434 | 0.2967 | -0.85% | -1.9755 | 0.0482 | -2.1567 | 0.031 |
| AD | -0.12% | -0.6124 | 0.5403 | -0.7503 | 0.4531 | -0.69% | -2.5241 | 0.0116 | -2.6789 | 0.0074 |
| CAR between AD and ED | | | | | | | | | | |
| Exclusive of ED | 2.24% | 3.7082 | 0.0002 | 4.9433 | 0 | -3.00% | -3.5333 | 0.0004 | -4.2091 | 0 |
| Inclusive of ED | 1.35% | 2.1463 | 0.0318 | 3.3019 | 0.001 | -1.43% | -1.7696 | 0.0768 | -2.2627 | 0.0237 |
| Trading Days after ED | | | | | | | | | | |
| ED | -0.89% | -4.151 | 0 | -5.2188 | 0 | 1.58% | 5.1971 | 0 | 6.4225 | 0 |
| 1 day | -1.37% | -4.4053 | 0 | -5.5601 | 0 | 2.08% | 5.3041 | 0 | 5.7183 | 0 |
| 3 days | -1.82% | -4.3481 | 0 | -4.8561 | 0 | 2.90% | 5.3594 | 0 | 5.7425 | 0 |
| 5 days | -2.79% | -5.6929 | 0 | -6.1733 | 0 | 4.38% | 6.5174 | 0 | 6.5674 | 0 |
| 10 days | -3.91% | -5.773 | 0 | -6.0999 | 0 | 6.72% | 5.9096 | 0 | 7.0437 | 0 |
| 15 days | -5.43% | -5.7716 | 0 | -6.5483 | 0 | 7.40% | 5.635 | 0 | 6.2222 | 0 |
| 20 days | -5.79% | -5.7893 | 0 | -5.9149 | 0 | 8.96% | 5.8205 | 0 | 6.7734 | 0 |
| 25 days | -6.04% | -5.1282 | 0 | -5.4136 | 0 | 10.69% | 5.8655 | 0 | 6.9706 | 0 |
| 30 days | -6.11% | -4.5999 | 0 | -4.9598 | 0 | 11.40% | 5.7159 | 0 | 7.0568 | 0 |

*Table 8. Average Cumulative Return Relative to Market and Its T-statistics, Jan 2003 – June 2018*

| Trading Days Before AD | CAR Inclusions | T-test cross sectional | Prob. | Patell Z | Prob. | CAR Exclusions | T-test cross sectional | Prob. | Patell Z | Prob. |
|---|---|---|---|---|---|---|---|---|---|---|
| 18 days | -3.15% | -2.2093 | 0.0272 | -1.7892 | 0.0736 | -1.22% | -0.6595 | 0.5096 | -0.7615 | 0.4463 |
| 15 days | -2.97% | -2.2262 | 0.026 | -1.9856 | 0.0471 | -1.90% | -1.2796 | 0.2007 | -1.235 | 0.2168 |
| 10 days | -2.12% | -1.9534 | 0.0508 | -1.9682 | 0.049 | -1.80% | -1.7044 | 0.0883 | -1.6062 | 0.1082 |
| 5 days | 0.35% | 0.5221 | 0.6016 | 0.5445 | 0.5861 | -0.45% | -0.6332 | 0.5266 | -1.0168 | 0.3093 |
| 3 days | -0.02% | -0.0396 | 0.9684 | -0.1207 | 0.9039 | -0.55% | -1.013 | 0.311 | -1.0522 | 0.2927 |
| 1 day | -0.09% | -0.2926 | 0.7699 | -0.4365 | 0.6625 | -0.32% | -0.9185 | 0.3584 | -0.8723 | 0.383 |
| AD | 0.12% | 0.5779 | 0.5633 | 0.5669 | 0.5708 | 0.04% | 0.1414 | 0.8875 | 0.2221 | 0.8242 |
| CAR between AD and ED | | | | | | | | | | |
| Exclusive of ED | 4.30% | 5.5288 | 0 | 5.2772 | 0 | -4.16% | -3.9909 | 0.0001 | -4.7149 | 0 |
| Inclusive of ED | 2.77% | 3.3077 | 0.0009 | 3.431 | 0.0006 | -2.62% | -2.5407 | 0.0111 | -3.1566 | 0.0016 |
| Trading Days after ED | | | | | | | | | | |
| ED | -1.53% | -4.889 | 0 | -5.6172 | 0 | 1.53% | 4.6451 | 0 | 4.7029 | 0 |
| 1 day | -2.50% | -5.8585 | 0 | -6.0699 | 0 | 1.99% | 3.8421 | 0.0001 | 4.0419 | 0.0001 |
| 3 days | -2.77% | -4.2482 | 0 | -4.7182 | 0 | 2.77% | 3.5269 | 0.0004 | 4.0693 | 0 |
| 5 days | -4.16% | -5.759 | 0 | -5.9311 | 0 | 3.79% | 3.8281 | 0.0001 | 4.2086 | 0 |
| 10 days | -5.14% | -4.8623 | 0 | -5.179 | 0 | 6.02% | 3.7721 | 0.0002 | 4.3671 | 0 |
| 15 days | -6.33% | -4.6727 | 0 | -5.3773 | 0 | 6.67% | 3.2155 | 0.0013 | 3.9894 | 0.0001 |
| 20 days | -7.55% | -4.9578 | 0 | -5.3133 | 0 | 7.54% | 3.1078 | 0.0019 | 4.1083 | 0 |
| 25 days | -8.50% | -4.6448 | 0 | -5.3681 | 0 | 9.23% | 3.4777 | 0.0005 | 4.3136 | 0 |
| 30 days | -8.74% | -4.2005 | 0 | -5.1216 | 0 | 9.88% | 3.4097 | 0.0007 | 4.466 | 0 |

*Table 9. Average Cumulative Return Relative to Market and its T-statistics, June 2009 - June 2018*

Our analysis of the different CAR intervals provides highly significant t-statistics in the period after the announcement date in the event window. Coupled with the high abnormal returns, our findings are consistent with similar studies on OSEBX and S&P 500. One interesting observation from our results is the high abnormal returns that can be achieved by reversing the positions and betting on reversals. We did expect this feature of the index effect but did not realise the impact it would have on abnormal returns. All t-statistics shows significant CARs at the one per cent level for the period after the rebalancing date. By looking at pure numbers the strategy to bet purely on reversals seems like the most profitable and statistically sound solution.

One obvious shortcoming with our results is that trading costs are not accounted for. Short selling is not necessarily cheap or readily available for the investor. In addition, the reversal effect is substantial and statistically significant in our results, but it is not as well documented as the effect between AD and ED is in other studies. To bet on the rebalancing seems like the safest solution. However, one could try to bet on reversals but should keep in mind that trading costs might not make this a viable solution.

The t-statistics give reliable results for the total sample and the post-crisis sample. These results are based on data from bull markets, the pre-crisis sample which includes data from 2003-2007 and the post-crisis with sample from 2009-2018. Perhaps our proposed trading strategies are best suited for good times but do not necessarily support any evidence for bad times. It could therefore be reasonable to investigate the period during the financial crisis to see if we get somewhat same results. When the whole market gets struck by a major event such as a financial crisis, it seems reasonable to believe that our model will get affected by such an event.

# 7. A Brief Look at the Financial Crisis of 2008

We found it interesting to perform the exact same analysis when the financial crisis hit the Norwegian Stock Market in 2008. We have studied the abnormal returns of inclusions and exclusions mainly in bull markets, and thus wish to nuance our perspective on the proposed trading strategy. Notably, we want to investigate if our proposed trading strategy still holds in times of a financial crisis.

Norway is a small, open economy combined with a Stock Exchange dominated by oil and oil-related companies (Grytten & Hunnes 2016). As a result, Norway experienced a tough time for the OSEBX during the second half of 2008 as the oil prices fell with more than one-third (ibid). However, the Norwegian recession was surprisingly short-lived. Oil prices rose rapidly back to their high levels, and the Central Bank of Norway was proactive and decreased the interest rate to prompt economic growth (ibid). The demand for Norwegian products remained high both within the country and internationally.

Furthermore, the oil-wealth helped the Norwegian state as well as the business community to cope with the crisis. Nonetheless, the OSEBX got walloped during the financial crisis, and our analysis of the asset returns of the inclusions and exclusions relative to the market can help Borea to make a more informed choice in bad times. Furthermore, it makes our recommendations more dynamic rather than relying on that our proposed trading strategies are universal independent of macroeconomic events.

| Trading Days Before AD | Inclusions | Patell Z | Exclusions | Patell Z | I - E |
|---|---|---|---|---|---|
| 7 days | -2.18% | -0.4154 | -9.21% | -3.4056 | 7.03% |
| 3 days | 2.34% | 1.7554 | -3.62% | -2.1355 | 5.96% |
| 2 days | 1.84% | 1.6474 | -2.15% | -1.5462 | 3.99% |
| 1 day | 0.46% | 0.5315 | -1.54% | -1.1152 | 2.00% |
| AD | -0.72% | 0.0648 | -3.12% | -3.7298 | 2.40% |
| CAR between AD and ED | | | | | |
| Exclusive of ED | 5.82% | 2.9902 | -9.36% | -2.969 | 15.18% |
| Inclusive of ED | 4.94% | 2.4986 | -5.49% | -1.5807 | 10.43% |
| Trading Days after ED | | | | | |
| ED | -0.88% | -1.5115 | 3.86% | 4.9867 | -4.74% |
| 1 day | -1.64% | -1.7833 | 4.78% | 4.295 | -6.42% |
| 3 days | -2.37% | -1.4139 | 6.49% | 3.9962 | -8.86% |
| 5 days | -4.15% | -2.2803 | 9.29% | 4.7466 | -13.44% |
| 10 days | -7.96% | -3.1348 | 11.65% | 3.9441 | -19.61% |
| 20 days | -9.82% | -2.8022 | 13.77% | 3.7586 | -23.59% |
| 25 days | -10.16% | -2.1078 | 15.40% | 3.6627 | -25.56% |
| 30 days | -12.58% | -2.2763 | 17.06% | 3.5038 | -29.64% |

*Table 10. Average Cumulative Return Relative to Market and its T-statistics, Jan 2008 - Jan 2009*

Our analysis stretches from January 2008 to January 2009, and OSEBX experienced 12 inclusions and 23 exclusions in this period. We observe that the index effect is indeed stronger during a crisis compared to the whole sample. Borea Asset Management can extract 15.18% of going long in inclusions and short exclusions on the announcement and cancel out the positions the day ex-ante ED. What's more, is that the reversal effect is stronger 30 days ex-post ED than for the other samples and contains the same significance levels as the whole- and subsamples. Thus, Borea Asset Management could earn a return of 30% with a long-short position of exclusions and inclusions 30 days ex-post ED. In conclusion, it looks like the proposed strategy works in times of a financial crisis and that the index effect is indeed stronger during a financial crisis.

The results should be viewed with scepticism. The sample size is an essential feature for any event study where the goal is to make inferences about the whole sample. The risk of sampling variability increases with smaller samples. Put differently; smaller samples tend to have larger standard errors where both tails of the distribution are fatter. The central assumption of the market model is the assumption of normally distributed returns. Thus, a violation of this assumption weakens the credibility of the results.

Investing during a crisis is also extremely risky, where the timeline and scope of recovery are highly uncertain. Moreover, investors tend to let irrationality wash over them in times of a bear market. Typically, investors panic and sell off their assets at low prices after a stock market collapse. If the Norwegian stock market were to experience a new financial crisis in the future, Borea could benefit from a financial crisis by simply buying under-priced assets that the restless individuals have sold off out of fear for further losses.

OSEBX fell with 2.85% on a single day at 20 November 2018. The sharp decrease of the oil price was one of the main drivers of the poor performance of the OSEBX. The markets are extremely nervous as investors expect that the enormous growth of the OSEBX since the financial crisis, may end. For now, however, Borea must follow the stock markets closely and should look for the trend in the oil price, inflation and profit reporting from businesses in the near future. We believe that the OSEBX will experience a downward adjustment, but when, is uncertain. In sum, Borea should avoid typical biases associated with bull markets and make an educated choice of trading during a potential financial crisis. Our proposed trading strategy involves many risks, and Borea may merely buy and hold a portfolio of companies that are expected to survive if a financial crisis should occur.

# 8. Implications & Criticism

Our findings indicate that Borea Asset Management can exploit the index effect by going long-short on inclusions and exclusions in the grace period. Notably, they should bet on mean reversals as our model reveals statistically significant abnormal returns. However, the proposed trading strategy is risky in that sense that Borea must gamble on the temporary price effect where timing is crucial. The rest of this chapter will investigate the event study methodology. Even though it is prevalent among financial researchers does not mean that the methodology itself consists of assumptions that do not necessarily hold in practice. Lastly, short-selling restrictions may pose implications for the proposed trading strategy.

## 8.1 Choice of Benchmark

It is essential to choose a reasonable benchmark for estimating abnormal returns. After all, alpha is calculated based on the choice of the benchmark (Ang 2014). The ideal benchmark should be well defined, tradeable, replicable and adjusted for risk (ibid). However, is there such a thing as a true alpha? Hansen and Jagannathan (1997) argue that there is always possible to find an ex-post benchmark that produces no alpha. In sum, alpha is instead a statement about the benchmark rather than abnormal returns.

OSEAX is the choice of benchmark in our model as it represents all shares listed on the Oslo Stock Exchange. On one hand, OSEAX is a broad index representing all firms on the local stock market which makes it a suitable benchmark. However, one can also argue that OSEAX is too narrow as it does not represent global macroeconomic events such as the MSCI world index would do. When performing an event study for a specific country most researches prefer to use the country's broadest stock index as a proxy for the market portfolio. In general, the selection of the benchmark index and the estimation procedure determines alpha and should, therefore, be chosen carefully. Yet, the literature on how to choose the right benchmark is ambivalent. Some researchers recommend a more sophisticated model such as the FF3F model, while others argue that the added factors have limited explanatory powers. Finally, we believe that OSEAX works as a proxy for stocks sensitivity to systematic risk. It is challenging to choose a benchmark ex-ante that account for all risk factors. Thus, there will always be a risk that the alpha may represent a risk factor not captured by the benchmark.

## 8.2 Estimation Window

There is no prevailing theory for which event and estimation window to use, except that the two windows should not overlap. MacKinlay (1997) suggested when facing daily data; one should have an estimation window of 120 before the event. Lynch and Medenhall (1997) and Dihillon and Johnson (1991) were also fond of applying an estimation window ex-ante the event and applied an estimation window of approximately 700 and 200, respectively. However, Bechmann (2002) disagreed. The selection bias argues that inclusions (exclusions) are expected to overperform (underperform) on the market in the period before the index revision. Thus, Bechmann argues that the market model estimators should be estimated using the period ex-post the event window to avoid the selection bias. Moreover, Brooks et al. (2008) applied 250 daily observations ex-post the event window. Our analysis applies an estimation window of 200 days prior to the event date (t=0) and ends one day before the start of the event window [t-200, t-31] and represents the standard event methodology for daily, market-adjusted excess returns. In sum, providing an estimation window before the event can lead to biased estimates of abnormal returns as exclusions (inclusions) must have performed worse (better) in the period before the event.

## 8.3 Residuals and Non-Normality

Regression models are at its core based on many statistical assumptions. In particular, the model assumes that the residuals are normally distributed with a mean of zero, are not serially correlated and have a constant variance (Glenn & Henderson 1990). Security returns are not normally distributed. The nonnormality problem has shown to be more troublesome with daily returns (ibid). The assumption of the error term of X has a mean of zero is an assumption that must be made as it is difficult to know what the error term consists of. However, there could be omitted variable bias that causes the assumption to break. However, as we have applied a relatively long estimation window in our normal return model, we assume that the residuals are normally distributed around the mean and has an expected value of zero.

## 8.4 Reliability of the T-statistics

Even though we have applied a sophisticated t-stat that takes cross-correlation into account, errors in the abnormal return calculations can indirectly bias the t-statistics. Firstly, the prediction about securities unconditional expected returns (OLS estimators) are imprecise (Kothari 2006). Secondly, individual returns at the time of an event will also be affected for reasons unrelated to the event (ibid). It is nearly impossible to have a thoroughly "clean sample" where the returns used in the study is solely caused by the index effect alone. Moreover, there

will always be a risk of a biased t-stat as the standard deviation of the t-stat is only an estimator. However, applying a t-stat that accounts for cross-correlation mitigates biased estimates to a certain degree.

The power of the test can statistically be proven right or wrong, but the economic interpretation is not straightforward seeing as all t-tests are joint tests (Kothari 2006). Our t-stat is well-specified only to the extent that the assumptions underlying their estimation are correct (ibid). Put differently; we test whether abnormal returns are different from zero given that the market model of expected returns is correct (ibid). Also, we assume that the statistical properties of abnormal returns are also correct. To illustrate, our t-test assumes that the mean abnormal performance for the cross-section of securities must be normally distributed. As a result, the statistical inferences from the t-tests needs to be interpreted with caution. The figure below shows a histogram of the abnormal returns on the event date for both exclusions and inclusions. The approximation of normally distributed abnormal returns holds, especially for inclusions. However, the approximation is not entirely fulfilled for exclusions as there are some significant outliers on the both tails. Overall, the distribution of the events appears normal.

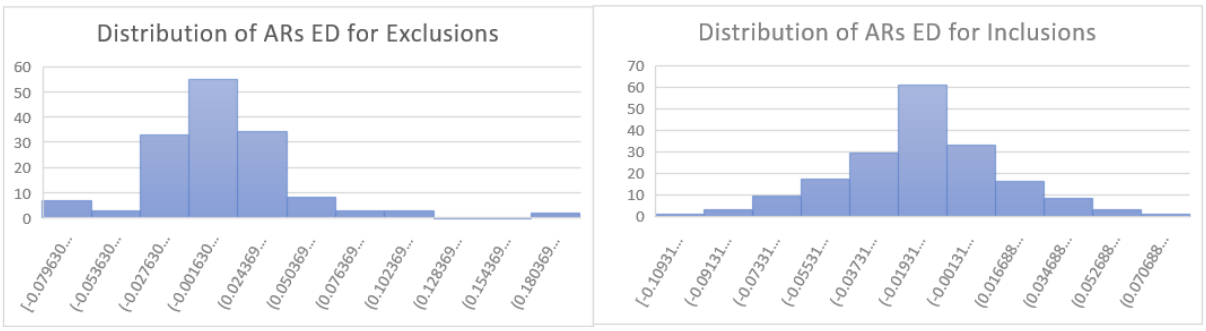


*Figure 10. The Distribution of ARs for Exclusions and Inclusions on the ED for The Full Sample*

## 8.5 Use of Daily Data

The use of daily data can pose implications for our dataset. Daily stock return for individual securities can exhibit substantial departures from normality (Warner 1984). Fama and French (1991) suggest that distribution of daily returns are fat-tailed; meaning that there are more outliers. The same holds true for daily excess return. However, The Central Limit Theorem establish that the distribution of daily excess return is well approximated by a normal distribution when n is large. In our sample, the number of events (n) is 362. If there are many observations, and each observation is independently and identically distributed, the distribution of the average CAR and AR will be approximately normally distributed. Furthermore, daily

data permits a more precise measure of abnormal returns and more informative studies of announcement effects (Khotari 2006). As the previous sub-chapter highlighted, the main disadvantage of using daily stock returns is that they depart more from normality than monthly returns.

## 8.6 The Norwegian Market May Pose Short-Selling Restrictions

In hindsight of the financial crisis in 2007-2008 and the damage short-selling provided to international markets; The European Parliament presented a common regulatory framework to harmonise the rules of short-selling (Finanstilsynet 2016). The framework wants to ensure transparency, market liquidity and efficient market pricing of securities. Moreover, the framework may restrict or ban short-selling in times of financial instability (ibid). To ensure transparency, investors must report larger short positions in shares listed on a regular market (ibid).

Norway implemented the short sales regulation in 2017. Not only can the regulation stop Borea from executing the proposed trading strategy in times of financial instability, but Borea's bets are visible for all market participants. More specifically, any positions that exceed 0.2% of a company's outstanding shares must be reported to "Finanstilsynet" by midnight at the end of the trading day (ibid). Generally, as market participants become aware of potential alpha-strategies, others will exploit the alpha until there is no alpha to extract and markets will eventually become efficient and absorb the anomaly.

Short-selling is also highly risky. The most an investor can earn on a short-position is around 100 % if a share price collapse to zero. However, there is no theoretical limit on how high a price can go so that any potential losses can be large. If Borea were to go forward with our proposed long-short strategy, they must also consider the trading costs associated with the bets. Borea must cover expenses such as margin interest, stock borrowing costs and dividend payments (Investopedia 2018). Margin interest can occur if short positions are kept open over an extended period. Stock borrowing costs can be substantial if shares are difficult to borrow due to limited float, high short-interest or other reasons. The short seller is also responsible for making dividend payments on the shorted stock to the entity from whom the stock has been borrowed (Finanstilsynet 2016). Besides, any corporate events such as share-splits, spin-offs and bonus share issues are payments the short-seller must cover, and these events are rather unpredictable. To conclude, the combination of the trading costs, regulatory risk and timing make short-selling risky for Borea Asset Management.

# 9. Summary & Conclusions

This paper examines the index effect indirectly by observing returns on various CAR intervals within the event window. Using the market model as a framework to calculate expected and abnormal returns based on historical log-return data, the paper investigates different trading strategies that can help Borea to exploit the index effect. Within the grace period, we found that the most prominent results were a long-short portfolio of inclusions and exclusions exclusive of ED which gave a return of 5.24% over the full sample. Moreover, the strong reversal effect reinforced our hypothesis that the price pressure effect mainly drove the index effect. Thus, our analysis reveals that the abnormal returns are larger for mean reversals than of the index effect itself. Ultimately, Borea can best exploit the index effect by buying inclusions and selling exclusions on the announcement date and cancel out the position the day before the ED. The next step would be to reverse the position on the event day by going long in exclusions and short inclusions. However, the paper investigates potential problems that arise with the chosen framework. These include (1) the choice of benchmark, (2) the choice of estimation window, (3) non-normality, (4) econometric issues with the t-statistics, (5) use of daily data, and (6) the high risk and regulatory problems with short-selling.

## 9.1 Confirming Our Expected Findings

We proposed several hypotheses about the index effect. Throughout our research, we have obtained results that support most of our expectations with some unexpected results. The table below summarises that our findings support hypothesis 1,2,4 and 5.

| Hypothesis | Confirmed | Plausible | Not confirmed |
|---|---|---|---|
| H1 | ✓ | | |
| H2 | ✓ | | |
| H3 | | ✓ | |
| H4 | ✓ | | |
| H5 | ✓ | | |

*Table 11. Overview of Proposed Hypotheses*

**H1**. In the short term, stocks of companies entering the OSEBX will experience abnormal returns. Conversely, a deleted company's stock will experience negative abnormal returns

Our results confirm this hypothesis as we observe higher abnormal returns for inclusions in the period between AD and ED. Likewise, exclusions experience negative abnormal returns in the same period for both the full and post crisis sample.

**H2.** There will be a stronger index effect ex-post the financial crisis of 2008

We calculated abnormal returns for the period before and after the financial crisis and found that the index effect is almost non-existent in the pre-crisis sample. On the other hand, we found abnormal returns for the post-crisis sample to be higher than the total sample as shown in Appendix G and table 7, which leads us to the conclusion that the effect has been stronger after the financial crisis.

**H3**. We will observe the index effect already before the announcement day and in-between the grace period

When we conducted the statistical testing, we found a positive CAR of 4.30% for inclusions and negative CAR of -4.16% for exclusions in the grace period, exclusive of ED, for the post-crisis sample (Appendix G). However, we did not observe any index effect before the announcement date which is not consistent with our expectations. Since this is an observed effect in other studies, we believe this could be due to our choice of event-window or choice of benchmark. In other words, even though we do not observe any effect before the announcement, we do not want to reject this hypothesis completely and thereby conclude that the hypothesis is plausible.

**H4**. Executing a long-short strategy of inclusions and exclusions within the grace period will outperform the market

Table 7 and Appendix G, as well as figure 4 and 5, gives a good picture of the potential of such a strategy. We observed positive abnormal returns of 5.24% in the total sample and 8.46% in the post-crisis sample with high statistical significance. This strategy outperforms the market and offer a substantial return, even though our analysis has not accounted for trading costs.

**H5.** Borea Asset Management can further increase the return on their trading strategy by betting on reversals after the effective date

Our results point towards a strong reversal effect after the ED. The initial expectations were that H4 would be the most profitable strategy and the reversal effect would be present but not as strong as our findings indicate. Our analysis indicates a potential CAR of 18.62% in the post crisis sample as shown in figure 8, by going long exclusions and short inclusions in the period

between ED and ED+30. The results are statistically significant as shown in table 9 leaving us to the conclusion that Borea can earn abnormal returns by betting on reversals.

## 9.2 Recommendation for Borea Asset Management

This study reveals the noticeable index effect that can be exploited by Borea Asset Management. We have constructed three possible trading strategies for Borea. Firstly, we believe betting on the rebalancing of OSEBX by going long inclusions and short exclusions within the grace period could be a profitable strategy. As mentioned earlier, Borea can earn a cumulative abnormal return of 8.46% as shown in subsample ex-post the financial crisis. Secondly, they could try to exploit the reversal effect by going long exclusions and short inclusions in the period from ED to ED+30. Our analysis suggests a potential CAR of 18.62% for this strategy. Thirdly, they could try a combination of the two which could yield as much as 25.06% in cumulative abnormal returns.

Since we are going to recommend the most viable trading strategy, the three different trading strategies should be discussed. Our initial strategy exploits a well-documented phenomenon which is the abnormal returns observed in the grace period. We believe that this strategy is sound, as it consists of a relatively short holding period and will take place at the AD where new index constituents are revealed for all market participants. The second proposed strategy has a potential of higher returns but is less documented than the first strategy. We believe this is an exciting strategy but introduces more risk to the portfolio as the necessary holding period is longer. We believe this strategy needs more documentation and testing before we can genuinely recommend it. The third strategy gives the highest returns but is probably the least practical one. One of the most significant problems here is the importance of timing, as a significant portion of the observed abnormal returns happens at ED-1 and ED. This strategy looks promising in theory, but when we take timing and trading costs into account, this is probably the least viable solution of the three proposed strategies. In sum, we recommend that Borea Asset Management should go forward with the first proposed strategy.

# 10. Further Areas of Study

This paper has discussed potential trading strategies to exploit the index effect. For further research, we suggest covering topics that have not been dealt with in-depth in this study. We suggest four areas for further research that would shed light on the index effect on Oslo Stock Exchange.

i) Our results indicate a robust reversal effect after the rebalancing date in our chosen event-window. It could be interesting to go in-depth of what causes this effect. Could mean reversions be justified by examining valuations multiples before and after the event-window? Furthermore, one could test other trading strategies through the options market. The supply and demand of options in the Norwegian market are relatively limited compared to other markets like the U.S. Nevertheless, there could be arbitrage opportunities related to options on popular stocks or derivatives who applies the OSEBX as an underlying benchmark.

ii) Another interesting study would be to see how abnormal returns vary between different choices of benchmarks and estimation models. Many researchers favour the market model because it is simple and provides reasonable results. The Fama-French three-factor model could be favourable as the added factors may capture more risk than what the simple market model would do. Also, one should study how abnormal returns varies with different estimation windows. To illustrate, would the abnormal returns be significantly different if we had applied an estimation window ex-post the effective date?

iii) The methodology guidelines outlined by the Oslo Stock Exchange for index revisions are relatively predictable. One could investigate if there are any abnormal returns by forecasting inclusions and exclusions before the announcement date by extending the event window over a longer time-period.

iv) Arnott et al. (2018) found that on average, only three stocks in the top 10 list when ranked by global market cap ("top-dogs") remained on the list ten years later. It could be interesting to study the performance of the largest market-cap stocks on the OSEBX and study if a portfolio strategy excluding the top-dogs would improve portfolio return.

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# Appendix

## Appendix A. OSEBX – Total Inclusion Events from January 2003 to June 2018

| Period | Ticker | AD | ED | Source |
|---|---|---|---|---|
| June 2018 | BWO | 09.05.2018 | 01.06.2018 | https://newsweb.oslobors.no/message/450938 |
| | NEL | 09.05.2018 | 01.06.2018 | https://newsweb.oslobors.no/message/450938 |
| | FJORD | 09.05.2018 | 01.06.2018 | https://newsweb.oslobors.no/message/450938 |
| | AUSS | 09.05.2018 | 01.06.2018 | https://newsweb.oslobors.no/message/450938 |
| | PCIB | 09.05.2018 | 01.06.2018 | https://newsweb.oslobors.no/message/450938 |
| | BGBIO | 09.05.2018 | 01.06.2018 | https://newsweb.oslobors.no/message/450938 |
| December 2017 | BDRILL | 10.11.2017 | 01.12.2017 | https://newsweb.oslobors.no/message/438410 |
| | BWLPG | 10.11.2017 | 01.12.2017 | https://newsweb.oslobors.no/message/438410 |
| | QEC | 10.11.2017 | 01.12.2017 | https://newsweb.oslobors.no/message/438410 |
| | TRVX | 10.11.2017 | 01.12.2017 | https://newsweb.oslobors.no/message/438410 |
| | NOFI | 10.11.2017 | 01.12.2017 | https://newsweb.oslobors.no/message/438410 |
| | EVRY | 10.11.2017 | 01.12.2017 | https://newsweb.oslobors.no/message/438410 |
| | FUNCOM | 10.11.2017 | 01.12.2017 | https://newsweb.oslobors.no/message/438410 |
| June 2017 | GSF | 05.05.2017 | 01.06.2017 | https://newsweb.oslobors.no/message/426553 |
| | SRBANK | 05.05.2017 | 01.06.2017 | https://newsweb.oslobors.no/message/426553 |
| | GIG | 05.05.2017 | 01.06.2017 | https://newsweb.oslobors.no/message/426553 |
| | LINK | 05.05.2017 | 01.06.2017 | https://newsweb.oslobors.no/message/426553 |
| December 2016 | AKSO | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| | AMSC | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| | LSG | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| | NOFI | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| | B2H | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |

| | | | | |
|---|---|---|---|---|
| | OPERA | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| | ASETEK | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| | KIT | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| | HNB | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| June 2016 | HEX | 12.05.2016 | 01.06.2016 | https://newsweb.oslobors.no/message/401742 |
| | NEXT | 12.05.2016 | 01.06.2016 | https://newsweb.oslobors.no/message/401742 |
| | SAS NOK | 12.05.2016 | 01.06.2016 | https://newsweb.oslobors.no/message/401742 |
| | AXA | 12.05.2016 | 01.06.2016 | https://newsweb.oslobors.no/message/401742 |
| | GIG | 12.05.2016 | 01.06.2016 | https://newsweb.oslobors.no/message/401742 |
| December 2015 | MULTI | 12.11.2015 | 01.12.2015 | https://newsweb.oslobors.no/message/389255 |
| | EPR | 12.11.2015 | 01.12.2015 | https://newsweb.oslobors.no/message/389255 |
| June 2015 | AVANCE | 13.05.2015 | 01.06.2015 | https://newsweb.oslobors.no/message/377940 |
| | FRO | 13.05.2015 | 01.06.2015 | https://newsweb.oslobors.no/message/377940 |
| | RENO | 13.05.2015 | 01.06.2015 | https://newsweb.oslobors.no/message/377940 |
| | NANO | 13.05.2015 | 01.06.2015 | https://newsweb.oslobors.no/message/377940 |
| | THIN | 13.05.2015 | 01.06.2015 | https://newsweb.oslobors.no/message/377940 |
| | IDEX | 13.05.2015 | 01.06.2015 | https://newsweb.oslobors.no/message/377940 |
| | QFR | 13.05.2015 | 01.06.2015 | https://newsweb.oslobors.no/message/377940 |
| | PHO | 13.05.2015 | 01.06.2015 | https://newsweb.oslobors.no/message/377940 |
| December 2014 | WEIFA | 13.11.2014 | 01.12.2014 | https://newsweb.oslobors.no/message/364913 |
| | SSO | 13.11.2014 | 01.12.2014 | https://newsweb.oslobors.no/message/364913 |
| | XXL | 13.11.2014 | 01.12.2014 | https://newsweb.oslobors.no/message/364913 |
| June 2014 | AMSC | 15.05.2014 | 02.06.2014 | https://newsweb.oslobors.no/message/353052 |
| | BIOTEC | 15.05.2014 | 02.06.2014 | https://newsweb.oslobors.no/message/353052 |
| | PHO | 15.05.2014 | 02.06.2014 | https://newsweb.oslobors.no/message/353052 |
| | BAKKA | 15.05.2014 | 02.06.2014 | https://newsweb.oslobors.no/message/353052 |
| | BWLPG | 15.05.2014 | 02.06.2014 | https://newsweb.oslobors.no/message/353052 |

| | | | | |
|---|---|---|---|---|
| | HEX | 15.05.2014 | 02.06.2014 | https://newsweb.oslobors.no/message/353052 |
| December 2013 | SAS NOK | 14.11.2013 | 02.12.2013 | https://newsweb.oslobors.no/message/339876 |
| | SALM | 14.11.2013 | 02.12.2013 | https://newsweb.oslobors.no/message/339876 |
| June 2013 | AFG | 14.05.2013 | 03.06.2013 | https://newsweb.oslobors.no/message/327982 |
| | ASETEK | 14.05.2013 | 03.06.2013 | https://newsweb.oslobors.no/message/327982 |
| | OLT | 14.05.2013 | 03.06.2013 | https://newsweb.oslobors.no/message/327982 |
| | PLCS | 14.05.2013 | 03.06.2013 | https://newsweb.oslobors.no/message/327982 |
| December 2012 | EMGS | 16.11.2012 | 03.12.2012 | https://newsweb.oslobors.no/message/316029 |
| | SONG | 16.11.2012 | 03.12.2012 | https://newsweb.oslobors.no/message/316029 |
| June 2012 | DETNOR | 16.05.2012 | 01.06.2012 | https://newsweb.oslobors.no/message/305470 |
| | FUNCOM | 16.05.2012 | 01.06.2012 | https://newsweb.oslobors.no/message/305470 |
| | VEI | 16.05.2012 | 01.06.2012 | https://newsweb.oslobors.no/message/305470 |
| December 2011 | AIK | 11.11.2011 | 01.12.2011 | https://newsweb.oslobors.no/message/293301 |
| | AKER | 11.11.2011 | 01.12.2011 | https://newsweb.oslobors.no/message/293301 |
| | BAKKA | 11.11.2011 | 01.12.2011 | https://newsweb.oslobors.no/message/293301 |
| | NSG | 11.11.2011 | 01.12.2011 | https://newsweb.oslobors.no/message/293301 |
| | WWIB | 11.11.2011 | 01.12.2011 | https://newsweb.oslobors.no/message/293301 |
| June 2011 | AKBM | 12.05.2011 | 01.06.2011 | https://newsweb.oslobors.no/message/282536 |
| | GOL | 12.05.2011 | 01.06.2011 | https://newsweb.oslobors.no/message/282536 |
| | SEAW | 12.05.2011 | 01.06.2011 | https://newsweb.oslobors.no/message/282536 |
| December 2010 | BWO | 15.11.2010 | 01.12.2010 | https://newsweb.oslobors.no/message/270931 |
| | JIN | 15.11.2010 | 01.12.2010 | https://newsweb.oslobors.no/message/270931 |
| | MORPOL | 15.11.2010 | 01.12.2010 | https://newsweb.oslobors.no/message/270931 |
| | SAS NOK | 15.11.2010 | 01.12.2010 | https://newsweb.oslobors.no/message/270931 |
| | WWASA | 15.11.2010 | 01.12.2010 | https://newsweb.oslobors.no/message/270931 |
| June 2010 | BAKKA | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | CLAVIS | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |

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|---|---|---|---|---|
| | ECHEM | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | ELT | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | FBU | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | KOG | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | NOD | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | NUT | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | ODF | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | PHO | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | QEC | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | QFR | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| December 2009 | AKER | 13.11.2009 | 01.12.2009 | https://newsweb.oslobors.no/message/249061 |
| | ALGETA | 13.11.2009 | 01.12.2009 | https://newsweb.oslobors.no/message/249061 |
| | COP | 13.11.2009 | 01.12.2009 | https://newsweb.oslobors.no/message/249061 |
| | LSG | 13.11.2009 | 01.12.2009 | https://newsweb.oslobors.no/message/249061 |
| | SONG | 13.11.2009 | 01.12.2009 | https://newsweb.oslobors.no/message/249061 |
| | VEI | 13.11.2009 | 01.12.2009 | https://newsweb.oslobors.no/message/249061 |
| June 2009 | BWG | 14.05.2009 | 02.06.2009 | https://newsweb.oslobors.no/message/237687 |
| | PSI | 14.05.2009 | 02.06.2009 | https://newsweb.oslobors.no/message/237687 |
| December 2008 | QEC | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | SAS NOK | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| January 2008 | CECO | 04.12.2007 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| | COP | 04.12.2007 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| | GOL | 04.12.2007 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| | IMAREX | 04.12.2007 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| | MEC | 04.12.2007 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| | NLPR | 04.12.2007 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| | NOD | 04.12.2007 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |

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|---|---|---|---|---|
| | PRON | 04.12.2007 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| | SALM | 04.12.2007 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| | SONG | 04.12.2007 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| July 2007 | AKBM | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | AUSS | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | BLO | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | BWO | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | ECHEM | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | ITE | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | JIN | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | MAMUT | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | SST | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | WAVE | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| January 2007 | ALX | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | ASD | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | AWO | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | DAT | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | GOGL | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | HNA | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | NPRO | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | OLT | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | PAR | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | RIE | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | STP | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | TCO | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | VIZ | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| July | AKER | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |

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|---|---|---|---|---|
| 2006 | SEVAN | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | SIN | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | CEQ | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | GAS | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | CRU | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | NORGAN | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | IGE | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | NAS | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | STP | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | BWG | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | FUNCOM | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | MEC | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| January 2006 | SUB | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | OCR | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | FJO | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | OPC | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | LSG | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | KOA | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | PAN | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | HNB | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | AKASA | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | BLO | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | ATG | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | BIRD | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | APP | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| July 2005 | SME | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | DNO | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | FOE | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |

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|---|---|---|---|---|
| | AKY | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | OSLO | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | CECO | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | QFR | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | TTS | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | TCO | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | DAT | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | DIAG | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| January 2005 | STO | 23.12.2004 | 03.01.2005 | https://newsweb.oslobors.no/message/101369 |
| | NORMAN | 23.12.2004 | 03.01.2005 | https://newsweb.oslobors.no/message/101369 |
| | VME | 23.12.2004 | 03.01.2005 | https://newsweb.oslobors.no/message/101369 |
| | CATCH | 23.12.2004 | 03.01.2005 | https://newsweb.oslobors.no/message/101369 |
| | PRO | 23.12.2004 | 03.01.2005 | https://newsweb.oslobors.no/message/101369 |
| | SUO | 23.12.2004 | 03.01.2005 | https://newsweb.oslobors.no/message/101369 |
| | MEC | 23.12.2004 | 03.01.2005 | https://newsweb.oslobors.no/message/101369 |
| July 2004 | YAR | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | AKVER | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | TGS | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | SME | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | FJO | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | KVE | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | OPERA | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | JIN | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | BIRD | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | OPC | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | NEXT | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | ASD | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | NTL | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |

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|---|---|---|---|---|
| | BLO | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| January 2004 | PGS | 04.12.2003 | 02.01.2004 | https://newsweb.oslobors.no/message/86807 |
| | ELT | 04.12.2003 | 02.01.2004 | https://newsweb.oslobors.no/message/86807 |
| | ACTA | 04.12.2003 | 02.01.2004 | https://newsweb.oslobors.no/message/86807 |
| | SOI | 04.12.2003 | 02.01.2004 | https://newsweb.oslobors.no/message/86807 |
| | MEC | 04.12.2003 | 02.01.2004 | https://newsweb.oslobors.no/message/86807 |
| July 2003 | APP | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| | BIRD | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| | KVE | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| | NOD | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| | ODFB | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| | TAD | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| | TAT | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| | VME | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| January 2003 | DAT | 05.12.2002 | 02.01.2003 | https://newsweb.oslobors.no/message/72500 |
| | KOG | 05.12.2002 | 02.01.2003 | https://newsweb.oslobors.no/message/72500 |
| | NOK | 05.12.2002 | 02.01.2003 | https://newsweb.oslobors.no/message/72500 |
| | WWI | 05.12.2002 | 02.01.2003 | https://newsweb.oslobors.no/message/72500 |
| | WWIB | 05.12.2002 | 02.01.2003 | https://newsweb.oslobors.no/message/72500 |

## Appendix B. OSEBX – Total Exclusion Events from January 2003 to June 2018

| Period | Ticker | AD | ED | Source |
|---|---|---|---|---|
| June 2018 | NPRO | 09.05.2018 | 01.06.2018 | https://newsweb.oslobors.no/message/450938 |
| | TRE | 09.05.2018 | 01.06.2018 | https://newsweb.oslobors.no/message/450938 |
| | SDRL | 09.05.2018 | 01.06.2018 | https://newsweb.oslobors.no/message/450938 |
| Dec 2017 | - | - | - | https://newsweb.oslobors.no/message/438410 |
| June 2017 | NOFI | 05.05.2017 | 01.06.2017 | https://newsweb.oslobors.no/message/426553 |
| | MULTI | 05.05.2017 | 01.06.2017 | https://newsweb.oslobors.no/message/426553 |
| | AMSC | 05.05.2017 | 01.06.2017 | https://newsweb.oslobors.no/message/426553 |
| | BIOTEC | 05.05.2017 | 01.06.2017 | https://newsweb.oslobors.no/message/426553 |
| December 2016 | ASC | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| | BWLPG | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| | GIG | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| | SAS NOK | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| | AVANCE | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| | QFR | 10.11.2016 | 01.12.2016 | https://newsweb.oslobors.no/message/413232 |
| June 2016 | AKSO | 12.05.2016 | 01.06.2016 | https://newsweb.oslobors.no/message/401742 |
| | AMSC | 12.05.2016 | 01.06.2016 | https://newsweb.oslobors.no/message/401742 |
| | PRS | 12.05.2016 | 01.06.2016 | https://newsweb.oslobors.no/message/401742 |
| December 2015 | FOE | 12.11.2015 | 01.12.2015 | https://newsweb.oslobors.no/message/389255 |
| | RENO | 12.11.2015 | 01.12.2015 | https://newsweb.oslobors.no/message/389255 |
| June 2015 | AKA | 13.05.2015 | 01.06.2015 | https://newsweb.oslobors.no/message/377940 |
| | BIONOR | 13.05.2015 | 01.06.2015 | https://newsweb.oslobors.no/message/377940 |
| December 2014 | QFR | 13.11.2014 | 01.12.2014 | https://newsweb.oslobors.no/message/364913 |
| | LSG | 13.11.2014 | 01.12.2014 | https://newsweb.oslobors.no/message/364913 |
| | PHO | 13.11.2014 | 01.12.2014 | https://newsweb.oslobors.no/message/364913 |

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|---|---|---|---|---|
| | ASETEK | 13.11.2014 | 01.12.2014 | https://newsweb.oslobors.no/message/364913 |
| | HEX | 13.11.2014 | 01.12.2014 | https://newsweb.oslobors.no/message/364913 |
| June 2014 | PLCS | 15.05.2014 | 02.06.2014 | https://newsweb.oslobors.no/message/353052 |
| | SAS NOK | 15.05.2014 | 02.06.2014 | https://newsweb.oslobors.no/message/353052 |
| | ODF | 15.05.2014 | 02.06.2014 | https://newsweb.oslobors.no/message/353052 |
| | CEQ | 15.05.2014 | 02.06.2014 | https://newsweb.oslobors.no/message/353052 |
| December 2013 | HNB | 14.11.2013 | 02.12.2013 | https://newsweb.oslobors.no/message/339876 |
| | EVRY | 14.11.2013 | 02.12.2013 | https://newsweb.oslobors.no/message/339876 |
| | EMGS | 14.11.2013 | 02.12.2013 | https://newsweb.oslobors.no/message/339876 |
| | AUSS | 14.11.2013 | 02.12.2013 | https://newsweb.oslobors.no/message/339876 |
| June 2013 | BAKKA | 14.05.2013 | 03.06.2013 | https://newsweb.oslobors.no/message/327982 |
| | CLAVIS | 14.05.2013 | 03.06.2013 | https://newsweb.oslobors.no/message/327982 |
| | FRO | 14.05.2013 | 03.06.2013 | https://newsweb.oslobors.no/message/327982 |
| | SALM | 14.05.2013 | 03.06.2013 | https://newsweb.oslobors.no/message/327982 |
| | SONG | 14.05.2013 | 03.06.2013 | https://newsweb.oslobors.no/message/327982 |
| December 2012 | FUNCOM | 16.11.2012 | 03.12.2012 | https://newsweb.oslobors.no/message/316029 |
| | PHO | 16.11.2012 | 03.12.2012 | https://newsweb.oslobors.no/message/316029 |
| June 2012 | MORPOL | 16.05.2012 | 01.06.2012 | https://newsweb.oslobors.no/message/305470 |
| | NSG | 16.05.2012 | 01.06.2012 | https://newsweb.oslobors.no/message/305470 |
| | SEVAN | 16.05.2012 | 01.06.2012 | https://newsweb.oslobors.no/message/305470 |
| December 2011 | ACTA | 11.11.2011 | 01.12.2011 | https://newsweb.oslobors.no/message/293301 |
| | AKBM | 11.11.2011 | 01.12.2011 | https://newsweb.oslobors.no/message/293301 |
| | ARCHER | 11.11.2011 | 01.12.2011 | https://newsweb.oslobors.no/message/293301 |
| | KVAER | 11.11.2011 | 01.12.2011 | https://newsweb.oslobors.no/message/293301 |
| | QEC | 11.11.2011 | 01.12.2011 | https://newsweb.oslobors.no/message/293301 |
| | SAS NOK | 11.11.2011 | 01.12.2011 | https://newsweb.oslobors.no/message/293301 |
| June | BWO | 12.05.2011 | 01.06.2011 | https://newsweb.oslobors.no/message/282536 |

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|---|---|---|---|---|
| 2011 | FBU | 12.05.2011 | 01.06.2011 | https://newsweb.oslobors.no/message/282536 |
| | JIN | 12.05.2011 | 01.06.2011 | https://newsweb.oslobors.no/message/282536 |
| | SONG | 12.05.2011 | 01.06.2011 | https://newsweb.oslobors.no/message/282536 |
| | VIZ | 12.05.2011 | 01.06.2011 | https://newsweb.oslobors.no/message/282536 |
| December 2010 | AIK | 15.11.2010 | 01.12.2010 | https://newsweb.oslobors.no/message/270931 |
| | BAKKA | 15.11.2010 | 01.12.2010 | https://newsweb.oslobors.no/message/270931 |
| | ECHEM | 15.11.2010 | 01.12.2010 | https://newsweb.oslobors.no/message/270931 |
| June 2010 | AKER | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | BLO | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | COP | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | MAMUT | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | NSG | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | SAS NOK | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| | VEI | 12.05.2010 | 01.06.2010 | https://newsweb.oslobors.no/message/260497 |
| December 2009 | DAT | 13.11.2009 | 01.12.2009 | https://newsweb.oslobors.no/message/249061 |
| | IMAREX | 13.11.2009 | 01.12.2009 | https://newsweb.oslobors.no/message/249061 |
| | KOG | 13.11.2009 | 01.12.2009 | https://newsweb.oslobors.no/message/249061 |
| | ORO | 13.11.2009 | 01.12.2009 | https://newsweb.oslobors.no/message/249061 |
| | PSI | 13.11.2009 | 01.12.2009 | https://newsweb.oslobors.no/message/249061 |
| | QEC | 13.11.2009 | 01.12.2009 | https://newsweb.oslobors.no/message/249061 |
| June 2009 | AKER | 14.05.2009 | 02.06.2009 | https://newsweb.oslobors.no/message/237687 |
| | CECO | 14.05.2009 | 02.06.2009 | https://newsweb.oslobors.no/message/237687 |
| | ECHEM | 14.05.2009 | 02.06.2009 | https://newsweb.oslobors.no/message/237687 |
| | HNA | 14.05.2009 | 02.06.2009 | https://newsweb.oslobors.no/message/237687 |
| | LSG | 14.05.2009 | 02.06.2009 | https://newsweb.oslobors.no/message/237687 |
| | ODFB | 14.05.2009 | 02.06.2009 | https://newsweb.oslobors.no/message/237687 |
| December | ASD | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |

| | | | | |
|---|---|---|---|---|
| 2008 | BIRD | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | BWG | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | COP | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | ELT | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | FUNCOM | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | JIN | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | KOM | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | NLPR | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | NOD | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | ODF | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | OLT | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | PAR | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | PHO | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | SONG | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | SPDE | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | VEI | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| | WWIB | 11.12.2008 | 02.01.2009 | https://newsweb.oslobors.no/message/225109 |
| January 2008 | AKBM | 04.12.2008 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| | APP | 04.12.2008 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| | DIAG | 04.12.2008 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| | ODFB | 04.12.2008 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| | VEI | 04.12.2008 | 02.01.2008 | https://newsweb.oslobors.no/message/165057 |
| July 2007 | CECO | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | CRU | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | GAS | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | IGE | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | MEC | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | OLT | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |

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|---|---|---|---|---|
| | RIE | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| | TCO | 13.06.2007 | 02.07.2007 | https://newsweb.oslobors.no/message/153937 |
| January 2007 | QFR | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| | SIN | 04.12.2006 | 02.01.2007 | https://newsweb.oslobors.no/message/140290 |
| July 2006 | KOG | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | AKASA | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | BLO | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | JIN | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | TTS | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | NORMAN | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | TCO | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | ASD | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| | DAT | 09.06.2006 | 03.07.2006 | https://newsweb.oslobors.no/message/130152 |
| January 2006 | OLT | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | KVE | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | GRE | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | VME | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | STP | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | SOI | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| | MEC | 12.12.2005 | 02.01.2006 | https://newsweb.oslobors.no/message/118421 |
| July 2005 | APP | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | BIRD | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | BLO | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | FJO | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | GOL | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | KVI | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| | NTL | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |

| | | | | |
|---|---|---|---|---|
| | OPC | 07.06.2005 | 01.07.2005 | https://newsweb.oslobors.no/message/109177 |
| January 2005 | SME | 23.12.2004 | 03.01.2005 | https://newsweb.oslobors.no/message/101369 |
| | NOR | 23.12.2004 | 03.01.2005 | https://newsweb.oslobors.no/message/101369 |
| | KOM | 23.12.2004 | 03.01.2005 | https://newsweb.oslobors.no/message/101369 |
| | HNB | 23.12.2004 | 03.01.2005 | https://newsweb.oslobors.no/message/101369 |
| | TCO | 23.12.2004 | 03.01.2005 | https://newsweb.oslobors.no/message/101369 |
| July 2003 | SST | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | TAD | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | HNA | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| | MEC | 04.06.2004 | 01.07.2004 | https://newsweb.oslobors.no/message/94124 |
| January 2004 | KVE | 04.12.2003 | 02.01.2004 | https://newsweb.oslobors.no/message/86807 |
| | AVA | 04.12.2003 | 02.01.2004 | https://newsweb.oslobors.no/message/86807 |
| | OPC | 04.12.2003 | 02.01.2004 | https://newsweb.oslobors.no/message/86807 |
| | VME | 04.12.2003 | 02.01.2004 | https://newsweb.oslobors.no/message/86807 |
| | BIRD | 04.12.2003 | 02.01.2004 | https://newsweb.oslobors.no/message/86807 |
| July 2003 | DAT | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| | IFC | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| | PAN | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| | PGS | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| | SOI | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| | TGS | 05.06.2003 | 01.07.2003 | https://newsweb.oslobors.no/message/80493 |
| January 2003 | BNB | 05.12.2002 | 02.01.2003 | https://newsweb.oslobors.no/message/72500 |
| | KVE | 05.12.2002 | 02.01.2003 | https://newsweb.oslobors.no/message/72500 |
| | MEC | 05.12.2002 | 02.01.2003 | https://newsweb.oslobors.no/message/72500 |
| | NOV | 05.12.2002 | 02.01.2003 | https://newsweb.oslobors.no/message/72500 |
| | TAT | 05.12.2002 | 02.01.2003 | https://newsweb.oslobors.no/message/72500 |
| | VME | 05.12.2002 | 02.01.2003 | https://newsweb.oslobors.no/message/72500 |

## Appendix C. AR and CAR in the Event Window over the Full Sample (Jan 2003 – June 2018)

| FULL SAMPLE | | | | |
|---|---|---|---|---|
| | INCLUSIONS | | EXCLUSIONS | |
| Date | AR | CAR | AR | CAR |
| -30 | 0.00% | 0.00% | -0.01% | -0.01% |
| -29 | 0.24% | 0.24% | 0.11% | 0.10% |
| -28 | -0.26% | -0.02% | 0.22% | 0.32% |
| -27 | 0.07% | 0.05% | -0.05% | 0.27% |
| -26 | -0.03% | 0.01% | 0.03% | 0.29% |
| -25 | 0.09% | 0.10% | 0.22% | 0.51% |
| -24 | -0.28% | -0.18% | 0.78% | 1.29% |
| -23 | 0.38% | 0.21% | 0.13% | 1.42% |
| -22 | -0.29% | -0.08% | -0.01% | 1.41% |
| -21 | -0.36% | -0.44% | -1.02% | 0.39% |
| -20 | -0.09% | -0.53% | -0.12% | 0.27% |
| -19 | -0.07% | -0.60% | -0.56% | -0.28% |
| -18 | -0.15% | -0.75% | 0.62% | 0.34% |
| -17 | -0.56% | -1.30% | -0.13% | 0.21% |
| -16 | 0.22% | -1.08% | -0.20% | 0.01% |
| -15 | -0.15% | -1.23% | 0.65% | 0.66% |
| -14 | -0.13% | -1.36% | -0.60% | 0.07% |
| -13 | -0.19% | -1.55% | -0.16% | -0.09% |
| -12 | -0.12% | -1.67% | -0.69% | -0.78% |
| -11 | 0.05% | -1.63% | -0.02% | -0.80% |
| -10 | -0.08% | -1.71% | -0.46% | -1.26% |
| -9 | -0.12% | -1.83% | 0.10% | -1.16% |
| -8 | -0.17% | -2.00% | 0.42% | -0.74% |
| -7 | -0.11% | -2.11% | 0.23% | -0.51% |
| -6 | -0.20% | -2.31% | 0.08% | -0.44% |
| -5 | -0.10% | -2.41% | 0.07% | -0.37% |
| -4 | 0.51% | -1.90% | -0.40% | -0.77% |

| | | | | |
|---|---|---|---|---|
| -3 | 0.50% | -1.40% | -0.66% | -1.43% |
| -2 | 0.33% | -1.07% | -0.02% | -1.45% |
| -1 | 1.77% | 0.69% | -1.65% | -3.10% |
| 0 | -0.89% | -0.20% | 1.58% | -1.52% |
| 1 | -0.48% | -0.68% | 0.50% | -1.02% |
| 2 | -0.24% | -0.91% | 0.64% | -0.37% |
| 3 | -0.21% | -1.13% | 0.17% | -0.20% |
| 4 | -0.28% | -1.41% | 0.83% | 0.63% |
| 5 | -0.69% | -2.10% | 0.65% | 1.28% |
| 6 | -0.02% | -2.12% | 0.18% | 1.46% |
| 7 | -0.11% | -2.23% | 0.60% | 2.06% |
| 8 | -0.54% | -2.77% | 0.84% | 2.90% |
| 9 | -0.31% | -3.08% | 0.34% | 3.24% |
| 10 | -0.14% | -3.22% | 0.38% | 3.62% |
| 11 | -0.20% | -3.42% | -0.24% | 3.38% |
| 12 | -0.15% | -3.57% | 0.61% | 3.99% |
| 13 | -0.67% | -4.24% | 0.08% | 4.07% |
| 14 | -0.56% | -4.80% | 0.30% | 4.37% |
| 15 | 0.06% | -4.74% | -0.06% | 4.31% |
| 16 | -0.15% | -4.89% | -0.02% | 4.29% |
| 17 | -0.08% | -4.97% | 0.70% | 4.99% |
| 18 | -0.05% | -5.02% | -0.25% | 4.73% |
| 19 | 0.09% | -4.93% | 0.62% | 5.35% |
| 20 | -0.17% | -5.09% | 0.51% | 5.86% |
| 21 | 0.05% | -5.04% | 0.33% | 6.19% |
| 22 | -0.48% | -5.52% | -0.11% | 6.08% |
| 23 | 0.23% | -5.30% | 0.21% | 6.29% |
| 24 | 0.14% | -5.16% | 1.19% | 7.48% |
| 25 | -0.19% | -5.35% | 0.11% | 7.59% |
| 26 | -0.04% | -5.38% | 0.17% | 7.77% |
| 27 | -0.38% | -5.76% | -0.09% | 7.68% |
| 28 | 0.33% | -5.44% | 0.39% | 8.07% |

| | | | | |
|---|---|---|---|---|
| 29 | -0.04% | -5.48% | -0.44% | 7.63% |
| 30 | 0.06% | -5.42% | 0.67% | 8.31% |

## Appendix D. AR and CAR in the Event Window Post-Crisis (June 2009 – June 2018)

| POST CRISIS | | | | |
|---|---|---|---|---|
| | INCLUSIONS | | EXCLUSIONS | |
| Date | AR | CAR | AR | CAR |
| -30 | 0.05% | 0.05% | 0.35% | 0.35% |
| -29 | 0.26% | 0.31% | 0.28% | 0.63% |
| -28 | -0.49% | -0.18% | 0.05% | 0.68% |
| -27 | -0.17% | -0.35% | -0.25% | 0.43% |
| -26 | -0.07% | -0.42% | 0.21% | 0.64% |
| -25 | -0.10% | -0.53% | -0.18% | 0.47% |
| -24 | -0.68% | -1.21% | -0.33% | 0.13% |
| -23 | 0.16% | -1.05% | 0.12% | 0.25% |
| -22 | 0.02% | -1.03% | 0.33% | 0.59% |
| -21 | -0.40% | -1.43% | -0.44% | 0.14% |
| -20 | -0.22% | -1.65% | -0.25% | -0.11% |
| -19 | -0.64% | -2.29% | -0.26% | -0.37% |
| -18 | -0.15% | -2.44% | -0.19% | -0.56% |
| -17 | -1.06% | -3.51% | -0.21% | -0.77% |
| -16 | 0.29% | -3.22% | -0.43% | -1.20% |
| -15 | 0.09% | -3.13% | 0.54% | -0.66% |
| -14 | 0.31% | -2.82% | 0.36% | -0.30% |
| -13 | -0.24% | -3.06% | -0.59% | -0.89% |
| -12 | -0.22% | -3.27% | -0.37% | -1.26% |
| -11 | 0.12% | -3.15% | 0.04% | -1.22% |
| -10 | 0.18% | -2.97% | -0.50% | -1.72% |
| -9 | -0.40% | -3.37% | 0.22% | -1.50% |
| -8 | -0.43% | -3.80% | -0.01% | -1.51% |
| -7 | -0.04% | -3.83% | 0.40% | -1.11% |
| -6 | -0.05% | -3.88% | -0.36% | -1.48% |
| -5 | 0.06% | -3.82% | 0.35% | -1.13% |

| | | | | |
|---|---|---|---|---|
| -4 | 0.78% | -3.04% | -0.59% | -1.72% |
| -3 | 0.32% | -2.72% | -0.23% | -1.95% |
| -2 | 0.75% | -1.96% | -0.39% | -2.34% |
| -1 | 2.99% | 1.03% | -3.08% | -5.42% |
| 0 | -1.53% | -0.50% | 1.53% | -3.88% |
| 1 | -0.97% | -1.48% | 0.45% | -3.43% |
| 2 | 0.07% | -1.41% | 0.85% | -2.58% |
| 3 | -0.34% | -1.74% | -0.07% | -2.65% |
| 4 | -0.40% | -2.14% | 0.63% | -2.01% |
| 5 | -1.00% | -3.13% | 0.39% | -1.62% |
| 6 | -0.19% | -3.32% | 0.13% | -1.50% |
| 7 | -0.46% | -3.79% | 0.58% | -0.91% |
| 8 | -0.22% | -4.01% | 0.56% | -0.35% |
| 9 | -0.44% | -4.45% | 0.32% | -0.03% |
| 10 | 0.33% | -4.12% | 0.63% | 0.60% |
| 11 | -0.21% | -4.33% | -0.28% | 0.32% |
| 12 | -0.13% | -4.46% | 0.72% | 1.04% |
| 13 | -0.36% | -4.82% | 0.09% | 1.13% |
| 14 | -0.37% | -5.19% | -0.20% | 0.93% |
| 15 | -0.12% | -5.31% | 0.32% | 1.25% |
| 16 | -0.02% | -5.33% | 0.26% | 1.51% |
| 17 | -0.50% | -5.83% | 0.24% | 1.75% |
| 18 | -0.02% | -5.85% | -0.26% | 1.48% |
| 19 | -0.14% | -5.99% | 0.35% | 1.83% |
| 20 | -0.53% | -6.52% | 0.29% | 2.12% |
| 21 | -0.08% | -6.61% | -0.18% | 1.94% |
| 22 | -0.77% | -7.38% | 0.31% | 2.26% |
| 23 | 0.45% | -6.94% | 0.41% | 2.67% |
| 24 | -0.05% | -6.99% | 1.26% | 3.93% |
| 25 | -0.48% | -7.47% | -0.12% | 3.81% |
| 26 | -0.04% | -7.51% | -0.12% | 3.69% |

| | | | | |
|---|---|---|---|---|
| 27 | -0.40% | -7.91% | -0.22% | 3.46% |
| 28 | 0.33% | -7.57% | 0.10% | 3.57% |
| 29 | -0.23% | -7.80% | 0.36% | 3.92% |
| 30 | 0.08% | -7.71% | 0.54% | 4.46% |

## Appendix E. AR and CAR in the Event Window Pre-Crisis (Jan 2003 – July 2007)

| PRE CRISIS | | | | |
|---|---|---|---|---|
| | INCLUSIONS | | EXCLUSIONS | |
| Date | AR | CAR | AR | CAR |
| -30 | -0.18% | -0.18% | -0.08% | -0.08% |
| -29 | 0.31% | 0.13% | 0.70% | 0.62% |
| -28 | 0.13% | 0.25% | 0.62% | 1.24% |
| -27 | 0.31% | 0.57% | 0.42% | 1.66% |
| -26 | 0.08% | 0.65% | -0.84% | 0.82% |
| -25 | 0.32% | 0.97% | 0.18% | 1.01% |
| -24 | 0.07% | 1.04% | 1.54% | 2.55% |
| -23 | 0.48% | 1.52% | 1.17% | 3.72% |
| -22 | -0.69% | 0.83% | -0.34% | 3.38% |
| -21 | -0.17% | 0.65% | -0.07% | 3.31% |
| -20 | 0.20% | 0.85% | 0.01% | 3.32% |
| -19 | 0.70% | 1.55% | -0.24% | 3.07% |
| -18 | -0.17% | 1.37% | 0.99% | 4.06% |
| -17 | -0.19% | 1.18% | 0.47% | 4.53% |
| -16 | 0.02% | 1.20% | 0.23% | 4.76% |
| -15 | -0.54% | 0.67% | 0.41% | 5.16% |
| -14 | -0.47% | 0.20% | -0.84% | 4.32% |
| -13 | -0.36% | -0.17% | 0.73% | 5.04% |
| -12 | -0.10% | -0.26% | -0.23% | 4.81% |
| -11 | -0.08% | -0.34% | -0.30% | 4.52% |
| -10 | -0.44% | -0.78% | -0.37% | 4.14% |
| -9 | 0.01% | -0.77% | -0.22% | 3.92% |
| -8 | 0.10% | -0.67% | 0.72% | 4.64% |
| -7 | -0.19% | -0.86% | -0.04% | 4.60% |
| -6 | -0.36% | -1.22% | 0.52% | 5.12% |

| | | | | |
|---|---|---|---|---|
| -5 | -0.25% | -1.48% | -0.39% | 4.73% |
| -4 | 0.24% | -1.23% | -0.05% | 4.68% |
| -3 | 0.45% | -0.78% | 0.14% | 4.82% |
| -2 | -0.02% | -0.81% | 0.29% | 5.11% |
| -1 | 0.81% | 0.00% | -0.62% | 4.49% |
| 0 | -0.26% | -0.26% | 0.75% | 5.24% |
| 1 | 0.03% | -0.22% | 0.39% | 5.63% |
| 2 | -0.49% | -0.72% | 0.04% | 5.67% |
| 3 | -0.08% | -0.80% | 0.42% | 6.10% |
| 4 | -0.02% | -0.83% | 1.06% | 7.16% |
| 5 | -0.43% | -1.26% | 0.45% | 7.61% |
| 6 | 0.10% | -1.16% | 0.24% | 7.85% |
| 7 | 0.06% | -1.10% | 0.29% | 8.14% |
| 8 | -0.61% | -1.71% | 0.80% | 8.94% |
| 9 | -0.21% | -1.92% | 0.63% | 9.57% |
| 10 | -0.22% | -2.14% | 0.41% | 9.98% |
| 11 | -0.28% | -2.42% | 0.14% | 10.12% |
| 12 | -0.24% | -2.65% | 0.86% | 10.98% |
| 13 | -0.69% | -3.34% | 0.45% | 11.43% |
| 14 | -0.49% | -3.84% | 0.39% | 11.82% |
| 15 | 0.16% | -3.67% | -0.09% | 11.73% |
| 16 | -0.34% | -4.01% | -0.78% | 10.95% |
| 17 | 0.35% | -3.66% | 0.45% | 11.40% |
| 18 | -0.10% | -3.76% | 0.00% | 11.40% |
| 19 | 0.05% | -3.71% | 0.81% | 12.20% |
| 20 | 0.25% | -3.46% | 0.72% | 12.92% |
| 21 | 0.06% | -3.40% | 0.36% | 13.29% |
| 22 | 0.07% | -3.33% | -0.11% | 13.17% |
| 23 | -0.11% | -3.44% | -0.44% | 12.73% |
| 24 | 0.32% | -3.11% | 1.34% | 14.07% |
| 25 | 0.11% | -3.00% | 0.59% | 14.66% |
| 26 | -0.05% | -3.05% | 0.23% | 14.88% |

| | | | | |
|---|---|---|---|---|
| 27 | -0.45% | -3.50% | -0.07% | 14.82% |
| 28 | 0.43% | -3.08% | 0.22% | 15.04% |
| 29 | 0.43% | -2.65% | -0.58% | 14.46% |
| 30 | 0.05% | -2.60% | 0.51% | 14.97% |

## Appendix F. The CAR for Inclusions and Exclusions Pre-Crisis and its T-Statistics (Jan 2003 – July 2007)

| Trading Days Before AD | Inclusions | Exclusions | Inclusions minus Exclusions |
|---|---|---|---|
| 10 days | 0.02% | 4.34% | -4.32% |
| 5 days | 0.01% | 1.85% | -1.84% |
| 3 days | -0.88% | 2.09% | -2.97% |
| 1 day | -0.52% | 0.63% | -1.15% |
| AD | -0.54% | 0.41% | -0.95% |
| CAR between AD and ED | | | |
| Exclusive of ED | -1.20% | -0.27% | -0.93% |
| Inclusive of ED | -1.46% | 0.48% | -1.94% |
| Trading Days after ED | | | |
| ED | -0.26% | 0.75% | -1.01% |
| 1 day | -0.23% | 1.14% | -1.37% |
| 3 days | -0.80% | 1.61% | -2.41% |
| 5 days | -1.26% | 3.12% | -4.38% |
| 10 days | -2.14% | 5.49% | -7.63% |
| 15 days | -3.68% | 7.24% | -10.92% |
| 20 days | -3.46% | 8.44% | -11.90% |
| 25 days | -3.01% | 10.17% | -13.18% |
| 30 days | -2.60% | 10.49% | -13.09% |

*Average Cumulative Return Relative to Market over Various Horizons, Jan 2003 – July 2007*

| Trading Days Before AD | CAR Inclusions | T-test cross sectional | Prob. | Patell Z | Prob. | CAR Exclusions | T-test cross sectional | Prob. | Patell Z | Prob. |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 days | 0.02% | 0.0162 | 0.9871 | 0.6695 | 0.5032 | 4.34% | 2.6184 | 0.0088 | 3.3317 | 0.0009 |
| 5 days | 0.01% | 0.0156 | 0.9876 | 0.0581 | 0.9537 | 1.85% | 1.7688 | 0.0769 | 1.8648 | 0.0622 |
| 3 days | -0.88% | -1.6595 | 0.097 | -1.5214 | 0.1282 | 2.09% | 2.3777 | 0.0174 | 2.0292 | 0.0424 |
| 1 day | -0.52% | -1.7516 | 0.0798 | -0.821 | 0.4116 | 0.63% | 1.2231 | 0.2213 | 1.0177 | 0.3088 |
| AD | -0.54% | -2.3788 | 0.0174 | -1.02 | 0.3077 | 0.41% | 0.8915 | 0.3727 | 0.942 | 0.3462 |
| CAR between AD and ED | | | | | | | | | | |
| Exclusive of ED | -1.20% | -1.0482 | 0.2945 | 0.796 | 0.426 | -0.27% | -0.1723 | 0.8632 | -0.1855 | 0.8529 |
| Inclusive of ED | -1.46% | -1.2606 | 0.2075 | 0.4041 | 0.6862 | 0.48% | 0.3207 | 0.7484 | 0.3852 | 0.7001 |
| Trading Days after ED | | | | | | | | | | |
| ED | -0.26% | -0.9528 | 0.3407 | -1.4668 | 0.1424 | 0.75% | 2.1037 | 0.0354 | 2.2592 | 0.0239 |
| 1 day | -0.23% | -0.5759 | 0.5647 | -1.4233 | 0.1547 | 1.14% | 2.1129 | 0.0346 | 2.2255 | 0.0261 |
| 3 days | -0.80% | -1.6283 | 0.1035 | -1.8702 | 0.0615 | 1.61% | 2.2116 | 0.027 | 2.3858 | 0.017 |
| 5 days | -1.26% | -2.0715 | 0.0383 | -2.2743 | 0.0229 | 3.12% | 3.4417 | 0.0006 | 3.1076 | 0.0019 |
| 10 days | -2.14% | -2.8392 | 0.0045 | -2.5881 | 0.0097 | 5.49% | 3.4174 | 0.0006 | 4.1606 | 0 |
| 15 days | -3.68% | -2.8114 | 0.0049 | -2.6757 | 0.0075 | 7.24% | 3.9559 | 0.0001 | 4.0754 | 0 |
| 20 days | -3.46% | -2.7968 | 0.0052 | -2.2929 | 0.0219 | 8.44% | 4.0673 | 0 | 4.0423 | 0.0001 |
| 25 days | -3.01% | -2.0682 | 0.0386 | -1.761 | 0.0782 | 10.17% | 4.1356 | 0 | 4.1857 | 0 |
| 30 days | -2.60% | -1.6471 | 0.0995 | -1.2944 | 0.1955 | 10.49% | 4.2813 | 0 | 4.2227 | 0 |

*Average Cumulative Return Relative to Market and Its T-statistics, Jan 2003 – July 2007*

## Appendix G. The CAR for Inclusions and Exclusions Post Crisis

| Trading Days Before AD | Inclusions | Exclusions | Inclusions minus Exclusions |
|---|---|---|---|
| 18 days | -3.15% | -1.22% | -1.93% |
| 15 days | -2.97% | -1.90% | -1.07% |
| 10 days | -2.12% | -1.80% | -0.32% |
| 5 days | 0.35% | -0.45% | 0.80% |
| 3 days | -0.02% | -0.55% | 0.53% |
| 1 day | -0.09% | -0.32% | 0.23% |
| AD | 0.12% | 0.04% | 0.08% |
| CAR between AD and ED | | | |
| Exclusive of ED | 4.30% | -4.16% | 8.46% |
| Inclusive of ED | 2.77% | -2.62% | 5.39% |
| Trading Days after ED | | | |
| ED | -1.53% | 1.53% | -3.06% |
| 1 day | -2.50% | 1.99% | -4.49% |
| 3 days | -2.77% | 2.77% | -5.54% |
| 5 days | -4.16% | 3.79% | -7.95% |
| 10 days | -5.14% | 6.02% | -11.16% |
| 15 days | -6.33% | 6.67% | -13.00% |
| 20 days | -7.55% | 7.54% | -15.09% |
| 25 days | -8.50% | 9.23% | -17.73% |
| 30 days | -8.74% | 9.88% | -18.62% |

*Average Cumulative Return Relative to Market over Various Horizons, June 2009 – June 2018*

## Appendix H. Return on a Long-Short Portfolio over the period Jan 2003 – June 2018