Per Olav Collin

Price, Volume and Liquidity Fluctuations Around OBX Revisions

Evidence of Temporary Price Pressures and Index Effect Asymmetry

Master's thesis in Financial Economics
Supervisor: Snorre Lindset
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Norwegian University of Science and Technology
Faculty of Economics and Management
Department of Economics

NTNU
Norwegian University of
Science and Technology

Preface

This thesis concludes the two-year masters program in Financial Economics at the Norwegian University of Science and Technology (NTNU). My curiosity regarding index effects was awakened during the Norwegian Finance Initiative's Summer School of 2017, where the topic was first introduced to me. It has since been an inspiring maneuver analyzing the phenomenon in further detail. I would like to thank my supervisor, Professor Snorre Lindset at the Department of Economics, for support and critique throughout the process. I would also like to thank my wife, Rut Kristine, for her tireless and never-ending encouragement, for which I am grateful.

The results and analyses are entirely my own, and I take full responsibility of all content.

Trondheim, May 2018
Per Olav Collin

Abstract

This thesis seeks to isolate potential price, volume, and liquidity effects of revisions to the Oslo Børs Total Return Index (OBX). The research question is investigated using traditional event study methods. The market model is used to calculate normalized returns, whereas abnormal volume turnover is assessed using market-adjusted volume ratios. Additionally, bid-ask spreads are used to determine liquidity effects around index revisions. Through a comprehensive analysis of historical additions to and deletions from the OBX, findings point to significant temporary abnormal price pressures, most likely caused by index fund rebalancing, around the semi-annual revisions of the index. The results found are supportive of the price-pressure hypothesis, suggesting short-term downward sloping demand curves. Effects are materialized through stock prices, traded volumes, and stock liquidity. Moreover, the effects are proven to be stronger and more persistent for additions, compared to deletions. Hence, results point to considerable index effect asymmetry, possibly originating from asymmetric investor awareness. Moreover, the abnormal price, volume, and liquidity movements found have increased through time, as more capital has poured into funds replicating the OBX. Finally, the results do not show evidence of abnormal price fluctuations around revision announcements, confirming the a priori understanding that OBX revisions are information-free events.

Sammendrag

Formålet med denne masteroppgaven er å isolere mulige pris-, volum- og likviditetseffeker av de halvårlige revideringene av Oslo Børst Total Return Index (OBX). Problemstillingen utforskes ved å benytte tradisjonelle metoder for begivenhetsstudier. Markedsmodellen blir brukt til å beregne aksjers normalavkastning og markedsjusterte volumrater benyttes for å analysere potensielle volumeffekter. I tillegg blir bid-ask spread[1] benyttet til å analysere fluktuasjoner i likviditet rundt OBX-revideringene. En grundig analyse av historiske inkluderinger og ekskluderinger i OBX-indeksen viser et signifikant midlertidig prispress, mest sannsynlig grunnet indeksfond og deres betydelige påvirkning på aksjers etterspørsel. Resultatene som avdekkes støtter prispresshypotesen, som innebærer fallende kortsiktige etterspørselskurver. De samlede effektene kommer til uttrykk gjennom aksjepris, handelsvolum og aksjers likviditet. Samtidig viser analysen at indekseffektene er sterkere og mer vedvarende for aksjer inkludert i OBX-indeksen, sammenlignet med de aksjene som ekskluderes fra samme indeks. Resultatene taler derfor om asymmetriske indekseffekter, potensielt som en følge av asymmetrisk bevissthet hos investorene. I tillegg viser funnene at unormale fluktuasjoner i aksjers avkastning, handelsvolum og likviditet har økt de siste årene, samtidig som indeksfond har vokst i størrelse. Til slutt slår resultatene fra analysen fast at de unormale prisbevegelsene rund annonseringsdagen er små og ikke signifikante. Dermed bekreftes hypotesen om at OBX-revideringer ikke tilfører markedet ny informasjon.

[1] Med bid-ask spread menes forskjellen mellom kjøpers høyeste bud og den laveste prisen selger vil godta (Berk & DeMarzo, 2014).

Contents

1. Introduction

The notion that index revisions may impact stock prices and traded volumes has interested finance researchers since the mid 1980s. Shleifer (1986) was perhaps the first to test for such effects, uncovering significant upward drifts in stock prices following additions to the S&P 500 index. Following the pioneering study of Shleifer (1986), later studies have focused on price effects, volume effects, or both. The term "index effect" refers to such significant abnormal fluctuations in a stock's price or traded volume around the time of an index revision. Hence, the idea of index effects contradicts the efficient market hypothesis (EMH), first introduced by Fama (1970). When a stock is added to an index, the event itself should not carry new information to the market. Consequently, according to the EMH, index additions (deletions) should not have positive (negative) effects on stock price. Still, numerous studies on the S&P 500 index have concluded in favor of significant price effects associated with changes to the index composition (including Harris & Gurel, 1986; Dhillon & Johnson, 1991).

Previous studies have largely been based on US stock indices, and agree to a great extent about the presence of significant price effects. However, disagreements regarding the scope and characteristics of such price drifts have resulted in a range of literature aiming at explaining the puzzle. More recent studies have targeted potential index effects on Norwegian indices. Certain studies have uncovered evidence of temporary price pressures created by index funds (Myhre & Nybakk, 2012; Knutsen, 2014; Mæhle & Sandberg, 2015). Others have suggested more permanent effects on stock prices (Wøllo & Kouabache, 2017). Most studies on Norwegian indices are one-sided, in the sense they consider only effects of index additions.

The main research question of this study has been whether or not revisions of the Oslo Børs Total Return Index (OBX) affect the prices, traded volumes, and liquidity of the stocks added to or deleted from the index. Moreover, this paper seeks to compare the effects of additions and deletions to determine the degree of index effect symmetry. The research question has been answered using event study methodology, as introduced by Fama, Fisher, Jensen, and Roll (1969). The event study has been based on daily stock returns, trading volumes, and bid-ask spreads over the period 1999 – 2017. The market model has been used to estimate normalized returns additions to and deletions from the OBX over the complete period. Normalized volume levels have been computed using average volume ratios, as proposed by Harris and Gurel (1986). Furthermore, this thesis examines the bid-ask spreads of the stocks in question, to determine possible liquidity effects originating from index revisions. Hence, this study provides a comprehensive analysis of multiple sides of index revisions, including price, volume, and liquidity, for both additions to and deletions from the OBX.

The results found in this study suggest temporary price pressures around the semi-annual revisions of the OBX, most likely due to index fund rebalancing. Studying the time period following the global financial crisis, findings show average abnormal returns of 2.41% for added stocks on the day prior to revision. On the opposite side, deleted stocks have experienced average abnormal returns of -2.03% the same day. Both effects are found significant on the 1% level. The effects uncovered are largely asymmetric, meaning that the positive abnormal returns for additions are greater and more persistent than the negative abnormal returns found for deletions. Negative price effects from deletions are completely reversed after only two days, when looking at data following the global financial crisis. On the contrary, positive price effects for additions last for ten days, when assessing the same data. Furthermore, results show that volume turnover is more than doubled for both additions and deletions on the final day before revision. Moreover, bid-ask spreads decrease for added stocks and increase considerably for deleted stocks around the same day, contributing to an overall tripled index effect.

2. Background

2.1. Stock Indices and Index Funds

The concept of financial indices lies to the heart of this study. A financial index is "a market-capitalization-weighted average of a specific and relatively static list of securities" (Lo, 2016, p. 21). The first stock market index was formed in the 1880s by the company Dow, and named the Railroad Average, today known as the Dow Jones Transportation Average (Lo, 2016). Around a decade later the same firm formed the Dow Jones Industrial Average, which still exists as one of the most renowned indices within finance.

The first index funds were introduced in 1982, based on the NYSE Composite, S&P 500 and the Value Line index (Lo, 2016). These funds were set up with the sole purpose of replicating an index, leading to a high degree of diversification. Hence, index funds offered investors a new type of diversified investing. The development of index funds continued through the 1980s and the 1990s, and soon index fund investing became available to the average investor. Still, the most significant increase in capital managed by Norwegian index funds came following the global financial crisis of 2008 (Norwegian Fund and Asset Management Association (VFF), 2018).

2.2. The OBX

The OBX is a financial index made up of the 25 most actively traded stocks listed on Oslo Stock Exchange (OBX Total Return Index, 2017). The OBX was formed in 1987, and has since been adjusted on a semi-annual basis according to traded volumes over the previous six months. Index revisions are implemented on the third Friday of June and December (Effective date, ED), whereas the announcements (Announcement date, AD) of the revisions do not come on any specific dates, but usually around seven days prior to ED. The dynamics of the revisions process are further illustrated in Figure 2.1. The announcements of index revisions are made on Oslo Stock Exchange's news website.[2] During the time period between the semi-annual revisions, the general rule is to keep index weights constant (Oslo Børs, 2017). However, this may be altered in case of delistings, mergers, capital adjustments, or similar corporate events. Hence, the number of firms listed on the OBX may deviate from 25 in certain periods, as illustrated by the OBX's composition history found in Appendix A.

[2] Oslo Stock Exchange's news website is "www.newsweb.no".

Figure 2.1. Number of Days Between AD and ED

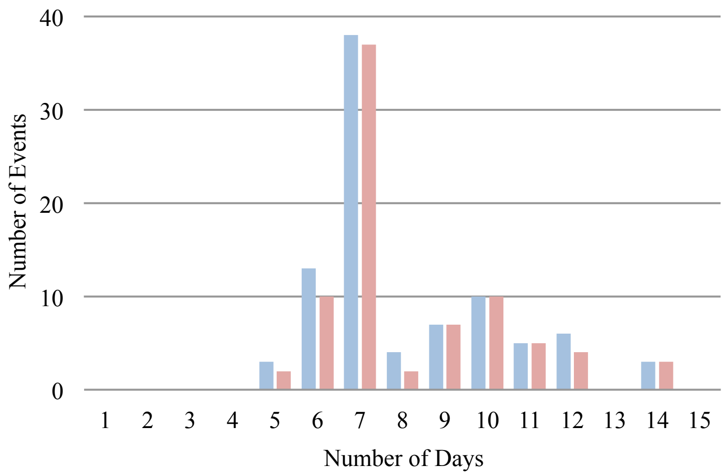

Figure 2.1. Bars display the number of days between the announcement date (AD) and effective date (ED). The analysis has been based on historic OBX revisions over the time period 1999 – 2017. Blue bars indicate index additions, whereas red bars indicate index deletions.

The 25 firms listed on the OBX account for approximately 75% of the total market capitalization of Oslo Stock Exchange.[3] The OBX is a tradable index, meaning both futures and options on the index are available to investors. Furthermore, certain financial intermediaries offer funds that are fully based on the composition of the OBX. These funds have gained popularity over the past decade (Norwegian Fund and Asset Management Association (VFF), 2018). Figure 3.1. below displays the development of capital managed by such index funds.

2.2.1. Adjustment of Index Weights

OBX weights are capped in order to comply with certain regulatory frameworks (Oslo Børs, 2017). Hence, the largest firm cannot make up more than 30% of the total index, whereas other firms are capped at 15%. The total weight of non-EEA firms[4] is limited to 10% of the index. If capping occurs, the weight removed from one firm is distributed among the remaining firms on the index, according to their weights (Oslo Børs, 2017). For a more detailed explanation of the techniques behind OBX calculations, readers are advised to review the Oslo Stock Exchange's document on index methodology (Oslo Børs, 2017).

[3] Information is based on calculations from 13 April 2018, using the latest updated market capitalization data from Oslo Stock Exchange.
[4] The term non-EEA firms refers to companies stationed in countries that are not part of the European Economic Area.

3. Theory

3.1. The Efficiency of Capital Markets

The EMH, developed by researcher Eugene Fama (1970), has been a central part of financial theory for decades. The theory has been comprehensively debated, as research on the topic continues to disagree, and new theories on behavioral finance have gained attention (Bodie, Kane, & Marcus, 2014). According to the EMH, financial markets are efficient in the sense that all available information is reflected in the prices of financial instruments (Fama, 1970). Hence, the question of efficiency relates to whether or not prices reflect the information available. The EMH argues that it is impossible for an investor to outperform the market as a whole, as stocks cannot under any circumstance be mispriced. As a result, investors should not spend time on conducting firm analyses and outlining investment strategies, but rather invest available funds in the market as a whole, using a so-called passive investment strategy. However, opponents would disagree, arguing that reality has proven that some investors manage to outperform the market, at least in the short run. For a more detailed explanation of the EMH, please see Fama (1970). The validity of the EMH has been further discussed by Bodie et al. (2014).

3.2. Index Investing and Tracking Error

Index funds have gained momentum over the previous decades, attracting more and more capital (Tu, Adeyemi, Karambelas, Callagy, & Pinto, 2017). Index investors minimize risk by being only exposed to the overall market, while removing firm-specific risk, as index funds are considered highly diversified. The performance of an index fund is measured using tracking error, meaning how well the fund is able to replicate the exact return of its trailed index. The tracking error should be minimized, ideally zero. Focus on minimizing tracking error has increased as the popularity of index funds has risen, resulting in greater price pressure around ED (Chen, Noronha, & Singal, 2004). Hence, index funds strive to be updated with the latest index compositions. In order to limit tracking error, many index funds wait until ED to rebalance, despite the announcement often being made several days before (Beneish & Whaley, 1996).

3.2.1. Popularity of Index Funds and Price Pressure

Most Norwegian stock funds are actively managed, and it was not until after the global financial crisis that Norwegian index investing surged (Norwegian Fund and Asset Management Association, 2018). Growth in index funds could lead to greater index effects, due to rebalancing by funds around ED, as supported by Harris and Gurel (1986).

Figure 3.1. Capital Managed by Funds Tracking the OBX

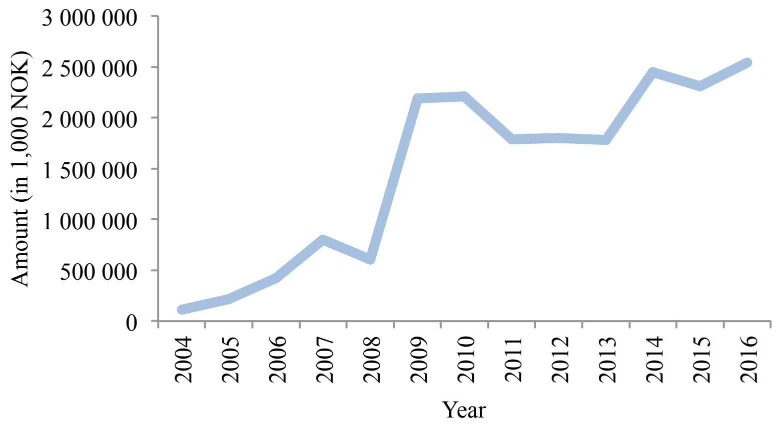

Figure 3.1. Development in capital managed by index funds replicating the OBX (Norwegian Fund and Asset Management Association (VFF), 2018).

Pruitt and Wei (1989) studied the effects that financial intermediaries have on the S&P 500 index, in particular volume changes that occur following the announcement of index revisions. They found evidence of price pressures resulting from increased demand of stocks around the time of the revisions. Pruitt and Wei (1989) also discovered a significant increase in the number of institutional investors holding stocks after the announcement. Studies on the OBX have also found support for price pressure generated by index fund rebalancing (Myhre & Nybakk, 2012; Knutsen, 2014; Mæhle & Sandberg, 2015).

3.3. Explaining Price and Volume Effects

Although there is no conclusive theory explaining the dynamics behind the observed index effects, several hypotheses aiming at solving the puzzle have been proposed. The following is a presentation of four theories that all have been supported by previous research.

3.3.1. Price-Pressure Hypothesis

The price-pressure hypothesis states that higher (lower) buying pressure around index additions (deletions) will shift demand curves upward (downward), resulting in temporary price and volume effects. The hypothesis has been supported by several studies on the S&P 500 index, including the early study of Harris and Gurel (1986). Central to the hypothesis of price pressure is the idea of imperfectly elastic short-term demand curves. A demand shock to a short-term downward sloping demand curve will lead to temporary price changes. Long-term demand curves are assumed to be perfectly elastic, ensuring a correction of abnormal return effects in the long run. The price-pressure hypothesis is closely tied to the idea of index fund rebalancing around the time of index revisions, leading to a temporary increase (decrease) in demand, and thus price.

3.3.2. Imperfect Substitution Hypothesis

Unlike the price-pressure hypothesis, the hypothesis of imperfect substitution suggests permanent price effects, which implies downward sloping long-term demand curves. This hypothesis was supported by Shleifer (1986), who discovered persistent price effects following additions to the S&P 500. The hypothesis suggests that stocks are imperfect substitutes, and consequently higher (lower) demand will lead to permanently higher (lower) prices. Unlike the price-pressure hypothesis, the imperfect substitution hypothesis only considers price effects, leaving the question of volume changes unanswered.

3.3.3. Awareness Hypothesis

The awareness hypothesis builds on the idea that added firms are followed more closely by investors, despite no new information being released at the time of the additions. The theory was supported by Chen et al. (2004), who discovered asymmetric index effects, suggesting that index additions would raise investor awareness, whereas index deletions would not make investors unaware of a firm. Hence, price effects are permanently positive for additions, whereas there are no permanent price effects for deletions, the awareness hypothesis claims. Chen et al. (2004) tested for investor awareness by comparing the number of shareholders before and after index revisions. They found a significant increase in shareholders following an addition announcement. On the contrary, Chen et al. (2004) found a less significant decrease in shareholders following deletions, supporting the awareness hypothesis. The awareness hypothesis is sometimes also referred to as the liquidity hypothesis, suggesting that added stocks receive more media attention, lowering trading costs for investors, and thereby decreasing bid-ask spreads (Bechmann, 2004). Amihud (2002) confirmed more illiquid firms (greater bid-ask spreads) could expect greater average returns. In addition, Beneish and Whaley (1996) found evidence of temporary liquidity effects when studying additions to the S&P 500 index. Studies have suggested that the awareness hypothesis is most relevant for larger indices containing smaller firms, not already widely traded (Beneish & Gardner, 1995). Hence, the awareness hypothesis is perhaps more fitting for indices like the S&P 500 index. The OBX consists of only 25 firms that are well known to Norwegian investors. Consequently, it could be more difficult to argue in favor of considerably raised awareness following additions to the OBX.

3.3.4. Information Hypothesis

Unlike other hypotheses listed, the information hypothesis opposes the a priori understanding of index revisions being information-free events. Rather, the hypothesis suggests that additions will result in persistently higher stock prices and traded volumes because new information is presented at the time of the announcements. Both Dhillon and Johnson (1991) and Cai (2007) found support in favor of informational content being provided around index revisions. Unlike the other theories aiming at explaining the index effect, the information hypothesis does not oppose the theory of efficient capital markets, as higher prices come as a result of new information. The hypothesis is most relevant for index revisions based on combinations of qualitative and quantitative selection criteria, unlike the OBX, which relies on a purely mathematical selection process.

3.4. Previous Studies

Previous studies have looked at a range of indices. This chapter contains a presentation of the most predominant studies on the S&P 500 index and Norwegian indices, later summarized in Table 3.1. The following research should be considered most relevant for this thesis.

3.4.1. Shleifer (1986)

Shleifer (1986) studied price effects on the S&P 500 index using data from 1966 to 1983, and found significant positive price drifts around AD. According to Shleifer (1986), effects were persistent, at least for ten days, supporting the imperfect substitution hypothesis. He explained the positive effects by referring to index funds that replicate the S&P 500 index, creating pressure on newly added stocks. The study uncovered an abnormal price increase of 2.79% on AD, when looking only at the period 1976 - 1983. Furthermore, Shleifer (1986) found that the price effects had increased over time. Shleifer (1986) also made an effort to test for the effect of information content in S&P 500 additions, but failed to find any significant evidence in favor of the information hypothesis.

3.4.2. Harris and Gurel (1986)

Harris and Gurel (1986) studied stock prices around AD, using data from 1973 to 1983. They found significant price effects of more than 3.13% for index additions. However, the effects found were temporary and the entire price effect was almost completely reversed two weeks after the announcement. Harris and Gurel (1986) explained the fluctuations by referring to the hypothesis of price pressure. Alongside Shleifer (1986), the study of Harris and Gurel (1986) paved the way for further research within the field of index effects.

3.4.3. Dhillon and Johnson (1991)

Dhillon and Johnson (1991) supported the findings by Harris and Gurel (1986) and Shleifer (1986) of positive permanent price effects around AD for index additions. They did however question both the price-pressure hypothesis and the imperfect substitutes hypothesis. Instead, Dhillon and Johnson (1991) studied option prices for firms added to the S&P 500 index, and found support for the information hypothesis when comparing stock prices and bond prices around AD. Dhillon and Johnson (1991) also found compelling evidence in support of the awareness hypothesis.

3.4.4. Chen, Noronha and Singal (2004)

Chen et al. (2004) studied price and volume effects of both additions to and deletions from the S&P 500 index from 1962 to 2000. This was one of the first studies to consider both additions and deletions. Chen et al. (2004) uncovered asymmetric index effects, meaning that additions create permanently positive abnormal returns, whereas deletions do not result in any permanently abnormal negative returns. The study uncovered some negative price effects following deletions, but only temporary. Chen et al. (2004) explained the observed asymmetry using the awareness hypothesis, meaning that additions will raise investor awareness, whereas deletions will not lead to negative investor attention, at least not in the long run.

3.4.5. Myhre and Nybakk (2012)

Myhre and Nybakk (2012) studied price and volume effects of additions to the OBX over the time period 1997 – 2012. They used both the capital asset pricing model (CAPM) and the market model to compute normalized returns. In addition, they separated the data in subsamples, before and after the global financial crisis. Their findings did not support significant positive index effects for the period as a whole. However, for the period following 2008, Myhre and Nybakk (2012) found positive index effects on the day prior to implementation (ED-1). Furthermore, the study examined trading volumes, discovering significantly greater turnover on days surrounding ED. Overall, they argued that there is no significant arbitrage opportunity existing from the index effect on the OBX. The slight price effect found is so small that it would not pose a real arbitrage opportunity, Myhre and Nybakk (2012) argued.

3.4.6. Knutsen (2014)

This study examined the price and volume effects for additions to the Oslo Børs Mutual Fund Index (OSEFX) over the period 2002 – 2014. Knutsen (2014) found an average abnormal return of 2.48% on the day prior to index addition (ED-1). He also found significantly greater traded volumes the same day. In line with Myhre and Nybakk (2012), the study examined the results from the subsamples before and after the global financial crisis, and Knutsen (2014) also discovered greater price and volume effects following 2008. The findings were in line with the price-pressure hypothesis, Knutsen (2014) argued, resulting in temporary price and volume effects around ED. He also found some support in favor of the awareness hypothesis.

3.4.7. Mæhle and Sandberg (2015)

In their thesis, Mæhle and Sandberg (2015) studied price and volume effects of both additions to and deletions from the Oslo Børs Benchmark Index (OSEBX), using both the market model and the Fama-French three factor model (FF3F) as measures of normalized return. Mæhle & Sandberg (2015) found strong evidence of price and volume effects around ED, and further argued in favor of the price-pressure hypothesis. In addition, they were unable to reject the awareness hypothesis. The study also looked at liquidity changes by comparing historic volume turnover, rejecting the hypothesis of improved liquidity following index additions.

3.4.8. Wøllo and Kouabache (2017)

Wøllo and Kouabache (2017) studied data from 2001 to 2017 when testing for effects on both prices and volumes for OBX additions. The study used both the CAPM and the FF3F-model to compute normalized returns. Wøllo and Kouabache (2017) found a positive average abnormal return of 1.03% on the day prior to implementation (ED-1), accompanied by a significant increase in traded volumes the same day. They concluded that the effects found were permanent, supporting the imperfect substitution hypothesis. In additions, they were unable to identify any effects around AD, rejecting the information hypothesis.

Table 3.1.

Summary of Relevant Previous Research

Study	Index	Period	Topic	Add(+), Del(-)	Support	Norm. ret.
Shleifer (1986)	S&P 500	1966 - 1983	P	+	ISH	MM
Harris & G. (1986)	S&P 500	1973- 1983	P, V	+	PPH	CRSP Proxy
Dhillon & J. (1991)	S&P 500	1978 - 1988	P	+	IH	MM
Chen, N, & S. (2004)	S&P 500	1962 - 2000	P	+, -	AH	S&P 500
Myhre & N. (2012)	OBX	1997 - 2012	P, V	+	(PPH)	MM, CAPM
Knutsen (2014)	OSEFX	2002 - 2014	P, V	+	PPH, AH	MM
Mæhle & S. (2015)	OSEBX	2003 - 2013	P, V	+, -	PPH, AH	MM, FF3F
Wøllo & K. (2017)	OBX	2001 - 2016	P, V	+	ISH	CAPM, FF3F

Note. Ps and Vs in column four indicate "price effects" and "volume effects". "+" and "-" in column five refer to index additions and deletions, respectively. ISH = Imperfect substitution hypothesis, PPH = Price-pressure hypothesis, IH = Information hypothesis, AH = Awareness hypothesis. MM = Market model. CRSP = Center for Research on Security Prices. CAPM = Capital asset pricing model. FF3F = Fama-French three-factor model.

3.4.9. Comments to Previous Research

Despite various studies being conducted on index effects associated with the OBX, no study (to this author's knowledge) has looked at price, volume, and liquidity effects of both additions and deletions around AD and ED. This study has similarities with the thesis of Mæhle and Sandberg (2015), which tested for price and volume effects on the Oslo Børs Benchmark Index (OSEBX). On the contrary, the focus of this study has been to uncover possible asymmetry of index effects. Moreover, this thesis goes further in testing liquidity around the ED, using bid-ask spreads as a mean to test the awareness hypothesis. No previous study has (to this author's knowledge) considered bid-ask spreads around revisions of Norwegian indices. As a result, this study contributes to the topic of index effect research by covering new aspects of index effects, and focusing on possible asymmetry around revisions.

One should be cautious when comparing studies based on the S&P 500 index with studies on the OBX, as both the effects and underlying explanations differ across the indices. Hence, the results of this study will mostly be compared to other studies on the Norwegian market, particularly those on the OBX.

4. Methodology

Although there is no standardized procedure for measuring abnormal price, volume, and liquidity effects of particular events, most previous research rely on the event study methodology outlined by Fama et al. (1969), and later summarized by MacKinlay (1997). This chapter contains a brief description of the methods used to measure returns, trading volumes, and bid-ask spreads.

4.1. The Event Study

Event studies are used to measure the economic effects of particular events, like index revisions (MacKinlay, 1997). Kothari and Warner (2007) argue that event studies provide the best way to study the degree of efficiency in the financial markets, and that short-term event studies tend to provide reliable results. The procedure of using event studies on financial data, as carefully described by MacKinlay (1997), has been implemented to answer the research question in this thesis. The generalized procedure of an event study starts by determining the event in question. For the purpose of this study, there are two particular dates of interest, AD and ED. Second, the event window should be determined, meaning a time period surrounding the events studied. It is interesting to test for abnormal returns on a range of days around the two events, as index funds may rebalance their portfolios on surrounding days. Third, one must determine the selection criteria, meaning restrictions that should be imposed on the data set. Fourth, in order to determine abnormal returns one must be able to identify normalized values. The normalized returns are the returns one would expect to see if the event had not taken place. A certain return figure must be compared to a normalized benchmark in order to be considered abnormal (Brown & Warner, 1980). There are multiple ways of doing this, including the use of economic models like the CAPM or the FF3F. Other models, like the market model or the constant average return model, follow a statistical approach (MacKinlay, 1997). Fifth, the researcher should determine the estimation window used for the purpose of computing the normalized returns. Finally, after deciding on a research design, one can test, report and analyze the results.

All estimations conducted in this thesis were performed using Stata statistical software. A selection of the "Do-files"[5] used to complete the analyses can be found in Appendix B.

[5] The term Do-file refers to a particular file format used by Stata statistical software.

4.1.1. Event Window

Having identified the two events of interest, the event window must be formed around these two dates. The length of the event window should be adjusted according to the event in question (MacKinlay, 1997). Longer event windows enable the researcher to capture the persistency of index effects. On the contrary, longer event windows stand the chance of capturing other occasions than the event studied, thereby simply creating noise. Previous studies on the Norwegian market have used event windows that stretch from 60 days prior to the event to 60 days after (Myhre & Nybakk, 2012; Wøllo & Kouabache, 2017). This is also in line with studies on the S&P 500 index (Dhillon & Johnson, 1991). Such an event window should be sufficient in order to capture the desired effects. Hence, the 121-day event window illustrated in Figure 4.1. was used in this study.

Figure 4.1. Time Line of the 121-day Event Window

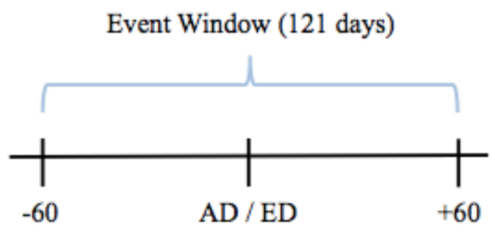

Figure 4.1. Illustration of the Event Window. AD = Announcement Date, ED = Effective Date.

As there is no clear procedure for announcing revisions of the OBX, this study considers announcements made before 1PM on AD. If the announcement was made after 1PM, the proceeding day is considered AD.

4.1.2. Measuring Normalized Returns, Volumes, and Liquidity

4.1.2.1. Normalized Return Calculation

Previous studies have used a mixture of economic and statistical models when computing levels of normalized returns. Such examples include both single-factor and multi-factor models, some more advanced than others. According to Brown and Warner (1980), the simple statistical market model proves to work well for most event studies. This has been supported by MacKinlay (1997), who argued that the benefits to using multi-factor models like the FF3F-model are limited, as the market factor alone has relatively high explanatory power. Moreover, there is a risk of excluding relevant factors when using more sophisticated models, making the model worse. MacKinlay (1997) also argued against using the CAPM, as deviations from its assumptions have been found, meaning the model has lost much of its value. Based on these arguments and the results of previous research, this study has used the market model to determine normalized returns. All market model estimations have been performed using the ordinary least squares method (OLS), as explained by Wooldridge (2016). For a more detailed explanation of the advantages and disadvantages to using other normalized return models, readers are advised to read MacKinlay's (1997) article on event study methodology.

4.1.2.1.1. The Market Model

The simple market model purposed by William Sharpe (1963) is a single-factor model that relies on the firm's covariance with the market portfolio (MacKinlay, 1997). The covariance is measured by the parameter beta, and the parameter alpha is used to capture other aspects of the firm that will affect its returns. In an efficient market alpha will be zero, and thus high alpha values could point to mispricing (Bodie et al., 2014). The market model builds on the assumption that there is a stable linear relationship between the market return and the stock return (MacKinlay, 1997). For the purpose of this study, the OBX has used as a proxy for the overall market. The simple market model is given by equation (1):

$$R_{it} = \hat{\alpha}_i + \hat{\beta}_i R_{mt} + \varepsilon_{it} \tag{1}$$

where
R_{it} is the return of stock i at time t,
$\hat{\alpha}_i$ is the estimated alpha of stock i,
$\hat{\beta}_i$ is the estimated beta of stock i,
R_{mt} is the market return at time t,
ε_{it} is the residual (abnormal return) of stock i at time t,
and

$$\hat{\beta}_i = \frac{\sum_{\tau=T_0+1}^{T_1}[R_{i\tau} - E(R_{it})][R_{m\tau} - E(R_{mt})]}{\sum_{\tau=T_0+1}^{T_1}[R_{m\tau} - E(R_{mt})]^2} \tag{2}$$

where $E(-)$ refers to expected (normalized) values.

Finally,

$$\hat{\alpha}_i = E(R_{it}) - \hat{\beta}_i E(R_{mt}) \tag{3}$$

and

$$E(R_{it}) = \frac{1}{T_1 - T_0} \sum_{\tau=T_0+1}^{T_1} R_{it} \tag{4}$$

The expected value of the residual is zero. The residual can be interpreted as the abnormal return (AR). Hence, the expression for the abnormal return is given by

$$\varepsilon_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{mt}) \tag{5}$$

and thus

$$AR_{it} = R_{it} - E(R_{it}) \tag{6}$$

This study seeks to determine whether an index revision on average leads to abnormal returns or significant changes in traded volume. Hence, abnormal returns are aggregated across all firms at time t, thus taking the cross sectional average abnormal return using

$$\overline{AR_t} = \frac{1}{N} \sum_{i=1}^{N} AR_{it} \tag{7}$$

Once the cross sectional average abnormal returns are found, they are aggregated across time by using the method of cumulative abnormal returns (Kothari & Warner, 2007). The cumulative average abnormal return is given by

$$\overline{CAR}(t_1, t_2) = \sum_{t=t_1}^{t_2} \overline{AR_t} \tag{8}$$

This enables analyses of the total price effects over certain time periods. For example, the cumulative abnormal return over a short period prior to AD would capture the effect of investors speculating on the forthcoming announcement.

Throughout this study, daily returns have been simply calculated arithmetically, using

$$(9) \qquad R_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

where P_t and P_{t-1} are the stock prices at time t and $t-1$, respectively.

4.1.2.2. Volume Ratio Calculation

Analyzing traded volumes around the announcement of index revisions has been less common than analyzing price effects. Comparing studies that test for volume effects gives various methods of computing a normalized volume ratio. A key component when computing volume ratios relates to adjusting for changes in total market volume. Hence, studies comparing a firm's volume to its own average (e.g. Dhillon & Johnson, 1991; Myhre & Nybakk, 2012) risk missing important fluctuations in total market turnover (Mæhle & Sandberg, 2015). To account for such market movements, this study has used the measure of abnormal trading volume introduced by Harris and Gurel (1986). First, the volume ratio (VR) is computed by comparing the average trading volumes of the market (V_m) and stock i (V_i) over the estimation window, with the trading volumes of the market (m) and stock i on a specific day in the event window, denoted V_{mt} and V_{it} respectively (Harris & Gurel, 1986). Hence, the volume ratio is formally expressed as

$$(10) \qquad VR_{it} = \frac{V_{it}}{V_{mt}} * \frac{V_m}{V_i}$$

Second, the average daily volume ratio (AVR) is computed by taking the average of all stocks' volume ratios on each day in the event window, using

$$(11) \qquad AVR_t = \frac{1}{N}\sum_{i=1}^{N} VR_{it}$$

Finally, the method allows for the following hypothesis testing,

$$H_0: AVR = 1$$

$$H_1: AVR \neq 1$$

where AVR-values of one represent normalized trading levels. Hence, AVR-values beyond unity represent enhanced trading volumes, and AVR-values less than one reflect lower trading volumes.

4.1.2.3. Measuring Changes to Liquidity

To gain a better understanding of the liquidity effects caused by OBX revisions, bid-ask spreads for stocks added to and deleted from the index have been investigated. A bid-ask spread is the difference between the prices quoted by the selling and purchasing parties of a stock (Berk & DeMarzo, 2014). The spread can be viewed as a transaction cost paid to market intermediaries for facilitating the trade. Higher spreads indicate lower liquidity, whereas lower spreads point to greater liquidity. Hence, if price pressures were created by index funds tracking the OBX, one would expect to find lower spreads following an index addition and greater spreads following a deletion. Later analyses are based on percentage spreads, estimated using

$$(12) \qquad Percentage\ Spread_{it} = \frac{Ask_{it} - Bid_{it}}{Ask_{it}}$$

and

$$(13) \qquad AverageSpread_t = \frac{1}{N}\sum_{i=1}^{N} Percentage\ Spread_{it}$$

Furthermore, spread ratios (SR), as introduced by Beneish and Whaley (1996), have been computed and analyzed. Together with changes to the average percentage spread, computed average spread ratios (ASR) should give clear indications of the effects in play. Spread ratios are computed using

$$(14) \qquad SR_{it} = \frac{Spread_{it}}{AvgSpread_i}$$

and

$$(15) \qquad ASR_t = \frac{1}{N}\sum_{i=1}^{N} SR_{it}$$

where

$Spread_{it}$ is the bid-ask spread of stock i at time t, and

$AvgSpread_i$ is the average bid-ask spread of stock i during the estimation window.

Consequently, an average spread ratio of one should reflect a normalized liquidity situation. Hence, a more liquid market is recognized by average spread ratios less than one, whereas values beyond unity reflect greater illiquidity.

4.1.3. Estimation Window

The estimation window is used to compute a firm's normalized levels for return and volume. To ensure that abnormal trading occurring in the event window does not affect normalized return, the estimation window should not overlap with the event window (MacKinlay, 1997). Most previous studies use the time prior to AD when computing normalized return. Other approaches include using a post-event window, or a combination of the two, a so-called pooled window (MacKinlay, 1997). The choice of design should be adjusted for each study, to best answer the research question. Jain (1987) argued in favor of using a post-event window, as the pre-event returns are non-stationary, resulting in a selection bias and thereby higher alpha values. Positive abnormal returns could lead to firms being added to the index, not the other way around, Jain (1987) argued. One solution to this problem would be to go back more than six months, creating a time gap between the estimation and event windows. Hence, the period relevant for OBX selection would not be included in the estimation window used to estimate normalized returns. However, one would still stand the risk of capturing abnormal movements that occur more than six months prior to the announcement. Another approach would be to use a post-event window, which historically has been less common in studies on the Norwegian market. The fact that OBX selection is based on trading volume over the previous six months makes selection biases highly relevant. One can expect added (deleted) stocks to have over (under) performed during the selection period, possibly altering the normalized return estimations (Bechmann, 2004). Hence, abnormal returns of additions (deletions) could be underestimated (overestimated) when using a pre-event estimation window. In deciding whether to use an estimation window before or after the event, it is important to discuss if the event itself is exogenous or endogenous, as event study methodology assumes exogenous events (MacKinlay, 1997). High and low trading volumes trigger the events captured in this study. Hence, it can be argued that the event itself is endogenous. To combat any problems this may cause, this study has used a post-event estimation window. A consequence of placing the estimation window after the event is that observations from the second half of 2016 and first half of 2017 are excluded, due to lack of estimation data.

Deciding on the length of the estimation window is to a great extent a consideration between data relevance and the data's explanatory power (Myhre & Nybakk, 2012). Long estimation windows provide more data, thereby increasing explanatory power. On the contrary, studies using longer estimation windows risk capturing other events, resulting in a lack of relevance. Previous studies on the Norwegian indices have used two-year estimation windows (Myhre & Nybakk, 2012; Wøllo and Kouabache, 2017). Comparing this to renowned studies on the S&P 500 index, a two-year estimation window is long. Considering the risk of gathering outdated and irrelevant data, this study used a shorter estimation window of one year (252 trading days).

Figure 4.2. Time Line of the Event and Estimation Windows

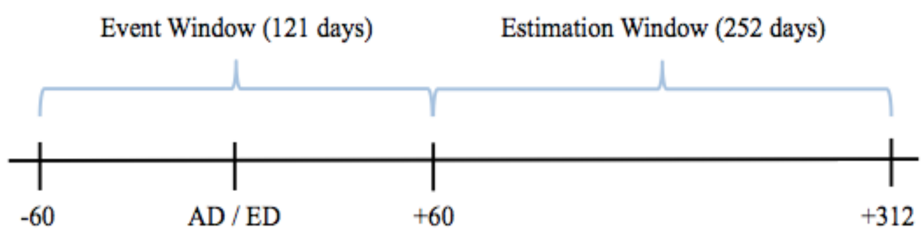

Figure 4.2. Illustration of the Event and Estimation Windows. AD = Announcement Date, ED = Effective Date.

It should be noted that the estimation method used in this study resulted in slight differences in the estimation windows for AD and ED, hence minor discrepancies in beta and alpha values across firms. However, after assessing the market model calculations this was not considered an issue, as differences are negligible.

Another aspect to consider relates to data frequency, and whether to use daily or weekly data when computing normalized returns and volumes. Using frequent data points will increase the number of observations, but may also have a negative noise affect, resulting in more volatile estimation periods. Research has also highlighted that daily return data tend to deviate more from normality, compared to less frequent return data (Fama, 1976; Brown & Warner, 1985). Bodie et al. (2014) address the fact that daily data respond to a range of events, making it challenging to isolate the effects of the particular event in question. On the contrary, less frequent data will decrease the number of observations, thereby potentially removing relevant information (Bodie et al., 2014). To prevent important information from being lost, this study has used daily data for stock returns, traded volumes, and bid-ask spreads. Furthermore, potential issues relating to normality are addressed in Chapter 6 of this thesis.

5. Data

This study has used data for additions and deletions of stocks to the OBX over the period June 1999 to June 2017. Oslo Stock Exchange provided information regarding which firms that were added and deleted over the period (Appendix A). The data used was limited to this time period, as Oslo Stock Exchange were unable to provide information going further back in time (Oslo Børs Information Services, personal communication, 9 January 2018). Additional information regarding the announcement dates was collected using Oslo Stock Exchange's news website.[6]

Data for stock prices, volume turnover, and bid-ask spreads before, around and after AD and ED was gathered using TITLON financial database. All prices are fully adjusted to account for corporate events and dividends (Sirnes, 2018). The OBX index was used as a proxy for the market as a whole. Hence, when referring to market return, it is the return of the OBX. The OBX price and return data were also collected from TITLON, whereas OBX volume data were downloaded from Oslo Stock Exchange's website. It should also be noted that TITLON data account for split and dividend adjustments implemented to the OBX in 2006 (Sirnes, 2018).

For the purpose of later analyses, the time period 1999 – 2017 was further split into two subsamples: 1999 – 2007 and 2008 – 2017. The objective behind looking at these subsamples was to determine any changes over time, and to test for any changes in index effects following the global financial crisis.

5.1. Selection Criteria

A key component in preparing data for event study analysis lies in imposing restrictions on the data used. This cleaning process has had the following steps. First, every stock in the data set needed an event window of 121 days and an estimation window of 252 days. Any event containing less daily return data was excluded from the analyses. Consequently, so-called "fast entries" were also excluded, meaning firms that entered the OBX immediately after being listed on Oslo Stock Exchange. A total of 13 additions and 15 deletions were excluded from the data set due to such lack of data. Second, stocks with highly volatile event or estimation windows were excluded. This was done to cut off extreme cases that would have

[6] Oslo Stock Exchange's news website is "www.newsweb.no".

created noise. Extreme returns in the estimation window could come as a result of extraordinary events, creating noise in the estimation of normalized returns. Hence, removing such extremes contributed to ensuring data validity. Sorokina, Booth, and Thornton (2013) highlighted the significance of treating extreme values when conducting event studies in finance. One usual way to treat extreme values is to set maximum and minimum values that define cut-off (Sorokina et al., 2013), and then remove extremes. Sorokina et al. (2013) argue that the problem with the approach is the possibility of removing important information, while improving statistical inferences. Four index additions and five index deletions were excluded due to extreme values and volatile event and estimation windows. Third, some data were unavailable through the channels used, reasons sometimes being unclear. Reasons could be that firms were involved in mergers, acquisitions or name changes around the time of index revision. This included ten additions and eight deletions. Finally, firms with more than 50 missing returns during the estimation period were excluded, totaling one addition and three deletions. This was done to ensure that normalized returns were computed based on sufficient data. After the cleaning process was conducted the final data set included 62 index additions and 50 index deletions, equal to 69% and 62% of the original data set, respectively. Appendix C contains information regarding which firms that were excluded from the data set.

5.2. Clean Sample

This study used 62 additions and 50 deletions when analyzing price effects to stocks added to or deleted from the OBX. For reasons mentioned in above, 28 additions and 31 deletions were excluded from the sample. Less sufficient data for volumes turnover limited the selection of stocks included in analyzing abnormal trading volumes. Hence, 59 additions and 39 deletions were included in the volume data set. The price and volume data were tested using standard T-tests, explained by Wooldridge (2016). The T-tests used rely on the assumption of cross sectional average abnormal returns being normally distributed (Wooldridge, 2016). This assumption has been further tested in Chapter 7. The analysis of bid-ask spreads has been based on 65 additions and 53 deletions, also limited by the data available through TITLON financial database.

6. Hypotheses

Based on the findings of previous studies, the following hypotheses were listed and later tested.

a) Significant price increase around AD for index additions. Hence, the null hypothesis

$$H_0: AAR_{AD}^{Add} > 0$$

b) Significant price reduction around AD for index deletions. Hence, the null hypothesis

$$H_0: AAR_{AD}^{Del} < 0$$

c) Significant price increase around ED for index additions. Hence, the null hypothesis

$$H_0: AAR_{ED}^{Add} > 0$$

d) Significant price reduction around ED for index deletions. Hence, the null hypothesis

$$H_0: AAR_{ED}^{Del} < 0$$

e) Significant increase in traded volume around ED for index additions: Hence, the null hypothesis

$$H_0: AVR_{ED}^{Add} > 1$$

f) Significant increase in traded volumes around ED for index deletions. Hence, the null hypothesis

$$H_0: AVR_{ED}^{Del} > 1$$

g) The index effect has increased over time, as funds tracking the OBX have become larger. Hence, the null hypothesis

$$H_0: AAR_{ED}^{Sub.1} < AAR_{ED}^{Sub.2}$$

h) Stocks become more liquid at the time of addition. Hence, the null hypotheses

$$H_0: AverageSpread_{ED}^{Add} < AverageSpread_{ED-1}^{Add}$$

and

$$H_0: ASR_{ED}^{Add} < 1$$

i) Stocks become less liquid at the time of deletion. Hence, the null hypotheses

$$H_0: AverageSpread_{ED}^{Del} > AverageSpread_{ED-1}^{Del}$$

and

$$H_0: ASR_{ED}^{Del} > 1$$

The first two hypotheses appeal the theories of informational content and investor awareness. Hypothesis c) has been proposed based on the findings of Myhre and Nybakk (2012), Knutsen (2014), and Mæhle and Sandberg (2015), who all found evidence of price pressures when studying additions to various Norwegian indices. Furthermore, hypothesis d) can be supported by the findings of Mæhle and Sandberg (2015). Hypotheses e), f) and g) appeal to the idea behind temporary price pressures, giving support to the price-pressure hypothesis. Hypothesis g) was also embraced by the findings of Myhre and Nybakk (2012) and Knutsen (2014). The final two hypotheses, h) and i) are in line with general financial theory of the effect on bid-ask spreads of changes to demand and price pressures.

7. Critical Testing of Data Set

An essential aspect of research relates to testing the quality of the data used. The term "BLUE" (Best Linear Unbiased Estimators) is often used to describe the desired characteristics of the estimators used in econometric testing using the OLS-method (Wooldridge, 2016). To establish whether the BLUE-criteria is satisfied, data has been tested for normality deviations, heteroscedasticity and serial correlation, making it possible to assess the reliability of the results, as proposed by Wooldridge (2016). A complete review of the results can be found in Appendix D.

7.1. Normality Deviations, Heteroscedasticity and Serial Correlation

Deviations from normality have been analyzed using the Shapiro-Wilk test in Stata. It should be noted that the Shapiro-Wilk test works best for data sets containing up to 50 observations (Rahman & Govindarajulu, 1997). Hence, the test is applicable only when looking at specific days. To assess the degree of heteroscedasticity and serial correlation, 20 randomly chosen events were chosen, evenly distributed between additions and deletions. As proposed by Wooldridge (2016), the White-test was then used to determine the degree of heteroscedasticity in abnormal returns, and the Breusch-Godfrey test was used to assess potential serial correlation.

Results from critical testing displayed partly deviations of normality, which must be kept in mind when assessing the reliability of the results found in this thesis. Furthermore, one third of the events selected did not satisfy the assumption of homoscedasticity. To help address these problems of heteroscedasticity, all regressions throughout this study have been performed using robust standard errors. Robust regressions are designed to give less weight to observations containing large abnormal returns, thereby reducing the problems caused by heteroscedasticity (Wooldridge, 2016.) Additionally, the Breusch-Godfrey test detected problems with serial correlation in 10% of the data.

7.2. Clustering

MacKinlay (1997) addressed problems with clustering that often occur in event studies. Clustering is a result of overlapping event windows between stocks added to or deleted from the OBX, and contributes to greater cross-sectional correlation between stocks in the data set. This could create problems when aggregating abnormal returns over time, as cross-sectional correlation will result in lower standard deviations, and thereby greater T-statistics (Kothari & Warner, 2007). This study contains clustering, as multiple stocks are added to or deleted from the OBX on the same date, creating duplicated event windows. Unfortunately, clustering is difficult to avoid, unless each event date had been limited to only one observation. However, this would result in few and highly questionable observations, reducing the overall validity of this study. Brown and Warner (1980) argue in favor of using the market model as a measure of normalized return in the case of event clustering, as the method will limit cluster implications.

7.3. Missing Data

The problem of missing return data arises numerous times in the raw data downloaded from TITLON. This may be the result of a stock not being traded on a particular date or the data containing errors. Missing returns could lead to a lack of estimation data, thereby creating problems related to drawing the correct conclusions from inference testing. To limit complications created by missing data, stocks with more than 50 missing returns over the 252-day estimation window have been excluded from the study. This comprised of one addition and three deletions. Furthermore, there is no case of missing volume or bid-ask spread data for any of the observations in the data set.

8. Results and Empirical Analysis

The following presentation of findings is split into three separate sections according to the sample used in the analysis. In each section, results are presented, analyzed, and later discussed. Moreover, liquidity changes around ED are presented and analyzed. Finally, overall findings are compared to previous research.

8.1. Complete Sample (1999 – 2017)

Results for average abnormal returns (AAR), cumulative abnormal returns (CAR) and average volume ratios (AVR) around AD are presented in Table 8.1. below. Similar results for tests around ED are presented in Table 8.2.

8.1.1. Findings Around the Announcement Date

Findings around the day of announcement are unable to reveal abnormal returns of any particular interest. This is the case for both index additions and deletions. During the 11-day window presented in Table 8.1., none of the AARs presented are significant. Hence, the general perception is that stock returns behave as expected, meaning the market does not display any abnormal reactions following the announcement of revisions to the OBX. A graphical illustration of the AAR-development during the event window can be found in Appendix E.

When aggregating abnormal returns for index additions over time, results show significant CARs for longer time periods around the announcement, including CAR[-60;+60] and CAR[-20;+20], each significant at the 5% level. CARs for index deletions are insignificant for all time periods. This result is harmonious with the overall perception of zero index effects around the announcement of deletions from the OBX. Moreover, findings show that aggregated returns leading up to AD are positive (6.81%) for index additions (CAR[-60;0]), significant at the 5% level, in line with expectations considering the OBX selection criteria.

The AVRs for days close to the announcement do not point to any considerable abnormal trading for index additions. Results show some enhanced trading on AD-3, AD-2 ad AD-1, although these movements appear to be minor. In the case of deletions, the general perception is that stocks are considerably less traded around the announcement. AVRs for AD-3, AD-1, AD and AD+1 are significantly negative for index deletions.

Table 8.1.

Average Abnormal Return (AAR), Cumulative Abnormal Return (CAR) and Average Volume Ratio (AVR) Around the Announcement Date (AD), (1999 – 2017)

Average Abnormal Return (AAR)				
	Additions		Deletions	
	N = 62		N = 50	
Days	AAR	T-value	AAR	T-value
-5	-0.0001	-0.04	-0.0021	-0.61
-4	-0.0014	-0.51	-0.0031	-0.76
-3	-0.0015	-0.48	0.0028	0.79
-2	-0.0022	-0.66	0.0048	1.55
-1	-0.0044	-1.05	-0.0040	-1.01
0 (AD)	-0.0004	-0.12	-0.0026	-0.76
1	-0.0005	-0.17	-0.0028	-0.71
2	0.0035	1.10	0.0022	0.56
3	0.0021	0.64	-0.0041	-1.15
4	0.0058	1.57	-0.0070	-1.47
5	0.0027	0.80	0.0030	0.83

Cumulative Abnormal Return (CAR)				
	Additions		Deletions	
Period	CAR	T-value	CAR	T-value
[-60;+60]	0.1128	2.47**	0.0100	0.17
[-60;0]	0.0681	2.19**	-0.0359	-1,00
[0;+60]	0.0443	1.65	0.0434	1.26
[-20;+20]	0.0525	2.15**	0.0122	0.48
[-10;+10]	0.0206	1.23	0.0036	0.22
[-10;0]	0.0096	0.94	0.0040	0.30
[0;+10]	0.0106	0.89	-0.0030	-0.26
[-5;+5]	0.0036	0.32	-0.0129	-1.31
[-2;+5]	0.0067	0.69	-0.0104	-1.05
[0;+5]	0.0133	1.51	-0.0113	-1.13
[-1;+2]	-0.0018	-0.29	-0.0072	-1.09
[-1;+1]	-0.0053	-0.9	-0.0093	-1.54

Average Volume Ratio (AVR)				
	Additions		Deletions	
	N = 59		N = 39	
Days	AVR	T-value	AVR	T-value
-5	0.9192	-0.81	0.9892	-0.05
-4	1.0785	0.55	0.9643	-0.26
-3	1.1876	1.19	0.7689	-2.37**
-2	1.1624	1.64*	0.9811	-0.12
-1	1.2026	1.03	0.7629	-2.34**
0 (AD)	1.0027	0.03	0.7602	-2.57***
1	1.2587	1.01	0.8276	-1.79**
2	1.0409	0.33	0.9306	-0.60
3	1.0371	0.31	1.0975	-0.62
4	1.4008	1.75**	1.4642	2.05**
5	1.4826	2.12**	1.0643	0.55

Note. AARs and CARs have been tested using two-sided T-tests. AVRs are tested using one-sided T-tests.
*, ** and *** indicate significance levels of 10%, 5% and 1%, respectively.

8.1.2. Findings Around the Effective Date

When examining the entire time period from 1999 to 2017, results indicate significant positive price effects for index additions on both ED-1 and ED, as illustrated in Table 8.2. below. AARs on ED-1 and ED are 0.89% and 0.63% respectively, significant at the 5% and 10% levels. This two-day period is the only with two subsequent significant positive abnormal returns, strengthening the hypothesis of some actual index effect being captured. Conversely, in the case of index deletions, results do not show considerable significant price effects over the same time period. Hence, findings indicate some index effect asymmetry. Nevertheless, one should note some volatility in abnormal returns for additions and deletions around ED, reasons being unclear.

Table 8.2.

Average Abnormal Return (AAR), Cumulative Abnormal Return (CAR) and Average Volume Ratio (AVR) Around the Effective Date (ED), (1999 – 2017)

Average Abnormal Return (AAR)				
	Additions		Deletions	
	N = 62		N = 50	
Days	AAR	T-value	AAR	T-value
-5	-0.0002	-0.07	0.0011	0.30
-4	0.0035	1.08	-0.0058	-1.22
-3	0.0004	0.14	-0.0056	-1.68*
-2	-0.0015	-0.46	-0.0055	-1.53
-1	0.0089	2.08**	-0.0029	-0.60
0 (ED)	0.0063	1.97*	0.0048	1.03
1	-0.0013	-0.37	0.0026	0.65
2	-0.0013	-0.41	-0.0006	-0.17
3	0.0039	1.11	0.0023	0.65
4	-0.0035	-1.17	0.0062	1.47
5	-0.0048	-1.76*	0.0101	2.37**

Cumulative Abnormal Return (CAR)				
	Additions		Deletions	
Period	CAR	T-value	CAR	T-value
[-60;+60]	0.0827	1.78*	-0.0278	-0.47
[-60;0]	0.0608	1.93*	-0.0578	-1.61
[0;+60]	0.0282	1.09	0.0348	1.06
[-20;+20]	0.0492	2.26**	-0.0154	-0.67
[-10;+10]	-0.0049	-0.30	0.0155	1,00
[-10;0]	0.0018	0.15	-0.0149	-1.28
[0;+10]	-0.0004	-0.04	0.0352	2.63**
[-5;+5]	0.0105	0.96	0.0068	0.58
[-2;+5]	0.0067	0.72	0.0171	1.86*
[0;+5]	-0.0007	-0.10	0.0255	2.48**
[-1;+2]	0.0125	1.68*	0.0039	0.60
[-1;+1]	0.0138	2.20**	0.0044	0.71

Average Volume Ratio (AVR)

	Additions		Deletions	
	N = 59		N = 39	
Days	AVR	T-value	AVR	T-value
-5	0.9698	-0.30	0.8637	-0.93
-4	1.3001	1.25	0.8393	-1.46*
-3	1.0327	0.25	1.1535	0.66
-2	0.8901	-1.02	0.8529	-1.29
-1	2.0042	3.55***	1.7329	3.13***
0 (ED)	1.3974	2.12**	0.9398	-0.45
1	1.0765	0.50	1.0253	0.18
2	1.2416	1.38*	1.0003	0.00
3	1.4983	2.70***	1.0610	0.38
4	1.4748	2.66***	0.9628	-0.26
5	1.3193	1.93**	1.2381	0.99

Note. AARs and CARs have been tested using two-sided T-tests. AVRs are tested using one-sided T-tests.
*, ** and *** indicate significance levels of 10%, 5% and 1%, respectively.

Figure 8.1. Average Abnormal Returns Around ED (1999 – 2017)

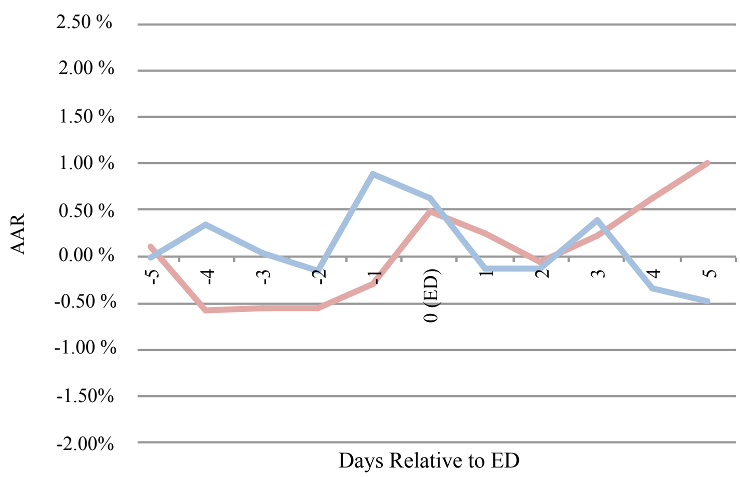

Figure 8.1. Illustration of average abnormal returns (AAR) around the effective date (ED). Blue line indicates index additions, whereas the red line reflects deletions.

Aggregation over time points to positive CARs for index additions over shorter periods. CAR[-1;+2] and CAR[-1;+1] are significant on 10% and 5% levels, respectively. An investor holding added stocks from ED-1 to ED+1 would on average gain 1.38% on the trade, supporting the hypothesis of positive abnormal price effects. On the contrary, aggregation of abnormal returns does not display opposite negative results for index deletions. In fact, one should note positive CAR[0;+10] and CAR[0;+5], both significant at the 5% level. Hence, results indicate that deleted stocks perform better than average over the ten and five-day periods following the revision, contrasting the idea behind index effects. Figures 8.2. and 8.3. below display the developments of CARs over the 121-day event window, split at ED. These graphs indicate that added stocks considerably outperform deleted stocks, particularly in the 15-day period following ED. Over the 121-day event window as a whole, added stocks overperform by 8.27%, whereas stocks deleted from the OBX underperform by 2.78%, on average.

Figure 8.2. Cumulative Abnormal Returns [-60;0]

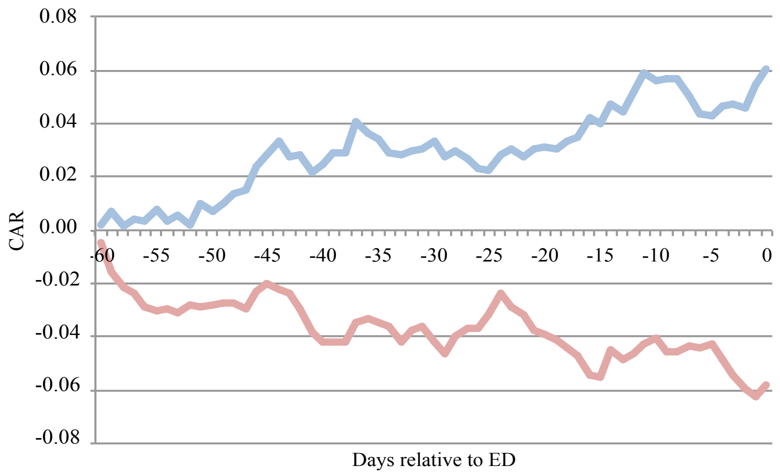

Figure 8.2. Illustration of cumulative abnormal returns (CARs) over the 60-day period leading up to the effective date (ED). Blue line indicates index additions, whereas the red line reflects deletions.

Figure 8.3. Cumulative Abnormal Returns [0;+60]

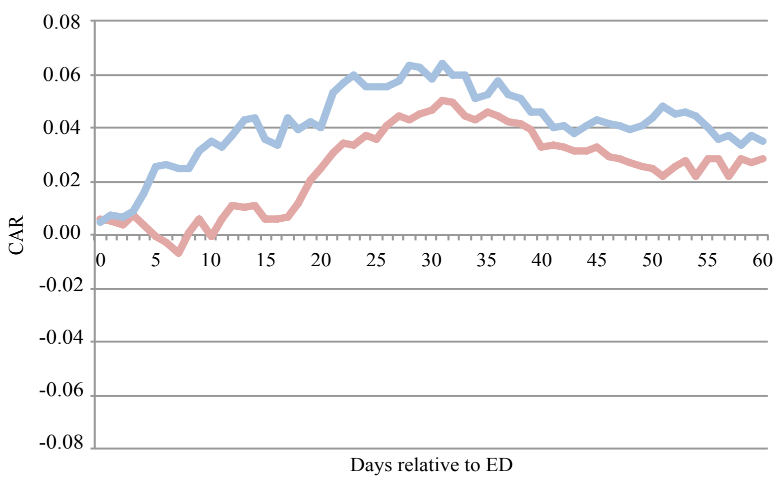

Figure 8.3. Illustration of cumulative abnormal returns (CARs) over the 60-day period following the effective date (ED). Blue line indicates index additions, whereas the red line reflects deletions.

Significantly greater trading volumes are found in conjunction with positive price effects for additions on ED-1 and ED (Table 8.2.). The AVR on ED-1 is 2.00, significant at the 1% level, suggesting a doubling of traded stocks compared to normalized levels. On the following day, ED, the AVR is 1.38, significant at the 5% level, also highlighting a considerable volume effect. Furthermore, results show significantly greater trading activity on four of the five days following the addition. Greater volume turnover is also highlighted when studying the average AVR for the ten day period leading up to ED. AVR[-10;-1] is 1.16, whereas AVR[+1;+10] is 1.30, pointing to a considerable rise in traded volumes on days following ED. In the case of index deletions, results point to a significant increase in trading on ED-1, when the average volume turnover is more than 73% higher than normal, also significant at the 1% level. Furthermore, looking at average AVRs for index deletions, results show AVR[-10;-1] of 0.98 and AVR[+1;+10] of 1.14.

8.1.3. Discussion

Findings display zero price effects around the announcements of OBX revisions. These results suggest that OBX-announcements should be considered information-free, backing a rejection of the information hypothesis. Moreover, findings around ED suggest asymmetric price effects, as only effects around additions are proven significant. This could point to investor awareness effects, as discussed by Chen et al. (2004). Greater awareness would increase the attention the stock receives from both investors and market intermediaries. As highlighted in previous studies, greater market attention could result in more lucrative financing, and increased media scrutiny could provide additional information, thereby lowering the investor's required return (Dhillon & Johnson, 1991). These are all aspects of index effect theory that can be supported by the results found. Furthermore, the analysis of price effects around ED shows significant positive abnormal returns on ED-1 and ED for index additions. On the contrary, the price movements found for deletions the same days are small and insignificant.

Results from aggregation of abnormal returns for additions around AD show only significance for longer time periods around the event. This finding supports the idea of zero index effects around the announcements, and is yet another conclusion that points to a rejection of the information hypothesis. The effects found when studying longer time periods should be interpreted with caution, as longer time spans capture more data. Hence, the effects found could be price movements resulting from abnormal fluctuations around ED.

Studying index additions, results show significant positive CAR for the 60-day period leading up to the announcement (6.81%), as shown in Table 8.1.. This should come as no surprise, considering the selection criteria used to construct the OBX. On the opposite side, results point to negative CAR for the 60-day period leading up to the announcement of an index deletion (-3.59%), again in line with expectations. Note however, that these negative movements are smaller and insignificant, compared to effects found for additions. Still, one should note that such early market movements could point to investors speculating on future index revisions. However, looking at the final ten days leading up to the announcement, results do not indicate investors preparing for the revision, as CAR[-10;0] is found insignificant for both additions and deletions.

According to the findings of this study, deleted stocks are traded less on days close to AD. AVRs for AD-1, AD and AD+1 are significantly negative. One possible explanation could be that investors are reluctant to invest in deleted firms around the announcement, reason being the firms looking less attractive for investment. Such psychological effects coming from the announcement oppose the theory of efficient capital markets. Unfortunately, it is difficult to test such effects. Interestingly, results do not indicate that the reductions in volume turnover have significant effects on stock prices the same days. On the contrary, price effects found around ED could be a result of more trading around ED. This would support the price-pressure hypothesis, meaning that greater price pressure from index funds result in an upward pressure on stock prices on days surrounding ED. As expected, results indicate enhanced trading volumes for both additions and deletions on ED-1, which could be evidence of index fund rebalancing. The CAR-analysis shows that price pressures are highly temporary, and the positive price effects for index additions are completely reversed after only five days.

8.2. First Subsample (1999 – 2007)

Results from estimations on the first subsample are presented in Tables 8.3. and 8.4. below. The analyses consist of 36 additions and 30 deletions, whereas the analyses of volume turnover are based on 33 additions and 22 deletions. Illustrations of abnormal returns are found in Appendix F.

8.2.1. Findings Around the Announcement Date

Results are unable to uncover significant price effects around AD, looking only at the subsample leading up to the global financial crisis, as illustrated in Table 8.3. There is a negative abnormal return of 0.68% on AD for index additions, significant on the 10% level. Still, the overall findings are similar to those found using the complete sample, where few days around the announcement display significant abnormal returns.

Aggregating abnormal returns over time strengthens the perception of zero price effects around addition announcements. With the exception of CAR[-20;+20], all CARs are insignificant, particularly for shorter time spans around AD. On the contrary, the results different for index deletions. Both CAR[-1;+2] and CAR[-1;+1] are found significant at the 10% level, pointing to negative CARs for the days close to the deletion announcement.

Table 8.3.

Average Abnormal Return (AAR), Cumulative Abnormal Return (CAR) and Average Volume Ratio (AVR) Around the Announcement Date (AD), (1999 – 2007)

Average Abnormal Return (AAR)				
	Additions		Deletions	
	N = 36		N = 30	
Days	AAR	T-value	AAR	T-value
-5	-0.0020	-0.49	-0.0047	-0.94
-4	-0.0051	-1.41	-0.0035	-0.60
-3	0.0031	0.81	0.0078	1.58
-2	0.0052	1.29	0.0009	0.21
-1	-0.0001	-0.02	-0.0029	-0.48
0 (AD)	-0.0068	-1.72*	-0.0044	-0.85
1	0.0004	0.10	-0.0079	-1.49
2	0.0023	0.52	0.0003	0.08
3	0.0058	1.30	-0.0014	-0.28
4	-0.0001	-0.01	-0.0028	-0.45
5	-0.0032	-0.80	-0.0014	-0.40

Cumulative Abnormal Return (CAR)				
	Additions		Deletions	
Period	CAR	T-value	CAR	T-value
[-60;+60]	0.1079	1.66	-0.0320	-0.43
[-60;0]	0.0693	1.46	-0.0396	-0.77
[0;+60]	0.0319	0.85	0.0031	0.08
[-20;+20]	0.0575	1.95*	0.0368	1.07
[-10;+10]	0.0099	0.45	-0.0104	-0.46
[-10;0]	0.0040	0.34	-0.0000	0,00
[0;+10]	-0.0009	-0.05	-0.0148	-1.01
[-5;+5]	-0.0004	-0.03	-0.0199	-1.59
[-2;+5]	0.0036	0.28	-0.0195	-1.61
[0;+5]	-0.0015	-0.13	-0.0175	-1.38
[-1;+2]	-0.0042	-0.58	-0.0148	-1.81*
[-1;+1]	-0.0065	-0.98	-0.0151	-1.95*

Average Volume Ratio (AVR)

	Additions		Deletions	
	N = 33		N = 22	
Days	AVR	T-value	AVR	T-value
-5	0.8080	-1.70**	1.0199	0.05
-4	0.9486	-0.36	0.9015	-0.43
-3	1.1284	0.53	0.8199	-1.12
-2	1.2016	1.34	0.9923	-0.04
-1	1.0841	0.27	0.6506	-2.31**
0 (AD)	0.8918	-1.05	0.6298	-3.28***
1	0.7428	-2.57***	0.6775	-2.35**
2	0.9167	-0.61	0.8469	-0.81
3	0.8277	-1.69**	1.0317	0.14
4	0.9770	-0.07	0.8751	-0.67
5	1.1474	0.65	0.8324	-1.24

Note. AARs and CARs have been tested using two-sided T-tests. AVRs are tested using one-sided T-tests.
*, ** and *** indicate significance levels of 10%, 5% and 1%, respectively.

Trading volumes are lower than normal on the four days following an addition announcement. Volumes are particularly low on AD+1, when trading is only 74% of normalized levels, significant at the 1% level. Lower volumes are also found on days surrounding the announcement of deletions, particularly on AD-1, AD and AD+1, significant at the 5% and 1% levels. These results are similar to the low AVRs found for deletions when examining the complete sample of revisions. Again, it does not seem that significantly reduced trading volumes directly lead to significantly lower stock returns on the same days.

8.2.2. Findings Around the Effective Date

Results displayed in Table 8.4. show few significant AARs around ED, both in the case of additions and in the case of deletions. Abnormal returns are positive for additions on ED and negative for deletions the same day, however both are small and insignificant. None of the aggregated abnormal returns for days surrounding the announcement of additions are found significant. The CAR for the complete 121-day event window is 8.15% for additions and -5.38% for deletions, in line with results from the complete sample. CAR[0;+10] is 3.99% for index deletions, significant at the 5% level, opposing the initial hypothesis of negative price effects following deletions.

AVRs show enhanced trading for index additions on ED-1 and ED, the first being significant at the 10% level. The effects are smaller compared to those found when studying the time period 1999 – 2017. Furthermore, findings suggest a considerable drop in traded volume two days before an addition (AVR = 0.70), significant at the 1% level. Results indicate increased trading on four of the five days following the addition. Furthermore, the results show reduced volume turnover for index deletions on ED and the following five days. The findings are significant for ED only. Significant drops in trading volumes are also found on ED-2 and ED-4 for deletions. Furthermore, results show considerable drops in trading on all five days following a deletion.

Table 8.4.

Average Abnormal Return (AAR), Cumulative Abnormal Return (CAR) and Average Volume Ratio (AVR) Around the Effective Date (ED), (1999 – 2007)

Average Abnormal Return (AAR)				
	Additions		Deletions	
	N = 36		N = 30	
Days	AAR	T-value	AAR	T-value
-5	0.0008	0.21	-0.0037	-0.74
-4	0.0056	1.47	-0.0131	-2.17**
-3	-0.0037	-0.88	-0.0061	-1.65
-2	0.0016	0.38	-0.0042	-0.97
-1	-0.0021	-0.39	0.0087	1.31
0 (ED)	0.0056	1.42	-0.0041	-0.77
1	-0.0022	-0.47	0.0043	0.78
2	-0.0016	-0.38	-0.0024	-0.53
3	0.0078	1.57	0.0014	0.31
4	-0.0032	-1.03	0.0075	1.13
5	-0.0084	-2.32**	0.0100	1.82*

Cumulative Abnormal Return (CAR)				
	Additions		Deletions	
Period	CAR	T-value	CAR	T-value
[-60;+60]	0.0815	1.19	-0.0538	-0.74
[-60;0]	0.0540	1.13	-0.0573	-1.23
[0;+60]	0.0331	0.93	-0.0006	-0.01
[-20;+20]	0.0372	1.35	0.0246	0.80
[-10;+10]	0.0061	0.27	0.0210	1.04
[-10;0]	-0.0045	-0.28	-0.0230	-1.52
[0;+10]	0.0162	1.27	0.0399	2.16**
[-5;+5]	0.0004	0.03	-0.0017	-0.11
[-2;+5]	-0.0023	-0.19	0.0212	1.64
[0;+5]	-0.0018	-0.22	0.0167	1.14
[-1;+2]	-0.0002	-0.02	0.0065	0.75
[-1;+1]	0.0014	0.20	0.0089	0.96

Average Volume Ratio (AVR)

	Additions		Deletions	
	N = 33		N = 22	
Days	AVR	T-value	AVR	T-value
-5	0.7582	-2.09**	0.7753	-1.04
-4	1.0141	0.04	0.6720	-2.12**
-3	0.8423	-1.08	1.2477	0.62
-2	0.6980	-3.91***	0.6593	-3.05***
-1	1.4557	1.34*	1.0949	0.52
0 (ED)	1.2298	0.78	0.7381	-1.68**
1	0.9227	-0.32	0.9179	-0.40
2	1.1650	0.60	0.9342	-0.35
3	1.6600	2.27**	0.8768	-0.76
4	1.2287	1.37*	0.9367	-0.29
5	1.1013	0.58	0.9484	-0.26

Note. AARs and CARs have been tested using two-sided T-tests. AVRs are tested using one-sided T-tests.
*, ** and *** indicate significance levels of 10%, 5% and 1%, respectively.

8.2.3. Discussion

The overall results point to smaller price and volume effects for the period leading up to 2008, when compared to results based on the complete sample. There are no indications of significant price effects around AD or ED. Additionally, the results do not point to any meaningful significant CARs around the same dates. Findings show significant drops in traded volumes around the announcement of a deletion, in line with findings on the complete sample. In contrast with findings from the complete sample, lower AVRs are found on days following index deletions. Summing up findings from the first subsample, no positive price or volume effects are found for additions, and no similar negative effects are found for deletions. Hence, results from the first subsample do not support the hypotheses listed in Chapter 6.

8.3. Second Subsample (2008 – 2017)

Results from the second subsample are presented in Tables 8.5. and 8.6., along with Figures 8.4., 8.5., and 8.6. below. The return analyses are based on 26 additions and 20 deletions, whereas the volume analyses are comprised of 26 additions and 17 deletions.

8.3.1. Findings Around the Announcement Date

Results do not show significant price effects for additions or deletions on the day of the announcement, as displayed in Table 8.5. below. One should however note an AAR of 0.85% for additions on AD, accompanied with a close-to-zero abnormal return for deletions the same day. Despite these effects being insignificant, findings give indications of price effect asymmetry around the announcement. Results show AAR of -1.24% on AD-2 for index additions, significant at the 5% level. Furthermore, there are positive AARs exceeding 1% for additions on AD+4 and AD+5. The overall picture of abnormal returns around the announcement of additions displays some volatility, more than the other two samples show around the same day. Consequently, it could prove more difficult to draw reliable conclusions from the results. Furthermore, there is a positive abnormal return for index deletions on AD-2 of 1.08%, significant at the 5% level, and a less significant effect is found on AD+4, although these findings do not point to any clear price effect patterns. Illustrations of the effects at play around AD are found in Appendix G.

Studying additions, both CAR[-60;+60] and CAR[-60;0] are positive and significant at the 10% level. CAR[0;+5] is 3.37%, and highly significant, mostly due to the positive abnormal returns found on AD+4 and AD+5, as mentioned earlier. On the opposite side, aggregation of abnormal returns for deletions does not point to noteworthy index effects around AD. CAR[0;+5] is negative, but close to zero. CAR[0;+60] is significantly positive for deletions, thereby not contributing to identifying any meaningful index effects. However, comparing this finding to the results for days closer to the announcement does not suggest that the event itself is having significant effects on stock returns. Hence, CAR[0;+60] may capture price effects unrelated to the particular event studied.

Enhanced AVRs are found for all days in the 11-day period surrounding the announcement of index additions. On the day following the announcement (AD+1), traded volumes are close to doubled, compared to normalized levels. Particularly high volume ratios for additions are also found on AD+4 and AD+5, the last being significant at the 5% level. Comparing these results to high abnormal returns the same days contribute to the theory of price pressures. Additionally, results show a considerable increase in trading on the day prior to the addition announcement. This could point to some investor speculation. In the case of index deletions, the volume ratios indicate trading below normal on the three days leading up to the announcement. Trading is particularly low on AD-3, when AVR is only 0.70. On the contrary, AVRs greater than one are found on all five days following the deletion announcement, particularly on AD+4 and AD+5, when results are found significant at the 1% and 5% level, respectively.

Table 8.5.

Average Abnormal Return (AAR), Cumulative Abnormal Return (CAR) and Average Volume Ratio (AVR) Around the Announcement Date (AD), (2008 - 2017)

Average Abnormal Return (AAR)				
	Additions		Deletions	
	N = 26		N = 20	
Days	AAR	T-value	AAR	T-value
-5	0.0025	0.74	0.0017	0.37
-4	0.0037	0.84	-0.0024	-0.47
-3	-0.0079	-1.45	-0.0048	-1.14
-2	-0.0124	-2.50**	0.0108	2.27**
-1	-0.0103	-1.53	-0.0056	-1.35
0 (AD)	0.0085	1.64	0.0002	0.05
1	-0.0019	-0.33	0.0048	0.86
2	0.0051	1.12	0.0049	0.63
3	-0.0029	-0.57	-0.0081	-1.61
4	0.0139	2.19**	-0.0133	-1.80*
5	0.0109	1.92*	0.0095	1.36

Cumulative Abnormal Return (CAR)				
	Additions		Deletions	
Period	CAR	T-value	CAR	T-value
[-60;+60]	0.1196	1.91*	0.0732	0.74
[-60;0]	0.0666	1.85*	-0.0305	-0.63
[0;+60]	0.0615	1.60	0.1038	1.72*
[-20;+20]	0.0455	1.08	-0.0248	-0.69
[-10;+10]	0.0354	1.36	0.0246	1.11
[-10;0]	0.0173	0.95	0.0100	0.58
[0;+10]	0.0265	1.75*	0.0148	0.84
[-5;+5]	0.0092	0.52	-0.0023	-0.14
[-2;+5]	0.0110	0.73	0.0033	0.20
[0;+5]	0.0337	2.77***	-0.0020	-0.12
[-1;+2]	0.0014	0.12	0.0043	0.41
[-1;+1]	-0.0037	-0.34	-0.0006	-0.06

Average Volume Ratio (AVR)				
	Additions		Deletions	
	N = 26		N = 17	
Days	AVR	T-value	AVR	T-value
-5	1.0603	0.34	0.9494	-0.35
-4	1.2433	0.90	1.0455	0.38
-3	1.2627	1.36*	0.7030	-3.49***
-2	1.1127	0.93	0.9666	-0.14
-1	1.3529	1.71**	0.9083	-0.75
0 (AD)	1.1435	1.24	0.9290	-0.47
1	1.9136	1.68**	1.0219	0.18
2	1.1985	0.88	1.0389	0.37
3	1.3030	1.33*	1.1827	0.81
4	1.9387	1.07	2.2266	3.09***
5	1.9082	2.17**	1.3645	1.97**

Note. AARs and CARs have been tested using two-sided T-tests. AVRs are tested using one-sided T-tests.
*, ** and *** indicate significance levels of 10%, 5% and 1%, respectively.

8.3.2. Findings Around the Effective Date

Results for the days surrounding ED are presented in Table 8.6. below. These findings of abnormal returns around ED, using only the second subsample, are perhaps the most interesting results identified by this study. Results indicate highly significant positive abnormal returns for index additions on ED-1 (2.41%), significant at the 1% level. One should also note that there are no other significant abnormal returns around ED, making the price movement on ED-1 stand out as a clear indication of a direct price effect of the addition itself. Although results are different in their form, findings for index deletions are perhaps just as interesting. Results point to a highly substantial negative abnormal return for deletions on ED-1 (-2.03%), significant at 1% level. This negative effect is immediately followed by a positive abnormal return of 1.80% the proceeding day (ED), significant at the 5% level. Together, these two price movements give indications of a highly temporary price effect, directly caused by the deletion itself.

CARs around ED are highly significant for additions, with both CAR[-1;+2] and CAR[-1;+1] being over 3%. The fact that these price fluctuations are greatly centered around ED strengthens the hypothesis of real positive price effects being captured. When it comes to index deletions, neither CAR[-1;+2] nor CAR[-1;+1] are found significant. The CAR[-1;+2] of only -0.01% indicates that the abnormal return movements found on ED-1 and ED are fully cancelled out only two days after the event. Figure 8.5. below shows aggregation of abnormal returns starting at ED-1. The price effects caused by additions last for ten days, whereas price effects for deletions last only for two days following ED, as the figure illustrates.

Results from the volume analysis of additions point to a significant increase in trading around ED, particularly on ED-1, when volume turnover on average is 270% of normalized levels, as illustrated by Figure 8.6. below. Trading on ED is also high, with levels averaging 61% above normal. Furthermore, it should be noted that traded volumes are generally high for all days proceeding index additions. In the case of deletions, results also indicate some enhanced trading levels, with an AVR of 2.61 on ED-1, significant at the 1% level. Boosted trading volumes are also found on five of the subsequent six days.

Table 8.6.

Average Abnormal Return (AAR), Cumulative Abnormal Return (CAR) and Average Volume Ratio (AVR) Around the Effective Date (ED), (2008 - 2017)

Average Abnormal Return (AAR)

	Additions		Deletions	
	N = 26		N = 20	
Days	AAR	T-value	AAR	T-value
-5	-0.0016	-0.37	0.0083	1.71*
-4	0.0007	0.11	0.0051	0.72
-3	0.0062	1.32	-0.0048	-0.76
-2	-0.0059	-1.11	-0.0075	-1.16
-1	0.0241	4.01***	-0.0203	-3.85***
0 (ED)	0.0072	1.34	0.0180	2.35**
1	-0.0002	-0.04	-0.0000	-0.01
2	-0.0010	-0.18	0.0022	0.40
3	-0.0015	-0.31	0.0037	0.62
4	-0.0039	-0.68	0.0044	1.09
5	0.0002	0.06	0.0104	1.48

Cumulative Abnormal Return (CAR)

	Additions		Deletions	
Period	CAR	T-value	CAR	T-value
[-60;+60]	0.0845	1.42	0.0112	0.11
[-60;0]	0.0702	1.92*	-0.0586	-1.02
[0;+60]	0.0214	0.57	0.0879	1.66
[-20;+20]	0.0660	1.85*	0.0015	0.04
[-10;+10]	-0.0201	-0.87	0.0072	0.29
[-10;0]	0.0105	0.58	-0.0028	-0.15
[0;+10]	-0.0234	-1.29	0.0280	1.47
[-5;+5]	0.0243	1.57	0.0196	1.10
[-2;+5]	0.0190	1.29	0.0109	0.87
[0;+5]	0.0008	0.07	0.0388	2.93***
[-1;+2]	0.0301	2.10**	-0.0001	-0.01
[-1;+1]	0.0310	2.96***	-0.0023	-0.32

Average Volume Ratio (AVR)

	Additions		Deletions	
	N = 26		N = 17	
Days	AVR	T-value	AVR	T-value
-5	1.2383	1.43*	0.9851	-0.08
-4	1.6631	1.93**	1.0694	0.51
-3	1.2743	1.20	1.0238	0.21
-2	1.1338	0.62	1.1192	0.57
-1	2.7003	3.83***	2.6101	3.92***
0 (ED)	1.6101	2.98***	1.2172	0.98
1	1.2717	1.69**	1.1728	0.89
2	1.3389	1.69**	1.0911	0.44
3	1.2931	1.48*	1.3143	1.05
4	1.7871	2.32**	0.9988	-0.01
5	1.5960	1.98**	1.6363	1.29

Note. AARs and CARs have been tested using two-sided T-tests. AVRs are tested using one-sided T-tests.
*, ** and *** indicate significance levels of 10%, 5% and 1%, respectively.

Figure 8.4. Average Abnormal Returns Around ED (2008 – 2017)

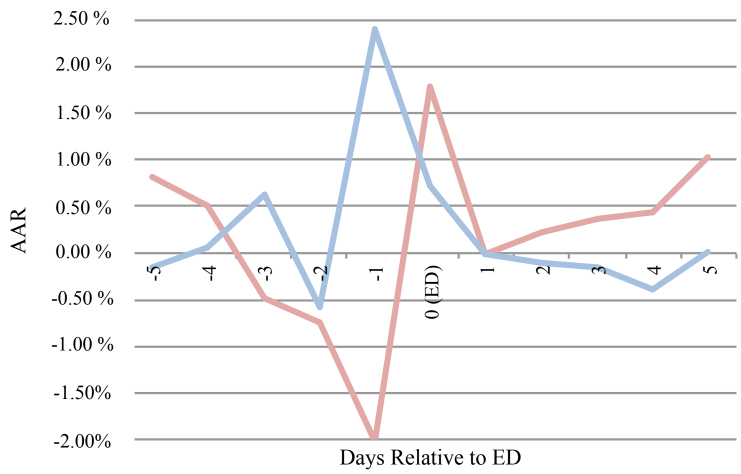

Figure 8.4. Illustration of average abnormal returns (AARs) around the effective date (ED), using only the second subsample (2008 – 2017). Blue line indicates index additions, whereas the red line reflects deletions.

Figure 8.5. Cumulative Abnormal Returns Around ED (2008 – 2017)

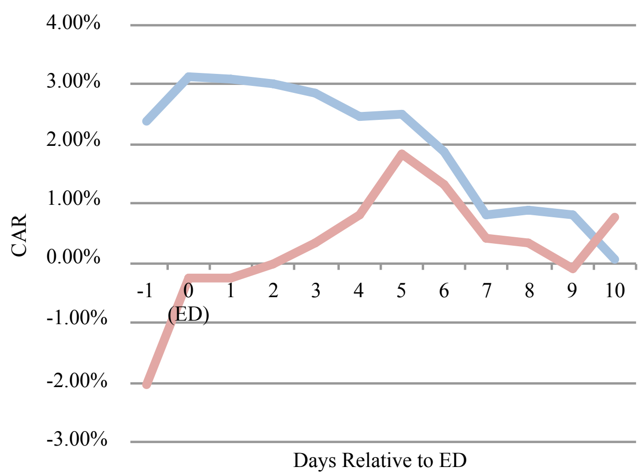

Figure 8.5. Illustration of cumulative abnormal returns (CARs) around the effective date (ED), using only the second subsample (2008 – 2017). Aggregation starts at ED-1 and stretches until ED+10. Blue line indicates index additions, whereas the red line reflects deletions.

Figure 8.6. Average Volume Ratios During the Event Window (2008 – 2017)

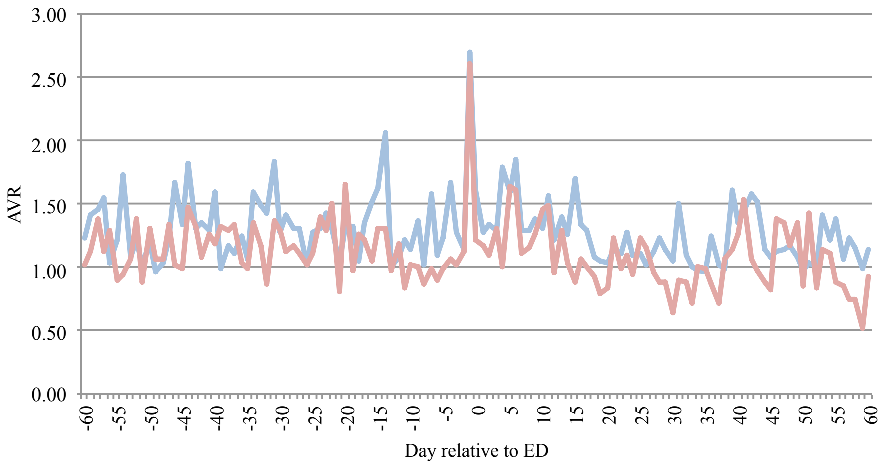

Figure 8.6. Illustration of average volume ratios (AVRs) for the 121-day event window around the effective date (ED), using only the second subsample (2008 – 2017). Blue line indicates index additions, whereas the red line reflects deletions. AVR-value of one reflects normalized trading levels.

8.3.3. Discussion

Analyzing the results from the second subsample show strong indications of greater price pressures, resulting in significant index effects around ED. These findings are supported by both higher abnormal returns and greater volume turnover. In the case of index additions, results show an AVR of 2.70 on ED-1, accompanied with an AAR of 2.41% the same day. This should be considered clear indications of price pressures caused by index fund rebalancing on the day prior to implementation. In the case of deletions, findings show an AVR of 2.61 on ED-1, along with a negative AAR of -2.03% the same day. This result indicates index fund sell-out on the same, giving support to the price-pressure hypothesis. Furthermore, the AAR of 1.80% found on ED contributes the theory of a temporary demand shock.

The results found analyzing returns around the announcement point to a rejection of the information hypothesis, as no considerable AARs are found around AD. Hence, findings suggest that the announcement itself does not provide additional information to the market.

Figure 8.6. above displays a graphical interpretation of the AVR-development throughout the 121-day event window surrounding ED. The AVRs mostly fluctuate between 0.9 and 1.5, with the exception of ED-1, when traded volumes are more than doubled, compared to

normalized levels. In the case of additions, one should note that the average AVR over the complete event window is 1.29, indicating generally higher trading. Furthermore, Figure 8.6. gives an interesting illustration of trading following index deletions. Results indicate more volatile AVRs following deletions, along with overall reduced trading. Average AVR over the 60-day period preceding ED is 1.17, whereas average AVR over the period [0;+60] is 1.06. The decline in volume contributes to a picture of greater illiquidity following a deletion. To analyze this further, the next section will cover liquidity effects around ED.

8.4. Liquidity Effects

To further explore the effects of index revisions of stock liquidity, this study has examined bid-ask spreads and further computed average spread ratios (ASRs) for all sample stocks. An increase in bid-ask spread would point to lower liquidity, whereas a decrease in spread would indicate to positive liquidity effects. Hence, in the case of price pressures caused by index fund rebalancing, one would expect to find lower bid-ask spreads following ED. The aim of this section is to search for a connection between the price and volume effects discovered, and the liquidity of stocks added to or deleted from the OBX. First, liquidity effects around ED are presented and analyzed using the complete sample (1999 – 2017). Later, effects found using the first and second subsamples are investigated in further detail.

8.4.1. Complete Sample (1999 – 2017)

Table 8.7. below illustrates a considerable decline in the average spread of added stocks over 11-day period surrounding ED. The average percentage bid-ask spread for additions over the 60-day period leading up to ED is 0.71%, compared to 0.55% for the 60-day period proceeding ED. On the contrary, results for deletions do not point to an opposite increase of the same magnitude, although there are indications of some short-term upward trend in average bid-ask spreads. One should particularly not the sharp increase in average percentage spread from 0.71% on ED-2 to 1.03% on ED-1, as shown in Table 8.7., and further illustrated in Appendix H. In the case of deletions, the average percentage bid-ask spread over the 60-day period prior to ED is 0.75%, whereas the average percentage spread during 60-day period following ED is 0.83%. By comparison, the average percentage spread for deletions over the period ED-1 to ED+1 is 0.98%. Hence, effects for deletions appear to be highly temporary, whereas the effects found for additions show greater persistency.

The ASR-analysis uncovers considerable liquidity effects around ED, both for additions and for deletions, as illustrated by Figure 8.7. below. Results show a sharp drop in the ASR for additions over the four-day period [-1;+2]. On the opposite side, findings illustrate a considerable increase in the ASR for deletions over the three-day period [-2;0]. Overall findings show the same development as illustrated when examining percentage bid-ask spreads. Furthermore, one should note that the ASRs for additions are significant on all days leading up to ED. This finding could be a result of possible bias, considering that spread ratios are based on average spreads over the post event estimation window. If so, the computed T-values should be interpreted with caution. Nevertheless, the sharp ASR-movements around ED contribute to highlighting real liquidity effects, and fluctuations found in Figure 8.7. should still be interpreted as valid.

Table 8.7.

Bid-Ask Spreads Around the Effective Date (ED), (1999 – 2017)

Average Bid-Ask Spread (%)		
	Additions	Deletions
Days	N = 65	N = 53
-5	0.72%	0.81%
-4	0.67%	0.79%
-3	0.65%	0.78%
-2	0.65%	0.71%
-1	0.65%	1.03%
0 (ED)	0.68%	0.99%
1	0.59%	0.91%
2	0.53%	0.81%
3	0.60%	0.90%
4	0.53%	0.80%
5	0.56%	0.75%

Average Spread Ratio (ASR)				
	Additions		Deletions	
Days	ASR	T-value	ASR	T-value
-5	1.5655	3.79***	0.8569	-1.31*
-4	1.6226	3.23***	0.8581	-1.29
-3	1.6046	3.55***	0.8910	-0.92
-2	1.5117	3.61***	0.7148	-3.37***
-1	1.5548	3.40***	1.1856	1.10
0 (ED)	1.4224	3.14***	1.2204	1.24
1	1.1597	1.55*	1.0022	0.02
2	1.0782	0.70	0.9449	-0.59
3	1.2359	1.87**	1.0878	0.89
4	0.9836	-0.18	0.8724	-1.77**
5	1.1449	1.01	0.9093	-1.03

Note. ASRs have been tested using one-sided T-tests.
*, ** and *** indicate significance levels of 10%, 5% and 1%, respectively.

Figure 8.7. Average Spread Ratios During the Event Window (1999 – 2017)

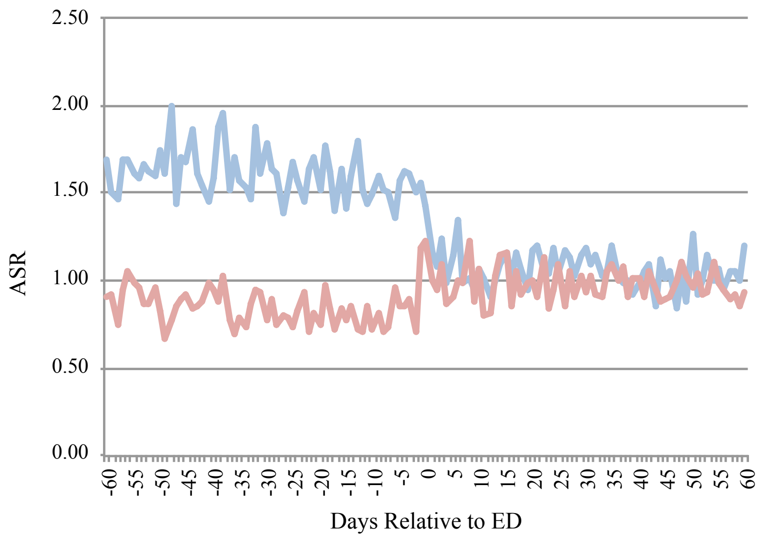

Figure 8.7. Illustration of the development in average spread ratio (ASR) over the 121-day event window around the effective date (ED). Blue line indicates index additions, whereas the red line reflects deletions.

8.4.2. First Subsample (1999 – 2007)

When studying results from the liquidity analysis based on the first subsample, liquidity effects for additions seem to follow the same trend as found when studying the complete sample. However, bid-ask spreads are generally larger for the first subsample, pointing to greater illiquidity for the market as a whole. Average bid-ask spread for additions over the 60-day preceding ED is 0.84%, whereas the average bid-ask spread is 0.72% over the 60 days following the event. Hence, the liquidity trend is downward sloping, as expected, yet less compared to the reduction found on the complete sample. At first glance, the results for index deletions are more unexpected. In fact, the liquidity trend for deletions is also downward sloping over the 121-day event window, suggesting improved liquidity following deletions. This finding should be viewed in context with earlier analyses on returns and traded volumes over the same time period. Studying the first subsample, past results did not indicate abnormal negative returns or abnormal trading during the event window. Hence, it is no surprise that the liquidity analysis does not show a meaningful trend during the same period.

Results from ASR-calculations contribute to an overall picture of less liquidity effects for the first subsample, as shown in Table 8.8. below. Still, ASRs for additions point to the same downward sloping trend found when examining average percentage bid-ask spreads. Looking at deletions, one should note the negative spike on ED-2 and the positive spike on ED-1, both significant at the 5% level, reflecting some liquidity movements around the event of interest. Still, when comparing to the overall results, these movements do not contribute to identifying any clear liquidity trends of interest. Figures displaying the developments in percentage bid-ask spreads and ASRs are found in Appendix I.

Table 8.8.

Bid-Ask Spreads Around the Effective Date (ED), (1999 – 2007)

Average Bid-Ask Spread (%)		
	Additions	Deletions
Days	N = 39	N = 32
-5	0.88%	1.08%
-4	0.78%	1.03%
-3	0.72%	1.01%
-2	0.78%	0.94%
-1	0.75%	1.34%
0 (ED)	0.86%	1.07%
1	0.74%	1.10%
2	0.66%	0.90%
3	0.73%	1.03%
4	0.70%	0.98%
5	0.72%	0.86%

Average Spread Ratio (ASR)				
	Additions		Deletions	
Days	ASR	T-value	ASR	T-value
-5	1.1485	1.08	0.9053	-0.76
-4	1.1052	0.70	0.9345	-0.55
-3	1.0593	0.47	0.8916	-0.82
-2	1.1929	1.11	0.7727	-1.92**
-1	1.0679	0.59	1.4553	1.95**
0 (ED)	1.1890	1.51*	0.9697	-0.20
1	0.9257	-0.80	0.9654	-0.29
2	0.8883	-1.29	0.8694	-1.02
3	0.8862	-1.35*	1.0544	0.43
4	0.8380	-2.12**	0.9136	-0.85
5	0.9406	-0.37	0.9091	-0.82

Note. ASRs have been tested using one-sided T-tests.
*, ** and *** indicate significance levels of 10%, 5% and 1%, respectively.

8.4.3. Second Subsample (2008 – 2017)

Analyzing liquidity effects on the second subsample shows considerable fluctuations around ED, as displayed in Table 8.9. below. Moreover, average percentage bid-ask spreads are lower, compared to the spreads computed using only the two other samples. This result is an indication of improved stock market liquidity for the time period following the global financial crisis.

Table 8.9.

Bid-Ask Spreads Around the Effective Date (ED), (2008 – 2017)

Average Bid-Ask Spread (%)		
	Additions	Deletions
Days	N = 26	N = 21
-5	0.49%	0.40%
-4	0.51%	0.43%
-3	0.53%	0.42%
-2	0.46%	0.35%
-1	0.51%	0.55%
0 (ED)	0.42%	0.88%
1	0.37%	0.63%
2	0.34%	0.66%
3	0.40%	0.70%
4	0.26%	0.52%
5	0.32%	0.59%

Average Spread Ratio (ASR)				
	Additions		Deletions	
Days	ASR	T-value	ASR	T-value
-5	2.1827	4.40***	0.7868	-1.06
-4	2.3883	3.67***	0.7511	-1.21
-3	2.4117	4.42***	0.8901	-0.50
-2	1.9835	4.69***	0.6308	-3.15***
-1	2.2755	3.98***	0.7946	-0.97
0 (ED)	1.7678	2.88***	1.5839	1.61*
1	1.5060	2.56***	1.0556	0.34
2	1.3592	1.51*	1.0545	0.40
3	1.7512	2.95***	1.1362	0.85
4	1.1992	1.01	0.8126	-1.91**
5	1.4472	1.72**	0.9097	-0.61

Note. ASRs have been tested using one-sided T-tests.
*, ** and *** indicate significance levels of 10%, 5% and 1%, respectively.

Liquidity effects for additions follow a similar tendency throughout 121-day event window, as displayed by Figures 8.8. and 8.9. below. However, the results show a sharper and more distinct drop in the average percentage bid-ask spread when using only the second subsample, compared to the fluctuations found using the two other samples. This finding points to stronger liquidity effects coming from the event itself, in line with earlier findings on both stock returns and volume turnover. On the opposite side, the liquidity effects found for deletions stand out as particularly powerful, and in direct contrast to average bid-ask spreads found when analyzing the complete sample. Results show that the average percentage bid-ask spread for deletions increases from 0.55% on ED-1 to 0.88% the subsequent day, easily observed when studying Figure 8.8. Furthermore, the average percentage bid-ask spreads for deletions over the 60-day period prior to ED is 0.36%, whereas the 60 days following ED are associated with an average percentage spread of 0.66%, underlining considerable effects to stock liquidity.

Figure 8.8. Average Bid-Ask Spreads During the Event Window (2008 – 2017)

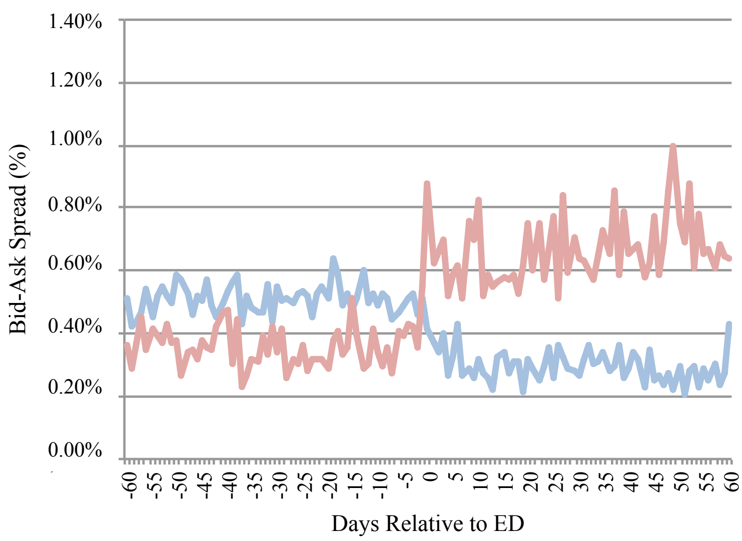

Figure 8.8. Illustration of average percentage bid-ask spreads over the 121-day event window around the effective date (ED), using only the second subsample (2008 – 2017). Blue line indicates index additions, whereas the red line reflects deletions.

Sharp liquidity changes around ED are also reflected in the ASRs computed using only the second subsample, as displayed in Figure 8.9. Results show a considerable decline in ASR on ED for index additions, and an equivalent opposite increase in ASR for deletions the same day. In the case of additions, ASR is reduced from 2.28 on ED-1 to 1.36 on ED+2, as the results in Table 8.9. show. On the contrary, index deletions experience a substantial increase in ASR from 0.63 on ED-2 to 1.58 on ED.

Figure 8.9. Average Spread Ratios During the Event Window (2008 – 2017)

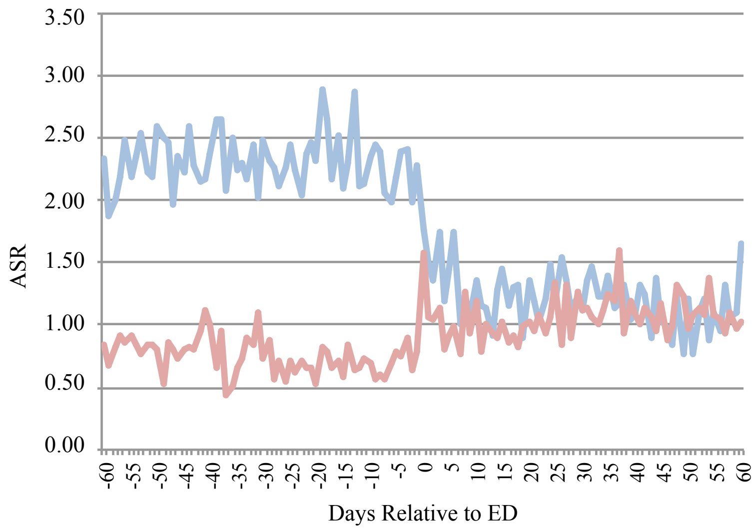

Figure 8.9. Illustration of the development in average spread ratio (ASR) over the 121-day event window around the effective date (ED), using only the first subsample (2008 – 2017). Blue line indicates index additions, whereas the red line reflects deletions.

8.5. Discussion and Implications of Overall Findings

The overall findings presented show evidence of considerable index effects following revisions to the OBX. The general perception is that index effects are less significant during the first sub-period, when compared to the complete sample. Still, analyses on none of the three samples point to significant positive abnormal returns for additions on AD, or significant negative abnormal returns for deletions the same day. Hence, findings suggest a rejection the information hypothesis, confirming the idea of OBX revisions being information-free events. Studying the effects around ED, the positive abnormal returns found for additions, using the complete sample, indicate temporary price pressures caused by index fund rebalancing. Results show greater volume turnover for additions on ED-1 and ED, accompanied by significant positive drifts in stock price. On the contrary, findings do not suggest any significant reductions in stock prices around ED for index deletions over the same time period. Hence, findings point to distinct index effect asymmetry, in line with the findings of Chen et al. (2004). Furthermore, this can be viewed as support for the awareness hypothesis.

The findings suggest that the degree of significance in index effects has been varying through time. Price, volume, and liquidity effects found around ED are greater for the time period following 2008, when compared to the time period leading up to the global financial crisis. In fact, the results do not show significant abnormal return effects for additions or deletions when studying only the first subsample. However, there are considerable upturns in traded volume around ED for both additions and deletions, when looking at the same time period. On the contrary, results from the second subsample show distinct fluctuations in stock prices, traded volume and stock liquidity around ED. Furthermore, the movements contribute to the hypothesis of temporary price pressures caused by index fund rebalancing.

The analyses of CARs suggest temporary price effects around ED, supporting the price-pressure hypothesis. Still, over the 121-day event window as a whole, added stocks overperform by 8.27%, whereas stocks deleted from the OBX underperform by 2.78%, on average. Studying the days surrounding ED using only the second subsample, results show that price effects for additions last for ten days, illustrated by Figure 8.5.. In the case of deletions, the negative price effects found are completely reversed after only two days. Consequently, this study has uncovered distinct index effect asymmetry associated with revisions of the OBX.

Results from the spread analyses support the idea of asymmetric index effects. Findings indicate a distinct permanent reduction in bid-ask spreads around index additions. Results do not support an equivalent persistent increase in bid-ask spreads for deletions, when studying the complete sample. However, when looking at the second subsample, results show considerable breakdown to stock liquidity around ED.

Going back to the hypotheses listed in Chapter 6, the findings of this study reject hypotheses a) and b) of significant price effects around AD. The same conclusion can be drawn from looking at all three samples of observations. As a direct implication, the results found in this study do not support the information hypothesis. Hence, findings suggest that revisions of the OBX are information-free events, in line with the stated policy of Oslo Stock Exchange. Hypothesis c) of significant positive price drifts around ED for index additions is supported when looking at the complete sample, and particularly when studying the second subsample. Yet, the hypothesis is rejected when looking only at the first subsample. Consequently, this study has found some compelling support for the price-pressure hypothesis. Hypothesis d) of significant price reductions following ED for index deletions is supported only when looking at the second subsample. Interestingly, the effects are highly temporary, lasting only for two days. Greater volume turnover around ED for additions are found using all three samples, uniformly supporting hypothesis e). Still, the effects found are more significant using the second subsample. Equivalent positive abnormal trading volumes for index deletions are found only when looking at the complete sample and the second subsample, giving partly support of hypothesis f). Furthermore, the results support hypothesis g), stating that the index effects have increased over time. This tendency is found for price, volume and liquidity effects. All analyses on liquidity support hypothesis h), stating that added stocks become more liquid around the time of additions. As for deletions, poorer liquidity is found when assessing the complete sample and the second subsample, the last being highly substantial. In sum, the results are unable to conclusively support hypothesis i).

8.6. Comparing Results of Previous Studies

Both Myhre and Nybakk (2012) and Knutsen (2014) found evidence of greater index effects following the global financial crisis, in harmony with the findings in this study. Furthermore, this study has uncovered evidence of temporary price pressures, also partly supported by the OBX-study of Myhre and Nybakk (2012). Mæhle and Sandberg (2015) found support of both the price-pressure hypothesis and the awareness hypothesis in their study on the OSEBX, in line with the findings of this study. On the contrary, the results of this study indicate even more temporary effects, compared to those found by Mæhle and Sandberg (2015). Liquidity effects have not been a major topic of previous studies. Mæhle and Sandberg (2015) did however conclude that liquidity of additions remained unchanged after ED, by simply studying the effects to traded volumes. Their finding is contradicted by the results found in this study. Still, it can be argued that simply assessing traded volumes are an insufficient way of analyzing stock liquidity. This study has studied liquidity fluctuations using both average bid-ask spreads and spread ratios. Hence, this study provides a more thorough analysis of changes to liquidity around index revisions.

9. Conclusions

This chapter contains concluding remarks on the most significant results found in this study. Additionally, fair critiques and suggestions for further research on the topic of index effects are stated.

9.1. Results and Implications

Results found do not indicate significant index effects over the time period 1999 – 2007. However, when assessing at the period following the global financial crisis, findings point to substantial effects to stock price, traded volume and stock liquidity. Results show an AAR of 2.41% for added stocks on ED-1. On the opposite side, deleted stocks experienced an AAR of -2.03% the same day. Both effects are found significant on the 1% level. Furthermore, volume turnover is more than doubled for both additions and deletions on ED-1. Bid-ask spreads decreased for added stocks and increased considerably for deleted stocks around the same day, contributing to an overall tripled index effect. Furthermore, results indicate that index funds replicating the OBX are having an increasing impact on the price, traded volume, and liquidity of the stocks added to or deleted from the index.

The overall findings of this study suggest temporary price pressures around ED, most likely caused by index fund rebalancing, directly supporting the price-pressure hypothesis. Hence, the imperfect substitution hypothesis is rejected, as abnormal returns are proven to diminish few days after the event. Still, the price effects found are largely asymmetric, meaning that positive abnormal returns for additions are greater and more persistent than the negative abnormal returns found for index deletions, providing some evidence of investor awareness effects. The negative price effects found for deletions are completely reversed after only two days, when looking at data following the global financial crisis. Conversely, positive price effects for index additions last for ten days, when assessing the same data. Finally, there are no indications that index revisions provide additional information to the market, and hence the information hypothesis is rejected.

9.2. Critique

The data set used in this study has some problems related to heteroscedasticity and deviations from normality. This is not unusual for studies looking at stock returns. Nevertheless, it is a weakness that should be considered when assessing the results found and the conclusions drawn. Furthermore, a fair critique of this study relates to the size of the data set analyzed, particularly when breaking down the complete sample into two subsamples. The first subsample included 36 additions and 30 deletions, whereas the second subsample consisted of 26 additions and 20 deletions. The size of the data set was a direct consequence of the data provided by Oslo Stock Exchange and the applied structure of the event study. Another weakness of the event study methodology relates to the independent calculations of alpha and beta values. Hence, different values have been computed for the same firms, depending on time of addition or deletion. As an example, the addition of DNO in the second half of 2011 has been analyzed using alpha and beta values of 0.0012 and 1.03, respectively, when looking at AD, and 0.0009 and 1.02, respectively, when looking at ED. Such deviations are representative for other additions and deletions in the data set. Nevertheless, It should be emphasized that these deviations are minor, and not decisive for the results presented.

9.3. Further Studies

Despite liquidity effects not being the sole topic of the analyses conducted, this study has made an attempt of addressing an interesting research topic of changes to stock liquidity surrounding index revisions. Liquidity fluctuations are insufficiently covered in the existing literature on index effects. In order to investigate this topic further, future research could perform thorough liquidity analyses, in the spirit of Beneish and Whaley (1996), alternatively using more complex measures of liquidity, like those proposed by Amihud (2002).

No study (to this author's knowledge) has looked at changes to the number of shareholders around revisions of Norwegian stock indices. Hence, another possible research question is to test for significant growth (decay) in the number shareholders following additions (deletions) to the OBX, in the spirit of Chen et al. (2004) and Pruitt and Wei (1989). If such movements were discovered, it would shed new light on investor awareness effects on the OBX.

Reference list

Amihud, Y. (2002). Illiquidity of Stock Returns: Cross-Section and Time-Series Effects. *Journal of Financial Markets, Vol.5(1), 31-56.*

Bechmann, K.L. (2004). Price and Volume Effects Associated with Changes in the Danish Blue-Chip Index: The KFX Index. *Multinational Finance Journal, Vol.8(1/2), 3-34.*

Beneish, M.D., & Gardner, J.C. (1995). Information Costs and Liquidity Effects from Changes in the Dow Jones Industrial Average List. *Journal of Financial and Quantitative Analysis, Vol.30(1), 135-157.*

Beneish, M.D., & Whaley R.E. (1996). An anatomy of the "S & P Game": The Effects of Changing the Rules. *The Journal of Finance, Vol.51(5), 1909-1930.*

Berk, J., & DeMarzo, P. (2014). *Corporate Finance* (Third Edition). Essex: Pearson Education Limited.

Bodie, Z., Kane, A., & Marcus A.J. (2014). *Investments* (Tenth Global Edition). New York: McGraw Hill Higher Education.

Brown, S.J., & Warner, J.B. (1980). Measuring Security Price Performance. *Journal of Finncial Economics, Vol.8(1), 205-258.*

Brown, S.J., & Warner, J.B. (1985). Using Daily Stock Returns: The Case of Event Studies. *Journal of Finncial Economics, Vol.14(1), 3-31.*

Cai, J. (2007). What's in the News? Information Content of S&P 500 Additions. *Financial Management, Vol.36(3), 113-124.*

Chen, H., Noronha, G. & Singal, V. (2004). The Price Response to the S&P 500 Index Additions and Deletions: Evidence of Asymmetry and a New Explanation. *The Journal of Finance, Vol.59(4), 1901-1930.*

Dhillon, U., & Johnson, H. (1991). Changes in the Standard and Poor's 500 List. *The Journal of Business, Vol.64(1), 75-85.*

Fama, E.F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *Journal of Finance, Vol.25(2), 383-417.*

Fama, E.F. (1976). *Foundations of Finance*, New York: Basic Books.

Fama, E.F., Fisher, L., Jensen, M.C., & Roll, R. (1969). The Adjustment of Stock Prices to New Information. *International Economic Review, Vol.10(1), 1-21.*

Harris, L., & Gurel, E. (1986). Price and Volume Effects Associated with Changes in the S&P 500 List: New Evidence for the Existence of Price Pressures. *The Journal of Finance, Vol.41(4), 815-829.*

Jain, P.C. (1987). The Effect on Stock Price of Inclusion in or Exclusion from the S&P 500. *Financial Analysts Journal, Vol.43(1), 58-65.*

Knutsen, H.L., (2014). Indekseffekten på Oslo Børs Fondindeks (OSEFX) – En studie på pris- og volumeffekter ved inkludering av aksjer (Master's thesis). Norwegian University of Life Sciences (NMBU).

Kothari, S.P., & Warner, J.B. (2007). Econometrics of Event Studies. E.E. (Ed.), *Handbook of Empirical Corporate Finance* (1st ed., pp.3-36). North Holland Publishing Company.

Lo, A.W. (2016). What Is an Index? *The Journal of Portfolio Management, Vol.42(2), 21-36.*

MacKinlay, A.C. (1997). Event Studies in Economics and Finance. *Journal of Economic Literature, Vol.35(1), 13-39.*

Myhre, E.M., Nybakk, K. (2012). *Indekseffekten – En empirisk studie av pris- og volumeffekter ved inkludering av aksjer i OBX-indeksen* (Master's thesis). NHH Norwegian School of Economics.

Mæhle, S., & Sandberg, T.S. (2015). Price and Volume Effects Associated with Index Revisions in the OSEBX (Master's thesis). Copenhagen Business School.

Norwegian Fund and Asset Management Association (VFF). (2018). Historisk statistikk. Retrieved from: https://vff.no/historisk-statistikk

OBX Total Return Index. (2017). Retrieved from: https://www.oslobors.no/ob_eng/markedsaktivitet/#/details/OBX.OSE/overview

Oslo Børs. (2017). *Index Methodology – Equities.* Oslo Børs ASA.

Pruitt, S.W., & Wei, J. (1989). Institutional Ownership and Changes in the S&P 500. *The Journal of Finance, Vol.44(2), 509-513.*

Rahman, M.M., & Govindarajulu, Z. (1997). A modification of the test of Shapiro and Wilk for normality. *Journal of Applied Statistics, Vol.24(2), 219-236.*

Sirnes, E. (2018). TITLON – Financial data for Norwegian academic institutions. Retrieved from: https://uit.no/forskning/forskningsgrupper/sub?sub_id=417205&p_document_id=352767

Sharpe, W.F. (1963). A Simplified Model for Portfolio Analysis. *Management Science, Vol.9(2), 277-293.*

Shleifer, A. (1986). Do Demand Curves for Stocks Slope Down? *The Journal of Finance, Vol.41(3), 579-590.*

Sorokina, N., Booth, D.E., & Thornton, J.H. (2013). Robust Methods of Event Studies: Empirical Evidence and Theoretical Implications. *Journal of Data Science, Vol.11(3), 575-606.*

Tu, S., Adeyemi, H.O, Karambelas, P., Callagy, R.M., & Pinto, M.R. (2017). *Passive Market Share to Obertake Active in the US No Later than 2024.* (2 February 2017) Moody's Investors Service.

Wooldridge, J.M. (2016). *Introductory Econometrics: A Modern Approach* (6th Edition). Boston, MA: Cengage Learning.

Wøllo, H. & Kouabache, M. (2017). Innrullering i OBX-indeksen: Avkastning og Risiko (Master's thesis). Norwegian University of Life Sciences (NMBU).

Appendices

Appendix A: Historic OBX Revisions[i]

Table A.1.

Historic OBX additions and deletions over the period June 1999 – June 2017.

Date	Additions	Deletions	Time of Announcement	AD	ED
1H 2017	Grieg Seafood (GSF)	Schibsted ser. B (SCHB)	8 Dec 2016, 8 AM	8 Dec 2016	16 Dec 2016
2H 2016[ii]	SalMar (SALM) Lerøy Seafood Group (LSG) Aker Solutions (AKSO)	Nordic Semiconductor (NOD) Avance Gas Holding (AVANCE)	7 June 2016, 8 AM	7 June 2016	17 June 2016
1H 2016	Schibsted ser. B (SCHB) Avance Gas Holding (AVANCE) Bakkafrost (BAKKA)	Fred. Olsen Energy (FOE) Aker Solutions (AKSO) Royal Caribbean Cruises (RCL)[iii]	11 Dec 2015, 8 AM	11 Dec 2015	18 Dec 2015
2H 2015[iv]	Nordic Semiconductor (NOD) Frontline (FRO)	Golden Ocean Group (GOGL) Akastor (AKA) Schibsted ser. B (SCHB)	11 June 2015, 8 AM	11 June 2015	19 June 2015
1H 2015[v]	Det Norske Oljeselskap (DETNOR)	Prosafe (PRS) Rec Solar ASA (RECSOL)	11 Dec 2014, 8 AM	11 Dec 2014	19 Dec 2014
2H 2014[vi]	BW LPG (BWLPG) Rec Solar ASA (RECSOL)	Det Norske Oljeselskap (DETNOR)	5 June 2014, 8 AM	5 June 2014	20 June 2014
1H 2014	Golden Ocean Group (GOGL) Opera Software (OPERA)	Electromagnetic Geo.(EMGS) Polarcus (PLCS)	12 Dec 2013, 8 AM	12 Dec 2013	20 Dec 2013
2H 2013	Polarcus (PLCS)	Songa Offshore (SONGA)	13 June 2013, 8 AM	13 June 2013	21 June 2013
1H 2013[vii]	Norwegian Air Shuttle (NAS) Electromagnetic Geo.(EMGS)	Frontline (FRO)	13 Dec 2012, 8 AM	13 Dec 2012	21 Dec 2012
2H 2012[viii]	Det Norske Oljeselskap (DETNOR) Songa Offshore (SONGA)	Cermaq ASA (CEQ)	14 June 2012, 8 AM	14 June 2012	22 June 2012
1H 2012[ix]	Cermaq ASA (CEQ) Algeta ASA (ALGETA) Golar LNG (GOL)	Archer (ARCHER) Kværner (KVAER) Questerre Energy Corp (QEC) Golden Ocean Group (GOGL)	8 Dec 2011, 6:46 PM		16 Dec 2011
2H 2011[x]	Archer (ARCHER) DNO International (DNO)	Sevan Marine ASA (SEVAN)	10 June 2011, 12:56 AM	10 June 2011	17 June 2011
1H 2011	Statoil Fuel and Retail (SFR) Gjensidige Forsikring (GJF) Schibsted (SCH)	Kongsberg Automotive (KOA) DNO International (DNO) Songa Offshore (SONGA)	9 Dec 2010, 6:45 PM		17 Dec 2010
2H 2010	Kongsberg Automotive (KOA) Questerre Energy Corp (QEC)	Schibsted (SCH) Norwegian Property (NPRO)	10 June 2010, 6 PM		18 June 2010
1H 2010	Norwegian Property (NPRO) Songa Offshore (SONGA)	Norske Skogindustrier (NSG) Tandberg ASA (TAA)	9 Dec 2009, 5:45 PM		18 Dec 2009
2H 2009	Royal Caribbean Cruises (RCL)	Aker ASA (AKER)	11 June 2009, 5:47 PM		19 June 2009
1H 2009[xi]	Norske Skogindustrier (NSG)		11 Dec 2008, 5:40 PM		19 Dec 2008
2H 2008	Sevan Marine ASA (SEVAN) Aker ASA (AKER) Schibsted (SCH)	Aker Yards ASA (AKY) Norske Skogindustrier (NSG) Tomra Systems ASA (TOM)	9 June 2008, 5:14 PM		20 June 2008
1H 2008	Aker Yards ASA (AKY)	Aker ASA (AKER)	7 Dec 2007, 3:23 PM		21 Dec 2007
2H 2007[xii]	Renewable Energy Corp (REC) Golden Ocean Group (GOGL)	Ocean Rig ASA (OCR)	13 June 2007, 6:16 PM		22 June 2007
1H 2007	Aker ASA (AKER) Awilco Offshore (AWO) Ocean Rig ASA (OCR)	Royal Caribbean Cruises (RCL) Stolt-Nielsen S.A. (SIN) Fast Search & Transfer (FAST)	11 Dec 2016, 6:16 PM		22 Dec 2006
2H 2006[xiii]	PanFish (PAN) SeaDrill Ltd (SDRL)	Schibsted (SCH)	12 June 2006, 6:04 PM		16 June 2006
1H 2006	Subsea 7 (SUB)	Jinhui Shipping & T. (JIN)	12 Dec 2005, 5:49 PM		16 Dec 2006
2H 2005	Jinhui Shipping & T. (JIN) Fred. Olsen Energy (FOE) DNO International (DNO) Smedvig ASA (SME)	Eltek (ELT) Ementor (EME) Aktiv Kapital (AIK) Golar LNG (GOL)	6 June 2005, 5:22 PM		17 June 2005

1H 2005	Aker Kværner (AKVER) Stolt-Nielsen S.A. (SIN) Stolt Offshore (STO) Aktiv Kapital (AIK) Eltek (ELT) Ementor (EME)	Fjord Seafood (FJO) Nera (NER) Opticom (OPC) Kværner (KVI) Smedvig ASA (SME) Aker ASA (AKER)	9 Dec 2004, 5:20 PM		17 Dec 2004
2H 2004	Fjord Seafood (FJO) Opticom (OPC) TGS-Nopec (TGS) Smedvig ASA (SME) Petroleum Geo-Services (PGS)	Eltek (ELT) EDB Business Part (EDBASA) Visma (VIS) Ekornes (EKO) Tandberg Data (TAD)	10 June 2004, 9:03 AM	10 June 2004	18 June 2004
1H 2004[xiv]	Golar LNG (GOL) Tandberg Data (TAD) Eltek (ELT)	Opticom (OPC) Telecomputing (TCO)	12 Dec 2003, 10:45 AM	12 Dec 2003	19 Dec 2003
2H 2003[xv]	Telecomputing (TCO) Fast Search & Transfer (FAST) Visma (VIS) Tandberg Television (TAT)	TGS-Nopec (TGS) InFocus Corp (IFC)	12 June 2003, 8:51 AM	12 June 2003	20 June 2003
1H 2003[xvi]	Nera (NER) Ekornes (EKO) Bergesen d.y. ser A (BEA) Bergesen d.y. ser B (BEB)	Fast Search & Transfer (FAST) Tandberg Television (TAT) Petroleum Geo-Services (PGS) Telecomputing (TCO) PanFish (PAN)	10 Dec 2002, 9:33 AM	10 Dec 2002	20 Dec 2002
2H 2002[xvii]	PanFish (PAN) Prosafe (PRS) Fast Search & Transfer (FAST)	Smedvig ASA (SME) Bergesen d.y. ser A (BEA) Nera (NER) Apptix (APP)	13 June 2002, 9:16 AM	13 June 2002	21 June 2002
1H 2002	Smedvig ASA (SME) Telecomputing (TCO)	Eltek (ELT) PanFish (PAN)	7 Dec 2001, 10:02 AM	7 Dec 2001	21 Dec 2001
2H 2001	Statoil ASA (STL) EDB Business Part (EDBASA)	Enitel (ENI) Elkem (ELK)	8 June 2001, 9:29 AM	8 June 2001	22 June 2001
1H 2001	InFocus Corp (IFC) Eltek (ELT) Telenor ASA (TEL)	Netcom (NTC) Kredittkassen (CKR) Det Sønderfjeldske (SFJ)	5 Dec 2000, 9:53 AM	5 Dec 2000	22 Dec 2000
2H 2000[xviii]	Opticom (OPC) Royal Caribbean Cruises (RCL) Enitel (ENI) PanFish (PAN) Frontline (FRO)	Aker Maritime (AMA) Tandberg Data (TAD) Proxima (PRX) Fred. Olsen Energy (FOE)	9 June 2000, 2:01 PM		16 June 2000
1H 2000[xix]	TGS-Nopec (TGS) Aker Maritime (AMA)	Prosafe (PRS)	2 Dec 1999, 1:08 PM		17 Dec 1999
2H 1999	Prosafe (PRS) Nera (NER)	Kværner B (KVIB) Orkla B (ORKB)	3 June 1999, 9:59 AM	3 June 1999	18 June 1999

Note. 1H 2017 refers to the first half year of 2017, 2H 2016 to the second half year of 2016, e

[i] Data shared by Oslo Børs Information Services in a personal E-Mail dated 15 November 2017.
[ii] 24 Companies in 1H due to OPERA-acquisition.
[iii] Out due to delisting in March 2016.
[iv] 26 companies in June due to split of SCH into A and B class.
[v] 26 companies in September due to spin-off of AKA from AKSO.
[vi] 24 companies in 1H due to Algeta-acquisition.
[vii] 24 companies since late August due to delisting of GOL.
[viii] 24 companies in June due to SFR-acquisition.
[ix] 26 companies in July due to demerger of KVAER from AKSO.
[x] 24 companies due to merger of ACY and SUB.
[xi] AWO out in August due to acquisition.
[xii] TAT out in March due to acquisition.
[xiii] SME out in January due to acquisition.
[xiv] Merger in early December 2003 of GNO and DNO.
[xv] BEA and BEB out in May due to acquisition.
[xvi] 26 companies due to fast entry of GNO in early September.
[xvii] Spin-off of APP from TCO in April.
[xviii] Acquisition of NCL in April.
[xix] SAG out in late June due to acquisition.

Appendix B: Stata Do-files

This appendix contains three Do-files used to perform the analyses on stock returns, traded volumes, and bid-ask spreads. Do-files can be run using Stata statistical software.

Testing for price effects for additions around AD:

```
* IMPORT CLEAN DATA SET:
use "/Users/perolavcollin/Desktop/Masteroppgave/data2useADIncl.dta"
sort GroupId Date
by GroupId: gen TradeDay = _n
by GroupId: gen EventObs = EventDate == Date
bysort GroupId (EventObs): gen Days = TradeDay - TradeDay[_N] if EventDate[_N] == Date[_N]

* CREATE EVENT WINDOW AND ESTIMATION WINDOW:
gen W_Event = inrange(Days,-60,60)
gen W_Estimation = inrange(Days,61,312)
by GroupId: egen N_W_Event = total(W_Event)
by GroupId: egen N_W_Estimation = total(W_Estimation)
drop if N_W_Event < 121
drop if N_W_Estimation < 252

* ESTIMATE NORMALIZED RETURNS USING THE MARKET MODEL:
sort GroupId Date
gen ReturnEst = Return if W_Estimation
rangestat (reg) ReturnEst MarketReturn, interval(GroupId 0 0)
gen NormalRet = b_cons + b_MarketReturn * MarketReturn if W_Event

* ESTIMATE ABNORMAL RETURNS (AR):
sort GroupId Date
gen AR = Return - NormalRet if W_Event

* ESTIMATE AND TEST CUMULATIVE ABNORMAL RETURNS (CAR):
by GroupId: egen CAR_6060 = total(AR) if Days>=-60 & Days<=60
by GroupId: egen AR_SD_6060 = sd(AR) if Days>=-60 & Days<=60
gen T_CAR_6060 = (1/sqrt(121))*(CAR_6060/AR_SD_6060)
reg CAR_6060 if Days == 0, robust
sum CAR_6060 if Days == 0

by GroupId: egen CAR_600 = total(AR) if Days>=-60 & Days<=0
by GroupId: egen AR_SD_600 = sd(AR) if Days>=-60 & Days<=0
gen T_CAR_600 = (1/sqrt(61))*(CAR_600/AR_SD_600)
reg CAR_600 if Days == 0, robust
sum CAR_600 if Days == 0

by GroupId: egen CAR_060 = total(AR) if Days>=0 & Days<=60
by GroupId: egen AR_SD_060 = sd(AR) if Days>=0 & Days<=60
gen T_CAR_060 = (1/sqrt(61))*(CAR_060/AR_SD_060)
reg CAR_060 if Days == 0, robust
sum CAR_060 if Days == 0

by GroupId: egen CAR_2020 = total(AR) if Days>=-20 & Days<=20
by GroupId: egen AR_SD_2020 = sd(AR) if Days>=-20 & Days<=20
gen T_CAR_2020 = (1/sqrt(41))*(CAR_2020/AR_SD_2020)
reg CAR_2020 if Days == 0, robust
sum CAR_2020 if Days == 0

by GroupId: egen CAR_1010 = total(AR) if Days>=-10 & Days<=10
by GroupId: egen AR_SD_1010 = sd(AR) if Days>=-10 & Days<=10
gen T_CAR_1010 = (1/sqrt(21))*(CAR_1010/AR_SD_1010)
reg CAR_1010 if Days == 0, robust
sum CAR_1010 if Days == 0

by GroupId: egen CAR_100 = total(AR) if Days>=-10 & Days<=0
by GroupId: egen AR_SD_100 = sd(AR) if Days>=-10 & Days<=0
gen T_CAR_100 = (1/sqrt(11))*(CAR_100/AR_SD_100)
reg CAR_100 if Days == 0, robust
sum CAR_100 if Days == 0

by GroupId: egen CAR_010 = total(AR) if Days>=0 & Days<=10
by GroupId: egen AR_SD_010 = sd(AR) if Days>=0 & Days<=10
gen T_CAR_010 = (1/sqrt(11))*(CAR_010/AR_SD_010)
reg CAR_010 if Days == 0, robust
sum CAR_010 if Days == 0

by GroupId: egen CAR_55 = total(AR) if Days>=-5 & Days<=5
by GroupId: egen AR_SD_55 = sd(AR) if Days>=-5 & Days<=5
gen T_CAR_55 = (1/sqrt(11))*(CAR_55/AR_SD_55)
reg CAR_55 if Days == 0, robust
sum CAR_55 if Days == 0

by GroupId: egen CAR_25 = total(AR) if Days>=-2 & Days<=5
by GroupId: egen AR_SD_25 = sd(AR) if Days>=-2 & Days<=5
gen T_CAR_25 = (1/sqrt(8))*(CAR_25/AR_SD_25)
reg CAR_25 if Days == 0, robust
sum CAR_25 if Days == 0

by GroupId: egen CAR_05 = total(AR) if Days>=0 & Days<=5
by GroupId: egen AR_SD_05 = sd(AR) if Days>=0 & Days<=5
gen T_CAR_05 = (1/sqrt(6))*(CAR_05/AR_SD_05)
reg CAR_05 if Days == 0, robust
sum CAR_05 if Days == 0

by GroupId: egen CAR_12 = total(AR) if Days>=-1 & Days<=2
by GroupId: egen AR_SD_12 = sd(AR) if Days>=-1 & Days<=2
gen T_CAR_12 = (1/sqrt(4))*(CAR_12/AR_SD_12)
reg CAR_12 if Days == 0, robust
sum CAR_12 if Days == 0

by GroupId: egen CAR_11 = total(AR) if Days>=-1 & Days<=1
by GroupId: egen AR_SD_11 = sd(AR) if Days>=-1 & Days<=1
gen T_CAR_11 = (1/sqrt(3))*(CAR_11/AR_SD_11)
reg CAR_11 if Days == 0, robust
sum CAR_11 if Days == 0

* ESTIMATE AND TEST AVERAGE ABNORMAL RETURNS (AAR) AROUND THE EVENT:
sort Days
by Days: egen AAR = mean(AR) if Days>=-60 & Days<=60
reg AR if Days == -10, robust
reg AR if Days == -9, robust
reg AR if Days == -8, robust
reg AR if Days == -7, robust
reg AR if Days == -6, robust
reg AR if Days == -5, robust
reg AR if Days == -4, robust
reg AR if Days == -3, robust
reg AR if Days == -2, robust
reg AR if Days == -1, robust
reg AR if Days == 0, robust
reg AR if Days == 1, robust
reg AR if Days == 2, robust
reg AR if Days == 3, robust
reg AR if Days == 4, robust
reg AR if Days == 5, robust
reg AR if Days == 6, robust
reg AR if Days == 7, robust
reg AR if Days == 8, robust
reg AR if Days == 9, robust
reg AR if Days == 10, robust
```

Testing for volume effects for additions around AD:

```
* IMPORT CLEAN DATA SET:
use "/Users/perolavcollin/Desktop/Masteroppgave/data2useVolumeADIncl.dta"
sort GroupId Date
by GroupId: gen TradeDay = _n
by GroupId: gen EventObs = EventDate == Date
bysort GroupId (EventObs): gen Days = TradeDay - TradeDay[_N] if EventDate[_N] == Date[_N]

* CREATE EVENT WINDOW AND ESTIMATION WINDOW:
gen W_Event = inrange(Days,-60,60)
gen W_Estimation = inrange(Days,61,312)
by GroupId: egen N_W_Event = total(W_Event)
by GroupId: egen N_W_Estimation = total(W_Estimation)
drop if N_W_Event < 121
drop if N_W_Estimation < 252

* ESTIMATE VOLUME RATIOS (VR):
sort GroupId Date
by GroupId: gen StockVolEst = StockVolume if W_Estimation == 1
by GroupId: egen AvgStockVol = mean(StockVolEst)
by GroupId: gen MktVolEst = MarketVolume if W_Estimation == 1
by GroupId: egen AvgMktVol = mean(MktVolEst)
by GroupId: gen VR = (StockVolume/MarketVolume) * (AvgMktVol/AvgStockVol) if W_Event == 1

* ESTIMATE AND TEST AVERAGE VOLUME RATIOS (AVR) AROUND THE EVENT:
sort Days GroupId
by Days: egen AVR = mean(VR)
sort GroupId Date
ttest VR == 1 if Days == -10
ttest VR == 1 if Days == -9
ttest VR == 1 if Days == -8
ttest VR == 1 if Days == -7
ttest VR == 1 if Days == -6
ttest VR == 1 if Days == -5
ttest VR == 1 if Days == -4
ttest VR == 1 if Days == -3
ttest VR == 1 if Days == -2
ttest VR == 1 if Days == -1
ttest VR == 1 if Days == 0
ttest VR == 1 if Days == 1
ttest VR == 1 if Days == 2
ttest VR == 1 if Days == 3
ttest VR == 1 if Days == 4
ttest VR == 1 if Days == 5
ttest VR == 1 if Days == 6
ttest VR == 1 if Days == 7
ttest VR == 1 if Days == 8
ttest VR == 1 if Days == 9
ttest VR == 1 if Days == 10
```

Testing for liquidity effects for additions around ED:

```
* IMPORT CLEAN DATA SET:
use "/Users/perolavcollin/Desktop/Masteroppgave/DataSpreadIncl.dta"
sort GroupId Date
by GroupId: gen TradeDay = _n
by GroupId: gen EventObs = EventDate == Date
bysort GroupId (EventObs): gen Days = TradeDay - TradeDay[_N] if EventDate[_N] == Date[_N]

* CREATE EVENT WINDOW AND ESTIMATION WINDOW:
gen W_Event = inrange(Days,-60,60)
gen W_Estimation = inrange(Days,61,312)
by GroupId: egen N_W_Event = total(W_Event)
by GroupId: egen N_W_Estimation = total(W_Estimation)
drop if N_W_Event < 121
drop if N_W_Estimation < 252

* ESTIMATE AVERAGE BID-ASK SPREAD
sort Days
by Days: gen PercentSpread = (BestAskPrice-BestBidPrice)/BestAskPrice if W_Event == 1
by Days: egen AvgSpread = mean(PercentSpread) if W_Event == 1
twoway (line AvgSpread Days if W_Event == 1)(lfit AvgSpread Days if W_Event == 1)
```

```
* IMPORT CLEAN DATA SET:
use "/Users/perolavcollin/Desktop/Masteroppgave/DataSpreadIncl.dta"
sort GroupId Date
by GroupId: gen TradeDay = _n
by GroupId: gen EventObs = EventDate == Date
bysort GroupId (EventObs): gen Days = TradeDay - TradeDay[_N] if EventDate[_N] == Date[_N]

* CREATE EVENT WINDOW AND ESTIMATION WINDOW:
gen W_Event = inrange(Days,-60,60)
gen W_Estimation = inrange(Days,61,312)
by GroupId: egen N_W_Event = total(W_Event)
by GroupId: egen N_W_Estimation = total(W_Estimation)
drop if N_W_Event < 121
drop if N_W_Estimation < 252

* ESTIMATE SPREAD RATIO AND TEST FOR DAYS AROUND THE EVENT:
sort GroupId Date
by GroupId: gen SpreadEst = Spread if W_Estimation == 1
by GroupId: egen AvgSpread = mean(SpreadEst)
by GroupId: gen SR = (Spread/AvgSpread) if W_Event == 1
sort Days GroupId
by Days: egen ASR = mean(SR)

ttest SR == 1 if Days == -10
ttest SR == 1 if Days == -9
ttest SR == 1 if Days == -8
ttest SR == 1 if Days == -7
ttest SR == 1 if Days == -6
ttest SR == 1 if Days == -5
ttest SR == 1 if Days == -4
ttest SR == 1 if Days == -3
ttest SR == 1 if Days == -2
ttest SR == 1 if Days == -1
ttest SR == 1 if Days == 0
ttest SR == 1 if Days == 1
ttest SR == 1 if Days == 2
ttest SR == 1 if Days == 3
ttest SR == 1 if Days == 4
ttest SR == 1 if Days == 5
ttest SR == 1 if Days == 6
ttest SR == 1 if Days == 7
ttest SR == 1 if Days == 8
ttest SR == 1 if Days == 9
ttest SR == 1 if Days == 10
```

Appendix C: Exclusion of Added and Deleted Firms

Table A.2.

Excluded OBX-additions and OBX-deletions

Additions

Count	Period	Firm	Reason of Exclusion
1	1H 2017	Grieg Seafood	Too short estimation period
2	2H 2016	SalMar (SALM)	Too short estimation period
3	2H 2017	Lerøy Seafood Group (LSG)	Too short estimation period
4	2H 2018	Aker Solutions (AKSO)	Too short estimation period
5	1H 2015	Det Norske Oljeselskap (DETNOR)	Insufficient data
6	2H 2014	Rec Solar ASA (RECSOL)	Too short estimation period
7	2H 2012	Det Norske Oljeselskap (DETNOR)	Insufficient data
8	1H 2012	Golar LNG (GOL)	Too short estimation period
9	1H 2011	Statoil Fuel & Retail (SFR)	Fast Entry
10	1H 2011	Gjensidige Forsikring (GJF)	Fast Entry
11	1H 2008	Aker Yards ASA (AKY)	Insufficient data
12	2H 2006	PanFish (PAN)	Cannot find data / name change
13	2H 2005	Jinhui Shipping & T. (JIN)	Volatile estimation period
14	2H 2005	Smedvig ser. A (SME)	Too short estimation period
15	1H 2005	Aker Kværner (AKVER)	Cannot find data / name change
16	1H 2005	Stolt Offshore (STO)	Cannot find data / name change
17	1H 2005	Ementor (EME)	Cannot find data / name change
18	2H 2003	Fast Search & Transfer (FAST)	Volatile estimation period
19	1H 2003	Bergesen d.y. ser. B (BEB)	Too short estimation period
20	1H 2003	Bergesen d.y. ser. A (BEA)	>50 missing returns in est.period
21	2H 2002	PanFish (PAN)	Cannot find data / name change
22	2H 2001	Statoil (STL)	Fast Entry
23	2H 2001	EDB Business Partner (EDB)	Cannot find data / name change
24	1H 2001	Infocus Corporation (IFC)	Volatile estimation period
25	1H 2001	Telenor (TEL)	Fast Entry
26	2H 2000	Opticom (OPC)	Volatile estimation period
27	2H 2000	Enitel (ENI)	Too short estimation period
28	2H 2000	PanFish (PAN)	Cannot find data / name change

Deletions

Count	Period	Firm	Reason of Exclusion
1	1H 2017	Schibsted ser. B (SCHB)	Too short estimation period
2	2H 2016	Nordic Semiconductor (NOD)	Too short estimation period
3	2H 2016	Avance Gas Holding (AVANCE)	Too short estimation period
4	1H 2016	Fred. Olsen Energy (FOE)	Volatile estimation period
5	1H 2016	Royal Caribbean Cruises (RCL)	Too short event period
6	2H 2015	Golden Ocean Group (GOGL)	Too short event period
7	2H 2015	Schibsted ser. B (SCHB)	Too short event period
8	1H 2015	Rec Solar ASA (RECSOL)	Too short estimation period
9	2H 2014	Det Norske Oljeselskap (DETNOR)	Cannot find data / name change
10	2H 2011	Sevan Marine ASA (SEVAN)	Volatile estimation period
11	2H 2008	Aker Yards ASA (AKY)	Cannot find data / name change
12	2H 2008	Norske Skogindustrier (NSG)	Abnormal estimation period
13	2H 2007	Ocean Rig ASA (OCR)	Too short estimation period
14	2H 2005	Ementor (EME)	Cannot find data / name change
15	1H 2005	Nera (NER)	>50 missing returns in est.period
16	1H 2005	Kværner (KVI)	Too short estimation period
17	2H 2004	EDB Business Partner (EDB)	Cannot find data / name change
18	2H 2003	Infocus Corporation (IFC)	Too short estimation period
19	1H 2003	Fast Search & Transfer (FAST)	Volatile estimation period
20	1H 2003	Petroleum Geo-Services (PGS)	Volatile estimation period
21	1H 2003	PanFish (PAN)	Cannot find data / name change
22	2H 2002	Bergesen A-shares	>50 missing returns in est.period
23	2H 2002	Apptix (APP)	Too short event period
24	1H 2002	PanFish (PAN)	Cannot find data / name change
25	2H 2001	Enitel (ENI)	Too short event period
26	1H 2001	Kreditkassen (CKR)	Too short estimation period
27	1H 2001	Det Søndenfjeldske (SFJ)	Cannot find data / name change
28	1H 2001	Netcom (NTC)	Cannot find data / name change
29	2H 2000	Aker Maritime (AMA)	>50 missing returns in est.period
30	2H 2000	Proxima (PRX)	Too short event period
31	2H 1999	Orkla B	Too short estimation period

Note. 1H 2017 refers to the first half year of 2017, 2H 2016 to the second half year of 2016, etc.

Appendix D: Results from Critical Testing

Figure A.1. Distribution of Abnormal Returns for Additions Around ED (1999 – 2017)

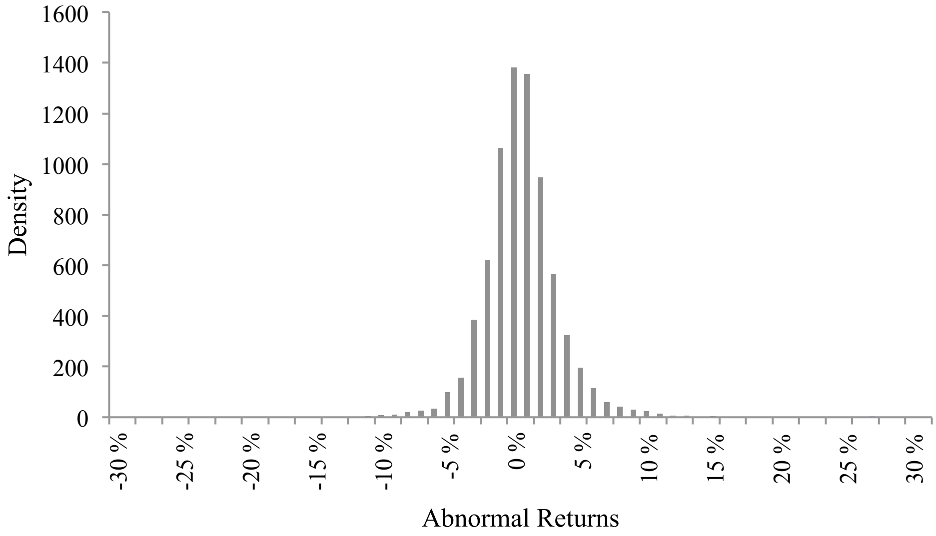

Figure A.1. The histogram displays excess kurtosis, and hence deviations from normality. Results are representative for both additions and deletion around AD and ED.

Table A.3.

Results from Shapiro-Wilk Normality Testing

Days	W	V	z	Prob > z
AD	0.972	1.543	0.936	0.175
ED-1	0.988	0.688	-0.808	0.791
ED	0.972	1.545	0.940	0.174
ED+1	0.949	2.841	2.255	0.012

Note. AD and ED refers to the announcement date and effective date, respectively. Ws and Vs are the Shapiro-Wilk test statistics. W-values closer to unity indicate normality, whereas smaller V-values point to normality. Z-score indicates deviations from the mean. Using $\alpha = 0.05$, AR-distributions for AD, ED-1 and ED prove normally distributed. Tests show that AR-distribution on ED+1 deviates from normality.

Table A.4.

Results from Critical Testing of Heteroscedasticity and Serial Correlation

GroupId	Alpha	Beta	R-Squared	White-test	Breusch-Godfrey
7	0.0006	1.2333	0.2043	0.2140	0.3453
27	-0.0008	1.2063	0.3396	0.6155	0.8090
35	0.0007	0.8213	0.0527	0.8527	0.2180
49	0.0006	0.7959	0.2658	0.0027	0.3219
55	-0.0007	0.8070	0.4905	0.0285	0.0514
101	-0.0023	1.3512	0.3775	0.1745	0.5433
105	0.0008	1.2752	0.3291	0.0621	0.0327
115	-0.0025	1.7813	0.0961	0.5092	0.0890
137	-0.0030	1.3236	0.1027	0.0129	0.5714
120	0.0011	0.7462	0.1908	0.7608	0.0539
33	-0.0011	0.7621	0.2259	0.5008	0.3704
29	0.0006	0.6021	0.1415	0.0118	0.0070
135	-0.0013	1.0259	0.2450	0.9970	0.8049
14	-0.0025	1.0289	0.0606	0.6118	0.2341
25	-0.0029	0.9102	0.1817	0.2516	0.1812
3	-0.0005	1.6784	0.3513	0.6137	0.2276
44	0.0000	0.6921	0.3134	0.0281	0.1938
10	0.0004	1.1528	0.2207	0.9487	0.4667
118	-0.0016	1.0658	0.4111	0.0674	0.3400
146	0.0009	1.1156	0.6215	0.0489	0.0676

Note. GroupId refers to the events randomly selected. White-test was used for heteroscedasticity testing, whereas the Breusch-Godfrey test was used to test for serial correlation. Red numbers indicate presence homoscedasticity or serial correlation, calculated using a 5% significance level.

Appendix E: Illustration of AARs Around AD (1999 – 2017)

Figure A.2. Average Abnormal Returns Around AD (1999 – 2017)

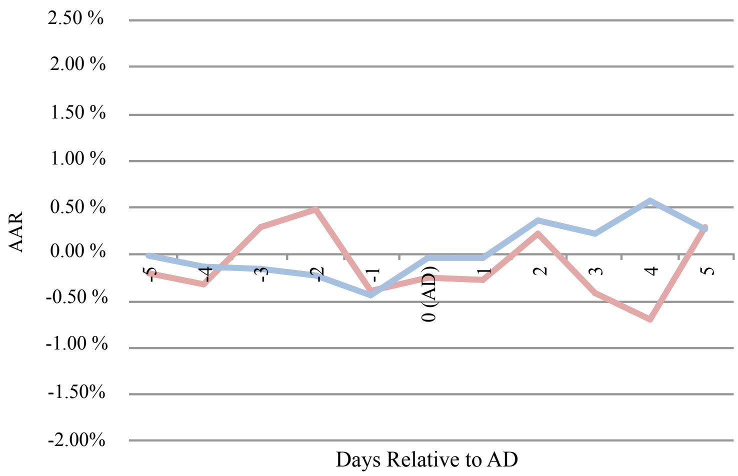

Figure A.2. Illustration of average abnormal returns (AAR) around the announcement date (AD). Blue line indicates index additions, whereas the red line reflects deletions.

Appendix F: Illustrations of AARs Around AD and ED (1999 – 2007)

Figure A.3. Average Abnormal Returns Around AD (1999 – 2007)

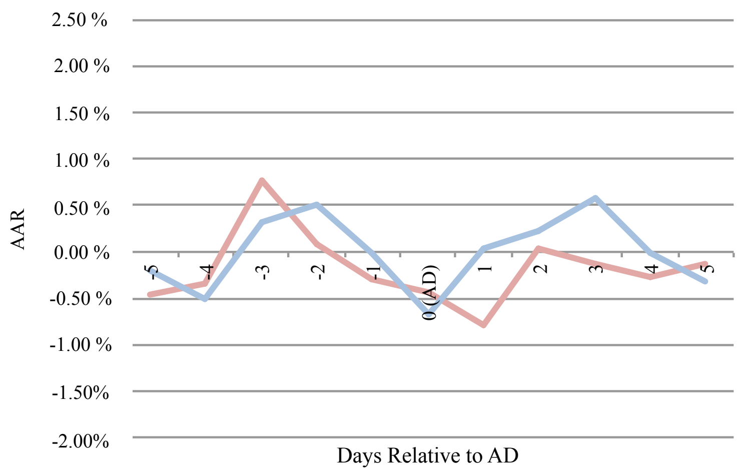

Figure A.3. Illustration of average abnormal returns (AAR) around the announcement date (AD), using only the first subsample (1999 – 2007). Blue line indicates index additions, whereas the red line reflects deletions.

Figure A.4. Average Abnormal Returns Around ED (1999 – 2007)

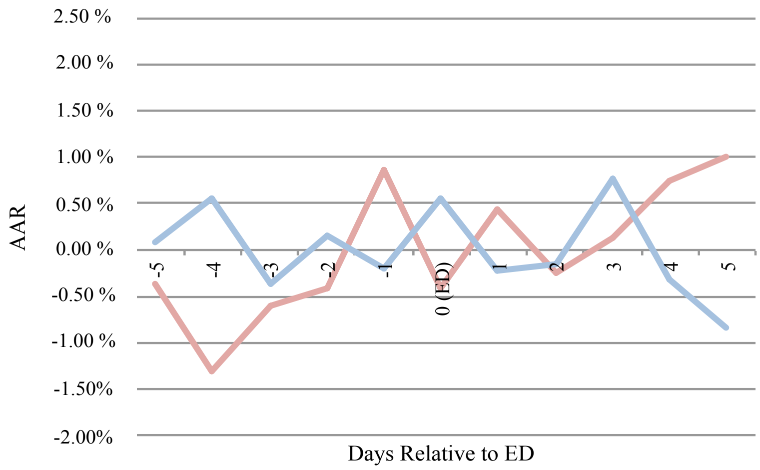

Figure A.4. Illustration of average abnormal returns (AAR) around the effective date (ED), using only the first subsample (1999 – 2007). Blue line indicates index additions, whereas the red line reflects deletions.

Appendix G: Illustration of AARs Around AD (2008 – 2017)

Figure A.5. Average Abnormal Returns Around AD (2008 – 2017)

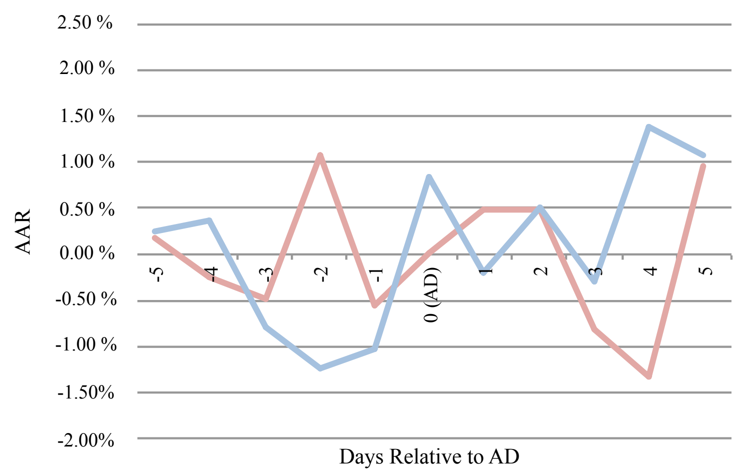

Figure A.5. Illustration of average abnormal returns (AAR) around the announcement date (AD), using only the second subsample (2008 – 2017). Blue line indicates index additions, whereas the red line reflects deletions.

Appendix H: Illustration of Average Bid-Ask Spreads (1999 – 2017)

Figure A.6. Average Bid-Ask Spreads During the Event Window (1999 – 2017)

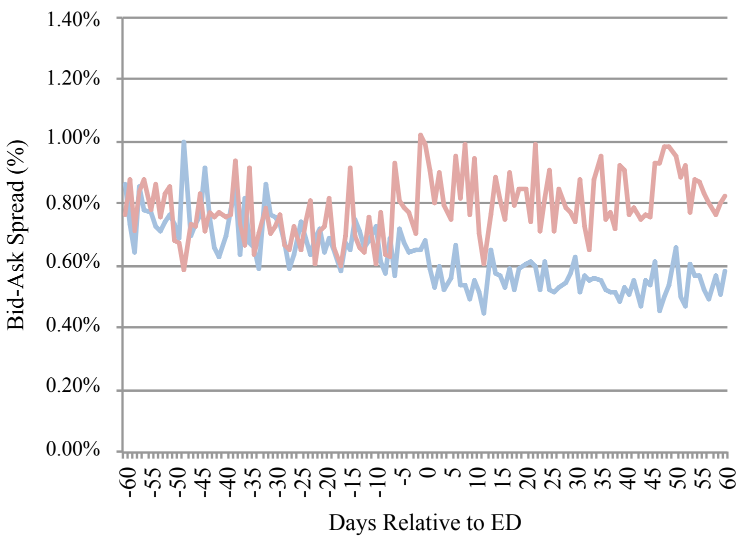

Figure A.6. Illustration of average percentage bid-ask spreads over the 121-day event window around the effective date (ED). Blue line indicates index additions, whereas the red line reflects deletions.

Appendix I: Illustrations of Spread Development During the Event Window (1999 – 2007)

Figure A.7. Average Bid-Ask Spreads During the Event Window (1999 – 2007)

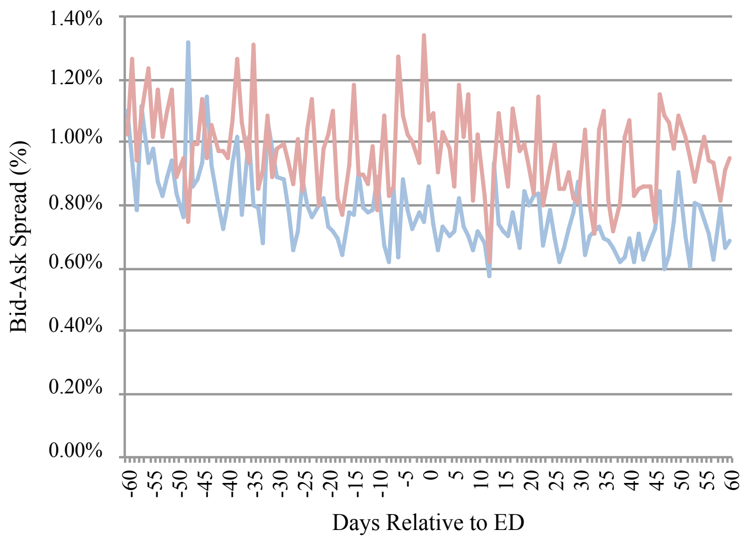

Figure A.7. Illustration of average percentage bid-ask spreads over the 121-day event window around the effective date (ED), using only the first subsample (1999 – 2007). Blue line indicates index additions, whereas the red line reflects deletions.

Figure A.8. Average Spread Ratios During the Event Window (1999 – 2007)

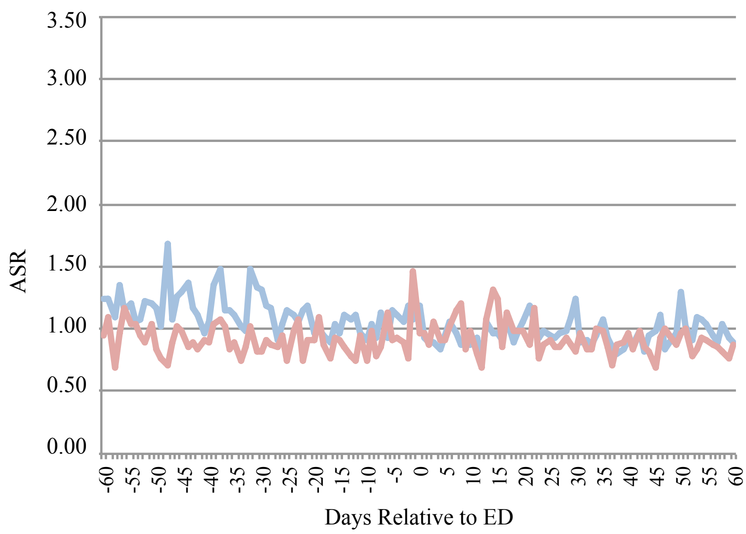

Figure A.8. Illustration of the development in average spread ratio (ASR) over the 121-day event window around the effective date (ED), using only the first subsample (1999 – 2007). Blue line indicates index additions, whereas the red line reflects deletions.