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Strategic Finance and Analytics

The effects of changes in stock index composition on stock prices

Case: European Blue-chip indices

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Abstract

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The purpose of this thesis is to examine price and volume effects related to index composition changes in three European blue-chip stock indices: DAX, Euro STOXX 50, and FTSE 100. Furthermore, the objective of the study is to reveal if the index composition changes generate abnormal price and volume effects for the stocks involved in the changes. The literature review studies the previous findings as well as the last 20 years' stock market microstructure improvements, which could impact the index effects.

The empirical analysis is conducted using an event study methodology, which measures the abnormal price and volume effects around the composition change event. The three inspected indices do not deliver similar price results as Euro STOXX 50 represents indications of price pressure, FTSE 100 represents indications of anticipatory price effects and investor awareness hypothesis, and DAX represents inverse price effects. Stocks from all indices exhibit a rise in trading volumes during the composition change event, which is analogous to index-tracking instruments trading their portfolios to match the underlying.

The results that thrived from the analysis suggest that the rising amount of funds in index-tracking instruments is not magnifying the index effects and therefore not generating losses for passive strategy investors. However, further studies should be targeted to examine composition change's informational aspects and the impacts of differences in index methodologies and selection criteria.

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Tämän Pro Gradu-tutkielman tavoitteena on kartoittaa indeksimuutosten vaikutuksia muutoksessa mukana olevien osakkeiden hinnoissa ja kaupankäyntivolyymissä. Työssä tutkitaan eurooppalaisten pääosakeindeksien DAX, Euro STOXX 50 ja FTSE 100 indeksimuutoksia. Työn tarkempana tavoitteena on selvittää tuottavatko indeksimuutoksen kohteena olevat yksittäiset osakkeet vertailuindeksiin nähden yli- tai alituottoja indeksimuutosten aikana sekä selvittää indeksimuutosten aiheuttamia poikkeamia kaupankäyntivolyymeissä. Työn kirjallisuuskatsaus käsittelee edeltäviä indeksimuutosten hinta- ja volyymivaikutuksiin keskittyneitä tutkimuksia sekä osakemarkkinoiden infrastruktuuriin tulleita muutoksia viimeisen 20 vuoden ajalta.

Tutkimusaineiston analysoinnissa käytetään aiempien tutkimusten tapaan tapahtumatutkimuksen metodeja, joilla pyritään mittaamaan mahdollisia osakkeiden yli- ja alituottoja sekä epänormaaleja kaupankäyntivolyymejä. Tutkimuksen tulokset osoittavat, että jokaisella indeksillä on uniikit tuloksensa. Euro STOXX 50-indeksin tulokset ovat hintapaine-teorian mukaisia, FTSE 100-indeksin tulokset viittaavat sijoittajien tietoisuus-teoriaan ja DAX-indeksin tulokset osoittavat käänteisiä hintavaikutuksia. Tutkielman tulokset viittaavat myös siihen, että rahan määrän kasvu passiivisissa indeksirahastoissa ei vahvistaisi osakkeiden haitallisia hinta- ja volyymivaikutuksia indeksimuutosten aikana. Eurooppalaisten indeksien muutoksia pitäisi kuitenkin tutkia lisää, jotta indeksimuutosten informatiivisista vaikutuksista tiedettäisiin enemmän. Myös indeksien sääntökirjoja ja valintaperusteiden eroja ja niiden aiheuttamia hinta- ja volyymivaikutuksia pitäisi tutkia syvemmin.

Table of Contents

List of Figures

List of Tables

1 Introduction

Equity indices are hotspots of financial media and building blocks for several products in the finance industry. Stock indices are underlying for options, futures, ETFs, and benchmarks for actively managed mutual funds. As there is a massive number of products built on top of different indices it is worth studying how the changes in the underlaying affect the prices of the stocks that are part of the changes. This thesis aims to study price and volume effects that are present during stock index composition changes. These effects are for example abnormal returns after index inclusion announcement and unusually high trading volumes around the composition change event. These effects are in certain ways inconsistent with the efficient market hypothesis.

The research subject is relevant due to the increased attraction of passive investing strategies. From the evolvement of the efficient market hypothesis in the 1950s and 1960s and after the emerging of modern portfolio theory it has been studied that an average investor could benefit from holding the “market portfolio” itself without the need for active fund management. (Anadu et al. 2018, 1-32) As the theory and research advised, nowadays passively managed mutual funds and Exchange traded funds (ETF) have become popular as people prefer them over actively managed substitutes. The trend appears not turning down and it might be that in the near future the wealth management industry shifts more and more to the passively managed product portfolios, while the customers and other investors are willing to accept the average market return. Still the effects related to the passive investment products are not completely covered in the literature and it is important to cast an eye for possible adverse effects formed by the structural change in the wealth management industry.

According to Anadu et al. (2018, 1-32) and Afego (2017, 228-239) the growth of funds in index-investing vehicles may add the index effects, which, according to the existing literature, are present in the markets. These effects form possibilities for arbitrageurs, but simultaneously generate losses for passive investors (Chen, Noronha, and Singal 2006, 31-47). On the other hand, during the last 15 years, the stock market infrastructure has evolved largely as the multilateral trading facilities (MTF) and algorithmic trading have gained a robust position in the markets. It has been reported that the presence of MTFs and trading algorithms is bettering liquidity on the markets and therefore promoting the quality of the stock markets (European Securities and Markets Authority 2016). Since existing literature suggests that index effects would magnify as the capital invested in index-tracking instruments grows while the literature concentrating on HFTs and algorithmic trading states that their presence betters the liquidity and market quality, it should be examined if the price and volume effects are significantly impacting the markets or if those are phenomena of the past.

To examine the possible index effects and to measure their magnitude and severity, I have collected data from FTSE 100, Euro STOXX 50 and DAX equity indices that are among the largest European indices measured by funds invested through Exchange Traded Funds. The data is studied using event study methodology and the results are compared and discussed with previous studies made on the subject.

The thesis begins with building the background framework and familiarizing with the existing literature on the subject. After the literature review, the thesis continues by assessing ongoing trends on the stock markets, trading, and passive investing. Thirdly, the research questions and hypothesis, as well as data and research methodology, are introduced, after which the results are represented and discussed. Lastly, conclusions are made, and possible future research subjects are suggested according to the results derived from the study.

2 Research Background

Equity indices are widely followed all over the globe. Fundamentals laying underneath indices are in many cases unexplained for the great public. Equity indices' main function is to represent the stock market performance of a sector, region, or some other similarity for a group. Usually, this explanation is sufficient for the great public. As we explore deeper into the world of stock indices, it becomes clear that indices come in many shapes and forms while their methodologies and construction principles vary much. As the greatest goal for an index is the representativeness of the sector or region it is trying to capture, it is obvious that indices need maintenance during their lifespan. Index maintenance actions include weight changes, constituent changes, corporate action adjustments, and methodology changes to name a few. The index methodology is the official rule book for maintenance actions that are made if some stock included in the index is for example involved in corporate actions, merger, or acquisition, or if its market value drops significantly.

While Chen, Noronha, and Singal (2006, 31-47) studied the amount of possible passive investing losses due to index effects they point out an important attribute of composition changes: the changes are in most cases driven by deletions. The researchers divide the composition changes into two classes, voluntary and involuntary. Involuntary change refers to a case where the stock included in an index does not exist publicly anymore. This may be due to merger, buyout, bankruptcy, delisting, or liquidation. After a stock is not traded anymore on the exchange it must be removed from the respective equity index as well. The involuntary stock deletions from an index are more or less predictable and obvious, but the to be included stock has a surprising effect on the market.

In contrast, voluntary index composition changes refer to cases where a stock is deleted from an index due to inadequate free float, market capitalization, or liquidity level. Every index-running company sets its own limits for these factors and if they are not met, index methodology explains how the new replacing stock is added to the index and the old one is deleted. These voluntary composition changes have more “surprise” effects for the market and therefore it could be anticipated that they experience stronger index effects. (Chen, Noronha, and Singal 2006, 31-47) In addition, Afego (2017, 228-239) discovers collaborating results in his literature survey pointing out that trading strategies where deletions are traded against added stocks may not be profitable, since many deleted stocks are deleted for a fundamental reason.

The voluntary - and involuntary aspect is important to remember while examining the research results. These aspects may explain why index additions and deletions do not deliver results with similar magnitudes and significance. One example of involuntary index change is the deletion of Wirecard and inclusion of Delivery Hero to DAX index during August 2020. The deleted company, Wirecard, had been involved in an accounting tangle where 1,9 billion Euros reported to be missing from its accounts. The scandal ended up with Wirecard’s stock price slumping close to zero and liquidity level falling as well. The company was removed from DAX with the help of a fast exit procedure, and it was announced that Delivery Hero would replace the stock. From this case, it can be noticed that the deleted stock did not suffer negative index effects while leaving the index, since there were no surprising effects in the deletion. In contrast, the added stock may experience positive index effects due to the good news of sudden index inclusion.

2.1 Price Effects and Related Financial Theories

Abnormal price patterns and unusual trading volumes have been research objects from the 1980s. The early studies concentrating on the Index Effects were conducted in the USA as Harris and Gurel (1986, 815-829) examined the price pressure hypothesis at times of index composition changes in the S&P 500. The researchers found economically and statistically significant abnormal returns for stocks that were announced to be included in S&P 500 index. In addition, the stocks experienced significant rises in the trading volume levels after the inclusion announcement. The study revealed that the index effects are existing, and also that the index effects were consequences of price pressure as a form of unexpected demand from index funds and other index investors. (Harris and Gurel 1986, 815-829)

Other researchers, like Lynch and Mendehall (1997, 351-383) and Chakrabarti et al. (2005, 1237-1264) have found supporting results on the index effects related to price patterns and trading volumes. In general, authors deliver results with different magnitudes, but there is a clear consensus that index composition changes deliver positive abnormal returns around the announcement day and the trading volumes intensify as stock is announced to be included in an index. On the other hand, stocks, which were deleted from an index usually suffer abnormal losses, although the price patterns are not always exactly inverse with additions. The effects on trading volumes are mixed due to the different nature of deletions. The arguments between authors consider if some share of the gains fades away a couple of days after the announcement and the underlying fundamental reasons for the index effects to exist. The forthcoming sections will concentrate first on price effects and secondly on volume effects while describing the theories related to the possible index effect explanations.

In a comprehensive literature review on the subject Afego (2017, 228-239) divides the possible reasons for index effects into two categories: demand-based theories and information-based theories. The demand-based theories include Price pressure hypothesis and Imperfect Substitutes Hypothesis while the information-based theories include information hypothesis, liquidity hypothesis, investor awareness hypothesis, and selection criteria hypothesis. (Afego 2017, 228-239)

As Harris and Gurel (1986, 815-829) first discovered, the price effects related to index composition changes are economically and statistically significant. In their study, conducted on S&P 500 index, they found a significant 3.13% excess “first day after the announcement day” - return during the years 1978-1983. In addition, researchers found that the 1st day’s abnormal returns fade away during the next 3 weeks after the announcement as the prices of stocks revert to their pre-announcement levels. The pattern is explained with the price pressure hypothesis as the paper also argues that the addition announcement conveys no new public information of the future earnings of the stock and there is a downward-sloping demand curve in the short term. (Harris and Gurel 1986, 815-829)

The price pressure hypothesis (PPH) assumes that the short-term demand curve of a particular stock is downward sloping during times of index composition changes. According to literature in the cases of index composition changes the demand curve is formed due to increased demand of included stock by index-tracking mutual - and ETF funds. Per the price pressure hypothesis, the demand and abnormal returns are greatest around the announcement and effective days. According to the PPH, investors who adjust to demand shifts, make changes to their portfolios in a rapid schedule, and carry the risk of quickly trading large amounts of shares are justified for compensation in form of a better trade price. If the PPH would hold at times of composition changes, the included stock’s price would gain abnormal returns after the announcement day, but since the demand curve of the stock is downward sloping in short term, the abnormal returns would fade away in near future. (Harris and Gurel 1986, 815-829)

Following the study of Harris and Gurel, Lynch and Mendenhall (1997, 351-383) studied S&P 500 composition changes from March 1990 to April 1995 and reported supporting results. Lynch and Mendenhall found economically, and statistically significant abnormal announcement day returns of 3.158% for additions and -6.263% for deletions. In contrast to the previous results the researchers report that the abnormal returns tend to persist, and they do not reverse in the short term. Lynch and Mendenhall suggest this is due to stocks having downward-sloping demand curves in the long-term and they are therefore promoting the imperfect substitutes as well as the information and liquidity hypotheses. In addition to these findings, researchers observe that given the existing literature on the subject and the results gotten from the analysis, the index effect seems to be contrary to the semi-strong form of the efficient market hypothesis. The existing information should promote arbitrageurs to build trading strategies for the index effect, but the anticipatory actions were not present in the inspections. (Lynch and Mendenhall 1997, 351-383)

The imperfect substitutes hypothesis is a close neighbor to the price pressure hypothesis. The imperfect substitutes hypothesis states that index additions do not have relevant alternatives and therefore it is justified that the price effects from the announcement day are expected to remain for a longer period and they do not fade away after the announcement period (Afego 2017, 228-239). The first paper to consider a more permanent index inclusion effect was Shleifer (1986, 579-590), who noticed that the price reversal was not complete in the sample of S&P 500 composition changes. He explained the phenomena by stocks' downward-sloping demand curves in the long term. (Shleifer 1986, 579-590)

The two other theories from Lynch and Mendenhall's paper consider information-based theories. The two previously introduced demand-based hypotheses, price pressure and imperfect substitutes hypothesis, assumed that the index inclusion announcement did not deliver new public information of company's future earnings that should be priced into the stock price.

Information-based hypotheses base themselves on the fact that in a way or another the index inclusion announcement delivers positive signs of the company and therefore it is justified to price the news to the stock price. The positive information may be in different forms: a stock is added to the index and it is therefore seen as a promising and prosperous investment while some investors become more aware of the company following wider analyst and media coverage. (Chen, Noronha, and Singal 2004, 1901-1930)

The second hypothesis with which Lynch and Mendenhall try to explain their findings is the information hypothesis. The hypothesis is formed properly by the study of Denis et al. (2003, 1821-1840) after they revealed that inclusion in S&P 500 index result in a significant increase in earnings per share forecasts and simultaneously significant improvements in realized earnings. Their results strongly suggest that index inclusion announcements are also informational events that indicate future success for the company and the information hypothesis cannot be bypassed while examining the index effects. (Denis et al. 2003, 1821-1840)

The third hypothesis Lynch and Mendenhall referred is the liquidity hypothesis and it states that since the company has gained more attention from the analysts and media, investors are more aware of the company and they have more information about the business it does. The increased information helps investors in decision-making and therefore promotes the stock's liquidity. In addition, many investors are willing to value more liquid stocks higher than their less-liquid counterparts. In the cases of composition changes, the liquidity hypothesis can be observed when the stock's liquidity level rises after the inclusion announcement and it holds its new increased level in long term. However, as a stock is deleted from an index, the reduction of media and analyst coverage may not be as instant and significant as it is around the index additions. Therefore, inverse effects in stock deletions are not always anticipated to be present with liquidity effects. (Chen, Noronha, and Singal 2004, 1901-1930)

In a study published in 2004, researchers Chen, Noronha, and Singal found contrary results with previous studies regarding price and volume effects' symmetry. For additions to S&P 500 from 1989 to 2000, the researchers report a significant 5.4% announcement day abnormal return, which does not revert to the pre-announcement day level in short term and the index inclusion effect seems to be permanent around 6% level. For deletions, the authors find a significant -8.5% announcement day abnormal loss while the loss gets even worse, -14.4% towards the effective day. However, the abnormal loss is reverted to the pre-announcement level on a 60-day period after the effective date. Chen, Noronha, and Singal argue that, since the price effect seems to be permanent for additions and no symmetrical with deletions, the price pressure cannot explain the empirical results. The authors explain their results referring to investor awareness hypothesis, which they rationalize with a rising number of institutional and private owners of the stock and slightly bettered liquidity and company's financial performance. (Chen, Noronha, and Singal 2004, 1901-1930)

The investor awareness hypothesis is a close relative to the liquidity hypothesis. The investor awareness hypothesis states that when a stock is announced to be added to an index, many investors and analysts start to monitor the company more closely. The greater overall interest in the company may lead to higher expectations of future cash flows since the analysts and investors force the company to perform more efficiently and by that way higher the future earnings. In addition, investor awareness helps companies to attract cheaper capital, since many institutions are more willing to lend for a firm in an index than outside the index. Overall, investor awareness helps and affects companies in many ways. (Chen, Noronha, and Singal 2004, 1901-1930)

Studying of price effects of index composition changes outside the USA has gained more attention after the year 2000. Chakrabarti, Huang, Jayaraman and Lee (2005, 1237-1264) examined composition changes in MSCI indices in 29 countries from 1998 to 2001. For added stocks, the researchers report abnormal announcement day returns of 3.35% and a significant permanent price effect on the stocks over the short-term period. For deleted stocks, the researchers found a significant -2.59% announcement day loss while the loss was permanent and even got worse on the follow-up period. Both findings for added and deleted stocks are in line with the imperfect substitutes hypothesis, which includes the price pressure due to increased demand while the demand curve is downward sloping in the long-term. In addition, the researchers report the highest price effects from Japan, which according to them is due to the existence of ETFs. More accurately, Chakrabarti et al assume that since Japan is the home market for the largest iShares net asset values the index effect's magnitude is the highest. (Chakrabarti et al. 2005, 1237-1264)

In 2007 Mase conducted research of possible price and volume effects occurring during FTSE 100 index composition changes. Mase reported only minor announcement day abnormal returns of 0-3% for additions and -0.29% for deletions.

However, the researcher marked significant “whole period” (change day -17 days to change day-1 day) abnormal returns of 4.7% and -7.6% for added and deleted stocks respectively. Mase suggests the whole period returns stem from anticipatory trading prior to the composition change. The researcher reports that the abnormal returns fade away during the next weeks after the announcement, which is consistent with the price pressure hypothesis. (Mase 2007, 461-484)

It is also worth mentioning that FTSE Russel and Standard and Poors maintain their indices differently while FTSE Russel offers more transparency and prediction in their index selection criteria. It may be one reason behind the fact that researchers receive different results from different regions and markets. Petajisto (2008) examined the equity indices’ selection criteria to notice if differences in the criteria result in greater or smaller index effects. The study was done in the USA comparing FTSE Russel’s and S&P’s selection criteria and the magnitude of index premium. The results indicate that index premium might be affected by index selection rules. Index selection rules and criteria may be transparent and anticipated with clear borders and mechanisms (i.e. market capitalization) or in some part random or deterministic (i.e. no clear boundaries in index selection rules or a committee that announces changes). (Petajisto 2008)

The recent findings from the FTSE 100 index of Fernandes and Mergulhão (2016, 79-90) represent that added and deleted stocks experience anticipatory trading before the announcement date, thus lowering the price effect related to the index constituent changes. However, Fernandez and Mergulhão report significant excess returns of 2.2% for added and -6.97% for deleted stocks in the post-announcement window. The researchers report a strong increase in liquidity levels with added and deleted stocks. The researchers suggest the findings are in line with the selection criteria hypothesis and the imperfect substitutes hypothesis. The selection criteria of FTSE 100 is based on stocks’ market capitalization, which is essentially publicly known and observable criteria. In addition, the FTSE 100 consists of the largest and known stocks from London Stock Exchange, and since index inclusion announcement does not promote the level of governance or monitoring in the company. Therefore, the authors state that the index inclusion announcement does not convey any new information of the stock and the index inclusion is an anticipated, not a random, event. In addition, the abnormal positive (negative) returns formed around the index addition (deletion) announcement were not reversed and the impact seemed to be permanent for a longer period. (Fernandes and Mergulhão 2016, 79-90)

The most recent findings from S&P 500 show encouraging results for market efficiency: the analysis of Kappou (2018, 235-244) indicates that the price effect around the announcement date would be around 3% for additions and -0.22% for deletions. The author does not find other significant price effects from the inspection period and she finds three major reasons to explain the findings. Firstly, Market efficiency is increased as the price effect is inherent only overnight between the announcement day and AD+1. Secondly, active traders do not start chasing profits between the AD and effective day, since the price patterns are not showing statistically and economically significant price patterns. Thirdly, the execution of large block transactions by trading algorithms may have helped the investing activities of passive investors by minimizing the price effects around the announcement and effective dates. (Kappou 2018, 235-244)

2.2 Volume Effects and Related Financial Theories

As the price effects, also the volume effects related to index composition changes have been widely examined. The early examiners, Harris and Gurel (1986, 815-829) report an increased volume level of 2.81 times as large as the daily mean volume during the last 8 weeks of trading for stocks added to S&P 500 between 1978-1983 on the first day after the announcement day. The researchers also noticed that the volume levels persist on the higher levels (1.10 – 1.20) during the next 8 trading weeks after the addition announcement. (Harris and Gurel 1986, 815-829) To support earlier volume effect results, Lynch and Mendenhall (1997, 351-383) represent significant abnormal trading volumes 5.784 times normal volume on the announcement day for added stocks. Lynch and Mendenhall report highest abnormal volume levels of 11.3 times normal volume on the day prior to the effective day, which the authors explain by the excess demand of the stock from index-tracking investors. For deletions, the researchers receive very similar results than with index additions. (Lynch and Mendenhall 1997, 351-383)

Researchers (Chakrabarti et al. 2005, 1237-1264), that examined MSCI indices in 29 different countries between 1998 and 2001 report a significant increase in trading volume levels for added and deleted stocks as the highest volume effects are reported around announcement and effective dates, day before the effective day accounting for the highest level of abnormal volume. The authors argue that the effect is consistent with the argument that index funds adjust their portfolios before the effective date to minimize the tracking error. In addition, the researchers describe that some (~2%) of the abnormal volume is permanent for the added stocks, whereas the abnormal volume levels revert to the regular levels in cases of index deletions. (Chakrabarti et al. 2005, 1237-1264)

As Mase (2007, 461-484) examined price and volume effects in British FTSE 100 index, he reported a significant abnormal volume level around the event day of 5.7% for additions and 4.6% for deletions. In addition, Mase reports abnormal volume levels during the pre-announcement period, indicating anticipatory trading prior to the index inclusion announcement for added stocks. The deleted stocks experience abnormal volumes only around the event day and it highlights the differences with added and deleted stocks. The volume asymmetry and anticipatory trading activities are verified by finding abnormal volumes in an analysis of “nearly in”-stocks. Moreover, that proofs that some investors are speculating with the announcements. (Mase 2007, 461-484) On contrary with Mase, Fernandes and Mergulhão (2016, 79-90) find abnormal trading volumes from FTSE 100 during the pre-announcement period for both additions and deletions. Otherwise, authors’ results are in line with Mase’s. As Kappou (2018, 235-244) suggests it may be that the existing information of the index effects has improved market efficiency to the extent that investors are able to predict the changes resulting in higher trading volumes prior to the announcement and smaller price effects following the announcement.

To conclude the findings from the literature, the index selection criteria and re-balancing principles influence largely the index effects and result-analysis. If the index’s selection criteria is not predictable and fully transparent, investors are not able to anticipate the changes and there will be some degree of “surprise effect” present at the time of index composition changes. Especially, in studies concerning S&P 500 it is important to acknowledge the difference in its selection criteria in respect to most other indices. S&P 500 selection criteria is not exactly stated, and it includes no absolute rules – the index committee conducts the index changes “responding to market events” (Afego 2017, 228-239). Keeping that in mind the magnitude of price effects varies depending on the inspected index and over time. As Afego (2017, 228-239) concludes it seems like the price effects would be shrinking as we close to 2020 from the beginning of the decade. The volume effects are present around the announcement and effective days. After the financial crisis of 2008, it is reported that trading volumes react to predictable composition changes already prior to the announcement, indicating anticipatory trading. The asymmetry of price and volume effects remains an unsolved topic since some researchers report it and others do not.

2.3 European Blue-Chip Indices

In general, stock indexes are measures of different sectors of stock markets. Stock indexes consist of a group of stocks with similar features for example home exchange, market capitalization size, or industry, to name a few. Nowadays, stock indexes are widely used as benchmarks or as an underlying on the wealth management industry. Stock indexes are run, maintained, and calculated by “index-houses” or stock exchanges like Standard & Poor’s, Nasdaq, Deutsche Börse, and FTSE group. These corporations build and maintain stock market indexes to offer correct information for investors. In addition, the corporations provide stock indices for financial institutions and wealth managers so they can issue options, futures, and index-tracking mutual – and ETF funds for private and institutional investors. Stock market indexes are adjusted according to their rulebook, but usually annually or quarterly. In the index reviews, the stock index composition and the stock weighing can change, and the changes are effective until further notice from the index running corporation. The maintenance actions are done to achieve three important aspects related to indexing: reproducibility, tradability, and representability. Reproducibility and tradability are both related to the productization of indices – if the index will serve as an underlaying for a wealth management company the underlaying must be tradable and duplicated for the client’s purpose. The representability refers to the goal that the index should represent the economic performance of the desired part of markets and only that. The most well-known European single-country stock indexes are DAX, FTSE 100, and CAC 40 whereas popular European multi-country stock indices are Euronext 100, Euro STOXX 50, and MSCI Europe.

2.3.1 DAX

In general DAX equity indices aim to best represent the performance of the indices' target market with transparent rules, clear methodology, and predictable index changes. The index house tries to achieve the best level in previously mentioned matters by basing its decision-making on public information and setting effort on transparency in all actions. The DAX-index running company DAX is nowadays part of index-house Qontigo, which was established in 2019 as STOXX, DAX, and Axioma combined. (STOXX 2020b)

The popular DAX index is an equity index of the 30 largest stocks traded in the Frankfurt stock exchange by highest free-float market capitalization and order book volume. Until November 2020, the index was officially reviewed once a year at the beginning of September, but stocks for the fast exit and fast entry rules were checked every quarter. To ensure predictability STOXX publishes monthly a ranking list, which is built on top of data from the last trading day of the previous month. The ranking list includes the order book volume and free-float market capitalization figures for each company involved in DAX, MDAX, and SDAX so that investors can possibly predict the future index changes. In addition, the monthly ranking list includes the new index weighing. Therefore, to create the ranking list DAX uses volume data and price data. Altogether the 30 stocks in DAX index account for approximately 80% of the market capitalization that is listed in Germany. (STOXX 2020)

On November 24th 2020 Qontigo released changes to the index rules to increase the quality of the DAX index. The index maintaining company released that 10 more stocks would be added to the index on September 2021 review to make the index more representative of the German equity market. From September 2021 there will be a total of 40 stocks in the DAX index. In addition, the index running house added a profitability requirement for companies in DAX – the company must have delivered positive EBITDA (earnings before interest, taxes, depreciation and amortization) for the two most recent fiscal years. Furthermore, the exchange turnover requirement, that a stock included in an index must hold a sufficient turnover of a whole index's turnover, is removed, and replaced by minimum turnover criteria. In the future scheduled index reviews will take place two times a year, during March and September. In addition, companies' corporate governance rules were tightened, and listing requirements loosened – companies are required to be listed on the "regulated marketplace" instead of the "prime standard of Frankfurt stock exchange". (Qontigo 2020) The changes are responses to the former DAX constituent Wirecard Ag's accounting scandal, which occurred during the spring of 2020.

2.3.2 Euro STOXX 50

Euro STOXX 50 is an equity index maintained by Qontigo (previously STOXX). The index represents the performance of the 50 largest listed enterprises "in terms of free-float market capitalization". The index tracks possible companies from 9 Eurozone countries: Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, and Spain. The index has a fixed number, 50, constitutes. The index is reviewed annually at the beginning of September and the index review's cutoff date is the last trading day of August. The index constituents are weighed by the free-float market capitalization and the maximum index weight for one stock is 10%. The free-float market cap is the share of a company's total market capitalization that is available for trading in the exchange. The weighing is done quarterly. In addition to the annual reviews, Qontigo updates monthly a selection list, which includes stocks that are possibly on their way to be included in the index. The Euro STOXX 50 index has rules for fast exit and fast entry which makes room for rapid component changes as needed if an included stock's market cap falls or if a company violates the law or performs other delisting actions (STOXX 2020c). Companies in the selection list are the most likely candidates to replace the deleted ones. The Euro STOXX 50 index is one of the most liquid indices in the Euro region and therefore it is held as an underlaying for several investment products (options, futures, ETFs and ETNs). (STOXX 2020a)

2.3.3 FTSE 100

The FTSE 100-index is an index, which represents the performance of the 100 largest shares from the London Stock Exchange. The index is run by FTSE Russel, which is a global index and stock market data provider (FTSE Russel 2020a). FTSE 100 consists of stocks, which have the largest full market capitalization, are domiciled in the United Kingdom and are denominated in Great Britain's sterling. The FTSE 100 index is reviewed quarterly in March, June, September, and December. The reviews are made with stock data from the last Tuesdays prior to the first Fridays in a review month. The reviews are made to secure the transparency and continuity of the index. To promote transparency FTSE Russel releases a "reserve list" of stocks that are nearly in the FTSE 100. In addition, the reserve list stocks are the strongest contenders to be included in the index, if some stock faces a fast exit procedure and is excluded from the index. The review process is made by calculating a list of companies' full market capitalizations. Then the list is tested for liquidity constraints and free float to ensure the index's tradability. After the tests, the top 100 stocks are selected to the FTSE 100 index. In addition, stocks between 90-111 are included in a "monitor list". The stocks in the monitor list are being monitored for market capitalization and liquidity requirements and replaced from the reserve list if something unusual happens and change is needed. In every quarterly review, new weighing is set for the stocks in the index. (FTSE Russel 2020b)

2.3.4 Selection Criteria Hypothesis and the European Blue-Chip Indices

The selection criteria on DAX, Euro STOXX 50, and FTSE 100 are largely similar with only minor differences in details related to market capitalization calculation and maintenance intervals. Stocks to DAX and Euro STOXX 50 are selected by free-float market capitalization whereas stocks to FTSE 100 are selected by full market capitalization. In all three indices, a regular index review schedule is published and even data collecting ways and exact days are announced to the public. Moreover, the calculation formulas and stock selection procedure are announced to the public and the data sources are based on completely public stock market information. By acting according to these manners, the index-houses provide a high level of transparency, which should make the index composition changes predictable for investors. The recompositions' predictableness is a key factor in considering the informational aspects, and price and volume effects related to composition changes (Petajisto 2008).

Researchers Fernandes and Mergulhão (2016, 79-90) consider in their study that FTSE 100 inclusion announcement contains no informational aspects of the future earnings and therefore informational-based hypothesis may be excluded from index effect explanations. They justify the argument firstly by pointing out that the index selection procedure is fully based on market capitalization in a certain previously known period, which is completely public information and available for all investors. Secondly, the FTSE 100 index constituents and firms nearly included in the index are very large UK-based companies. Thus, the companies are already highly monitored since the stocks are familiar to the great public. (Fernandes and Mergulhão 2016, 79-90)

To demonstrate that index composition changes with almost similar selection criteria than in FTSE 100 are predictable, Franz (2020, 135-153) builds an index change forecasting model for DAX-family indices. The model performs moderately since it can predict 71% of DAX composition changes correctly. Doing so Franz proves that the index changes do not necessarily include surprise effects for the market and arbitrageurs can therefore build trading strategies to benefit from the index effects. (Franz 2020, 135-153)

2.4 Sources for Price Pressure and other index effects

The price pressure in the context of index inclusions or exclusions can stem from several sources. The sources are mainly related to the concept of the "investable universe". Nowadays, the wealth management industry offers investors a wide range of index-linked products. Actively managed mutual funds have indices as benchmarks against which the mutual fund measures its performance, and which largely specifies the investable universe for the assets under management. Second, a more direct illustration is the case of passively managed mutual funds and Exchange-traded funds (ETFs). The majority of these instruments are made to track an underlaying index. The index-tracking funds' performance is usually measured by tracking error of the underlaying (Petajisto 2008) (Afego 2017, 228-239) (Petajisto 2011, 271-288). The passively managed instruments' investment universe is tightly determined by the underlaying index and changes in the underlaying results inevitable changes of assets in the passively managed fund. Thirdly, some institutions, foundations, pension funds, and other wealthy investors have borders in their investment universes. Borders limit the organizations' investment activities in a way that only assets in certain asset classes or for example assets in leading blue-chip indices are investable for the asset manager (Bunn and Campbell 2014). Index composition changes are events that may include a stock in or exclude a stock from several investors' investment universe, which may form price pressure for the stock. This chapter will focus on the different alternatives which may cause price pressure.

Active managed mutual funds base a major part of their investment universe and performance calculation on the benchmark index. The managers running the investment activities try to achieve higher returns than the benchmark index by selecting the most prosperous companies from the benchmark index and trading actively as market sentiment swings. Cremers and Petajisto (2009, 3329-3365) find in their study that managers, whose active share (the deviation of portfolio holdings from the holdings of benchmark index) is greater also outperforms the benchmark indices with higher probability. Moreover, the researchers show that managers with the lowest active share measure (portfolio holdings are close to similar with the benchmark index) will most probably underperform relative to the benchmark index due to higher transaction costs. These managers are also referred to as “closet indexers” indicating managers passivity and portfolio being close to the benchmark although the mutual fund should be actively managed. The authors find supporting evidence that small active mutual funds are more active while a significant number of the largest funds are closet indexers. In another study, Cremers et al. (2016, 539-560) find that about 20% of the worldwide active mutual fund assets are managed by closet indexers which means that their portfolio only slightly deviates from the benchmark index. It means that the mutual funds' investment universe and trading activities are defined by the changes and the overall constitution of the benchmark index. The trading and activities of actively managed mutual funds may therefore be a part of building the index effects around the index change event.

Another source for increased supply or demand at times of index changes could stem from the investment universes of institutional investors. As “institutional investors” I refer to wealth managing entities like institutions, pension funds, foundations, university trusts, and churches to name a few. These institutions use a governance document, a “rule book”, that describes the objectives and the means of investment activities. The governance document includes parts for asset allocation rules, which define the asset classes, geographical areas, and other borders in investable assets. In the family of equities, index-tracking ETFs and mutual funds are more encouraged than direct equity investment due to the wider diversification, thus lower risk levels. However, some institutions have allowed direct stock market investments to corporations that are in some major blue-chip index of a region. (Bunn and Campbell 2014) Therefore, when a stock is included in an index, it is probable that the stock is included in the investable universe of more institutions. The inverse happens in the events of index exclusions. In addition, Bunn and Campbell (2014) describe that the governance document includes parts for return objectives. Return objectives set the goals for yearly returns for assets under management. It of course depends on how the return objectives are stated but generally institutional investors are struggling to find good risk-return adjusted investments in the present zero-rate environment, which would fulfill the return objective. Therefore, many institutions have started to invest in equity ETFs that provide an average market return with a risk of a well-diversified portfolio. As Afego (2017, 228-239) describes, the rise in the amount of money directly tracking to an index can heavily influence the observable price and volume effects related to index composition changes. As more institutions allow investments to index-tracking instruments, such as ETFs, the amount of money tracking indices eventually grow – thus, generating a higher magnitude for the index effects.

The clearest contenders to add magnitude to the index effects are ETFs and other directly index-tracking instruments. Passive investment funds are typically tax-efficient and overall have very low trading and management fees. Those are appropriate to use when an investor uses passive investment strategies. Investors which are using passive investment strategy generally have a common hypothesis that a long-term buy and hold strategy provides a required rate of return to fulfill the investors’ goals. Investors have been attracted to these instruments since they usually outperform the returns from actively managed mutual funds. (Tokic 2020, 7-11) Fichtner et al. (2017, 298-326) describe that the rise of passively managed funds has captured rapid growth from the year 2005 claiming market share from active mutual funds and hedge funds, primarily due to lower costs and better performance. The majority of passive index funds replicate the stock indices by buying shares of the member firms and therefore duplicating the index. According to Morningstar (2019) the amount of assets invested in equity ETFs in Europe has grown robustly since 2009. Total assets were 112.14 billion Euros at the end of 2009 – 158.4 billion Euros at the end of 2012 – 314.3 billion Euros at the end of 2015 and 426.12 billion Euros at the end of 2018. The share of equity ETFs of all European ETF assets has been around 70% from 2013 to 2019. Furthermore, it is estimated that the total assets under management (AUM) for European ETFs would rise to 1000 billion Euros during 2020 since the AUM has grown approximately 15.5% in a year. Furthermore, it is estimated that assets in European equity ETFs top 700 billion Euros during 2020. Figure 1 below represents the total asset under management in European ETFs. (Morningstar 2019)

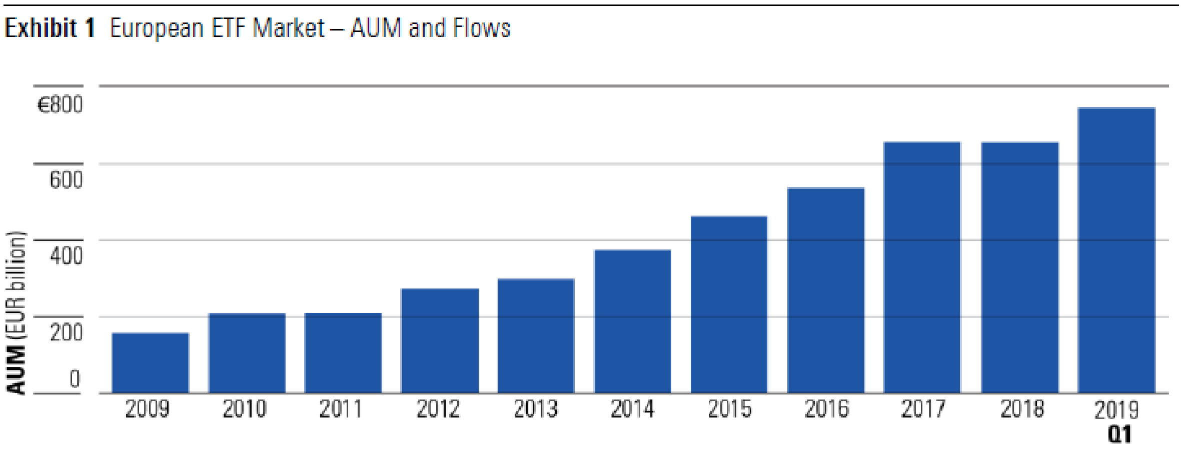


Figure 1 Total assets under management in European ETFs (Morningstar 2019)

The amount of money directly tracking to an index can influence the price and volume effects, since the majority of index tracking managers perform the index changes simultaneously around the announcement and effective date. The managers act this way since their performance is usually measured by tracking error and managers try to mitigate it (Lynch and Mendenhall 1997, 351-383) (Afego 2017, 228-239). Tracking error is measured as an annualized standard deviation of tracking difference datapoints, which are the differences between a fund's performance and the benchmark index's performance (Vanguard 2020). As the benchmark index's composition changes on the effective date, to achieve the lowest possible tracking difference and tracking error the fund manager must make the composition changes to her assets on the day prior to the effective date. The procedure can create significant price pressure around the effective date and as described previously the amount of money tracking an index through ETFs can positively correlate to the magnitude of the index effects.

Data from Refinitiv Eikon show that on the first of November 2020 there were approximately 13 billion euros invested in Euro nominated assets directly tracking the DAX index, approximately 38 billion euros invested in Euro nominated ETF assets directly tracking Euro STOXX 50 index, and 11 billion Great Britain Pounds (~ 12 billion Euros) invested in GBP nominated ETF assets directly tracking FTSE 100 index. If the amount of cash directly tracking to an index correlates positively with the magnitudes of index effects, Euro STOXX 50 should have the most observable index effects.

2.5 Modern Stock Markets' Cures for the Price Pressure

As some researchers report price pressure as the main source of index effects related to composition changes ((Lynch and Mendenhall 1997, 351-383), (Mase 2007, 461-484), (Harris and Gurel 1986, 815-829)), it is essential to consider the modern stock market's infrastructure that could impact on the formation of price pressure. The early studies of the subject were done during the 1980s and 1990s and market infrastructure and regulation have evolved with giant leaps to this date. The greatest effect on the market functionality has emerged from the development of information technology, following new regulatory standards. Especially, the greater computational force allows investors to trade faster as trading algorithms and electronic stock markets have claimed popularity. Nowadays, the markets allow improved liquidity and improved market efficiency in respect to what it was in the early 2000s (Boehmer, Fong, and Wu 2020, 47). Due to the more sophisticated market structure, it may be that the price pressure is harder to form, and markets are better prepared to match the suddenly increased supply or demand than before. This chapter will focus on the modern stock market's structures that help investors and fund managers to avoid adverse effects, like price slippage in order execution.

The traditional way for an institutional investor to perform a significant stock trade is to assign the order to a dealer in a stock brokerage firm and either she would find a counterparty for a single significant block trade or let her work the order during the trading day little by little. After the development of information technology, brokerage firms built trading algorithms to duplicate these dealers, assigning computers to work the large orders during the trading day. Nowadays algorithms decide the time, amount, price, and routing of orders while simultaneously monitoring the market conditions and updating the order quotes accordingly. The main goal for trading algorithms is to optimize the execution process by minimizing the transaction costs and reducing the market impact of the order. Usually, the algorithm does it by dividing the parent order into several smaller, child orders and executing the child orders over time until the whole parent order is filled. (Hendershott, Jones, and Menkveld 2011, 1-33)

The development of trading algorithms laid foundations for more recent and complex arrivals of stock markets – High-Frequency Traders (HFT) and Multilateral Trading Facilities (MTFs). Traditionally trading has taken place in the marketplaces of stock exchanges like the New York Stock Exchange (NYSE) or in Deutsche Börse (Frankfurt Stock Exchange, FRA), which maintain the tradable stock lists, matching engine and provide information for investors. In other words, trading has been done through a "centralized" system. In the early 2000s new marketplaces widely known as MTFs, and among them Dark Pools, were established to compete for volumes and trade-related fees against the traditional marketplaces. The new marketplaces offered stockbrokers and market participants lower trading and settlement fees and provided more alternatives in order types. As new markets like Chi-X, BATS and Turquoise were established in Europe year 2007 they collectively gained a robust market share of 20% to the year 2011. The MTFs are not only available for professional investors and HFTs. As the figure 2 below represents, the modern electronic stock market system is composed of the beneficiary investor, a retail customer, corporation, or an institution being close to different marketplaces and accessing them using proprietary or stockbroker's trading algorithms. (Menkveld 2014, 333-344)

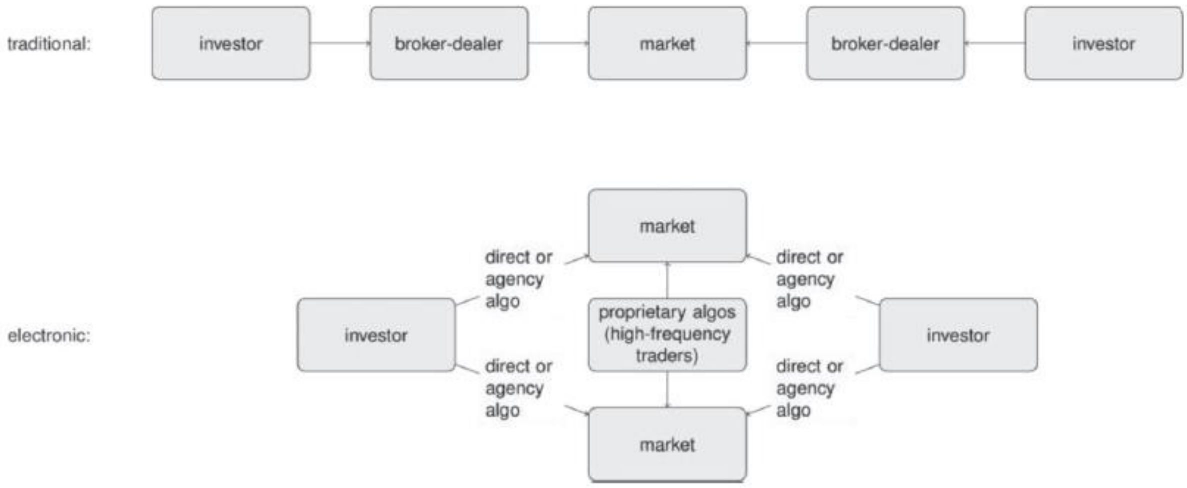


Figure 2 Traditional and electronic stock market structure (Menkveld, 2014)

In the middle of figure 2 is “proprietary algos”, which represent the High-Frequency Traders acting in the modern stock markets. Menkveld (2014, 333-344) introduces algorithms used by HFTs by two different categories: agency algorithms and proprietary algorithms. Agency algorithm users execute long-term stock position change at the best possible price and lowest transaction costs whereas the proprietary algorithm users take temporal positions with certain profits usually using the place-arbitrage as they have the speed advantage relative to other investors. The proprietary HFTs can in some situations be seen as market makers as they balance the prices across different markets and by doing so provide liquidity for other investors. As Menkveld describes the emergence of alternative marketplaces and high-frequency traders are tightly related since the new marketplaces benefit from the order quotes posted by HFTs while HFTs benefit from the new order types, speed, and more affordable trading possibilities. (Menkveld 2014, 333-344) HFTs and MTFs effects on liquidity, price discovery, and other market qualities have been a widely examined subject during the last decade and researchers are not uniform of the effects.

In Europe, “Markets in Financial Instruments Directive” (MiFiD) in 2007 laid regulatory foundations for fragmented securities markets, which allowed MTFs and HFTs to enter the markets and forced brokers to search for the best possible price-quote across all the possible markets for its customers. The task demanded by the regulators forced brokers to enter the HFT world and to use smart order routing, which routes the same order to several marketplaces simultaneously, to search for the best possible prices. The current market structure has led to a situation where HFTs are dominating the trading. It is estimated that HFTs produce half or even more of all trading volume in the markets. (O'Hara 2015, 257-270)

In his study of HFTs and their impacts on market quality O'Hara (2015, 257-270) describes that among researchers there is agreement that HFT market-making strategies better the stock market quality by reducing spreads, bettering informational efficiency, and therefore promoting liquidity. However, it must be considered that HFTs use a wide range of other strategies as well and in the cases of market-making, traders are not committed to continuously provide the market making. Thus, concerns of possible instability and illiquidity arise if HFTs should pull away from markets. (O'Hara 2015, 257-270)

Moreover, research on high-frequency traders suggests that they prefer trading high market value stocks mostly because of the higher liquidity (European Securities and Markets Authority 2014). In most cases the higher liquidity results in lower transaction costs, which in the modern stock markets can be measured by transaction cost analysis. Transaction cost analysis (TCA) evaluates not only the brokerage fees but also the adverse market impact of an order. The most important market impacts to inspect in TCA are the implementation shortfall and post-order price reversion. The implementation shortfall is measured by the market price's difference on the exact investment decision moment and the moment when the order has been fully executed. The post-order price reversion refers to the possible price reversal effect that the market exhibits after the order execution has ended. With these measures, a trader can inspect the adverse price effects and thus additional trading costs caused by the order.

In the recent studies of HFTs, MTFs, and market quality researchers Da Silva (2018, 179-206) and Gresse (2017, 1-20) deliver supporting results that the presence of MTFs and HFTs should be viewed as a value-creating competition, which benefits the global liquidity of stocks. Both authors report that fragmented markets benefit from an improved level of liquidity, lower transaction costs, and lower price impact of trades.

The latter is especially interesting while examining price and volume effects related to index composition changes. If the price effects on trades are reducing due to market fragmentation and HFTs, it makes trading activities of index-tracking funds, institutions, and other investors easier by allowing stocks' supply and demand curves to be more elastic and thus, diminishing the effects formed by price pressure hypothesis. Kappou (2018, 235-244) justified her findings of diminished index effects by improved market efficiency and by traders' improved execution algorithms and she is among the only authors to consider the development towards minimizing index effects would be a consequence of the greater development in market microstructure, regulatory development, and adoption of trading algorithms.

3 Research Questions and Hypothesis

The research aims to cover themes that affect stock prices and trading volumes in times of stock index composition changes. To evaluate the magnitude and significance of possible index effects I have formed 5 research questions.

1. Does the trading volume level of a single stock increase on the announcement date, around the effective date, and before the announcement date?
2. Does the price of an included stock gain abnormal returns on the announcement date, around the effective date, or before the announcement date?
3. Does the price of an excluded stock suffer abnormal losses on the announcement date, around the effective date, or before the announcement date?
4. Has the magnitude of abnormal returns (losses) increased or decreased from 2008-2013 to 2014-2020?
5. Does the trading volume of a single stock affect the magnitude of abnormal returns (losses) at a time of composition change?

The hypotheses for the corresponding research questions are represented below. As I use the word "around" in the hypothesis, it refers to a three-day period. Therefore, "around the effective day" refers to a three-day period, which includes ED-1, ED, and ED+1.

H1.1: The trading volume is on a higher than the historical level before the announcement day.
H1.2: The trading volume experiences a significant rise on the announcement day and around the effective day compared to the historical level.
H1.3: The trading volume reverts to the historical volume level after the effective day.

H2.1: The price of an included stock gains positive abnormal returns before the announcement day.
H2.2: The price of an included stock gains positive abnormal returns on the announcement day and around the effective day.
H2.3: The abnormal returns gained during the change event will fully revert to prior announcement level after the effective date.

H3.1: The price of an excluded stock suffers negative abnormal returns before the announcement day.
H3.2: The price of an excluded stock suffers negative abnormal returns on the announcement day and around the effective day.
H3.3: The abnormal returns suffered during the change event will not revert to prior announcement level after the effective date.

H4.1: The magnitude of abnormal returns (losses) has decreased on the prior announcement period from 2008-2013 to 2014-2020.
H4.2: The magnitude of abnormal returns (losses) has decreased on the announcement and around effective days from 2008-2013 to 2014-2020.

H5.1: Higher historical trading volume for a stock leads to lower abnormal returns or losses on the prior announcement period, on the announcement day, and around the effective day.

Table 1 Research questions and hypothesis

Research question	**Research hypothesis**

Q1: Does the trading volume level of a single stock increase on the announcement date, around the effective date, and before the announcement date?	H1.1: The trading volume is on a higher than the historical level before the announcement day.
	H1.2: The trading volume experiences a significant rise on the announcement day and around the effective day compared to the historical level.
	H1.3: The trading volume reverts to the historical volume level after the effective day.
Q2: Does the price of an included stock gain abnormal returns on the announcement date, around the effective date, and before the announcement date?	H2.1: The price of an included stock gains positive abnormal returns before the announcement day.
	H2.2: The price of an included stock gains positive abnormal returns on the announcement day and around the effective day.
	H2.3: The abnormal returns gained during the change event will fully revert to prior announcement level after the effective date.
Q3: Does the price of an excluded stock suffer abnormal losses on the announcement date, around the effective date, and before the announcement date?	H3.1: The price of an excluded stock suffers negative abnormal returns before the announcement day.
	H3.2: The price of an excluded stock suffers negative abnormal returns on the announcement day and around the effective day.
	H3.3: The abnormal returns suffered during the change event will not revert to prior announcement level after the effective date.
Q4: Has the magnitude of abnormal returns (losses) increased or decreased from 2008-2013 to 2014-2020?	H4.1: The magnitude of abnormal returns (losses) has decreased on the prior announcement period from 2008-2013 to 2014-2020.
	H4.2: The magnitude of abnormal returns (losses) has decreased on the announcement and around effective days from 2008-2013 to 2014-2020.
Q5: Does the trading volume of a single stock affect the magnitude of abnormal returns (losses) at a time of composition change?	H5.1: Higher historical trading volume for a stock leads to lower abnormal returns or losses on the prior announcement period, on the announcement day, and around the effective day.

Firstly, question 1 inspects the volume levels during the composition change event and H1.2 and H1.3 expect the volume levels to have a “spike” on the announcement day and the day prior to the effective day. In addition, hypothesis H1.1 predicts that volume levels are on the rise prior to the announcement, which would be an indication of anticipatory trading.

Hypotheses H2.1, H2.2, H2.3 and H3.1, H3.2, H3.3 state that I anticipate price effects to cause positive (negative) abnormal returns before the event and around the AD and ED for added (deleted) stocks. According to the hypotheses, the price effects would not be symmetrical on added and deleted stocks. The differences are found on H2.3 and H3.3 where I expect added stocks abnormal returns to fully revert to the prior announcement period whereas I expect excluded stocks to have more permanent price effects. The latest research finds price effects to be minimizing, but I still believe we could find some effects from the data.

Hypotheses H4.1 and H4.2 collaborates with the previous findings from Afego (2017, 228-239) and Kappou (2018, 235-244) and expect price effects to be weaker as we close to 2020. The previous literature suggests that the changes in the market microstructure have made the effects smaller and therefore promoted more efficient price discovery and market conditions.

Lastly, question 5 discovers the initial volume level’s impact on the possible price effects. As it has been reported, HFTs and their positive impact on modern stock markets’ liquidity and transaction costs are present mainly in the higher trading volume stocks (European Securities and Markets Authority 2014). Therefore, hypothesis H5.1 anticipates that stocks with a higher initial trading volume level should experience lower magnitude price effects on the prior announcement period, on the announcement day, and around the effective day.

In terms of previously suggested financial theories explaining the index effects, my hypotheses states that I could find supporting evidence with the imperfect substitutes hypothesis. The empirical findings to be in line with the hypothesis should be added stocks to have significant volume and price effects on the AD or AD+1 and ED-1 while the abnormal returns should reverse during the following days indicating high market efficiency. On the other hand, the deleted stocks should suffer abnormal negative returns on the AD or AD+1 and ED-1. Apart from added stocks, I assume deleted stock's abnormal returns not reverting themselves in the short-term and only slightly in the long-term. To be in line with the imperfect substitutes hypothesis, the trading volume levels should experience short-term effects and no permanent effects.

If I would find more permanent price and volume effects from added stocks, it would indicate my results to be in favor of investor awareness hypothesis. Furthermore, I do not assume the selection criteria hypothesis to form differences in the results, as the inspected indices have fairly similar selection criteria and reviewing principles. I assume the composition changes do not convey information for the investors as the index rules, maintenance procedures, and calculations are clearly stated and published to the public and since they include only quantifiable components. Therefore, permanent price effects explained by the information hypothesis are not anticipated. Furthermore, since I expect asymmetric price effects with additions and deletions and only short-term impacts on the trading volume levels, I do not expect to find supporting results with the liquidity hypothesis.

4 Data and Methodology

The research data includes time-series data from stock price indexes and time series data of stock prices and daily trading volume values. In addition, the data includes press releases of stock index composition changes, which include the announcement dates and effective dates of the composition changes. With the data, I am able to examine and evaluate the 5 research questions and corresponding hypotheses.

The composition change announcement data has a total of 304 constituent changes with an even number of index inclusions and exclusions. For DAX-index I have collected a total of 32 changes, of which 16 are additions to DAX and 16 are exclusions from DAX. The oldest composition change is announced on 3.9.2008 and the newest 19.8.2020.

For Euro STOXX50-index I have collected a total of 50 composition changes, of which 25 are additions to Euro STOXX50 and 25 are deletions from the index. The oldest change announcement is released on 1.9.2008 and the newest 1.9.2020.

For FTSE 100- index I have collected a total of 222 composition changes, of which 111 are additions to the index and 111 deletions from the index. The oldest observation is dated 12.3.2008 while the newest is announced on 2.9.2020. The composition change announcements were all collected from the index-running companies' websites during September and October 2020.

Below in table 2, you can see the distribution of composition change announcements from different years. As can be seen from the graph the most index composition changes occur during years with financial instability, since years 2008, 2009, and 2020 account for the most change announcements.

Table 2 Descriptive statistics of inspected index composition changes

Year	DAX	Euro STOXX 50	FTSE 100	Total
2008	6	2	32	40
2009	6	4	26	36
2010	2	2	14	18
2011	0	4	14	18
2012	4	4	12	20
2013	0	2	18	20
2014	0	2	16	18
2015	2	4	12	18
2016	2	6	16	24
2017	0	2	18	20
2018	4	6	10	20
2019	2	2	18	22
2020	4	10	16	30
Total	32	50	222	304

To examine the price and volume effects in these 304 composition changes, I have collected time-series-data of the daily closing price and daily trading volume value of all 304 stocks related to the changes and the same for the 3 benchmark indices. The date range for the time series data is 1.1.2007 - 30.11.2020. The time-series data was downloaded from Refinitiv Eikon. Furthermore, the correctness of the time-series data was checked by comparing the data with some similar time-series downloaded from Bloomberg terminal.

4.1 Methodology

To examine the prior announcement -, short-term - and permanent price and volume effects related to index composition changes, the methods used in the thesis must be mixed from previous studies. Therefore, the methodology of this thesis mixes methods from Lynch and Mendenhall (1997, 351-383), Chen, Noronha et al. (2004, 1901-1930), and Mase (2007, 461-484). The data is examined using the event-study methodology and as Lynch and Mendenhall did previously, the short-term effects are studied with Announcement Date (AD) and Effective Date (ED) setting boundaries for each examination sample. From Mase, I will include my data to cover a time period from 10 days before the AD. By this mean, Mase was able to examine the price trends and volume patterns before the crucial dates related to the index constituent changes. Moreover, to examine the permanence of index effects, I will follow Chen, Noronha et al. (2004, 1901-1930) and expand the time period after ED to 20 trading days. With this combination of intervals, I will be able to discover the magnitudes of the possible index effects and argue them against existing theories from the literature.

I am using event study methodology in which the abnormal returns are calculated using the market model:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

Where R_{it} is the return of a stock *i* and R_{mt} is the return of the market on a day *t*. The abnormal return is left on the residuals and thus equals the ε_{it} on the respective day *t*. (Mase 2007, 461-484) Furthermore, the early research done by Stapleton and Subrahmanyam (1983, 1637-1642) shows that the linear market model is sufficient to derive and estimate the market beta for a stock. With the beta, a researcher can estimate the risk-adjusted expected future returns for the stock.

The estimation window for the market model has varied greatly across researchers. Some authors ((Lynch and Mendenhall 1997, 351-383), (Harris and Gurel 1986, 815-829)) use pre-event time periods in estimating the market model while some authors

((Mase 2007, 461-484), (Amihud, Mendelson, and Lauterbach 1997, 365-390), (Bechmann 2004, 3-34)) use post-event period to find the alpha and beta estimates to be used in the market model calculations. The main argument to avoid the pre-event period is that in a longer period prior to the announcement the stocks, which are announced to be included (excluded) to an index perform well (poorly) generating biased model estimates. Estimation after the change event would produce biased coefficients as well since literature suggests that stocks included in an index have greater co-movement with each other than stocks not involved in a major index. The author explains this is due to the more popular use of passive investment vehicles. (Grégoire 2020, 101059) Furthermore, it is reported that liquidity effects also affect the stocks' behavior if it is included in a major index. Therefore, I will estimate the market model before the last 6 months prior to the announcement.

As the indexes examined in the thesis are reviewed quarterly (FTSE 100) or annually (DAX, Euro STOXX 50) I will use a six-month period from AD-252 to AD-127 to estimate the market model parameters. The time period avoids the latest six-month period prior to the announcement and therefore should not produce biased estimates for alpha and beta. Eventually, after the market model coefficient estimates are calculated, the abnormal returns for a stock i on a day t (AR_{it}) are calculated following the formulae below.

$$AR_{it} = R_{it} - (\alpha_i + \beta_i * R_{mt}),$$

Where R_{it} is the stock's return on the day t, α_i and β_i are coefficient estimates from the market model and R_{mt} equals the market return on the day t.

The cumulative Abnormal Return for an interval from t1 to t2 ($CAR_{t1,t2}$) is calculated by summing the abnormal returns of a stock (AR_t) of the inspection period. The Mean Abnormal Return (MAR) and the Mean Cumulative Abnormal Return (MCAR) are calculated as the averages of all stocks on a day in the particular sample.

The abnormal volume figures to evaluate volume-related research questions and hypothesis is calculated following Harris and Gurel's (1986, 815-829) approach. In the method, the abnormal volume is estimated by first calculating a volume ratio (VR_{it})

of the trading volumes of a particular stock adjusted to the market and then multiplying it with the inverse of the same calculation, but with the historical values.

$$VR_{it} = \frac{v_{it}}{v_{mt}} \times \frac{v_m}{v_i} ,$$

where v_{it} is stock i's volume value on time interval t and v_{mt} is index m's trading volume value on the same interval while the v_m and v_i are the average trading volume values from the last 8 weeks (40 trading days).

The mean volume ratio on a day t is represented by MVR_t. The figure is calculated by summing the previously calculated Volume Ratios and dividing the result by the number of stocks inspected.

$$MVR_t = \frac{1}{N} \times \sum_i VR_{it} ,$$

where N is the number of stocks included in the calculation. Then the MVR_t values represent the mean value of possible abnormal trading volume and the figures are calculated and collected to a matrix for further inspection. (Harris and Gurel 1986, 815-829)

Time periods inspected in this thesis mixes the timespans Lynch and Mendehall (1997, 351-383), Mase (2007, 461-484), and Chen, Noronha et al. (2004, 1901-1930) used in their paper. The combination of timespans is needed to examine all – anticipatory, short-term, and more permanent index effects. The inspected time intervals are:

1. *Prior announcement period – from "AD-10" to "AD-1"*
2. *Run-up window – from "AD" to "ED-1"*
3. *Post release window – from "ED" to "ED+20"*
4. *Post-AD effect window – from "AD+1" to "ED+20"*
5. *Total effect window – from "AD" to "ED+20"*

In addition, the time intervals are presented in the figure 3 below.

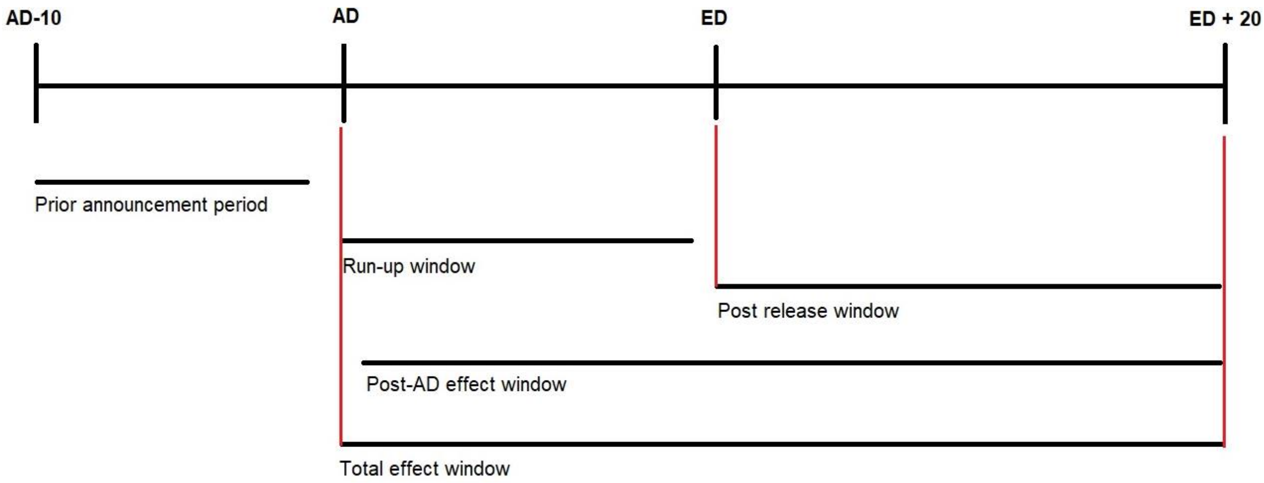


Figure 3 Time intervals used in the study

The press releases for the composition changes of DAX, Euro STOXX 50, and FTSE 100 indexes are usually released during the trading day and therefore the possible index effects should be visible on the AD. In contrast to Lynch and Mendehall's (1997, 351-383) study, Mase (2007, 461-484) added the "prior announcement period" of 10 days before the announcement day to his study to spot especially the exceptional volume levels, but also possible extraordinary price patterns prior the announcement. The exceptional volume levels would indicate that arbitrageurs are anticipating the composition change announcement and they are trying to take advantage of it. To spot the more permanent index effects Chen, Noronha et al. (2004, 1901-1930) extended their time interval to ED+20 and ED+60 days. From their study, I will add the ED+20 days period, which will represent the possible permanent index effects, that are not related to short-term price pressure.

To inspect the index effect magnitude's change by time as needed in the research question four, I will split my data sample into 2 halves. The first sample will cover a period starting from 2008 and ending in 2013. The second sample will include a period from 2014 to 2020. With these samples, I am able to examine if there are significant changes in price patterns during different times.

To inspect if the stock's initial liquidity level impacts the magnitude of price effects related to the composition change, I will split the sample data into 2 halves by the historical volume ratios. This way, I am able to observe if the initial volume level has any predictable power on the magnitude of index effects.

The statistical significance of the mean abnormal returns (*MAR*) is calculated and tested with a t-test on different significance values with Student's t distribution with n–1 degrees of freedom. Throughout the results, the asterisks represent that the mean value is statistically significant at * (90%), ** (95%), or *** (99%) confidence interval.

5 Results

The results are presented in this paragraph and every research question and hypothesis is covered in its own section. The price results are calculated first during the five intervals and then more accurately around the announcement and effective days. The calculations around the announcement and effective dates must have been done separately due to the fact that not every composition change has a similar number of days between the announcement and effective days. For example, regularly Euro STOXX 50 composition changes are announced 17 to 21 days prior to the effective day, but there are also fast exit and fast entry cases where there are only 3 or 7 days between the announcement and the effective day. Therefore, the results are generally presented first by the five different intervals, then by the announcement day, and lastly by the effective day. The volume level results are presented only by the announcement and effective dates.

Throughout the results, the asterisks represent that the mean value is statistically significant at * (90%), ** (95%), or *** (99%) confidence interval. The significance level is tested with a t-test on different significance values with Student's t distribution with n–1 degrees of freedom.

5.1 Volume effects of index inclusions and exclusions

The research question and hypothesis for volume effect inspection are represented in Table 3 below.

Table 3 First research question and hypothesis

<table>
<tr><th>Research question</th><th>Research hypothesis</th></tr>
<tr><td rowspan="3">Q1: Does the trading volume level of a single stock increase on the announcement date, around the effective date, and before the announcement date?</td><td>H1.1: The trading volume is on a higher than the historical level before the announcement day.</td></tr>
<tr><td>H1.2: The trading volume experiences a significant rise on the announcement day and around the effective day compared to the historical level.</td></tr>
<tr><td>H1.3: The trading volume reverts to the historical volume level after the effective day.</td></tr>
</table>

The research hypothesis is formed to match the recent literature's suggestions that there are anticipatory trading and volume patterns before the announcement day as well as significant volume spikes on the AD and ED while there would be no permanent volume effects. The figures below represent the volume levels by the announcement and effective day. The volume level of 1 represents the stocks' last 40 days average volume level and respectively level of 2 would represent double the average historical trading volume on the day.

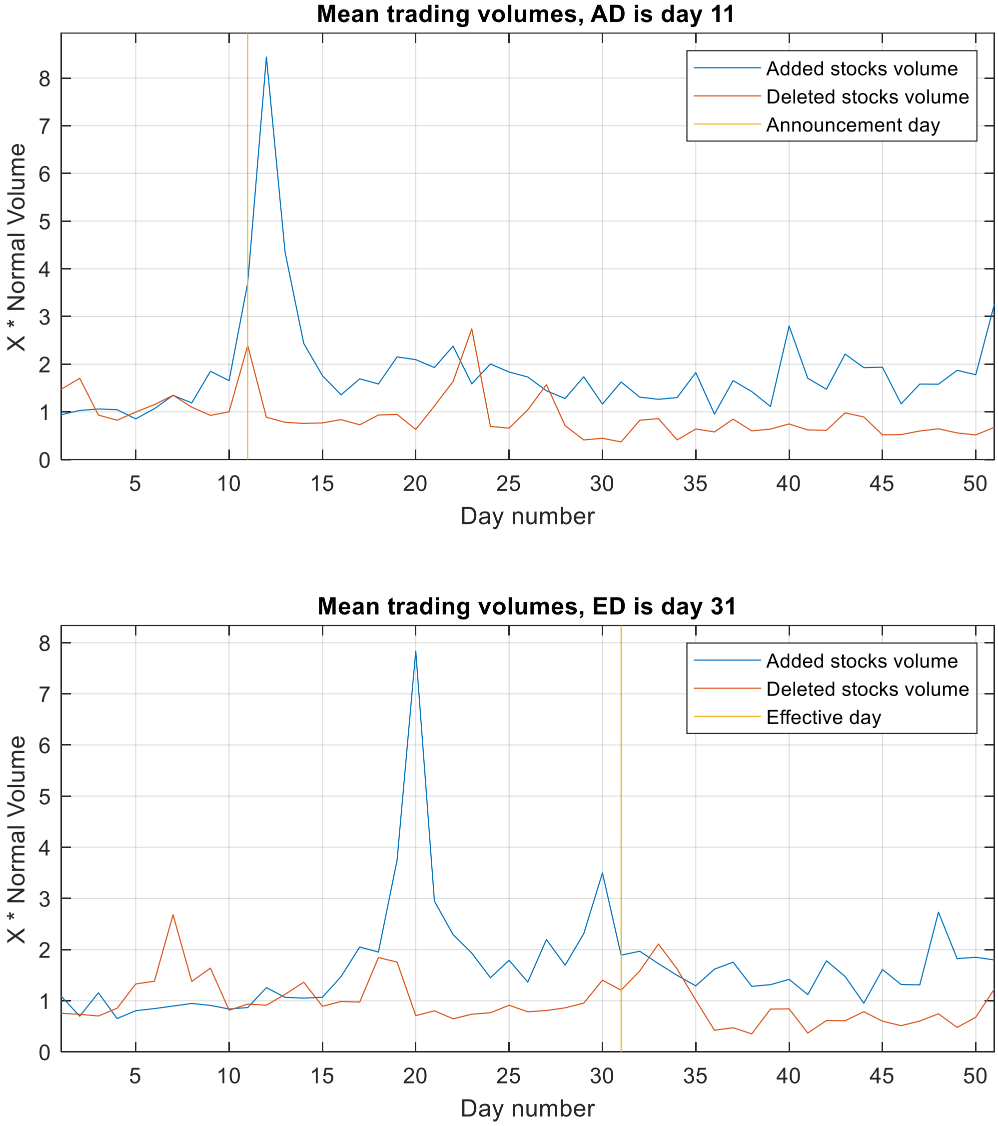


Figure 4 Abnormal volume levels around the announcement and effective day on DAX index

As seen in figure 4, volume levels related to additions to the DAX index represent a significant rise on trading days around the announcement day and before the ED. The volume levels on added stocks almost double on days before the AD, which indicates that some traders may be anticipating the inclusion announcement. After the effective day, added stocks' volume levels seem to persist on elevated levels and they do not completely convert back to the "normal" historical level.

Volume levels related to deletions to the DAX index represent dissimilar patterns than on added stocks. Deleted stocks experience only a modest volume rise on the AD and after that, the deleted stocks' volume level is around or modestly below the historically normal level before the event.

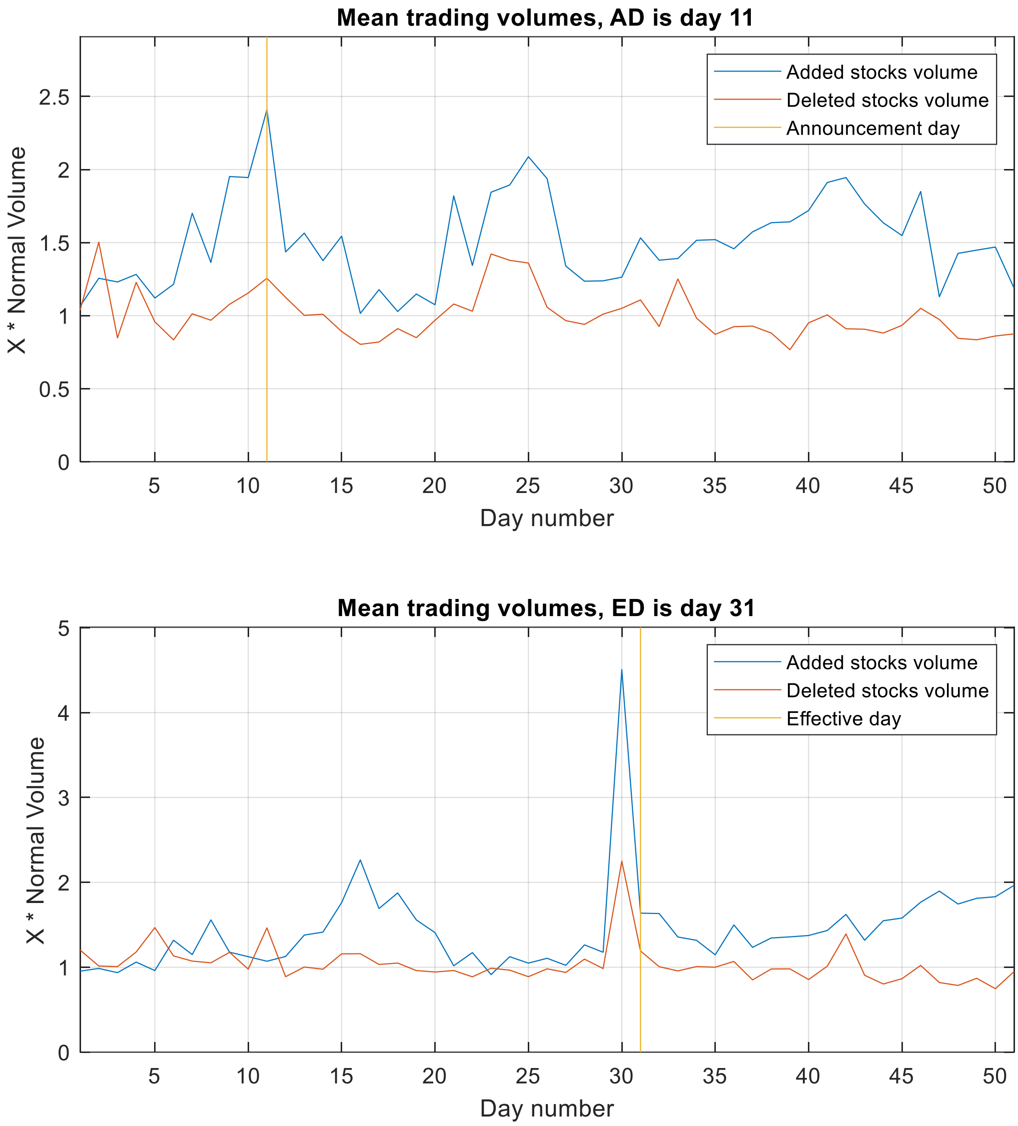
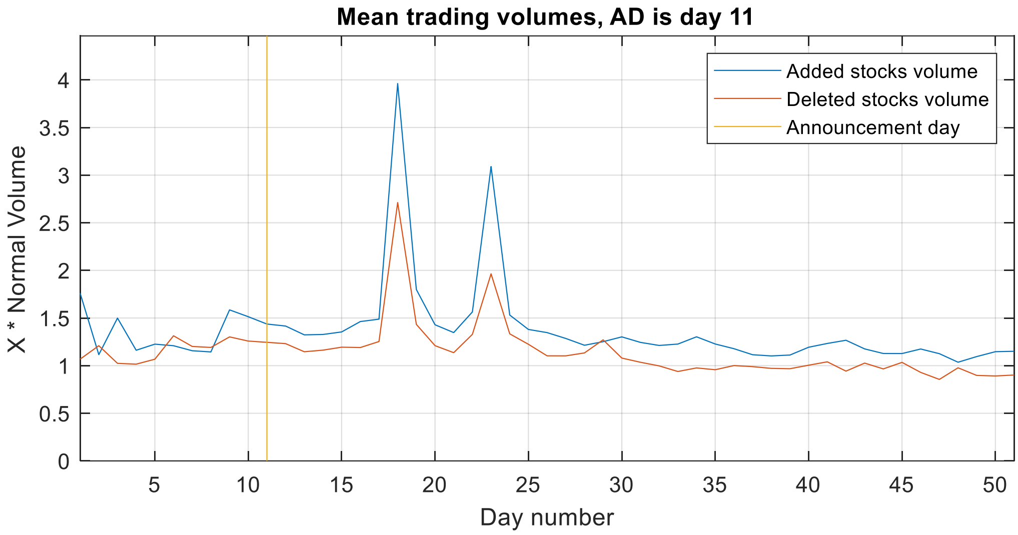


Figure 5 Abnormal volume levels around the announcement and effective day on Euro STOXX 50 index

Figure 5 above represents the volume levels of Euro STOXX 50 index additions and deletions. The added stocks' volume levels double on days before the announcement and are 2,5 times the normal level on the announcement day. The largest spike with Euro STOXX 50 added stocks' volume levels is found on ED-1 when index-tracking instruments perform most of their restructuring activities. After the ED, added stocks' volume levels persist on an elevated level.

The Euro STOXX 50 deletions' volume levels are around the normal historical level through the event, while the only exception is the ED-1 on which there is an observable double the 'historical normal volume' trading day.



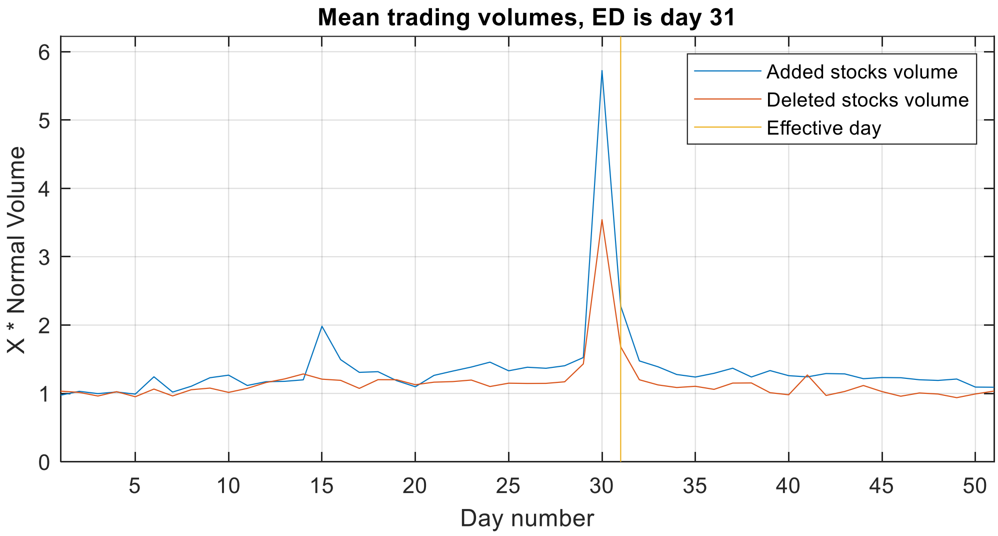


Figure 6 Abnormal volume levels around the announcement and effective day on FTSE 100 index

Figure 6 represents the volume levels for FTSE 100 index additions and deletions around the announcement and effective day. The volume levels for added stocks represent a modest rice (1,5 * Normal level) on days before the announcement and do not react to the announcement on AD. The added stocks' volume levels experience a significant spike on the trading day prior to the effective day. After the effective day, the volume levels revert to the prior-event normal level.

The volume levels for the FTSE 100 index's deleted stocks go hand in hand with the added stocks apart from a slightly lower volume spike on ED-1. The volume level differences between added and deleted stocks throughout the event are so small that no great conclusions can be thrived from the differences.

Table 4 represents the research question and inspected null hypotheses:

Table 4 Research question Q1 and inspected null hypotheses.

Research question	Inspected null hypothesis
Q1: Does the trading volume level of a single stock increase on the announcement date, around the effective date, and before the announcement date?	$H1.1_0$: The trading volume is not on a higher level on the prior announcement period.
	$H1.2_0$: The trading volume does not experience a rise on the announcement day and around the effective day compared to the historical level.
	$H1.3_0$: The trading volume levels are not on the historical normal level after the effective day.

The research hypothesis assumed that there would be anticipatory trading prior to the announcement day and high-volume trading days on the announcement day and the day before the effective day. All three indices revealed that the possibility of an index composition change is elevating the trading volume level approximately by 50%-100% on the AD-2 and AD-1 as investors are anticipating the announcement, and therefore we can reject the null hypothesis $H1.1_0$. Moreover, all three indices show a significant trading volume spike on ED-1, which is analogous to the procedure that index-tracking instruments balance their portfolios according to the changes in the underlying. The most significant difference in the volume results thrives from FTSE 100 index's trading volumes on the AD and AD+1. The trading volumes of the FTSE 100 index do not seem to react significantly to the inclusion or exclusion announcement and both, deleted and added stocks' volume levels are only in a modest rise (+20% - +40%). With the other two indices, the trading volume level experiences a spike on the AD and with the DAX index even on the AD+1. Therefore, DAX and Euro STOXX 50 index results reject the null hypothesis $H1.2_0$ while it cannot be rejected on FTSE 100 results.

The difference in the FTSE 100 index may be explained by the small differences in the index review policy. The FTSE 100 has the most transparent and predictable procedure to review the index as it states the data gathering dates, reserve lists, and calculations the clearest. Moreover, the FTSE 100 is reviewed quarterly, and it has by far the most composition changes of the inspected indices.

Furthermore, it can be observed that in all indices during the event and after the effective date the added stocks trading volume level is on a risen level and above the deleted stocks' trading volume levels. In DAX and Euro STOXX 50 additions, there are also some observable permanent volume effects. That is supporting the investor awareness hypothesis, which states that the added stocks gain more media and analyst coverage, which ultimately leads to investors being more informed of the stock. The deleted stocks maintain their "regular" historical trading volume level, which is also in line with the investor awareness hypothesis. The null hypothesis $H1.3_0$ cannot be rejected on DAX and Euro STOXX 50 while $H1.3_0$ can be rejected on FTSE 100.

To conclude the trading volume results, the DAX and the Euro STOXX 50 index's trading volumes were in line with the research hypotheses H1.1, H1.2 and not supporting hypothesis H1.3. The FTSE 100 index failed to deliver a trading volume spike on the AD, and therefore the results are in line with H1.1 and H1.3 and partly in line with H1.2.

5.2 Price effects of index inclusions and exclusions

The research questions and hypotheses for price effect inspections are represented in table 5 below.

Table 5 Research questions Q2 and Q3 and hypotheses

Research question	Research hypothesis
Q2: Does the price of an included stock gain abnormal returns on the announcement date, around the effective date, and before the announcement date?	H2.1: The price of an included stock gains positive abnormal returns before the announcement day.
	H2.2: The price of an included stock gains positive abnormal returns on the announcement day and around the effective day.
	H2.3: The abnormal returns gained during the change event will fully revert to prior announcement level after the effective date.
Q3: Does the price of an excluded stock suffer abnormal losses on the announcement date, around the effective date, and before the announcement date?	H3.1: The price of an excluded stock suffers negative abnormal returns before the announcement day.
	H3.2: The price of an excluded stock suffers negative abnormal returns on the announcement day and around the effective day.
	H3.3: The abnormal returns suffered during the change event will not revert to prior announcement level after the effective date.

Table 6 represents the price effects during the five different intervals. The results are mixed between the indices.

Table 6 Price effects during the five inspected time intervals

	n = 16	n = 25	n = 111	n = 16	n = 25	n = 111
	DAX Additions	SX5E Additions	FTSE 100 Additions	DAX Deletions	SX5E Deletions	FTSE 100 Deletions
Prior announcement period	2.26	0.47	4.98***	-2.65	-1.56*	-3.61***
Run-up period	-7.93***	1.50	-1.00	4.76*	-3.29*	1.87**
Post release window	-3.90	-2.87*	-1.28	-2.47	3.80**	1.28
Post AD- effect window	-11.10*	-2.09	-2.60**	2.21	0.48	2.87*
Total effect window	-11.83*	-1.37	-2.28*	2.29	0.50	3.15*

All the inspected indices provide positive (negative) abnormal returns on the prior announcement period for the included (excluded) stocks. After the announcement, on the Run-up period, the price effects were mixed. Added stocks suffered abnormal negative returns on the post release window. For the deleted stocks, the returns on the post release window were mixed, as DAX suffered negative returns whereas Euro STOXX 50 and FTSE 100 gained economically significant abnormal returns on the 20-day period after the ED. When we examine the two longer time periods, Post AD-effect window and total effect window, we can see that added stocks suffer negative abnormal returns from the AD+1 to ED+20 and AD to ED+20, whereas excluded stocks gain positive abnormal returns on the periods. The results do not support the presence of price pressure. Moreover, it seems like arbitrage traders are reversing their positions after the prior announcement period has ended. The permanent price effects are seen in FTSE 100 index additions as the added stocks gain statistically significant CMAR 4,98% on the prior announcement period and from that only -2,28% is reversed during the total effect window. In addition, DAX additions show a large -11,8% total effect window abnormal negative return after 2,26% prior announcement period positive return, but the sample size is only 16 and therefore the robustness of the results is poor, although the figure is statistically significant on 10% confidence interval.

Tables for the daily mean abnormal returns for added and deleted stocks around the announcement date are represented in Appendix 1 (added stocks) and Appendix 2 (deleted stocks) and Tables for daily mean abnormal returns for added and deleted stocks around the effective date are represented in Appendix 3 (added stocks) and Appendix 4 (deleted stocks). Overall, there are no significant visible price effects on any particular day around the announcement day. The most significant observation is the added stocks' strong performance on the days before the inclusion announcement. After the announcement, the prior announcement period's abnormal returns start to fade away. Similar, but inverse effects are seen in the events of index exclusion. Below, the daily abnormal returns are inspected at a more accurate level.

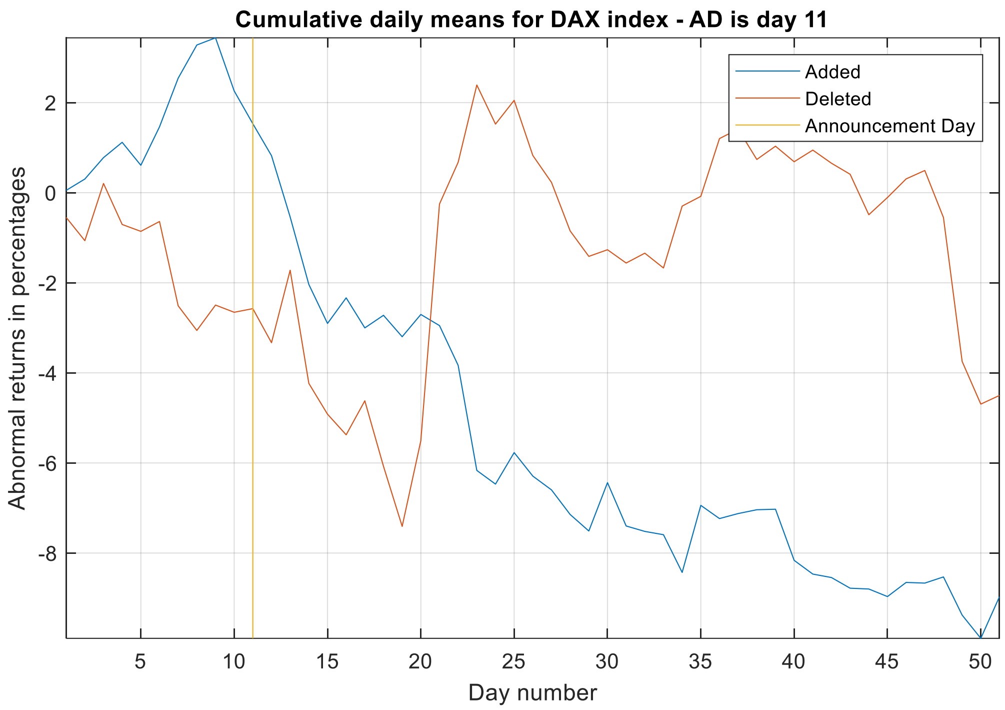


Figure 7 Cumulative daily mean abnormal returns of the DAX index changes plotted by the announcement day

Figure 7 represents the cumulative daily mean abnormal returns of the DAX index changes plotted by the announcement day. As the figure shows, the returns for index additions and deletions develop in a predicted manner until the announcement day after which the mean of added stocks exhibits a sharp decline whereas the mean of deleted stocks reverts on the pre-event levels after 9 days from the announcement. The number of observations in the added and deleted samples was only 16 in each, which makes the DAX index results weak and therefore no great conclusions are to be made from them.

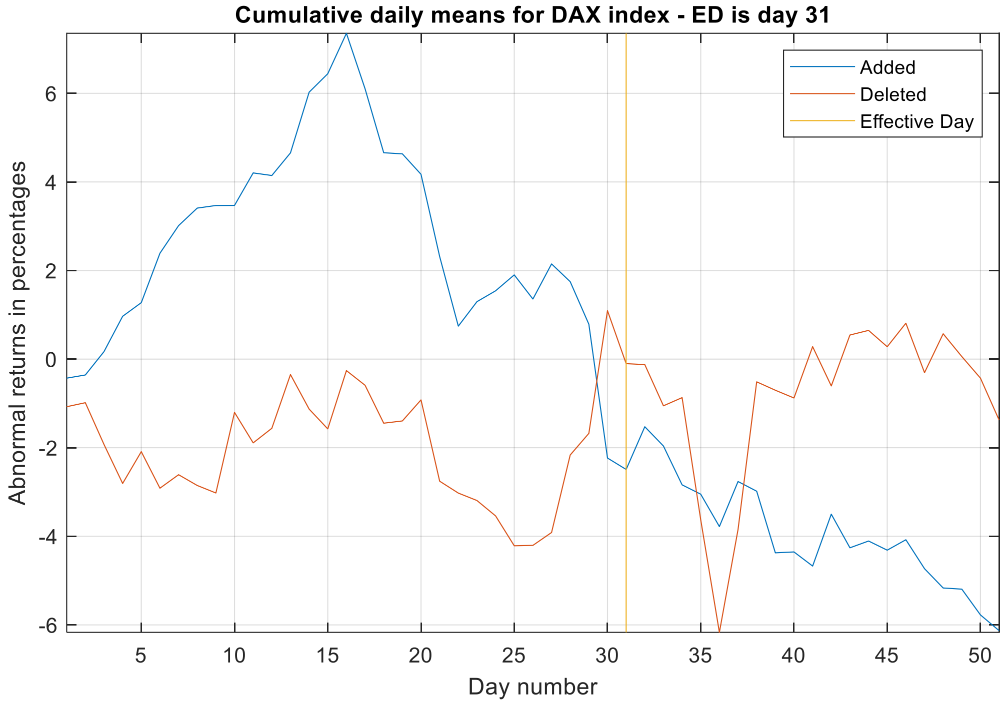


Figure 8 Cumulative daily mean abnormal returns of the DAX index changes plotted by the effective day

Figure 8 represents the cumulative daily mean abnormal returns of the DAX index changes plotted by the effective day. As the figure shows, the returns for index additions and deletions exhibit inverse patterns that price pressure and previous studies would suggest. Around the ED added stocks mean declines whereas deleted stock's mean increases. The patterns do not support any previous theories related to index changes and therefore propose the non-existence of index effects.

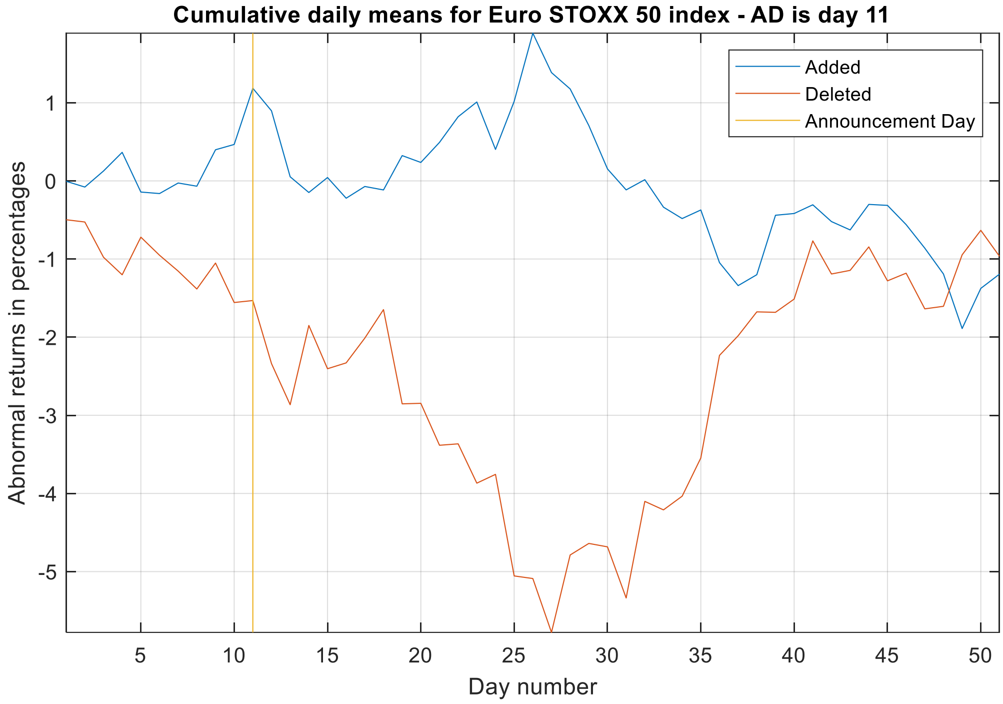


Figure 9 Cumulative daily mean abnormal returns of the Euro STOXX 50 index changes plotted by the announcement day

Figure 9 represents the cumulative daily mean abnormal returns of the Euro STOXX 50 index changes plotted by the announcement day. Euro STOXX 50 is the only index in the study, which delivers a slight possibility of price pressure around announcement day. With additions to the index, the mean abnormal announcement day return is 0,72%*, which is statistically significant on a 10% confidence level. The price effect could be caused by the price pressure. Moreover, the deletions exhibit a further decline after the exclusion announcement, which could be caused by the excess supply of the stock. The -0,81%* abnormal loss for deleted stocks on AD+1 is statistically significant on a 10% confidence level.

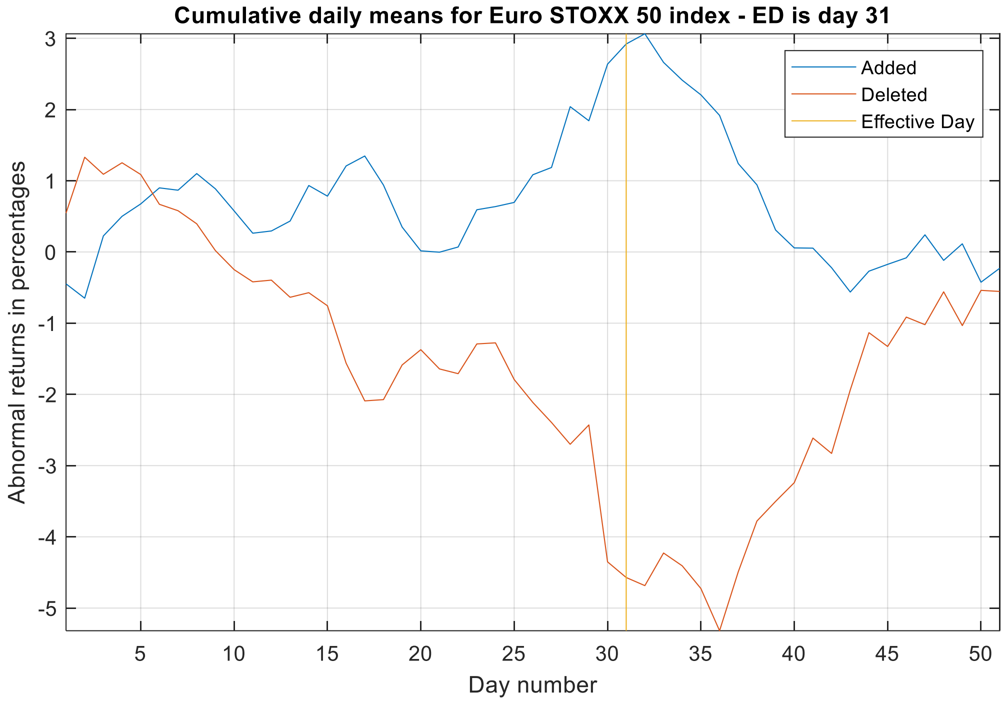


Figure 10 Cumulative daily mean abnormal returns of the Euro STOXX 50 index changes plotted by the effective day

Figure 10 represents the cumulative daily mean abnormal returns of the Euro STOXX 50 index changes plotted by the effective day. Apart from other indices, Euro STOXX 50 index shows positive abnormal returns on the day prior to the ED for added stocks (0,8%**) and the inverse (-1,92%***) for excluded stocks. The other two indices do not have any significant price effects close to the effective day. The observation supports the presence of price pressure around the effective day of the composition change while there is no evidence of permanent price effects as the abnormal returns (losses) revert to pre-event levels after 20 days from the ED.

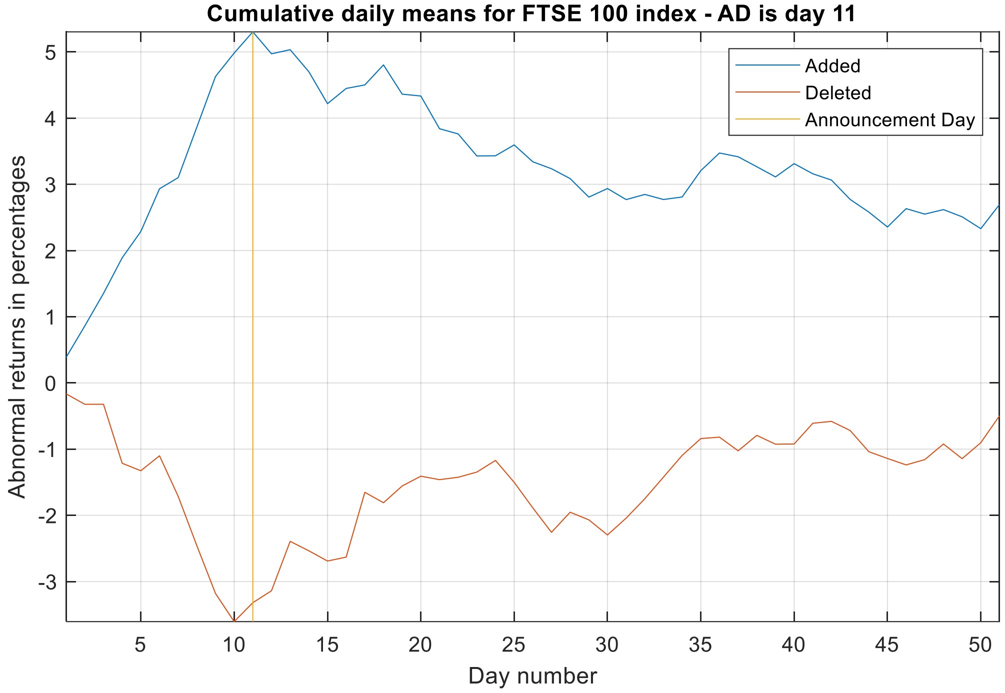


Figure 11 Cumulative daily mean abnormal returns of the FTSE 100 index changes plotted by the announcement day

Figure 11 represents the cumulative daily mean abnormal returns of the FTSE 100 index changes plotted by the announcement day. The abnormal return levels show that the excess returns and losses related to the composition change are gained prior to the announcement. The abnormal returns or losses start to revert themselves after the inclusion or exclusion announcement and on AD+1 added stocks suffer statistically significant -0,33%** reverse in the gained returns. Furthermore, on AD+4 added stocks suffer statistically significant -0,48%*** losses as the prior AD gains fade away whereas the deleted stocks gain statistically significant 0,75%*** on AD+2 as it begins reverting as well.

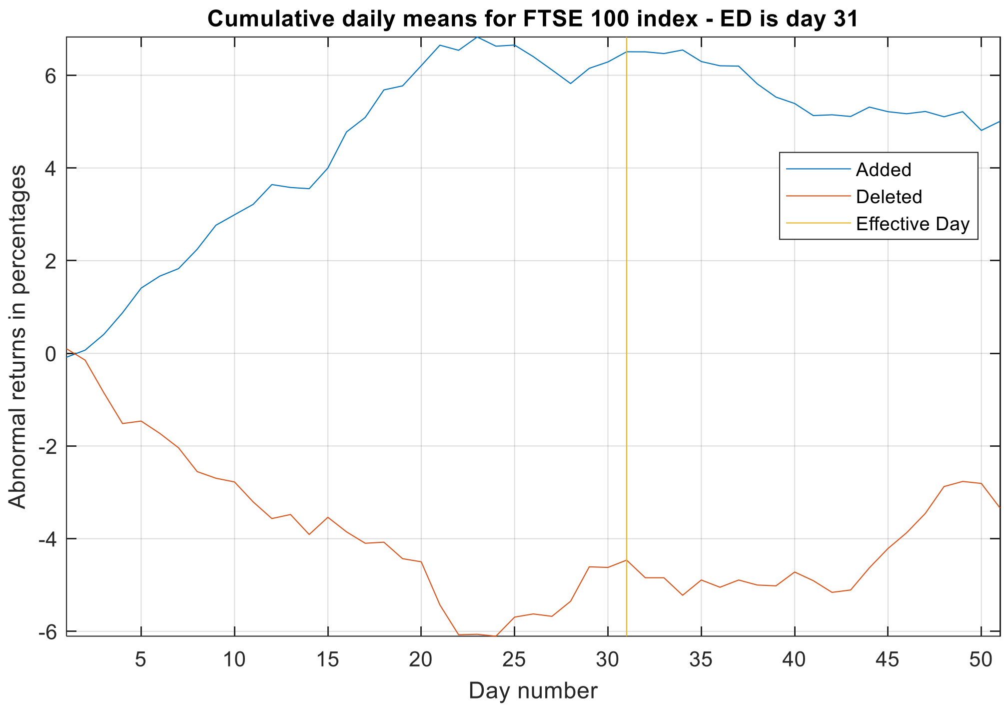


Figure 12 Cumulative daily mean abnormal returns of the FTSE 100 index changes plotted by the effective day

Figure 12 represents the cumulative daily mean abnormal returns of the FTSE 100 index changes plotted by the effective day. The abnormal return levels represent no observable price pressure around the effective day. As we investigate the permanent effects it can be observed that both samples, additions, and deletions, exhibit permanent price effects, since the abnormal returns or losses do not fully revert themselves during the 20 days after the effective day.

The research questions and inspected null hypotheses for the price effects are:

Table 7 The second and third research questions and inspected null hypotheses.

Research question	Inspected null hypothesis
Q2: Does the price of an included stock gain abnormal returns on the announcement date, around the effective date, and before the announcement date?	$H2.1_0$: The price of an included stock does not gain abnormal returns before the announcement day.
	$H2.2_0$: The price of an included stock does not gain abnormal returns on the announcement day and around the effective day.
	$H2.3_0$: The abnormal returns gained during the change event do not revert to prior announcement level after the effective date.

Q3: Does the price of an excluded stock suffer abnormal losses on the announcement date, around the effective date, and before the announcement date?	$H3.1_0$: The price of an excluded stock does not suffer negative abnormal returns before the announcement day.
	$H3.2_0$: The price of an excluded stock does not suffer negative abnormal returns on the announcement day and around the effective day.
	$H3.3_0$: The abnormal returns suffered during the change event revert to prior announcement level after the effective date.

The three indices, DAX, Euro STOXX 50, and FTSE 100 delivered dissimilar results. DAX index delivered inverse price effects and failed to support the research hypotheses – on the announcement day the added sample started losing abnormal returns and from the announcement day level the stock fell over 11% towards the end of the inspection period and was not reversed. The DAX index additions rejected the null hypotheses $H2.1_0$ but did not reject the null hypotheses $H2.2_0$, and $H2.3_0$. The DAX index deletions suffered some abnormal losses on the prior announcement period and after the announcement day, but the losses were fully reverted after 10 trading days from the announcement. Furthermore, the deleted sample exhibited some abnormal gains before the ED and therefore, we can conclude that the results rejected the null hypothesis $H3.1_0$ but did not reject the null hypotheses $H3.2_0$, and $H3.3_0$. To conclude the DAX index's price results, they rather show inverse price effects and do not support the previous literature's findings from other markets.

Euro STOXX 50 abnormal returns showed predictable patterns around the announcement and effective days. The added sample's price effects reject the null hypotheses $H2.1_0$, $H2.2_0$, and $H2.3_0$ and therefore were fully in line with hypotheses H2. The deleted sample's price effects reject the null hypotheses $H3.1_0$ and $H3.2_0$ while the null hypothesis $H3.3_0$ could not be rejected. Therefore, hypotheses H3.1, H3.2, H3.3 were in line with the results apart from the price reversal – hypothesis H3.3 stated that the deleted sample's losses would be permanent, but the losses reverted themselves in trading after the effective day. The abnormal returns on both samples were reverted after ED+20 (4 weeks) and therefore the results support the price pressure hypothesis.

FTSE 100 additions did not gain abnormal returns on the AD or around ED and the price effects, which formed on the prior announcement period were by some part permanent. As we analyze the added stock's results, we can reject the null hypothesis $H2.1_0$ but are not able to reject the null hypotheses $H2.2_0$ and $H2.3_0$. Therefore, the FTSE 100 addition's price pattern was supporting H2.1 and not in line with H2.2 or H2.3. Deleted-sample performed in a similar way than additions – price effects were formed during the prior announcement period and no observable price changes were present around AD or ED. The price effects were partly reversed after the effective day. As we analyze the deleted stock's results, we can reject the null hypothesis $H3.1_0$ and $H3.3_0$ but are not able to reject the null hypothesis $H3.2_0$. Overall, the deleted stock's price effect results were supporting H3.1 and H3.3 and not supporting H3.2. The permanent price effects of the FTSE 100 index additions and deletions are supporting informational hypotheses. As we know from the volume inspection, both samples' trading volume levels were around the historical normal volume level. Therefore, the information hypothesis and investor awareness hypothesis could explain the FTSE 100 index effects best.

5.3 Has the magnitude of price effects changed during 2014-2020 compared to 2008-2013?

I inspected the development of the magnitude of the price effects by dividing the inspected samples into two halves by time. The "old" sample includes composition changes from the start of 2008 to the end of 2013. The "recent" sample represents the composition changes from the start of 2014 to September 2020. The research question and hypothesis inspected in this section are seen in table 8.

Table 8 Fourth research question and hypotheses

Research question	Research hypothesis
Q4: Has the magnitude of abnormal returns (losses) increased or decreased from 2008-2013 to 2014-2020?	H4.1: The magnitude of abnormal returns (losses) has decreased on the prior announcement period from 2008-2013 to 2014-2020.
	H4.2: The magnitude of abnormal returns (losses) has decreased on the announcement and around effective days from 2008-2013 to 2014-2020.

Table 9 and Table 10 represent the abnormal returns on the five different intervals for the older and more recent sample.

Table 9 Recent samples' abnormal returns

Recent 2014 - 2020

	n = 7	n = 16	n = 53	n = 7	n = 16	n = 53
	DAX Additions	SX5E Additions	FTSE 100 Additions	DAX Deletions	SX5E Deletions	FTSE 100 Deletions
Prior announcement period	0.83	-0.37	3.77***	-3.41	-1.06	-1.47
Run-up period	-6.83***	-0.24	-3.43***	4.92	-2.17	0.97
Post release window	-4.35	-1.22	0.17	-6.02	2.48	1.30
Post AD- effect window	-11.17***	-2.19	-3.31**	-3.35	0.64	2.22
Total effect window	-11.18***	-1.47	-3.26**	-1.10	0.32	2.27

Table 10 Old samples' abnormal returns

Old, 2008 - 2013

	n = 9	n = 9	n = 58	n = 9	n = 9	n = 58
	DAX Additions	SX5E Additions	FTSE 100 Additions	DAX Deletions	SX5E Deletions	FTSE 100 Deletions
Prior announcement period	3.37	1.95	6.09***	-1.99	-2.44	-5.56***
Run-up period	-8.79*	4.59**	1.22	4.62	-5.30	2.69**
Post release window	-3.54	-5.79*	-2.60	0.63	6.13	1.27
Post AD- effect window	-11.05	-1.90	-1.95	7.08	0.20	3.46
Total effect window	-12.34	-1.19	-1.38	5.26	0.83	3.96

As we compare these two samples on these five different intervals it can be observed that the older sample has stronger price effects during the prior announcement period than the more recent sample. In addition, the FTSE 100 index seems to reverse the abnormal returns from the prior announcement period already during the run-up period in the more recent sample. The finding suggests bettered market efficiency and lowered price effects. Furthermore, Euro STOXX 50 index represents lowered run-up period and post release window price effects in the recent sample than in the older one. More accurately, the Euro STOXX 50 recent additions are not delivering positive returns during any of the five intervals. It is a sign of diminishing price effects. The results show supporting evidence to Kappou's (2018, 235-244) results since it seems that the 'recent'-sample's price effect magnitude is lower than the same in the older sample. The following section will cover the diminishing price effects more accurately around AD and ED. The graphs below show how the cumulative abnormal returns develop around the announcement and effective days for each index respectively.

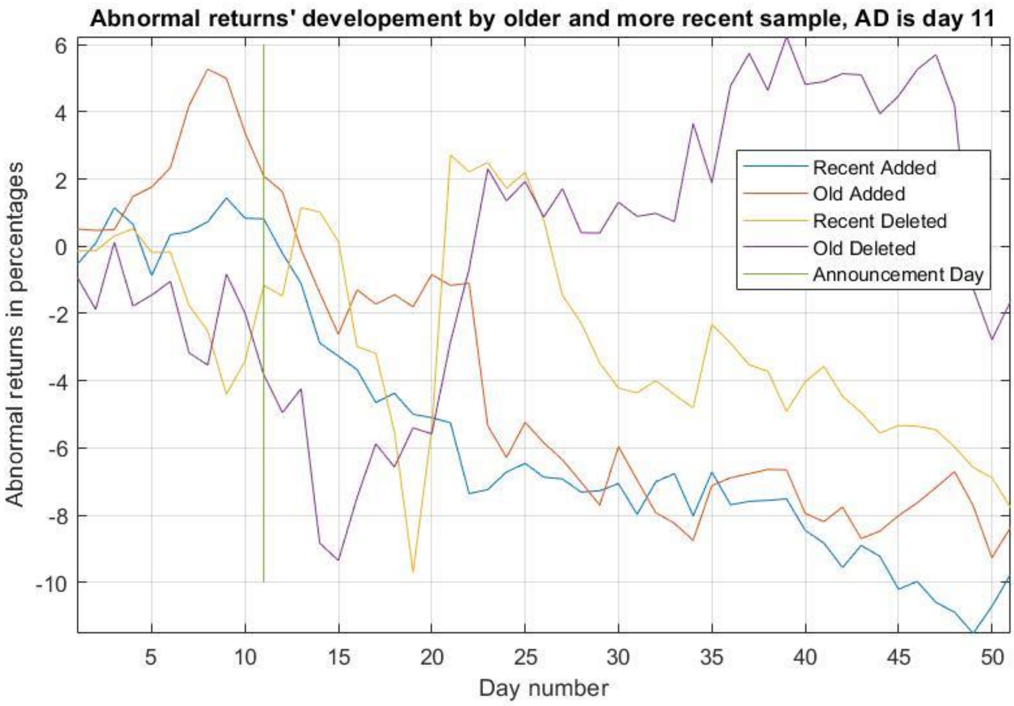


Figure 13 Cumulative daily mean abnormal returns of the DAX index changes plotted by old and recent sample and the announcement day

Figure 13 represents the cumulative daily mean abnormal returns of the DAX index changes plotted by the announcement day. The graph does not deliver any evidence of anticipated price effects being present in the recent nor the old sample around the announcement day. Moreover, the samples for recent and old added stocks represent a similar path indicating no difference with the samples.

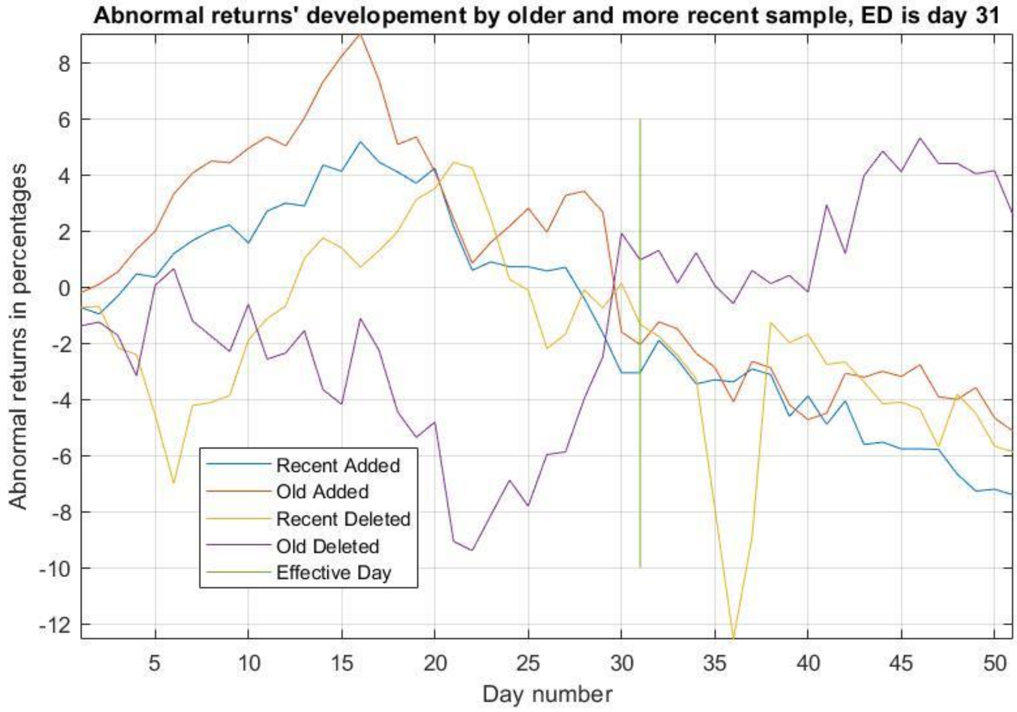


Figure 14 Cumulative daily mean abnormal returns of the DAX index changes plotted by old and recent sample and the effective day

Figure 14 represents the cumulative daily mean abnormal returns of the DAX index changes plotted by the effective day. There is no evidence of observable price effects, but it can be noticed that recent deleted and recent added samples develop in a similar way, which indicates that the magnitude of price effects has not changed between the old and recent samples.

Figure 15 Cumulative daily mean abnormal returns of the Euro STOXX 50 index changes plotted by old and recent sample and the announcement day

Figure 15 represents the cumulative daily mean abnormal returns of the Euro STOXX 50 index changes plotted by the announcement day. The plot shows how the old samples' abnormal returns are larger with additions and deletions. The difference can be seen especially in added stocks as the old sample gains over 2% abnormal returns prior to the announcement and continues to over 6% after the announcement. The recent sample on additions does not show any significant price effects on the prior announcement period.

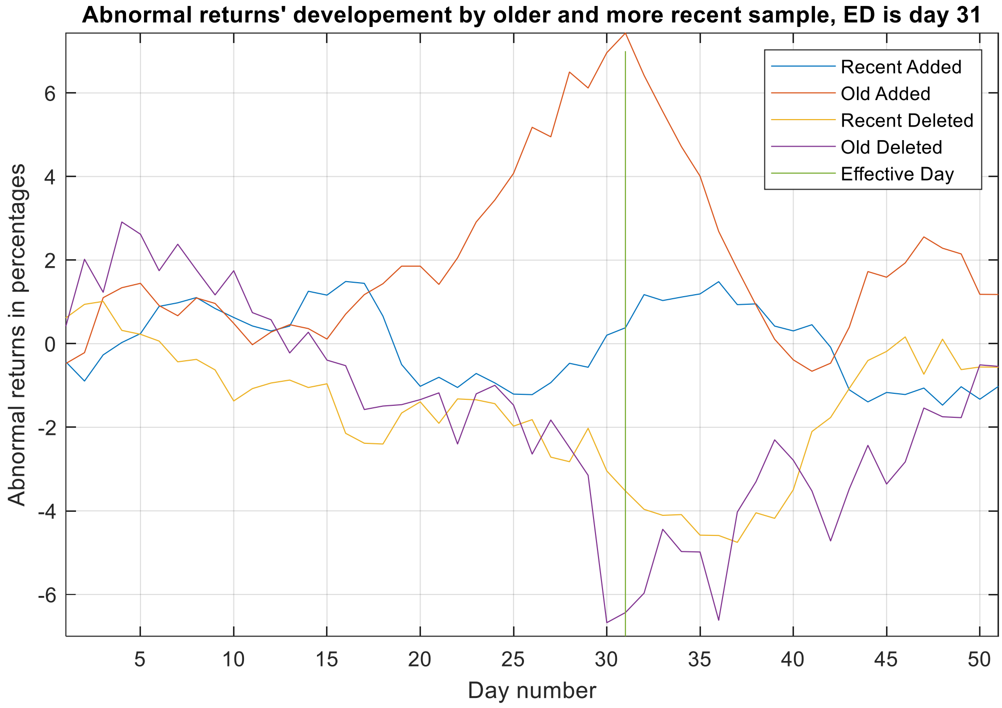


Figure 16 Cumulative daily mean abnormal returns of the Euro STOXX 50 index changes plotted by old and recent sample and the effective day

Figure 16 represents the cumulative daily mean abnormal returns of the Euro STOXX 50 index changes plotted by the effective day. The graph shows that there may be some price pressure on all the added and deleted samples around the effective day. However, it can be observed that the recent samples' price effect magnitudes are lower compared to the old samples' magnitudes. The old added sample gains 3,5% abnormal returns during the last 6 trading days before the ED. On ED-6 the old added sample gains 0,64%*, on ED-5 1,1%*** and on ED-3 1,55%*** abnormal returns. In contrast, the recent added sample gains only statistically significant returns on ED-1 0,77%*. In addition, both samples' abnormal returns revert to the pre-effective date level during the following 10-15 days of trading. On the other hand, the deleted old and recent samples represent an almost similar path, although the older sample exhibits 2% worse abnormal loss around the ED. Overall, the price effect magnitude is smaller on the recent sample, which suggests the market efficiency has improved between these two samples.

Figure 17 Cumulative daily mean abnormal returns of the FTSE 100 index changes plotted by old and recent sample and the announcement day

Figure 17 represents the cumulative daily mean abnormal returns of the FTSE 100 index composition changes plotted by the announcement day. The abnormal returns (losses) during the prior announcement period are lower with the recent sample. The older sample of additions gains 1,29%*** on AD-5, 1,33% on AD-3***, and 0,92%* on AD-2 whereas the only statistically significant return- day for the recent sample is AD-2 with 0,60%**. The same observation can be made with the deleted samples as the old-deleted sample losses -1,51%*** on AD-3, 1,22%*** on AD-2, and -0,74%* on AD-1 whereas the recent-deleted sample delivers no statistically significant losses or gains. There are no signs of price pressure on the announcement day. In addition, the recent samples' prior announcement returns (losses) are reverted after 10-15 days after the announcement. The graph represents clearly that the magnitude of abnormal returns has lowered during recent years.

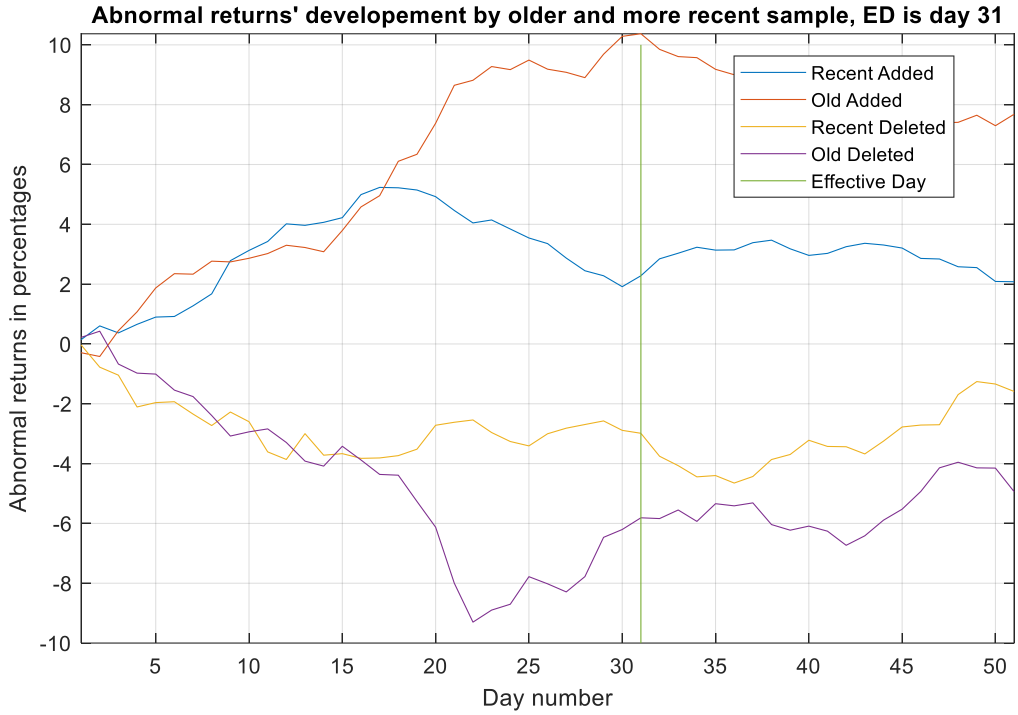


Figure 18 Cumulative daily mean abnormal returns of the FTSE 100 index changes plotted by old and recent sample and the effective day

Figure 18 represents the cumulative daily mean abnormal returns of the FTSE 100 index changes plotted by the effective day. The graph shows no economically significant price effects around the effective day and the samples do not experience significant price reversal after the effective day. The figure suggests the price effects found from the prior announcement period (Figure 17) are by some part permanent.

The research question and null hypotheses inspected in this section are:

Table 11 Fourth research question and hypotheses

Q4: Has the magnitude of abnormal returns (losses) increased or decreased from 2008-2013 to 2014-2020?	$H4.1_0$: The magnitude of abnormal returns (losses) has not decreased on the prior announcement period from 2008-2013 to 2014-2020.
	$H4.2_0$: The magnitude of abnormal returns (losses) has not decreased on the announcement and around effective days from 2008-2013 to 2014-2020.

The price results from the DAX index did not deliver clear results against our hypothesis and we cannot reject our null hypothesis $H4.1_0$ and $H4.2_0$. Therefore, we cannot state that the H4.1 and H4.2 would be true and must refuse the hypothesis.

The price results from Euro STOXX 50 represented a slight presence of price pressure around the AD and ED. Furthermore, the recent samples' price effect magnitudes were lower than the old-samples'. With the price results, we can reject the null hypotheses $H4.1_0$ and $H4.2_0$. Therefore, we can conclude that the results derived from the Euro STOXX 50 index are in line with the preliminary hypotheses H4.1 and H4.2, which suggests the price effects would be decreasing as we close to the year 2020.

The price results from FTSE 100 index represent recent samples' lowered price effects during the prior announcement period. Otherwise, the old and recent samples' returns developed similarly and there were no other observable price effects around the announcement and effective days. With the price results, we can reject the null hypothesis $H4.1_0$ but cannot reject the null hypothesis $H4.2_0$. As the prior announcement period's returns were the only effects found, we can conclude that the results are in line with hypothesis H4.1 but not supporting hypothesis H4.2.

5.4 Initial trading volume and price effects

I continue to inspect my research question and hypothesis five by dividing the inclusion and exclusion events into higher and lower volume samples. The whole sample was firstly divided into additions and deletions and then into two more samples by the median historical volume ratio by Harris and Gurrel (1986, 815-829), each index separately. The historical mean volume ratio is a mean of daily volume ratios from the last 40 days.

The research question and hypothesis inspected in this section are:

Table 12 Fifth research question and hypothesis

Research question	Research hypothesis
Q5: Does the trading volume of a single stock affect the magnitude of abnormal returns (losses) at a time of composition change?	H5.1: Higher historical trading volume for an included (excluded) stock leads to lower abnormal returns (losses) on the prior announcement period, on the announcement day, and around the effective day.

The results during the five inspected intervals are shown in table 13 (high volume sample) and table 14 (low volume sample) below.

Table 13 High volume samples' abnormal returns

High volume sample

	n = 7	n = 12	n = 45	n = 8	n = 13	n = 60
	DAX Additions	SX5E Additions	FTSE 100 Additions	DAX Deletions	SX5E Deletions	FTSE 100 Deletions
Prior announcement period	4.31	0.35	5.27***	-4.27	-0.36	-2.63*
Run-up period	-10.76*	0.10	-2.89**	9.70***	-3.59	1.92
Post release window	-1.37	-3.20	0.05	4.11	2.71	0.69
Post AD- effect window	-9.99	-4.11	-2.86*	12.62	-0.75	2.34
Total effect window	-12.14	-3.10	-2.84*	13.80	-0.88	2.61

Table 14 Low volume samples' abnormal returns

Low volume sample

	n = 9	n = 13	n = 66	n = 7	n = 12	n = 51
	DAX Additions	SX5E Additions	FTSE 100 Additions	DAX Deletions	SX5E Deletions	FTSE 100 Deletions
Prior announcement period	0.21	0.57	4.79***	-0.81	-2.85*	-4.75***
Run-up period	-5.11***	2.79*	0.29	-0.88	-2.97	1.82
Post release window	-6.42*	-2.55	-2.19	-9.99	4.98	1.98
Post AD- effect window	-12.22***	-0.22	-2.42	-9.69	1.80	3.48
Total effect window	-11.53**	0.23	-1.90	-10.86	2.00	3.80

DAX index's additions deliver again "inverse" price effects in respect to what an investor could anticipate. The high volume added sample gained 4,31%, whereas the low sample gained 0,21% abnormal returns during the prior announcement period. On the run-up period, the high-volume sample's excess returns were faded to the low sample's levels. Otherwise, the addition's low and high-volume samples delivered similar results and there were no clear differences in the samples. Instead, deleted stock's high and low-volume sample's abnormal returns diverge greatly. The high-volume DAX deletions suffer -4,27% prior announcement period losses, but then gain 13,8% during the following total effect window whereas the low-volume deletions suffer

-10,86% losses during the total effect window with most (-9,99%) of that on the post release window. The reason for these different patterns may be in the nature of deletions – deletions include stocks that are not performing well, but also stocks that are to be acquired or merged with another company. Corporate actions, like mergers and acquisitions, can drive the stock prices upwards and the index deletion is not a significant event for the stock. In addition, deleted stock's low-volume sample includes stocks that are performing extremely poorly as Wirecard in the summer of 2020 as it was deleted from DAX in the middle of the accountancy crisis. Therefore, it is not appropriate to make significant conclusions from DAX's deleted sample. Furthermore, the DAX index's samples suffer from a small sample size.

Results related to the Euro STOXX 50 high and low-volume additions show an interesting picture: both samples suffer about the same magnitude losses on the post release window, but the most significant difference is that low sample gains 2,8%* abnormal returns during the run-up period while high volume sample does not gain any significant abnormal returns. During the other intervals, high and low samples deliver similar results. It can be seen that high volume additions revert to below announcement day levels as low volume additions stay on the announcement day levels. The high and low-volume samples on deleted stocks diverge during the prior announcement period. While there are no abnormal returns on the high-volume sample, the deleted low-volume sample suffers -2,85%* abnormal returns during the prior announcement period. During the run-up period, the high and low samples suffer losses of similar magnitude (high –3,59%; low -2,97%), but during the post release window, the abnormal losses are reverted as high sample gains 2,71% and low sample gains 4,98%. As we take the prior announcement period into account the deleted stock's high and low volume sample end up with about -1% losses.

FTSE 100 index's high and low-volume additions delivered on level returns on the prior announcement period and the total effect window. Still, there was a difference in the return patterns. The high-volume additions sample gained 5,27%*** during the prior announcement period and that was partly reversed (-2,89%**) during the run-up period. Low-volume additions gained 4,79%*** during the prior announcement period, which was partly reversed (-2,19%) during the post release window. The faster price reversal in high volume added stocks is a sign of more efficient price discovery in the high-volume sample.

The FTSE 100 high and low-volume deletions acted similarly apart from differences in abnormal returns during the prior announcement period. The low-volume deletions suffered mean losses of -4,75%***, which was steadily but not completely reversed during the following total effect window (+3,80%). The high-volume sample suffered lower losses (-2,63%*), which were mostly (1,92%) reversed during the following run-up period. The results again suggest more efficient price discovery in the high-volume sample.

Below, every indices' samples are plotted and inspected for abnormal daily returns around the announcement and effective days.

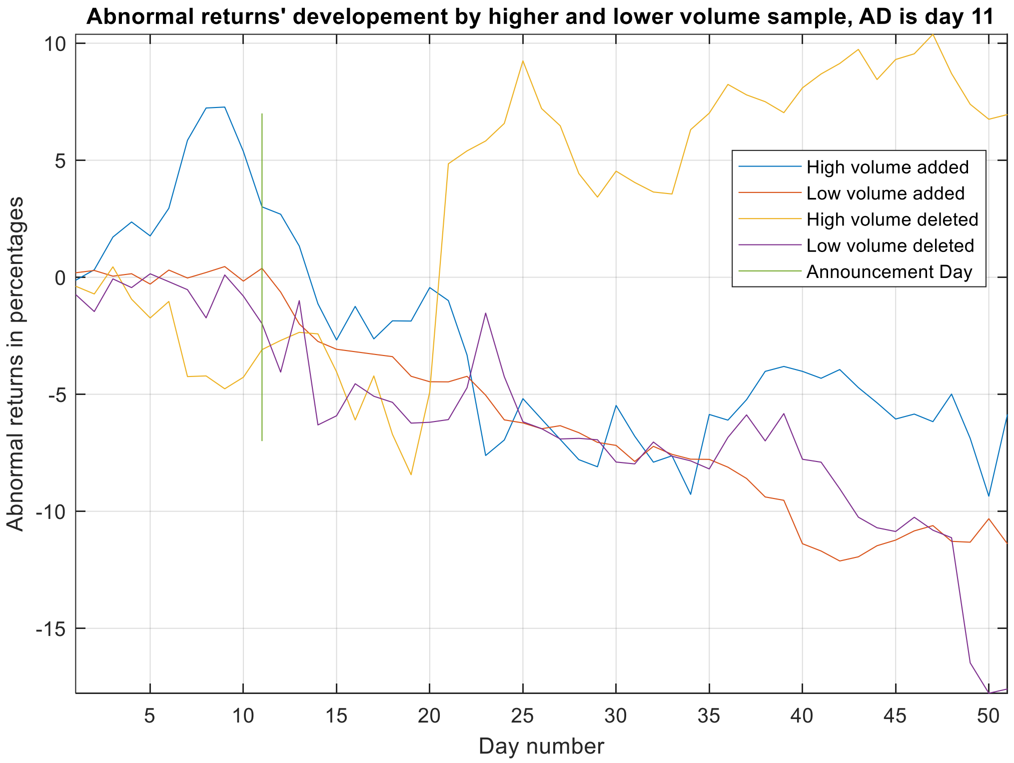


Figure 19 high volume and low volume DAX index additions' and deletions' abnormal returns plotted by the announcement day

Figure 19 represents high volume and low volume DAX index additions' and deletions' abnormal returns plotted by the announcement day. It can be seen that only high-volume samples experience prior announcement period abnormal returns (added stocks) or losses (deleted stocks). Low-volume samples develop hand-in-hand throughout the inspection period. Furthermore, there are inverse price effects around the announcement day on high volume samples, as added stocks' abnormal returns fade away and deleted stocks' sample gains over 2%.

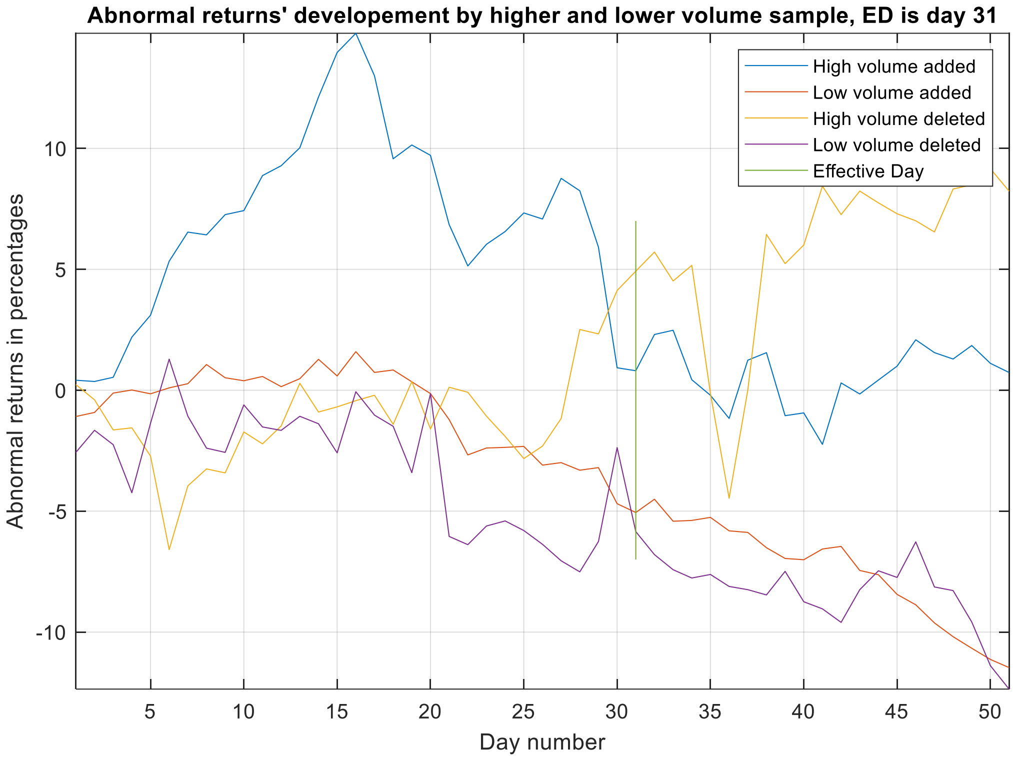


Figure 20 High volume and low volume DAX index additions' and deletions' abnormal returns plotted by the effective day

Figure 20 represents high volume and low volume DAX index additions' and deletions' abnormal returns plotted by the effective day. Again, the high-volume samples exhibit inverse price effects around the ED, as the added sample loses its abnormal returns whereas the deleted sample gains over 2%. These price observations may be results of small sample sizes or the absence of index effects.

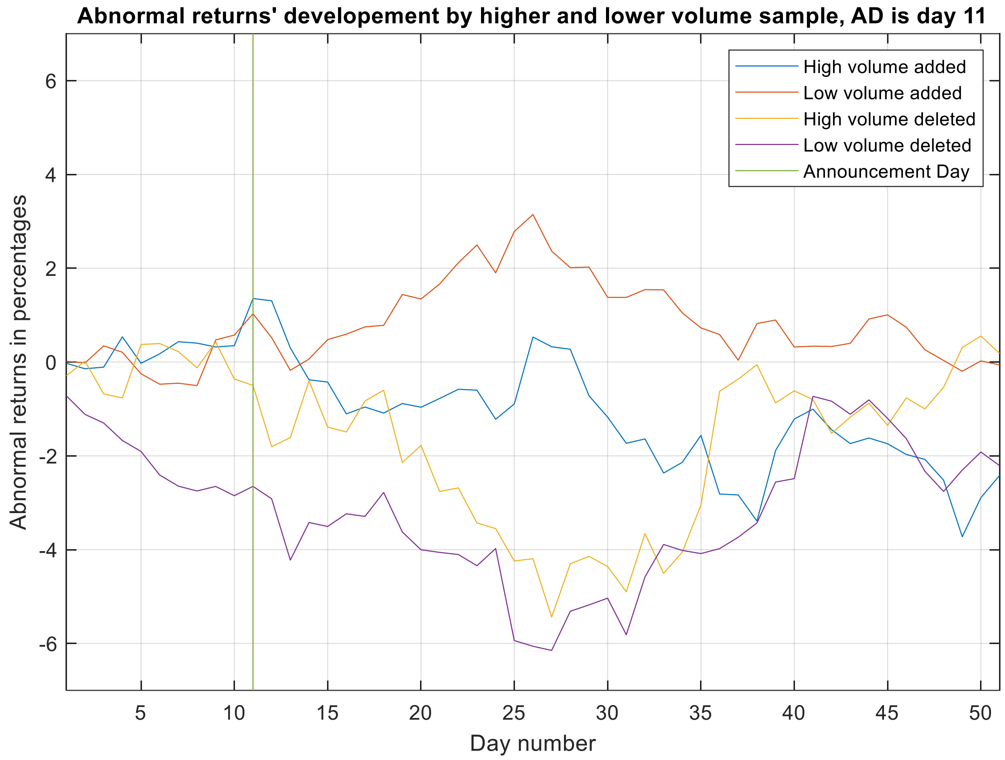


Figure 21 High volume and low volume Euro STOXX 50 index additions and deletions abnormal returns plotted by the announcement day

Figure 21 represents high volume and low volume Euro STOXX 50 index additions and deletions abnormal returns plotted by the announcement day. Low and High samples for added stocks perform in a similar manner around the announcement day with only slight announcement day returns. The deleted stock's low volume sample suffers some losses prior to the announcement day but none on that particular day, whereas the high-volume sample suffers slight losses on the announcement day. After the announcement day, the high and low-volume samples on deleted stocks perform similarly.

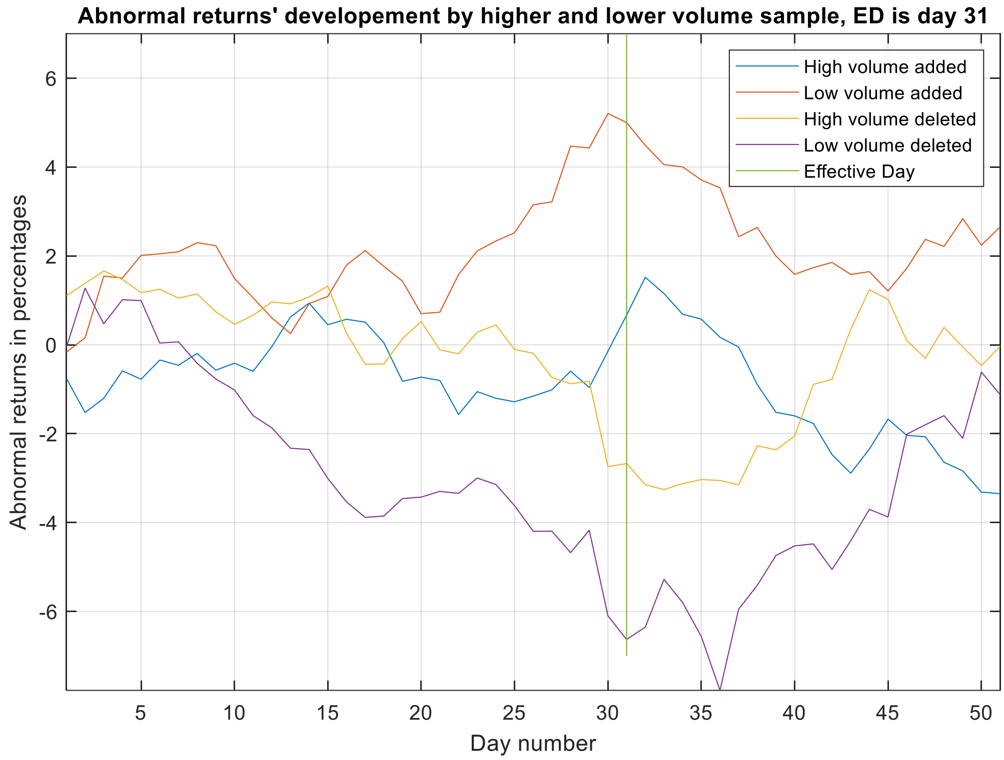


Figure 22 High volume and low volume Euro STOXX 50 index additions' and deletions' abnormal returns plotted by the effective day

Figure 22 represents high volume and low volume Euro STOXX 50 index additions' and deletions' abnormal returns plotted by the effective day. As the graph shows, there are some price effects on the days prior to the effective day. The high and low-volume samples on deleted stocks present ED-1 losses on a similar level (~ -2%) while the added stocks gain approximately the same amount. If we investigate prior 10 days to effective day, we can observe that low-volume additions gain 2% more than high volume added. The finding weakly supports the hypothesis that stocks in lower volume levels could deliver price effects with a stronger magnitude as supply and demand would not be as elastic as it is with stocks with higher daily volume.

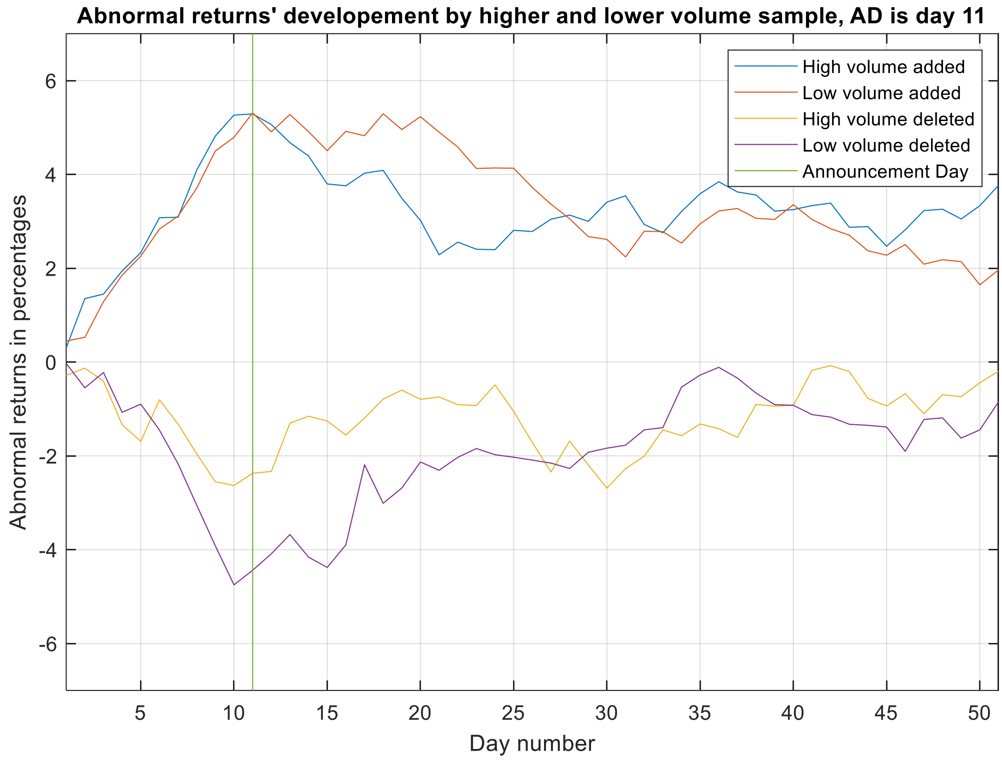


Figure 23 High volume and low volume FTSE 100 index additions' and deletions' abnormal returns plotted by the announcement day

Figure 23 represents high volume and low volume FTSE 100 index additions' and deletions' abnormal returns plotted by the announcement day. The high and low-volume samples for additions develop similarly to the announcement day. Both samples gain 5% abnormal returns and have no significant price effect following the announcement. The high-volume sample's abnormal returns start to revert faster than the low volume sample's, although only half of the gained returns fully revert themselves. The high and low volume samples for deleted stocks diverge prior to the announcement day – low sample losing -2% more than the high volume sample. The 2% difference is reverted during the next 15 days by the low volume sample. The results show that high volume samples are not experiencing as high and long-lasting price effects as the low-volume samples, which is an indication of faster and more efficient price discovery.

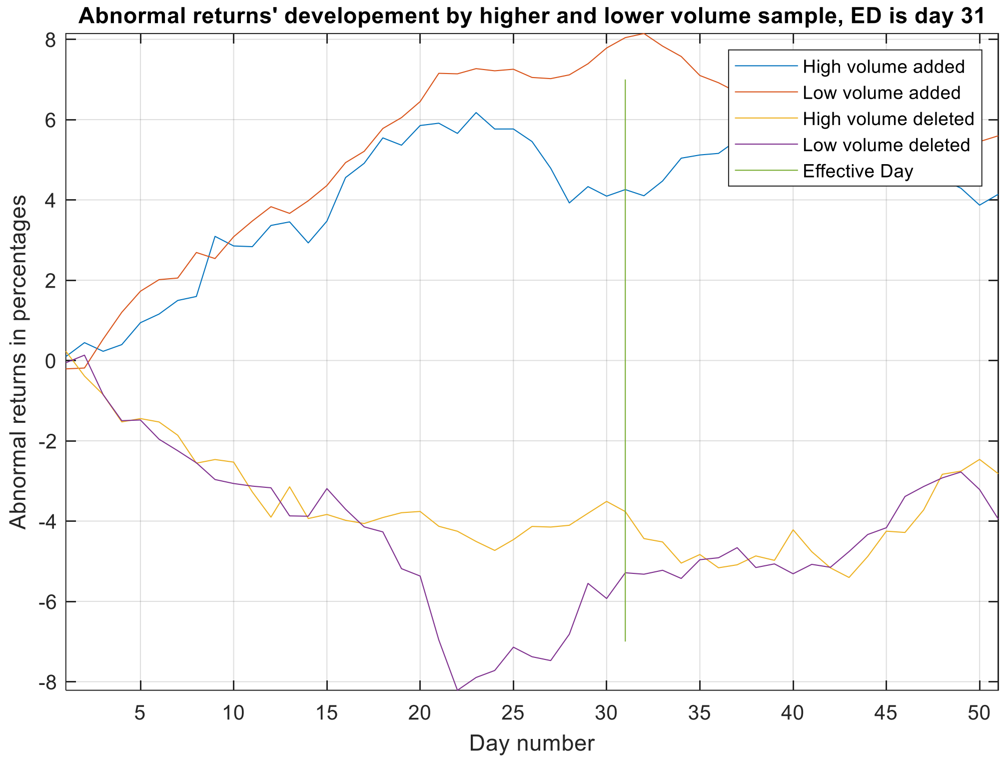


Figure 24 High volume and low volume FTSE 100 index additions' and deletions' abnormal returns plotted by the effective day

Figure 24 represents high volume and low volume FTSE 100 index additions' and deletions' abnormal returns plotted by the effective day. The high and low-volume samples for additions diverge 5 days before the effective day as the high-volume sample starts to revert -2% off of its prior announcement day returns whereas the low-volume sample stays approximately on the level. In addition, there are approximately 1% abnormal gains for the low volume added sample during the ED-2 to ED while the high-volume sample does not gain any abnormal returns during the period. The high and low-volume samples for deletions provide quite a similar story. The low-volume deleted sample suffers greater losses before the announcement (Figure 23) and during the days prior to the effective day (figure 24), it reverts those losses to match the high-volume sample. Apart from that, there are no other significant price effects between the high and low-volume samples.

The research question and null hypothesis inspected in this section are:

Table 15 Research question five and inspected null hypothesis

Research question	**Inspected null hypothesis**
Q5: Does the trading volume of a single stock affect the magnitude of abnormal returns (losses) at a time of composition change?	$H5.1_0$: Higher historical trading volume for a stock does not lead to lower abnormal returns or losses on the prior announcement period, on the announcement day, and around the effective day.

Again, the three indices provided ununified results. The DAX index proved no evidence to support my hypothesis as the high volume added sample outperformed the low-volume added sample around the AD and the deleted sample suggested contrary index effects. With the results, we are not able to reject the null hypothesis $H5.1_0$ and therefore we can state that DAX index results were not supporting hypothesis H5.1.

Moreover, we are not able to reject the null hypothesis $H5.1_0$ with FTSE 100 nor Euro STOXX 50 results. The FTSE 100 and Euro STOXX 50 indices were not in line with hypothesis H5.1 since the magnitude of price effects gained on the prior announcement period and AD and around ED were on a similar level. The relevant difference with these indices' results was that the high-volume samples reverted to the prior announcement day price levels faster than the low volume samples showing signs of more efficient price discovery, which is analogous with the previous literature. Therefore, we can conclude that all the results failed to support the research hypothesis 5.1.

6 Discussion

The empirical analysis aimed to gain insights into whether the index composition changes in the three European Blue-chip indices impact the trading volume levels and prices of stocks included in the changes. The first research question covers the trading volumes and the hypotheses were partly accepted with all the indices. DAX and Euro STOXX 50 indices represented some permanent volume effects while FTSE 100 did not deliver a volume spike on AD. All the indices represented higher volume levels on the prior announcement period and a significant volume spike on ED-1. The volume level results were in line with the previous literature as Mase (2007, 461-484), and

Fernandes and Mergulhão (2016, 79-90) both report higher volume levels during the prior announcement period stemming from anticipatory trading on FTSE 100 index. Furthermore, high volume trading days on the ED-1 revealed from all the indices are analogous with the fact that index-tracking instruments are executing the changes in the underlying as suggested by the early researchers Lynch and Mendenhall (1997, 351-383).

While the volume effects were mostly in line with the hypothesis the second and third research hypotheses related to the price effects were harder to judge. The second and the third hypotheses were mostly rejected on DAX and FTSE 100, while Euro STOXX 50 results were almost fully in line with the hypothesis. The DAX index did not deliver anticipated price effects. Moreover, the DAX index price effects were inverse than an investor would expect, which is supporting Franz's result as he was investigating DAX index changes during spring 2020. The DAX index's results suffered from the small sample size, which is resulting from the composition changes being rare.

The Euro STOXX 50 index's price results represent abnormal return "spikes" on the AD and around ED while the abnormal returns were fully reverted to the prior event level after 20 trading days after the ED. The results are in line with the price pressure hypothesis, which states that the price effects would be only visible in the short term. The most permanent price effects in the empirical analysis are found from the FTSE 100 index. The price effect related to composition changes appears during the prior announcement period after which the abnormal returns are not fully reversed, and they seem to be by some part permanent. The results from FTSE 100 index are supporting the price and volume results reported by Mase (2007, 461-484). Mase explains the price phenomena by the price pressure hypothesis since he is able to show full price reversal in his study. Since I do not report the full price reversion, I suggest the phenomena is formed due to the information and investor awareness hypotheses.

Research question four inspected the development of the magnitude of the price effects. The research hypotheses H4.1 and H4.2 suggested that the price effects would be decreasing as we close to 2020 primarily due to the development of HFTs and trading algorithms, which better the market quality (da Silva 2018, 179-206). The DAX index did not find relevant price effects on the old nor recent sample and therefore failed to prove the hypothesis. On the other hand, FTSE 100 and Euro STOXX 50 indices' results were in line with the hypothesis as the price effects were smaller in the recent sample. The result is in line with Kappou's (2018, 235-244) analysis which resulted in diminishing price effects related to composition changes.

Although some researchers suggest that index effects would be magnifying due to the increasing amount of assets in index-tracking instruments, I report contrary results. While the amount of assets in European passive ETFs has over doubled from 2013 to 2018, the price effects exhibit rather decrease than increase.

Research question five inspected the differences of price effects on stocks with high and low liquidity levels. The research hypothesis estimated that low volume level stocks should experience more severe price effects than their high liquid counterparts. The DAX index results were not in line with the hypothesis since there were no estimated index effects available. Furthermore, the Euro STOXX 50 and FTSE 100 indices did not support the inspected hypothesis. The hypothesis anticipated that the magnitude of price effect would be stronger on low volume stocks but instead, the price effects on the samples were on a similar level, but they were longer lasting in the low volume sample. That supports previous literature on the findings related to more efficient price discovery and better market quality on high liquid stocks where HFTs and trading algorithms are mostly present.

6.1 Limitations

The results in the thesis are calculated and presented according to the methodology presented in the study. The shortcomings for the event study methodology in the context of index composition changes are differences in the abnormal return calculations and differences related to abnormal volume calculations. There are no dominating methods according to which the previous authors would state are the best. The first shortcoming in my methodology is the market model estimating period. As some authors estimate the coefficients after the change event and some authors a few years before the event, the variation in the estimation window is great. It is obvious that the last 6-month period would deliver biased market model coefficients for added and deleted stocks since added stocks would have performed well while deleted stocks would have been performed poorly. Estimation after the change event would produce biased coefficients as well since literature suggests that stocks included in an index have greater co-movement with each other than stocks not involved in a major index. The author explains this is due to the more popular use of passive investment vehicles. (Grégoire 2020, 101059) Furthermore, it is reported that liquidity effects also affect the stocks' behavior if it is included in a major index. Therefore, the least feeble time period to estimate the market model would be before the last 6 months prior to the announcement.

Another shortcoming in my research is the lack of observations. As there are so few index composition changes in the annually-reviewed indices, DAX and Euro STOXX 50, it is hard to achieve statistically significant results. The issue highlights itself in the further analysis where the whole added, and deleted samples are divided into another subsamples. Having a longer research timespan wouldn't solve the problem, since the market microstructure has evolved greatly during the last 10 to 20 years and a researcher would have to manage these different time windows separately anyways.

Furthermore, more complicated abnormal returns and abnormal volume calculations can be developed, and authors may find more robust results from those. On the other hand, previous literature (Lynch and Mendenhall 1997, 351-383) suggests that simple and complex calculations deliver fairly similar results with insignificant differences. Therefore, the market model estimation is sufficient to be used in the thesis. The results obtained from the analysis are case sensitive and since different indices deliver unique results, robust generalizations of index effects are not to be made.

7 Conclusions

The results that emerged from the different European Blue-Chip indices inspected in the thesis were surprisingly different. The DAX showed inverse price effects, Euro STOXX 50 represented supporting results for the anticipatory price effects and the price pressure hypothesis, and the FTSE 100 delivered evidence for anticipatory price effects and informational hypotheses - the information and investor awareness hypothesis.

All the indices compose of stocks that are among the largest by market capitalization and most liquid in Europe. Two of the indices, DAX and FTSE 100, are single country indices while Euro STOXX 50 is a multinational stock index. Selection criteria for the indices are based on similar principles, although the number of stocks, publicity, and some structuring methods are different in the indices. The preferences listed above can all influence the results while I suggest the selection criteria and publicity of reserve list, calculations and announcements have the most impact on the results. Even the smallest differences in the methodologies can generate differences in index effects. As studying the index effects, it is crucial to acknowledge the differences in methodologies in different indices. While the S&P 500 is maintained by an index committee and these European indices are formed by calculations, the methodology's structure affects the possible surprise effect which can occur around the composition changes. Predictableness is essential in indexing.

Although the methodology's transparency in the inspected European indices is on a good level and the indices are constructed by calculations with publicly available data, further research should be done to inspect whether the composition changes convey new information for investors. Research, where 'the earnings per share estimates' and 'realized financial earnings' would be monitored after index inclusion announcement, should be conducted on FTSE 100 and Euro STOXX 50 indices. A similar study was originally designed on S&P 500 by Denis et al. (2003, 1821-1840) and it proved the existence of informational dimensions related to the composition changes in the USA.

Furthermore, as the literature and empirical findings point out, the market fragmentation and the presence of trading algorithms are topics for further research. Especially interesting topics are the HFTs' and trading algorithms' effects on stock liquidity and the elasticity of supply and demand during high volatility periods. Moreover, it could be compared if the amount of HFTs and algorithmic trading in certain stocks or markets could reflect on the index effect results.

To conclude the thesis, the rising popularity of index-tracking financial instruments does not necessarily lead to greater statistically significant abnormal returns around the index composition changes. The results are significant since I find evidence against the reported concern that the amount of money in index-tracking instruments would lead to more severe index effects. While the popularity of passive instruments rises further, it is crucial to continue the research to identify the possible adverse effects caused by the trend and perform corrective actions to avoid unnecessary bumps on the financial markets.

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Appendices

Appendix 1: The daily mean abnormal returns for added stocks by announcement day

The asterisks represent that the daily mean value is statistically significant at * (90%), ** (95%) or *** (99%) confidence interval. The significance level is calculated with t-test on different significance values with Student's t distribution with n – 1 degrees of freedom.

Additions

	DAX Additions by AD		Euro STOXX 50 Additions by AD		FTSE 100 Additions by AD	
	MAR	CMAR	MAR	CMAR	MAR	CMAR
AD-10	0.05	0.05	0.00	0.00	0.39**	0.39
AD-9	0.25	0.30	-0.07	-0.08	0.47	0.86
AD-8	0.47	0.78	0.21	0.13	0.49***	1.35
AD-7	0.34	1.12	0.24	0.37	0.54***	1.89
AD-6	-0.51	0.61	-0.51	-0.14	0.40**	2.29
AD-5	0.85	1.46	-0.02	-0.16	0.64***	2.93
AD-4	1.08	2.54	0.13	-0.03	0.17	3.10
AD-3	0.74	3.28	-0.04	-0.07	0.76***	3.86
AD-2	0.16	3.44	0.47	0.40	0.77***	4.63
AD-1	-1.18*	2.26	0.07	0.47	0.35	4.98
AD	**-0.73**	**1.53**	**0.72***	**1.19**	**0.32**	**5.30**
AD+1	-0.71	0.82	-0.29	0.90	-0.33**	4.97
AD+2	-1.36**	-0.54	-0.84*	0.05	0.06	5.03
AD+3	-1.50**	-2.04	-0.20	-0.15	-0.33*	4.70
AD+4	-0.87	-2.90	0.19	0.04	-0.48***	4.22
AD+5	0.57	-2.33	-0.26	-0.22	0.23	4.45
AD+6	-0.67	-3.00	0.15	-0.07	0.05	4.50
AD+7	0.28	-2.72	-0.04	-0.12	0.30	4.80
AD+8	-0.48	-3.20	0.44*	0.32	-0.44*	4.36
AD+9	0.49	-2.70	-0.09	0.24	-0.03	4.33
AD+10	-0.25	-2.95	0.26	0.49	-0.49	3.84
AD+11	-0.88	-3.83	0.33	0.82	-0.08	3.76
AD+12	-2.33**	-6.17	0.19	1.01	-0.33*	3.43
AD+13	-0.30	-6.47	-0.61	0.40	0.00	3.43
AD+14	0.70	-5.77	0.61*	1.02	0.16	3.60
AD+15	-0.52	-6.29	0.87**	1.89	-0.25	3.34
AD+16	-0.31	-6.60	-0.50	1.39	-0.11	3.24
AD+17	-0.55	-7.14	-0.21	1.18	-0.15	3.09
AD+18	-0.37	-7.51	-0.47	0.71	-0.28	2.81
AD+19	1.07	-6.44	-0.56	0.15	0.13	2.94
AD+20	-0.96	-7.40	-0.27	-0.11	-0.17	2.77

AD+21	-0.12	-7.52	0.13	0.02	0.08	2.85
AD+22	-0.07	-7.59	-0.35	-0.34	-0.08	2.77
AD+23	-0.84	-8.43	-0.15	-0.48	0.04	2.81
AD+24	1.49	-6.94	0.11	-0.37	0.40**	3.21
AD+25	-0.29	-7.24	-0.67**	-1.05	0.27	3.47
AD+26	0.11	-7.12	-0.29	-1.34	-0.06	3.42
AD+27	0.08	-7.04	0.14	-1.20	-0.15	3.27
AD+28	0.01	-7.03	0.76	-0.44	-0.15	3.11
AD+29	-1.14	-8.16	0.02	-0.42	0.20	3.31
AD+30	-0.30	-8.47	0.11	-0.31	-0.15	3.16
AD+31	-0.08	-8.54	-0.21	-0.52	-0.10	3.06
AD+32	-0.24	-8.78	-0.11	-0.63	-0.29	2.77
AD+33	-0.02	-8.80	0.33	-0.30	-0.19	2.58
AD+34	-0.17	-8.97	-0.01	-0.31	-0.23	2.36
AD+35	0.31	-8.65	-0.25	-0.56	0.28	2.63
AD+36	-0.01	-8.67	-0.30	-0.86	-0.08	2.55
AD+37	0.14	-8.53	-0.33	-1.19	0.07	2.62
AD+38	-0.85	-9.38	-0.70	-1.89	-0.11	2.51
AD+39	-0.52	-9.89	0.51	-1.38	-0.18	2.33
AD+40	0.92	-8.97	0.18	-1.19	0.36	2.69

Appendix 2: The daily mean abnormal returns for deleted stocks by announcement day

The asterisks represent that the daily mean value is statistically significant at * (90%), ** (95%) or *** (99%) confidence interval. The significance level is calculated with t-test on different significance values with Student's t distribution with n – 1 degrees of freedom.

Deletions

	DAX Deletions by AD		Euro STOXX 50 Deletions by AD		FTSE 100 Deletions by AD	
	MAR	**CMAR**	**MAR**	**CMAR**	**MAR**	**CMAR**
AD-10	-0.55	-0.55	-0.50*	-0.50	-0.17	-0.17
AD-9	-0.52	-1.06	-0.03	-0.53	-0.16	-0.32
AD-8	1.27	0.21	-0.45	-0.98	0.00	-0.32
AD-7	-0.91	-0.71	-0.22	-1.20	-0.89***	-1.21
AD-6	-0.15	-0.86	0.48	-0.72	-0.11	-1.33
AD-5	0.22	-0.64	-0.23	-0.95	0.23	-1.10
AD-4	-1.87	-2.51	-0.20	-1.15	-0.61	-1.71
AD-3	-0.55	-3.06	-0.23	-1.38	-0.74*	-2.46
AD-2	0.56	-2.50	0.33	-1.05	-0.72***	-3.18
AD-1	-0.16	-2.65	-0.50	-1.56	-0.42	-3.61
AD	**0.08**	**-2.57**	**0.02**	**-1.53**	**0.29**	**-3.32**
AD+1	-0.76	-3.33	-0.81*	-2.34	0.18	-3.14
AD+2	1.61	-1.72	-0.53	-2.86	0.75***	-2.39

AD+3	-2.51	-4.23	1.01*	-1.85	-0.14	-2.54
AD+4	-0.68	-4.92	-0.55*	-2.40	-0.15	-2.69
AD+5	-0.46	-5.37	0.08	-2.33	0.06	-2.63
AD+6	0.75	-4.62	0.32	-2.01	0.98*	-1.65
AD+7	-1.45	-6.08	0.36	-1.65	-0.16	-1.81
AD+8	-1.33	-7.41	-1.21***	-2.85	0.25	-1.56
AD+9	1.90	-5.51	0.01	-2.85	0.15	-1.41
AD+10	5.26	-0.25	-0.54	-3.38	-0.05	-1.46
AD+11	0.93	0.68	0.02	-3.37	0.04	-1.42
AD+12	1.72	2.39	-0.50	-3.87	0.08	-1.35
AD+13	-0.87	1.52	0.11	-3.76	0.18	-1.17
AD+14	0.53	2.05	-1.30**	-5.06	-0.33	-1.50
AD+15	-1.22	0.83	-0.03	-5.09	-0.39	-1.89
AD+16	-0.60	0.23	-0.69**	-5.78	-0.37	-2.26
AD+17	-1.08	-0.85	0.99*	-4.79	0.30	-1.95
AD+18	-0.57	-1.41	0.15	-4.64	-0.11	-2.07
AD+19	0.15	-1.27	-0.04	-4.68	-0.23	-2.30
AD+20	-0.30	-1.56	-0.65	-5.34	0.25	-2.04
AD+21	0.22	-1.34	1.24***	-4.10	0.29	-1.75
AD+22	-0.33	-1.67	-0.11	-4.21	0.33	-1.42
AD+23	1.37	-0.30	0.18	-4.04	0.33	-1.09
AD+24	0.22	-0.08	0.49	-3.55	0.25	-0.84
AD+25	1.28	1.20	1.31**	-2.23	0.02	-0.82
AD+26	0.21	1.41	0.25	-1.98	-0.21	-1.03
AD+27	-0.67	0.74	0.31	-1.68	0.23	-0.79
AD+28	0.29	1.03	-0.01	-1.68	-0.13	-0.93
AD+29	-0.35	0.69	0.17	-1.51	0.00	-0.92
AD+30	0.26	0.95	0.74	-0.77	0.31	-0.61
AD+31	-0.29	0.65	-0.42	-1.19	0.03	-0.58
AD+32	-0.24	0.41	0.05	-1.14	-0.14	-0.72
AD+33	-0.90	-0.49	0.30	-0.84	-0.32	-1.04
AD+34	0.38	-0.11	-0.43	-1.28	-0.10	-1.14
AD+35	0.41	0.31	0.10	-1.18	-0.10	-1.24
AD+36	0.19	0.49	-0.46	-1.64	0.08	-1.16
AD+37	-1.04	-0.55	0.03	-1.60	0.24	-0.92
AD+38	-3.19	-3.75	0.66	-0.95	-0.22	-1.14
AD+39	-0.95	-4.69	0.31	-0.63	0.24	-0.90
AD+40	0.19	-4.50	-0.33	-0.96	0.41	-0.50

Appendix 3: The daily mean abnormal returns for added stocks by effective day

The asterisks represent that the daily mean value is statistically significant at * (90%), ** (95%) or *** (99%) confidence interval. The significance level is calculated with t-test on different significance values with Student's t distribution with n – 1 degrees of freedom.

Additions

	DAX Additions by ED		Euro STOXX 50 Additions by ED		FTSE 100 Additions by ED	
	MAR	CMAR	MAR	CMAR	MAR	CMAR
ED-30	-0.43	-0.43	-0.45	-0.45	-0.08	-0.08
ED-29	0.07	-0.36	-0.20	-0.65	0.15	0.07
ED-28	0.53	0.17	0.87***	0.22	0.34	0.41
ED-27	0.80	0.97	0.28	0.50	0.47**	0.87
ED-26	0.31	1.27	0.17	0.67	0.53***	1.41
ED-25	1.12**	2.39	0.23	0.90	0.26	1.67
ED-24	0.62	3.01	-0.03	0.87	0.16	1.83
ED-23	0.40	3.41	0.23	1.10	0.42**	2.25
ED-22	0.06	3.47	-0.21	0.89	0.52	2.76
ED-21	0.00	3.47	-0.31	0.58	0.23	2.99
ED-20	0.73	4.20	-0.31	0.26	0.23	3.22
ED-19	-0.06	4.15	0.03	0.29	0.43*	3.64
ED-18	0.51	4.66	0.14	0.43	-0.06	3.58
ED-17	1.37*	6.03	0.50*	0.93	-0.03	3.55
ED-16	0.42	6.44	-0.15	0.78	0.45**	4.00
ED-15	0.91	7.36	0.42	1.21	0.78***	4.78
ED-14	-1.25**	6.10	0.14	1.35	0.31*	5.09
ED-13	-1.44*	4.66	-0.41	0.94	0.59**	5.68
ED-12	-0.02	4.63	-0.59	0.35	0.09	5.77
ED-11	-0.46	4.17	-0.33	0.02	0.44**	6.21
ED-10	-1.86***	2.32	-0.02	0.00	0.44*	6.65
ED-9	-1.57**	0.74	0.07	0.07	-0.11	6.54
ED-8	0.55	1.30	0.52***	0.59	0.29	6.83
ED-7	0.25	1.54	0.04	0.64	-0.20	6.63
ED-6	0.36	1.90	0.06	0.70	0.02	6.65
ED-5	-0.54	1.36	0.39	1.08	-0.25	6.40
ED-4	0.79	2.15	0.10	1.19	-0.29	6.12
ED-3	-0.40	1.75	0.85**	2.04	-0.29	5.82
ED-2	-0.96	0.79	-0.20	1.84	0.33	6.15
ED-1	-3.02***	-2.23	0.79**	2.64	0.14	6.29
ED	**-0.26**	**-2.49**	**0.28**	**2.92**	**0.22**	**6.51**
ED+1	0.96	-1.53	0.14	3.06	0.00	6.51
ED+2	-0.44	-1.96	-0.40	2.66	-0.04	6.47
ED+3	-0.88*	-2.84	-0.25	2.41	0.08	6.55
ED+4	-0.21	-3.05	-0.21	2.21	-0.25*	6.30
ED+5	-0.73	-3.78	-0.29	1.92	-0.09	6.20
ED+6	1.02	-2.76	-0.68**	1.24	-0.01	6.20
ED+7	-0.22	-2.98	-0.30	0.94	-0.38**	5.81
ED+8	-1.39	-4.37	-0.63**	0.31	-0.28	5.53
ED+9	0.02	-4.35	-0.25	0.06	-0.14	5.39
ED+10	-0.32	-4.67	0.00	0.05	-0.26	5.13

ED+11	1.17*	-3.50	-0.28	-0.22	0.02	5.15
ED+12	-0.76	-4.26	-0.34	-0.56	-0.04	5.11
ED+13	0.15	-4.11	0.29	-0.27	0.20	5.31
ED+14	-0.21	-4.31	0.10	-0.17	-0.10	5.21
ED+15	0.24	-4.08	0.09	-0.08	-0.04	5.17
ED+16	-0.65	-4.73	0.32	0.24	0.05	5.22
ED+17	-0.44	-5.17	-0.36	-0.12	-0.11	5.10
ED+18	-0.03	-5.19	0.23	0.11	0.11	5.21
ED+19	-0.58	-5.77	-0.54*	-0.42	-0.40**	4.81
ED+20	-0.36	-6.13	0.20	-0.23	0.20	5.01

Appendix 4: The daily mean abnormal returns for deleted stocks by effective day

The asterisks represent that the daily mean value is statistically significant at * (90%), ** (95%) or *** (99%) confidence interval. The significance level is calculated with t-test on different significance values with Student's t distribution with n – 1 degrees of freedom.

Deletions

	DAX Deletions by ED		Euro STOXX 50 Deletions by ED		FTSE 100 Deletions by ED	
	MAR	CMAR	MAR	CMAR	MAR	CMAR
ED-30	-1.07	-1.07	0.55	0.55	0.10	0.10
ED-29	0.09	-0.98	0.78	1.33	-0.25	-0.15
ED-28	-0.94	-1.93	-0.24	1.09	-0.70	-0.85
ED-27	-0.88	-2.81	0.16	1.25	-0.67	-1.52
ED-26	0.72	-2.09	-0.16	1.09	0.05	-1.46
ED-25	-0.82	-2.91	-0.42	0.67	-0.27	-1.73
ED-24	0.30	-2.61	-0.09	0.58	-0.31	-2.04
ED-23	-0.24	-2.85	-0.18	0.40	-0.51	-2.55
ED-22	-0.17	-3.02	-0.38	0.02	-0.14	-2.70
ED-21	1.82	-1.20	-0.27	-0.25	-0.08	-2.78
ED-20	-0.69	-1.89	-0.17	-0.42	-0.43	-3.21
ED-19	0.33	-1.56	0.02	-0.40	-0.36	-3.57
ED-18	1.21	-0.35	-0.24	-0.64	0.09	-3.48
ED-17	-0.78	-1.13	0.06	-0.57	-0.43	-3.91
ED-16	-0.45	-1.58	-0.18	-0.76	0.37	-3.54
ED-15	1.32	-0.26	-0.81**	-1.56	-0.31	-3.85
ED-14	-0.33	-0.59	-0.53	-2.09	-0.25	-4.10
ED-13	-0.86	-1.45	0.02	-2.07	0.02	-4.08
ED-12	0.05	-1.40	0.49	-1.59	-0.36	-4.43
ED-11	0.48	-0.92	0.21	-1.37	-0.07	-4.50

ED-10	-1.84	-2.76	-0.27	-1.64	-0.93***	-5.43
ED-9	-0.27	-3.02	-0.07	-1.71	-0.64**	-6.07
ED-8	-0.17	-3.19	0.42	-1.29	0.01	-6.06
ED-7	-0.35	-3.54	0.01	-1.28	-0.04	-6.10
ED-6	-0.67	-4.21	-0.51	-1.79	0.41	-5.69
ED-5	0.01	-4.20	-0.32	-2.11	0.07	-5.62
ED-4	0.29	-3.91	-0.28	-2.39	-0.05	-5.68
ED-3	1.75	-2.16	-0.31	-2.70	0.33	-5.35
ED-2	0.49	-1.68	0.27	-2.43	0.74**	-4.61
ED-1	2.77***	1.09	-1.92***	-4.35	-0.01	-4.62
ED	**-1.20**	**-0.10**	**-0.22**	**-4.57**	**0.16**	**-4.46**
ED+1	-0.02	-0.12	-0.11	-4.69	-0.38	-4.84
ED+2	-0.93	-1.05	0.46	-4.23	0.00	-4.84
ED+3	0.18	-0.87	-0.18	-4.41	-0.38*	-5.22
ED+4	-2.76*	-3.63	-0.32	-4.73	0.33	-4.89
ED+5	-2.54	-6.17	-0.59*	-5.32	-0.16	-5.05
ED+6	2.32	-3.85	0.83	-4.49	0.16	-4.89
ED+7	3.33	-0.51	0.71**	-3.78	-0.11	-5.00
ED+8	-0.19	-0.70	0.28	-3.50	-0.02	-5.02
ED+9	-0.18	-0.88	0.26	-3.24	0.30	-4.72
ED+10	1.16	0.28	0.63	-2.61	-0.19	-4.91
ED+11	-0.89	-0.61	-0.22	-2.83	-0.25	-5.16
ED+12	1.15	0.54	0.89*	-1.94	0.05	-5.11
ED+13	0.10	0.65	0.80**	-1.13	0.48	-4.63
ED+14	-0.37	0.28	-0.19	-1.33	0.42*	-4.21
ED+15	0.53	0.81	0.41	-0.91	0.34	-3.87
ED+16	-1.12	-0.31	-0.11	-1.02	0.42	-3.45
ED+17	0.88	0.57	0.46	-0.56	0.58**	-2.87
ED+18	-0.51	0.06	-0.47	-1.03	0.11	-2.76
ED+19	-0.49	-0.43	0.49	-0.54	-0.04	-2.81
ED+20	-0.95	-1.38	-0.02	-0.55	-0.53**	-3.34