Norwegian School of Economics
Bergen, Spring 2017

Is there a FTSE 100 index effect?

An empirical study of price and volume effects for stocks included in the FTSE 100 index

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Master thesis in Financial Economics

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Abstract

In this study, we examine quarterly inclusions in the FTSE 100 index which should not reveal new information regarding stock performances. Using the market model, we investigate returns and trading volume around the announcement and inclusion dates in the period 2005-2013 for index inclusions. On the day before the effective change of the index composition, we find a positive and significant abnormal return and abnormal trading volume. The positive price effect is however reversed the next trading day. Furthermore, we do not find a price and volume effect close to the announcement date. Our findings are supported by the price-pressure hypothesis and suggest that the market is not efficient in the semi-strong form. In addition, we test if there is a higher investor awareness for new constituents compared to previous constituents, resulting in higher abnormal returns. Our findings suggest that there is no evidence supporting the awareness hypothesis. Additionally, trading strategies using long and short positions in the included stocks are presented.

Preface

This thesis represents the end of our master studies at the Norwegian School of Economics.

The idea of conducting an event study to examine if there is an index effect in the FTSE 100 emerged during our exchange semester at Stockholm School of Economics. During the class "Asset Pricing and Portfolio Choice" we examined possible abnormal returns in connection with announcements of mergers and acquisitions, also known as "merger arbitrage". We further discussed if abnormal returns would be present in the case of index revisions. After conducting additional research on the topic, we learned about the "S&P 500 phenomenon". Our initial research on the index effect motivated us to contribute to the existing literature and to examine a possible index effect on a large index in Europe, namely the FTSE 100.

We would like to thank all those who have accompanied us during the working process. We would like to especially thank our supervisor Associate Professor Carsten Bienz for his support, patience and constructive feedback.

Bergen, July 10th, 2017

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1 Introduction

This thesis aims to investigate the impact of composition changes in the FTSE 100 index. The FTSE 100 index consists of 100 companies with the largest market capitalisation listed on the London Stock Exchange. The index composition changes are based on market capitalisation and should therefore not reveal new information. The purpose of the research is to determine whether there is a price and/or volume effect resulting from inclusions of stocks in the FTSE 100, which is commonly known as the index effect.

The index effect suggests positive abnormal returns associated with the inclusion of stocks in an index. Investigating the index effect is of interest since it represents a violation of the efficient market hypothesis, resulting in opportunities to exploit abnormal returns. Additionally, trading volume around index revisions may reveal valuable information about investment behaviour of market participants.

Previous research has examined the intensity and the length of the index effect in various indices, with a particular focus on the S&P 500[1]. Regarding the S&P 500, the index effect is described as the "S&P phenomenon" (Nasdaq, 2017). Some studies suggest that an inclusion in an index can signal positive expectations regarding future performance of a stock. Other studies suggest that the index effect is based on price pressure resulting from funds tracking the index, rebalancing their portfolio. According to this explanation, the increased demand results in a higher stock price. Additional attempts to explain the index effect are, among others, based on increased investor awareness as well as increased liquidity.

Intrigued by the idea that the "S&P phenomenon" might exist in the FTSE 100, we want to contribute to the existing literature by examining a possible FTSE 100 index effect, investigating the more recent period 2005-2013. Consequently, we want to the answer the following research question: *Do positive price and volume effects arise in regard to index inclusions in the FTSE 100?*

We conduct a short run event study investigating stocks included in the quarterly reviews of the FTSE 100 from March 2005 until December 2013. During the empirical analysis, we

[1] The S&P 500 is the largest index in the US representing the 500 largest stock listed companies on the New York Stock Exchange.

focus on three aspects; price, volume and new versus previous constituents.

We do not find positive average abnormal returns (AARs) close to the announcement date. Nonetheless, we observe a positive and significant AAR the day before the effective inclusion date. We argue that the positive AAR observed is due to index funds rebalancing their portfolios close to the effective inclusion date in order to minimise deviation from the benchmark portfolio. This argument is supported by the literature (Opong & Hamill, 2004; Mase, 2007; Mazouz & Saadouni, 2007). Nevertheless, the AAR is marginal, and the index effect observed the day before the effective inclusion is temporary and even reversed the next trading day.

Furthermore, we analyse the trading patterns around the event. We find significant abnormal trading volume around the announcement and the inclusion dates. Particularly on the day before the inclusion date, we find a prominent trading peak further supporting the price-pressure argument. In addition, we find evidence for increased trading activity for at least twelve days after the inclusion date.

Subsequently, we assess if new constituents will have a higher abnormal return compared to previous constituents in order to test the awareness hypothesis. The empirical findings do not reveal higher significant abnormal returns for new constituents entering the FTSE 100 for the chosen period, in comparison to previous constituents. Hence, we do not find evidence for the awareness hypothesis.

Lastly, we present trading strategies based on our empirical findings. By creating long and short positions in the stocks to be included in the FTSE 100, we find that the strategies exploiting the index effect yield positive abnormal returns despite transaction costs.

Methodologically we conduct a short run event study using the market model with event portfolio clusters for both price and volume. Due to overlapping event windows, resulting in the covariances between the abnormal returns no longer being zero (MacKinlay, 1997), clustering has been implemented. By clustering stocks into equally weighted portfolios by the date of the quarterly index revision, we address the problem regarding covariance between the abnormal returns, allowing us to aggregate the average abnormal return over time. The validity of our empirical analysis is discussed in Section 5.

The remainder of this thesis is organised as follows. Section 2 introduces the FTSE 100 index while Section 3 examines the role of indices and index funds. Section 4 presents the academic framework and the relevant literature. Section 5 provides an overview of the applicable event study methodology, describes the dataset and the implemented methodology. Section 6 describes the expected findings and the testable hypotheses, followed by the empirical findings in Section 7. Section 8 presents trading strategies in light of our findings and Section 9 concludes, addresses limitations and suggests proposals for future studies.

2 Description of the FTSE 100 index

2.1 The FTSE 100 index

The Financial Times Stock Exchange 100 index (FTSE 100) is the value-weighted equity index of the 100 companies with the highest market capitalisation listed on the London Stock Exchange. The index was created on January 1st, 1984 with the aim to be used for *"creation of index tracking funds, derivatives and as a performance benchmark"* (FTSE Russell, 2017b, p. 1). The FTSE 100 is the most well-known index in the UK, used by large investors, brokers and financial experts (London Stock Exchange, 2013). However, according to Morningstar (2015), *"the FTSE 100 is very heavy in giant- and large-cap UK companies that derive only a small portion of their revenues from the UK. (...) the index is acutely exposed to the fortunes of the broader global economy, and less to the health of the UK economy"* (p. 10).

The index level is based on weighted market capitalisation (FTSE Russell, 2015b, p. 4):

$$Index\ level = \frac{\sum_i Price\ of\ stocks_i \times Number\ of\ shares_i \times Free\ float\ adjustment\ factor_i}{Index\ divisor} \quad (1)$$

Formula (1) considers a free float adjustment factor which is a percentage of all issued shares available for trading (rounded to the nearest multiple of 5%). This adjustment *"helped avoid potential price distortions in index constituents with a limited proportion of their share capital available for public trading"* (FTSE Russell, 2015a).

2.2 Selection process

The FTSE 100 index includes stocks of companies that are traded on the London Stock Exchange, denominated in pound sterling or euro. To be included in the index, stocks are screened for sufficient liquidity and free float levels. Companies that are incorporated in the UK must have a minimum free float of 25% (FTSE Russell, 2017a, p. 10), whilst companies incorporated outside the UK must have a minimum free float of 50%[2] (FTSE Russell, 2017a, p. 10).

[2] The free float of 50% can be violated (if it is above 5%) if the free float level is expected to meet the minimum requirement within the next 12 months (FTSE Russell, 2017a, p. 10).

In contrast to the S&P 500 selection process, components such as past returns, industry, financial health or market representation are not considered. Therefore, one might consider the selection process for the FTSE 100 rather objective in comparison to the selection process regarding the S&P 500, which has been described as more of a subjective process (Mase, 2007). Hence, the stock selection for index revisions in the FTSE 100 is more predictable compared to the S&P 500. This fact needs to be taken into consideration for the interpretation of results found on the FTSE 100 in comparison to the S&P 500.

The FTSE 100 index is reviewed quarterly in March, June, September and December (FTSE Russell, 2017a, p. 15). The index operator ranks the 110 largest companies based on their full market capitalisation. Stocks rising to position 90 or above are included in the index, while stocks that fall to position 111 or below are excluded from the FTSE 100 and are included in the FTSE 250 (FTSE Russell, 2017a, p. 16).

In addition, the index operator publishes a reserve list with the six highest-ranking non-constituents of the FTSE 100 and the twelve highest-ranking non-constituents of the FTSE 250. The reserve list is used if changes in the index composition occur between the regular review events. The category “Fast entry” represents an additional non-regular entry track for companies whose full market capitalisation amounts to minimum 1% of the full capitalisation of the FTSE All-Share index (FTSE Russell, 2017a, p. 17).

2.3 Announcement and inclusion process

From April 1992 until December 2013, constituent changes were implemented on the third Friday of the review month after trading hours, with the effective inclusion date being the next Monday. The announcement of changes happened seven trading days before the effective inclusion date. However, since the announcement happened after trading hours[3], the effective announcement date was the next trading day. In March 2014[4], the period between the effective announcement and inclusion dates was extended to twelve trading days.

[3] Email confirmation from FTSE Russell, received on June 2nd, 2017.
[4] The results for the extended empirical analysis for the period 2005-2016 can be found in Table 4 in appendix.

3 Indices and index funds

3.1 The role of indices

According to financial theory, rational investors hold a combination of the optimal risky portfolio and a risk-free asset. The market portfolio should include all available stocks in the market where each stock is value-weighted according to its market capitalisation (Bodie et al., 2014). Nevertheless, it is hard to define the market portfolio in practice, and therefore, indices were established (Bodie et al., 2014). In financial markets, investors can hold a portfolio that replicates an index or invest in index funds or ETFs[5].

3.2 The role of index funds

An index fund is a mutual fund that replicates a benchmark index fully or to a certain extent. Index funds that fully replicate the index are passively managed, implicating lower management fees. However, in practice, the full replication of an index is efficient only if the index constituents are sufficiently liquid and if the number of constituents is not too large (Bodie et al., 2014).

Lynch and Mendenhall (1997) argue that most index funds rebalance their portfolios one day before the effective inclusion date, in order to minimise tracking error. Ang (2014) defines tracking error as follows: *"Tracking error is the standard deviation of the excess return; it measures how disperse the manager's return are relative to the benchmark"* (p. 307). According to Morningstar (2015), *"there is always a trade-off between minimizing costs and minimizing tracking error"* (p. 8). *"Funds that use sampling will likely exhibit higher tracking error than those that use full replication, especially during times of high market volatility. But the long-term performance of the former might be the same as (or even superior to) that of the latter because of potentially lower costs"* (Morningstar, 2015, p. 5). To minimise the tracking error during index composition changes, index funds are forced to change their portfolio as close to the effective inclusion date as possible. This rebalancing practice is still observed for index funds tracking the FTSE 100[6].

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[5] Exchange-traded funds.

[6] Email confirmation from Investment Association, received on June 8th, 2017. Furthermore, Nordea Markets confirmed on June 30th, 2017 that index tracking funds automatically rebalance their portfolios.

3.3 Index funds tracking the FTSE 100

According to Shleifer (1986), the increase in number and popularity of index funds is linked to a stronger index effect observed in the S&P 500. In the UK, an increase in the number of funds and invested capital since 1992 has been documented (Mase, 2007). As reported by the Investment Association (2016), the total value of UK domiciled funds stood at 872 billion pounds at the end of 2015, which represents a growth of 140% since 2008. Also, domestic equity index funds have more than doubled since 2006. Index tracking funds represented 9% of equity fund sales in 2013 and 15% in 2015 compared to 4% in 2006. Furthermore, the number of index tracking funds has grown from 77 in 2005 to 119 in 2015. Trackers as a percentage of industry funds under management increased in the period 2005-2013 from 6.6% to 10% and over 12% in 2015 (Investment Association, 2016, p. 61).

4 Academic framework

In this section, we present relevant academic framework, hypotheses explaining the index effect and literature review covering foreign indices as well as the FTSE 100.

4.1 The efficient market hypothesis

The efficient market hypothesis claims that security prices observed in the market fully reflect all pertinent information and therefore the market is efficient (Fama, 1970). According to the efficient market hypothesis, abnormal returns do not exist. All relevant information for the valuation of stocks must be reflected in the price. Early studies on market efficiency include Samuelson (1965), Mandelbrot (1966) and Fama (1970).

There are three forms of market efficiency: weak, semi-strong and strong (Bodie et al., 2014). The weak form implies that stock prices reflect all past information such as past earnings and returns. The semi-strong form implies that stock prices reflect all publicly available information, and the strong form implies the reflection of all public and private information in the stock price. If the market is efficient in the strong form, stock prices cannot be predicted.

4.2 The index effect

The existence of abnormal returns as a result of stocks entering an index is commonly known as the index effect (Kasch & Sarkar, 2011). Assuming that the index composition change is dependent on public information, such as market capitalisation, the inclusion of a stock in an index should have no new information content. Therefore, the index effect is a violation of the efficient market hypothesis in the semi-strong form. Several attempts to explain the index effect are addressed in the following section.

4.3 Hypotheses explaining the index effect

4.3.1 Price-pressure hypothesis

The price-pressure hypothesis states that, if the demand for a stock rises sharply at short notice, then its price also increases (Shleifer, 1986). However, the price increase is assumed to be temporary and should reach the original equilibrium again in a short time. As a possible explanation for the price increase, one can expect compensation for transaction costs and portfolio risk. As a result of increased demand, a higher trading volume is expected to be observed. Furthermore, the price-pressure hypothesis assumes that options of the underlying securities are not affected by the temporary index effect (Dhillon & Johnson, 1991).

4.3.2 Hypothesis of imperfect substitutes

The hypothesis of imperfect substitutes, introduced by Scholes (1972), suggests that stocks are not perfect substitutes for each other. This may be due to different stock characteristics. Based on this hypothesis, investors prioritise the selection of specific stocks based on their preferences and needs. If the demand for a particular stock increases, the price of the stock increases as well, until a new equilibrium is reached. If the demand decreases, the price of the stock also decreases. In contrast to the price-pressure hypothesis, the price effect is permanent.

4.3.3 Information hypothesis

The information hypothesis states that those who own large blocks of stocks tend to have more information regarding the future performance of stocks compared to owners of smaller stock quantities. Shleifer (1986) argues that the information hypothesis can explain the positive relationship between volume and return. If a large block of stocks is bought, the upward adjustment of the stock price is due to the expected value of information. Scholes (1972) states that the price adjustment is permanent.

4.3.4 Price-volatility hypothesis

The price-volatility hypothesis, introduced by Cooper and Woglom (2003), assumes that trading effects lead to a persistent effect on stock price volatility. *"The initial price increase prior to inclusion in the S&P 500 is a function of both short run excess demand, which, is associated with a permanent reduction in the supply of the stock as index funds incorporate* *the stock into their non-traded portfolio. As a consequence the stock experiences increased volatility post-addition from the shock to the Downward Sloping Demand Curve"* (Opong & Hamill, 2004, p. 6). The increased price volatility leads to *"higher post-addition risk premium, even though a firm's future cash-flows are unaffected, they are now discounted at a higher rate"* (Opong & Hamill, 2004, pp. 6-7) which results in a long-term price reversal after the inclusion.

4.3.5 Liquidity and transaction costs hypotheses

The liquidity hypothesis states that stocks that are listed in highly regarded indices are more liquid and have a higher information content than those listed in less highly regarded indices. This assumption is based on the increased public interest that stocks included in a highly regarded index receive. According to Shleifer (1986), *"as a result, the stock will be traded more widely, become more liquid, and the bid-ask spread on the stock will fall"* (p. 588). For example, a higher analyst coverage ensures a more intensive information flow, which results in a lower perceived risk and lower transaction costs, leading to lower risk premiums. In addition, the hypothesis implies higher abnormal returns for lesser-known stocks. The price effect is assumed to be permanent.

4.3.6 Awareness hypothesis

The awareness hypothesis states that only a certain amount of stocks is known to investors - who will only invest in stocks known to them. Merton (1987) argues that investors cannot fully diversify their portfolio and therefore have to bear so-called "shadow cost". Events that (in a positive sense) attract investors' attention to a particular stock, such as the inclusion in a reputable index, reduce the "shadow cost" and can have a positive and lasting effect on the stock price. If a larger number of investors are interested in these stocks, the demand will grow. If, however, a stock leaves the index, awareness is assumed to remain at a similar level, leading to a moderate reduction in price, if at all. Chen et al. (2004) argue that the asymmetric price effect around additions and deletions from the S&P 500 index is contradicting the downward sloping demand curve hypothesis, the information hypothesis and the liquidity hypothesis, but can be explained by the awareness hypothesis.

4.3.7 Selection criteria hypothesis

The selection criteria hypothesis introduces a bias further explained by Kasch and Sarkar (2012). This bias might be included in the analysis if the criteria for stock inclusion or deletion can explain the abnormal returns and changes in the trading volume. Kasch and Sarkar argue that the abnormal returns in connection with the inclusion in the S&P 500 index are based on the fundamental performance of the stock in the period preceding the inclusion. The selection criteria hypothesis states that the index effect is a reflection of the stock's previous and current performance. Hence, if a stock leaves the index, it is most likely due to preceding poor performance that would explain negative abnormal returns.

4.3.8 Stale news hypothesis

Tetlock's (2008) stale news hypothesis states that investors often overreact to news regarding changes in the index composition. By trading on old news and not taking into consideration other investors' behaviour, the market can overreact, leading to price increases. Nonetheless, the price increase reverses shortly after, which can be explained by the market overestimating the buying power of index funds, creating a mismatch between supply and demand. According to Tetlock (2008), *"return reversals after news will be larger when there is more old information about the firm"* (p. 3).

4.3.9 Summary of existing hypotheses

Table 1 provides an overview of the existing hypotheses for the index effect.

Hypothesis	Temporary price effect	Permanent price effect	Temporary volume effect	Permanent volume effect
Price-pressure hypothesis	Yes	No	Yes	No
Hypothesis of imperfect substitutes	No	Yes	Yes	Not specified
Information hypothesis	No	Yes	Yes	Not specified
Price-volatility hypothesis	Yes	Yes	Yes	Not specified
Liquidity and transaction costs hypotheses	No	Yes	No	Yes
Awareness hypothesis	No	Yes	Not specified	Not specified
Selection criteria hypothesis	No	Yes	No	Yes
Stale news hypothesis	Yes	No	Yes	Not specified

Table 1
Summary of the existing hypotheses
Summary of the existing hypotheses for price and volume effects associated with index inclusions. "Not specified" means that the hypothesis does not provide a clear explanation regarding the effect.

4.4 Literature review

4.4.1 Previous studies on foreign indices

4.4.1.1 Shleifer (1986)

In his study on demand curves for stocks, Shleifer states: *"if the demand curve is horizontal, inclusion of a stock into the S&P 500 should not be accompanied by a share price increase"* (p. 580). He examines the impact of inclusions on the S&P 500 index in the period 1966-1983 and finds a significant positive abnormal return related to the announcement of inclusions which remains *"for at least ten days after inclusion"* (p. 579). Shleifer argues that the abnormal return is due to the increased demand from index funds.

4.4.1.2 Harris and Gurel (1986)

Harris and Gurel perform an event study on stocks included in the S&P 500 in the period 1973-1983, studying *"price pressures caused by large transactions"* (p. 815). The authors state: *"Immediately after an addition is announced, prices increase by more than 3 percent. This increase is nearly fully reversed after 2 weeks"* (p. 815). Furthermore, they observe increased trading volume *"after the announcement date, which is suggestive of a shift in demand"* (p. 828).

4.4.1.3 Dhillon and Johnson (1991)

Dhillon and Johnson review the findings from the papers from Shleifer (1986) and Harris and Gurel (1986), questioning the price-pressure and imperfect-substitutes hypotheses. They perform an event study on stocks included in the S&P 500 in the period 1978-1988. For the period 1978-1983, they observe an effect on returns on the announcement date which is partially reversed, while for the period 1984-1988 the effect is not reversed until 60 days after the announcement date.

In addition, Dhillon and Johnson find increased bond and call prices and decreasing put prices after the announcement. Their findings are *"consistent with the information hypothesis, inconsistent with the price-pressure hypothesis, and consistent with the imperfect-substitutes hypothesis only if stocks, bonds, puts, and calls for the same firm are close substitutes"* (pp. 84-85).

4.4.1.4 Beneish and Whaley (1996)

Beneish and Whaley study the changes in the S&P 500 index composition from January 1986 through June 1994. They base their findings on a regulation change that resulted in a fixed period between announcement and inclusion. The authors argue that the regulation change led to the *"S&P game"* (p. 1909) allowing *"risk arbitrageurs"* to buy shares after the announcement but prior to the effective inclusion, resulting in selling at a higher price to index funds close to the inclusion date.

4.4.1.5 Lynch and Mendenhall (1997)

Lynch and Mendenhall investigate the index effect on price and volume of stocks included in and deleted from the S&P 500 in the period 1990-1995. Their study is based on the new inclusion policy, where the announcement happens one week before the actual inclusion. The authors find a *"significant positive announcement day abnormal return"* (p. 352) and a *"positive cumulative abnormal return (...) over the period starting the day after the announcement and ending the day before the effective date of the change"* (p. 352). Furthermore, they observe a reversal of this effect, following the effective inclusion date. For deletions, an inversion of the effect is observed. Abnormally high trading volume is also documented the day before the S&P 500 is revised.

4.4.1.6 Chen, Noronha and Singal (2004)

Chen et al. study the effect on the price of stocks included in and deleted from the S&P 500. They find a permanent price increase for stocks included in the period 1962-2000. However, no permanent price reduction is found for deleted stocks. The authors argue that the permanent price increase can be attributed to the changes in the expected cash flows or changes in the discount rate. Stocks included in the index gain attention from investors based on *"changes in investor awareness and the consequent effect on investor behavior"* (p. 1928).

4.4.1.7 Kasch and Sarkar (2011)

Kasch and Sarkar study the effect on price and co-movement of stocks included in the S&P 500 in the period 1989-2009, arguing against a permanent S&P 500 index effect. They investigate the performance of stocks included in the index compared to a sample of stocks that were not included in the index. The authors discover a similar pre-event performance for both groups. They argue that the effect of index inclusions on stock price and co-movement is based on the strong pre-inclusion performance that is however not unique to stocks included in the index.

4.4.1.8 Gerke, Arneth and Fleischer (1999)

Gerke et al. study the effect on the price of stocks included in and deleted from the German stock index DAX in the period 1994-1998. By conducting an event study, they find a cumulative abnormal return of over 9% in the event window, which they find surprising since the German capital market is considered *"relatively efficient"* (p. 1). After the inclusion date, the effect is partially reversed. Furthermore, the authors argue that the introduction of the German midcap index MDAX strengthened the index effect (p. 1).

4.4.2 Previous studies on the FTSE 100

4.4.2.1 Opong and Hamill (2004)

Opong and Hamill study the price and volume effects for stocks included in and deleted from the FTSE 100 in the period 1984-1999. They find a *"significant price increase prior to additions to the FTSE 100, which is followed by a price reversal, which appears to persist over the long-term"* (p. 2). Their findings for additions are *"consistent with the predictions from the Price-Volatility-Hypothesis. (...) Also, these findings appear to be an anomalous violation of semi-strong-form market efficiency"* (p. 2).

4.4.2.2 Mase (2007)

Mase investigates composition changes in the FTSE 100 for the period 1992-2005. The author finds evidence for the price-pressure hypothesis. Importantly, *"investor awareness and monitoring due to index membership do not explain the price effects"* (p. 461) which contradict the findings of Chen et al. (2004). Mase argues that companies added to the FTSE 100 are already large and have adequate monitoring.

4.4.2.3 Mazouz and Saadouni (2007)

Mazouz and Saadouni examine the price effect of stocks included in and deleted from the FTSE 100 in the period 1984-2003. They also find evidence for the price-pressure hypothesis which implies temporary abnormal returns in the period shortly before the announcement date until the inclusion date. Their findings suggest that there is no permanent price effect that can be attributed to changes in the discount rate, contradicting the findings of Chen et al. (2004).

4.4.2.4 Opong and Siganos (2013)

Opong and Siganos examine the changes in the FTSE 100 composition for the period 1992-2009. In line with previous studies conducted on the FTSE 100, the authors find evidence for the price-pressure hypothesis. In addition, trading strategies based on index revisions of the FTSE 100 are presented.

Table 2 provides an overview of previous studies on the foreign indices and the FTSE 100.

4.4.3 Summary of previous studies

Table 2 provides an overview of the existing hypotheses for the index effect.

Author(s)	Year	Index	Period	Price effect	Volume effect
Shleifer	1986	S&P 500	1996-1983	Permanent	Not specified
Harris & Gurel	1986	S&P 500	1973-1983	Temporary	Permanent
Dhillon & Johnson	1991	S&P 500	1978-1988	Permanent	Permanent
Beneish & Whaley	1996	S&P 500	1986-1994	Temporary	Permanent
Lynch & Mendenhall	1997	S&P 500	1990-1995	Temporary	Temporary
Chen, Noronha & Singal	2004	S&P 500	1962-2000	Permanent	Temporary
Kasch & Sarkar	2011	S&P 500	1989-2009	No price effect	Not specified
Gerke, Arneth & Fleischer	1999	DAX	1994-1998	Temporary	Not specified
Opong & Hamil	2004	FTSE 100	1984-1999	Temporary	Temporary
Mase	2007	FTSE 100	1992-2005	Temporary	Temporary
Mazouz & Saadouni	2007	FTSE 100	1984-2003	Temporary	Temporary
Opong & Siganos	2013	FTSE 100	1992-2009	Temporary	Temporary

Table 2
Summary of previous studies
Summary of previous studies exploring the price and volume effects associated with index inclusions. “Not specified” means that the hypothesis does not provide a clear explanation regarding the effect.

5 Methodology and data

This section covers existing event study methodology and applied methodology, followed by the discussion of applied data sources.

5.1 Event study methodology

5.1.1 Introduction to event studies

Event studies are commonly used to test the efficient market hypothesis - investigating price and volume effects over a specific time horizon. Kritzman (1994) states that event studies are not only a useful statistical tool to test the market efficiency but also valuable regarding investigating the magnitude of an event's impact. The following description of event study methodology draws on Thompson (1985), Ajinkya and Jain (1989), MacKinlay (1997), Amihud et al. (1997) and Mase (2007).

5.1.2 Definition of the event and the event window

The first step in an event study is to define the event of interest as well as the event window (MacKinlay, 1997). It is worth mentioning that for certain events, the date of announcement of the event and the event itself might differ. It is, therefore, necessary to further define the event of interest. The event window is the time frame of the event of interest for a chosen security. The event window is often chosen to include a certain amount of days before and/or after the event. Choosing an event window larger than the specific period of interest will allow further examination of the periods close to the event date. If one suspects an information leakage prior to the actual event, an event window that includes days before the event might be beneficial. Deciding the length of the event window is a trade-off between capturing the full effect of the event and running the risk of capturing other events that are outside the event of interest.

5.1.3 Definition of the estimation window

In the next step, the estimation window needs to be defined (MacKinlay, 1997). The estimation window includes data points that are used to calculate the parameters in the normal return model. The data points in the estimation window will normally be different to the data points in the event window, by choosing data points prior to the event. MacKinlay

(1997) states: *"It is typical for the estimation window and the event window not to overlap. This design provides estimators for the parameters of the normal return model which are not influenced by the returns around the event. Including the event window in the estimation of the normal model parameters could lead to the event returns having a large influence on the normal return measure."* (p. 20).

5.1.4 Selection criteria for stock inclusions

After defining the estimation window, the selection criteria for the inclusion of a given stock in the study needs to be determined (MacKinlay, 1997). The criteria might include restrictions such as different firm characteristics and/or restrictions due to data availability. The selection criteria form the final sample of stocks for the event study. One needs to be aware of certain biases that might arise from the selection process. For example, a selection bias may occur if certain industries are overrepresented.

5.1.5 Normal return model

To measure the effect of an event, a normal return model needs to be established. *"The normal return is defined as the expected return without conditioning on the event taking place"* (MacKinlay, 1997, p. 15). MacKinlay (1997) divides the normal return models into two groups: statistical and economic models.

Statistical models are based on statistical assumptions regarding the behaviour of asset returns and do not build on economic arguments. These models assume that asset returns are *"jointly normal, independently and identically distributed"* (MacKinlay, 1997, p. 35). Economic models, on the other hand, are based on both economic and statistical assumptions, where the latter is necessary for the use in practice. MacKinlay (1997) states: *"Economic models can be cast as restrictions on the statistical models to provide more constrained normal return models"* (p. 19).

In the following, statistical and economic models are presented.

5.1.5.1 Market model

The market model, also known as the single index model, is a statistical model that measures the return for a stock i, based on the market return and the parameters alpha and beta. The model assumes joint normality across all asset returns. MacKinlay (1997) states: *"The market model assumes a stable linear relation between the market return and the security return"* (p. 15).

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$
$$E(\varepsilon_{it}) = 0 \quad var(\varepsilon_{it}) = \sigma^2_{\varepsilon_i} \tag{2}$$

R_{it} and R_{mt} are the returns for stock i and the market portfolio at time t. The beta, β_i, represents the systematic risk of a security i, measuring how the security fluctuates with the market (Bodie et al., 2014). Alpha, α_i, is the average return in excess of a benchmark. The market return, R_{mt}, can be is calculated by using an appropriate stock index, representing the benchmark. e_{it} is the residual for stock i at time t with an expected value of zero.

The market model can also be applied to volume, where V_{it} and V_{mt} is the volume for stock i and the market.

$$V_{it} = \alpha_i + \beta_i V_{mt} + \varepsilon_{it}$$
$$E(\varepsilon_{it}) = 0 \quad var(\varepsilon_{it}) = \sigma^2_{\varepsilon_i} \tag{3}$$

5.1.5.2 Constant mean return model

The constant mean return model assumes that the mean return for an asset is constant over time.

$$R_{it} = \mu_i + \varepsilon_{it}$$
$$E(\varepsilon_{it}) = 0 \quad var(\varepsilon_{it}) = \sigma^2_{\varepsilon_i} \tag{4}$$

R_{it} is the constant expected return for stock i at time t, μ_i is the mean return for stock i, and e_{it} is the residual for stock i at time t. The residual has an expected value equal to zero. Brown and Warner (1980, 1985) find that this simple model can yield results similar to the more sophisticated models like the market model.

5.1.5.3 Multifactor models

A multifactor model is another statistical model that can be used to measure the normal return. MacKinlay (1997) states: *"Factor models are motivated by the benefits of reducing the variance of the abnormal return by explaining more of the variation in the normal return."* (p. 18). A well-known multifactor model is the Fama-French three-factor model. Generally, factor models have the following structure:

$$R_{it} = \alpha_i + \beta_1 F_1 + \beta_2 F_2 + \cdots + \beta_n F_n + \varepsilon_{it} \tag{5}$$

The coefficient given by beta, β_n, indicates how much of the return can be explained by a given factor, *F*. MacKinlay (1997) finds that the gain from applying a multifactor model, such as the Fama-French three-factor model, in an event study is limited. If, on the other hand, the data sample is skewed, for example, if a majority of firms from the data sample belongs to one specific category or industry, the use of a multifactor model will likely reduce the variance of the abnormal returns.

5.1.5.4 Capital Asset Pricing Model

The Capital Asset Pricing Model (CAPM) is an economic model based on the equilibrium theory by Sharpe (1964) and Lintner (1965). In the CAPM, the expected return of a given asset is determined by its covariance with the market portfolio (MacKinlay et al., 1997). The normal return is calculated using an estimate of beta and the market return.

$$R_{it} = R_f + \beta_i (R_m - R_f) \tag{6}$$

R_{it} is the return of the stock i, R_m is the market return, and R_f represents the risk-free rate. β_i represents the covariance with the market portfolio.

5.1.6 Framework for abnormal returns and volume

To measure the impact of an event, abnormal returns and volume are calculated. *"The abnormal return is the actual ex post return of the security over the event window minus the normal return of the firm over the event window."* (MacKinlay, 1997, p. 15). The formula for abnormal return is denoted by:

$$\widehat{AR}_{it} = R_{it} - E(R_{it}|\text{Normal return model})$$
$$\widehat{AR}_{it} \sim N(0, \sigma^2(\widehat{AR}_{it})) \tag{7}$$

Abnormal volume can be calculated similarly to abnormal returns. The formula for abnormal volume is denoted by:

$$\widehat{AV}_{it} = V_{it} - E(V_{it}|\text{Normal volume model})$$
$$\widehat{AV}_{it} \sim N(0, \sigma^2(\widehat{AV}_{it})) \tag{8}$$

To test the statistical significance of the abnormal returns and volume, aggregation needs to be implemented. *"The abnormal return observations must be aggregated in order to draw overall inferences for the event of interest. The aggregation is along two dimensions - through time and across securities."* (MacKinlay, 1997, p. 21). Firstly, by aggregating each stock's abnormal return and volume over time, we obtain the cumulative abnormal return and volume, defined as CAR_i and CAV_i, respectively. Secondly, the abnormal returns and volume are aggregated across stocks in the sample. The resulting average abnormal return and average abnormal volume are defined as AAR_t and AAV_t:

$$AAR_t = \frac{1}{N} \sum_{i=1}^{N} \widehat{AR}_{it} \tag{9}$$

$$AAV_t = \frac{1}{N} \sum_{i=1}^{N} \widehat{AV}_{it} \tag{10}$$

Additionally, the average abnormal returns across all stocks can be aggregated over time, given by the cumulative average abnormal return, CAAR.

5.1.7 Clustering

In an event study, the creation of event portfolios is necessary if event windows overlap. This is known as clustering. According to MacKinlay (1997), *"when the event windows do overlap and the covariances between the abnormal returns will not be zero, the distributional results presented for the aggregated abnormal returns are no longer applicable"* (p. 27).

In order to draw inference for the event study, event portfolios based on clustering are implemented. The following method is discussed by Thompson (1985) and applied by

Amihud et al. (1997) and Mase (2007). Mase (2007) explains in regard to clustering: *"model parameters and associated variances should be estimated by aggregating the shared-event firm returns into portfolios. For each event cluster, an equally weighted portfolio return is therefore calculated."* (p. 468).

5.2 Applied methodology

5.2.1 Choice of the event

Our study considers the effective announcement date as the event date since no new information regarding the event will be brought to the market at the inclusion date. As presented in the introduction of the FTSE 100 in Section 2, the index is revised every three months. During the composition change, two dates are of interest - the announcement date and the inclusion date. There is a fixed number of trading days between the announcement and the inclusion. In contrast to the effective inclusion, the announcement of stocks being included in the index happens after trading hours. We, therefore, define the effective announcement date in this event study as the first trading day after the initial announcement.

5.2.2 Choice of the event window

The event window is set to 21 trading days[7]: ten days before the event and ten days after the event. By examining a certain time frame before and after the event, we can observe if there is an index effect as well as in which intervals the effect, if any, is the most prominent and if it is of temporary nature. We examine a relatively large event window in light of a short run event study to understand how the market reacts before the announcement as well as after the inclusion. This is due to the index revisions being based on market capitalisation and price and volume changes before the announcement might be expected. In this study, a larger event window sheds light on the degree of market efficiency. Within the event window, shorter intervals for the average cumulative abnormal return are also investigated.

[7] The event window for the volume analysis has been set to (-20, +19) in order to observe trading volume over a longer period. Ajinkya and Jain (1989) state that a theory similar to the efficient market hypothesis does not exist in regard to trading volume. Therefore, there is little information about trading volume behaviour around an event. As a consequence, a longer event window is preferred.

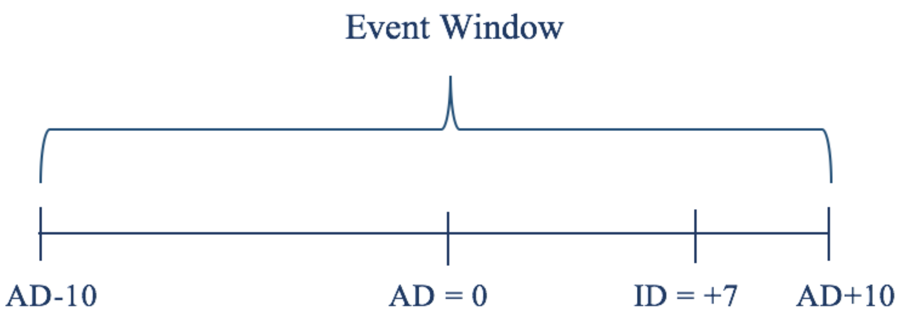

Figure 1
Choice of the event window
The figure shows the selected event window (-10, +10) for the empirical analysis. AD is the effective announcement date while ID is the effective inclusion date.

5.2.3 Choice of the estimation window

Choosing a suitable estimation window is important in order to detect potential abnormal returns during the event window. We apply an estimation window of a year[8]. A "quiet period" of 40 trading days is applied between the estimation window and the event window. By having a large enough gap between the estimation and event window, we reduce the risk of the event tainting the data used to calculate the parameters in the normal return model. Tainted data can lead to upwardly biased alpha estimates for index inclusions (Lynch & Mendenhall, 1997).

5.2.4 Choice of the normal return model

In the methodology section, commonly used statistical and economic models were presented. Several event studies conducted on the S&P 500 and the FTSE 100 (Lynch & Mendenhall (1997) and Mase (2007), among others) used the market model as their normal return model to investigate if there are abnormal price and volume effects. MacKinlay (1997) argues that statistical models can be more relevant since the validity of the restrictions imposed by the economic models, like the CAPM, can be questioned. Therefore, we use the market model to investigate price and volume effects. Since multiple stocks are, in most occasions, simultaneously included in the quarterly revisions of the FTSE 100, clustering will be present. The market model is therefore implemented on event portfolios.

Two statistical models, in addition to the market model, were previously presented: multifactor models and the constant mean return model. The reasons for implementing the

[8] This corresponds to around 252 trading days.

market model rather than the other statistical models are as follows. Multifactor models, such as the Fama-French three-factor model, are preferred normal return models if an industry is overrepresented in the data sample or if the data sample is heavily loaded on a factor dimension. In regard to our data sample, we do not find that any industry is overly represented.[9] Therefore, we do not conduct our event study using a multifactor model.

Regarding the constant mean return model, Brown and Warner (1980, 1985) argue that even if the constant mean return model is a simple model, it will often yield results comparable to more sophisticated statistical models. However, the authors find that the constant mean return model is not well suited for event studies where event windows will overlap, due to clustering.

5.3 Data

5.3.1 Data sources

The information regarding historic index additions and deletions for the FTSE 100 is obtained from the index operator (FTSE Russell, 2016). The index operator provides summarised data for inclusion dates. However, the announcement dates are provided separately and were manually collected for each inclusion. Stock prices, market and trading volume data are obtained from the database Datastream. The empirical analysis is conducted in Stata and Excel.

5.3.2 Data frequency

Daily, weekly and monthly data on stock prices and trading volume is available. For this study, we use daily data in the event window and weekly data in the estimation window. Daily data in the event window enables us to examine price and volume effects in different daily intervals around the event date. By examining daily versus weekly data in the event window, the precision of the effect measured increases.

In regard to the data frequency in the estimation window, the literature is divided. Brown and Warner (1980, 1985) argue that daily data has the tendency to not be normally distributed and

[9] Industry allocation of stocks included in the event study can be found in the Table 12 in appendix.

to have more "noise" than weekly and monthly data. Using daily data in the estimation period increases the risk of including kurtosis. Kurtosis is a measure that implies how much of the variance arises from extreme values, also known as outliers (Stock & Watson, 2015). Weekly data is therefore used in the estimation window. The benefit of using weekly data instead of monthly data is the increased number of data points within the selected estimation window, increasing the precision in our estimates.

5.3.3 Calculation of returns and trading volume

We use adjusted close prices, representing the market price at the end of the trading day, adjusted for stock splits and dividends. Furthermore, we use simple returns[10], calculated according to the following formula:

$$R_t = \frac{(P_t - P_{t-1})}{P_{t-1}} \quad (11)$$

Trading volume data is adjusted for capital changes. We use the following measure for trading volume:

$$V_{it} = \frac{log(V_{it})}{log(MV_{it})} \quad (12)$$

V_{it} is the turnover by value on day t for stock i, and MV_{it} is the market value of the outstanding shares on day t for stock i. The log-transformed measure is used in order to ensure a distribution close to normal (Ajinkya & Jain, 1989).

5.3.4 Market index

The FTSE 100 is chosen as the market index due to its strong representativeness on the London Stock Exchange. According to the CFA Institute (2017), the correlation between the FTSE 100 and the FTSE All-Shares[11] in the period 2000-2009 was 99.37%. Furthermore, our event study is conducted on the FTSE 100.

[10] Conducting the event study with log returns did not reveal significantly different results.
[11] The FTSE All-Share index represents the performance of all eligible companies listed on the London Stock Exchange's main market. It captures 98% of the UK's market capitalisation (FTSE Russel, 2017c).

5.3.5 Stock selection

We focus on the period from March 2005[12] until December 2013 to investigate if there is a FTSE 100 index effect, inspecting more recent data than previous studies. The main analysis does not focus on a later period due to a regulation change, effective from March 2014, which resulted in a longer period between the announcement and inclusion dates.

Each stock inclusion is defined as an event. For the selected time frame, we start with a sample of 109 inclusions. Stocks have been excluded due to the following practical and theoretical reasons:

- missing data in terms of announcement or inclusion date or stock data
- mergers, acquisitions, demergers and restructuring events
- fast track entries
- reserves - stocks inclusions that happened outside of the regular quarterly reviews on the basis of the reserve list provided by the index operator are excluded as they are considered as extraordinary events
- stocks with extreme alpha values, here defined as an alpha larger than +0.02 or smaller than -0.02 during the estimation period. Extreme alpha values result in tainted parameters for the normal return model.
- stocks with other events interfering in the event window.

Stocks in our final sample were listed at least one year before the event window and remain in the FTSE 100 index at least 20 trading days after the effective announcement. After evaluating the initial sample in regard to the criteria listed above, the final sample comprises of 56 inclusions.

Due to overlapping event windows, referred to by Brown and Warner (1980) as *"calendar time clustering of events"* (p. 207), we assign stocks into equally weighted portfolios by the date of the quarterly index revision. Resulting in 31[13] portfolios, also known as event clusters. By creating event clusters, the abnormal returns and volume can be aggregated over time and across stocks.

[12] The first index revision of the year happens in March. As mentioned earlier, the index is revised quarterly: March, June, September and December.

[13] Due to missing data for trading volume, the analysis regarding volume has been conducted on 29 clusters.

In light of the awareness hypothesis, we conduct a sub-event study distinguishing between new and previous constituents for the chosen period. We investigate if new constituents have a higher abnormal return, if any, compared to previous constituents. Data available from FTSE Russell regarding constituents in the FTSE 100 dates back to 1984. We have therefore looked at our sample (before clustering) of 56 inclusions from 2005 to 2013, and evaluated if the inclusions are new additions to the index or previous additions. We find 31 new and 25 previous constituents, resulting in 22 and 19 clusters, respectively[14].

5.3.6 Discussion regarding validity

It is debatable whether our sample of 31 event portfolio clusters is large enough to draw conclusions regarding possible price and volume effects on the FTSE 100 during the selected period. By applying event portfolio clustering, concerns regarding overlapping event windows and existing correlation among the standard errors are addressed. On the other hand, the reduced sample size can impair the statistical conclusion validity of the empirical results. With a smaller sample, the chance of the type II error increases.

[14] See Tables 7-11 in appendix for the lists of included and excluded stocks.

6 Expected findings

Previous research on the FTSE 100 (Opong & Hamill, 2004; Mase, 2007 and others) suggests that there is a temporary index effect for stocks included in the index. The authors support their findings with different hypotheses; however, attempts referring to increased trading volume around the inclusion date seem to be the most prominent.

In accordance with previous research on the FTSE 100, we expect to find positive abnormal returns and abnormal trading volume around the composition changes for stocks entering the FTSE 100.

Furthermore, we want to test the awareness hypothesis. In the light of this hypothesis, we expect higher positive abnormal returns for new compared to previous constituents of the FTSE 100.

In line with our research question *"Do positive price and volume effects arise in regard to index inclusions in the FTSE 100?"* we are interested in testing the following hypotheses:

1. If there are significant abnormal returns around the change of the index composition for stocks entering the FTSE 100.

H_0 = *There are no significant abnormal returns around the change of the index composition for stocks entering the index.*
H_A = *There are significant abnormal returns around the change of the index composition for stocks entering the index.*

2. If there is significant abnormal trading volume around the change of the index composition for stocks entering the FTSE 100.

H_0 = *There is no significant abnormal trading volume around the change of the index composition for stocks entering the index.*
H_A = *There is significant abnormal trading volume around the change of the index composition for stocks entering the index.*

3. If there are higher abnormal returns for stocks entering the FTSE 100 for the first time versus re-entering stocks.

H_0 = *There are no significant higher abnormal returns around the change of the index composition for stocks entering the index for the first time versus re-entering stocks.*
H_A = *There are significant higher abnormal returns around the change of the index composition for stocks entering the index for the first time versus re-entering stocks.*

7 Empirical findings

In this section, the empirical findings will be presented. We first present the results for abnormal returns and volume for the full sample around the effective announcement and inclusion dates. Subsequently, we run a sub-event study by splitting the sample into two groups - namely new and previous constituents, in order to test the awareness hypothesis.

7.1 Returns

Table 3[15] presents the results for the average abnormal returns (AARs) and the cumulative average abnormal returns (CAARs) for stocks included in the index in the period 2005-2013. AARs are reported for ten days prior to and ten days after the effective announcement date. No significant AARs can be found for the period -10 to -5 in the event window. On the day -4 we find a positive and significant AAR of 0.70%. On the effective announcement date, the AAR is negative (-0.88%) and significant on a 1% level.

On the day before the effective inclusion date, day +6, we find a positive and significant AAR of 0.83% whereas on the effective inclusion date we find a negative and significant AAR (-1.44%). This reversal is confirmed by Mase (2007). Negative and significant AARs are also reported for day +9 and +10 in the event window.

AARs (%) are illustrated in Figure 2. On the effective announcement date (day 0) there is a negative peak whereas on day +6 there is a positive peak that reverses the next trading day, namely the effective inclusion date.

[15] Tables 3-6 can be found in appendix.

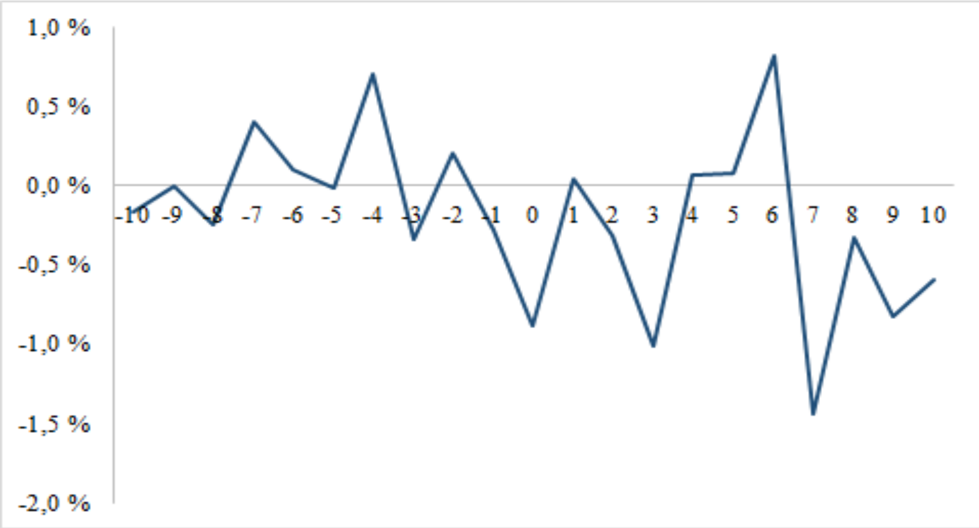

Figure 2
AARs around the announcement and inclusion dates
Average abnormal returns, AARs (%) for stocks included in the FTSE 100 index from March 2005 to December 2013. The effective announcement date is day 0, and the effective inclusion date is day +7. The AARs come from the market model $Rit = \alpha i + \beta iRmt + \varepsilon it$ with parameters estimated before the event, using weekly data over a year including a "quiet period" of 40 trading days.

Figure 3 plots the CAARs (%) for the event period -10 to +10. The graph shows positive CAARs for the period -6 to -1. However, after the effective announcement date, the CAARs fall despite a positive peak on day +6. The price reversal continues until the end of the post-event period. The post-event shape of the graph is similar to the findings of Opong and Hamill (2004) and Mazouz and Saadouni (2007).

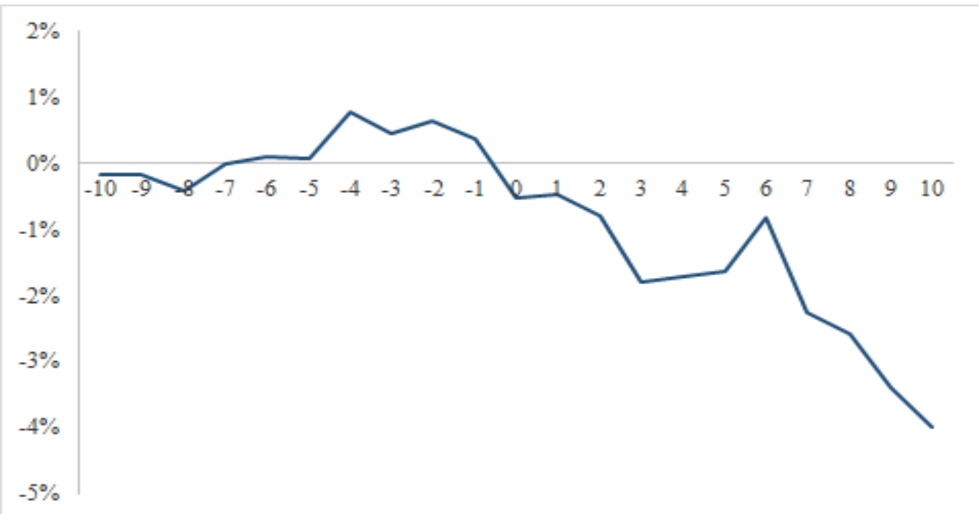

Figure 3
CAARs around the announcement and inclusion dates
Cumulative average abnormal returns, CAARs (%) for stocks included in the FTSE 100 index from March 2005 to December 2013. The effective announcement date is day 0, and the effective inclusion date is day +7. The CAARs come from the market model $Rit = \alpha i + \beta iRmt + \varepsilon it$ with parameters estimated before the event, using weekly data over a year including a "quiet period" of 40 trading days.

Furthermore, Table 3 shows the CAARs for different intervals. A negative and significant CAAR on a 10% level is found for the interval (-1, 0), namely close to the effective announcement date. For the interval representing the period after the effective inclusion date (+7, +10) we find a negative and significant CAAR of -3.18%. However, for the whole event window (-10, +10) as well as other intervals reported in Table 3, the CAARs are insignificant.

7.2 Trading volume

We further investigate the trading volume around the effective announcement and inclusion dates. Table 3 presents the average abnormal trading volume (AAV) for stocks added to the index in the period 2005-2013. For the days in the event window -2 to +10 we find positive and significant AAV with high values around day 0 and day +6, that is the effective announcement date and the day before the inclusion, on a 1% level. On the day before the effective inclusion date, the AAV is 7.76% with an associated t-statistic of 13.73.

The results for the AAV are illustrated in Figure 4. The graph shows a prominent peak on day +6, suggesting significant abnormal trading activity one day before the effective inclusion date. Furthermore, the positive and significant AAV of over 1% twelve days after the effective inclusion date, suggests increased trading activity after the index composition change. However, Ajinkya and Jain (1989) suggest that trading volume is prone to autocorrelation for longer event periods, even when clustering has been conducted. This may bias our interpretation of the post-inclusion results for trading volume. Therefore, the significant results for trading volume in the post-inclusion period can be questioned.

Nonetheless, the results are consistent with findings of Opong and Hamill (2004) and Mase (2007) who also report increased trading activity before and after the announcement date. *"This evidence of increased trading before the announcement implies traders anticipate the announcement"* (Mase, 2007, p. 475). This is in line with the FTSE 100 selection process, which is solely based on market capitalisation.

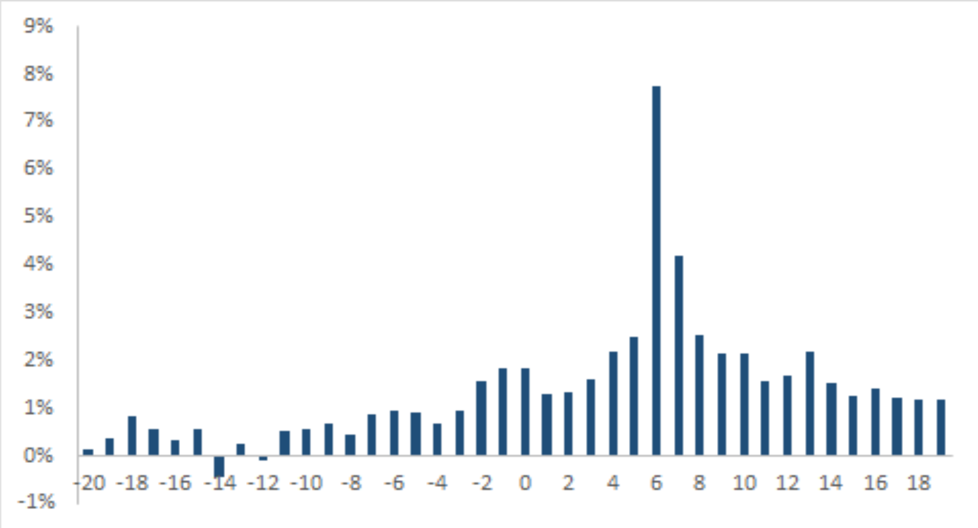

Figure 4
AAV around the announcement and inclusion dates
Average abnormal volume, AAV (%) for stocks for stocks included in the FTSE 100 index from March 2005 to December 2013. The effective announcement date is day 0, and the effective inclusion date is day +7. The average abnormal volume is obtained from the market model $Vit = \alpha i + \beta i\ Vmt + \varepsilon it$ estimated before the event, using weekly data over a year including a "quiet period" of 40 trading days.

7.3 Interpretation of findings

The results for the pre-announcement performance contradict the findings of a large body of the literature examining the index effect on the S&P 500 (for instance, Shleifer, 1986; Lynch & Mendenhall, 1997). As mentioned in Section 2, the choice of index inclusions on the S&P 500 includes subjective measures in comparison to the objective approach of the FTSE 100 - only taking market capitalisation into account. Consequently, we do not observe similar empirical results. Studies on the S&P 500 find positive abnormal returns on the effective announcement date. In contrast, we do not find a positive AAR on the effective announcement date.

On the day before the effective inclusion date, we find a positive price effect in connection with a significant increase in trading volume which supports the price-pressure hypothesis. The positive price effect being temporary, results in the price reversal observed on the effective inclusion date. An alternative explanation to the price-pressure hypothesis could be the stale news hypothesis which suggests increased interest from investors trading on stale news, resulting in a large price reversal swiftly after the price increase. The absence of a permanent price effect allows us to exclude the liquidity and transaction costs hypotheses as well as the hypothesis of imperfect substitutes.

Our results for the post-inclusion performance, showing further price reversal, are consistent with the findings of Opong and Hamill (2004) and Mazouz and Saadouni (2007). There are two possible explanations for the post-inclusion performance. According to the price-volatility hypothesis, the price decline after the inclusion can be explained by increased volatility due to excess demand from index funds prior to inclusion, observed on day +6 in the event window. According to Opong and Hamill (2004), the future cash flows would be discounted at a higher rate to reflect the premium for the additional volatility.

However, Mazouz and Saadouni (2007) examine the link between the CAAR reversal and the decreased discount rate and do not find a significant relationship. *"The total permanent event window indicates that the CAR reversal is not permanent implying that the price volatility hypothesis may not fully explain the price behaviour around the index revision dates"* (p. 505). The authors argue that the post-event window selection bias leads to the price reversal. Therefore, we believe that the price-pressure hypothesis is the best explanation for our findings.

7.4 Is there a FTSE 100 index effect?

Harris and Gurel (1986) argue that abnormal returns associated with the change of the index composition represent a violation of the efficient market hypothesis, in its semi-strong form. Our empirical results suggest that positive and significant abnormal returns and abnormal trading volume exist the day before the effective change of the index composition and thus there is a temporary index effect. Therefore, we reject the null hypotheses in regard to price and volume effects for the full sample. Nonetheless, we do not find an index effect in regard to positive AARs and AAV close to the announcement date. The mispricing found around the inclusions suggests that the market is not efficient in the semi-strong form.

7.5 Test of the awareness hypothesis

Chen et al. (2004) suggest that possible price effects associated with the change of the index composition are based on increased investor awareness and increased monitoring of the firm. According to Mase (2007), *"if changes in investor awareness or monitoring are important in explaining the price effects, then these should be most apparent in the new additions, and not* *in the additions of previous constituents. (...) However, the addition of a firm that has previously been a constituent should result in little change in investor awareness, and therefore the price effects should be temporary"* (p. 472). The author examines the FTSE 100 index composition changes and finds no evidence for increased investor awareness regarding new constituents, arguing that companies joining the index should already be large enough and well-known.

To test the awareness hypothesis, we conduct a sub-event study by splitting our initial sample in stocks that entered the index for the first time since 1984 (new constituents) and stocks that entered the index for at least the second time since 1984 (previous constituents).

Table 5 contains the results for AARs, CAARs and AAV for new constituents. On the effective announcement date, we find a negative AAR of -1.08% that is significant on a 5% level. Furthermore, one day before the effective inclusion date we find a positive AAR of 0.77%, which is however not significant. On the effective inclusion date, we find a negative and significant AAR of -1.52%.

Table 6 contains the results for previous constituents. On the effective announcement date, we find an insignificant negative AAR of -0.37%. Furthermore, one day before the effective inclusion date we find a positive AAR of 0.79% that is significant on a 5% level. On the effective inclusion date, we find a negative and significant AAR of -1.21%.

Figure 5 illustrates the AARs for both new and previous constituents. We observe that the AARs for new constituents are more volatile.

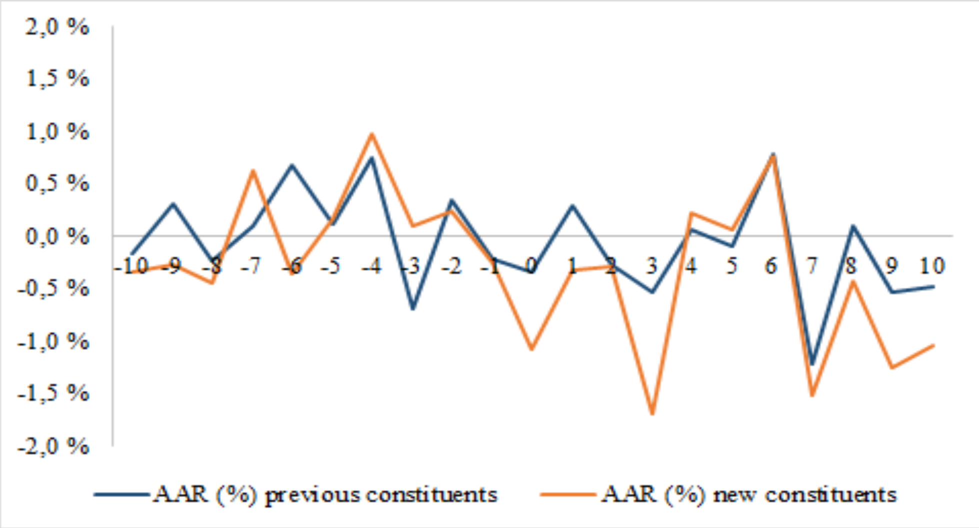

Figure 5
AARs around the announcement and inclusion dates for new and previous constituents
Average abnormal returns, AARs (%) for new and previous constituents included in the FTSE 100 index from March 2005 to December 2013. The effective announcement date is day 0, and the effective inclusion date is day +7.

Figure 6 plots the CAARs for both groups. For a large extent of the event period, CAARs are positive for previous constituents. For new constituents, the CAARs drop considerably at the effective announcement date. In addition, the post-inclusion price reversal is significantly higher for new constituents, reaching -6% on day +10.

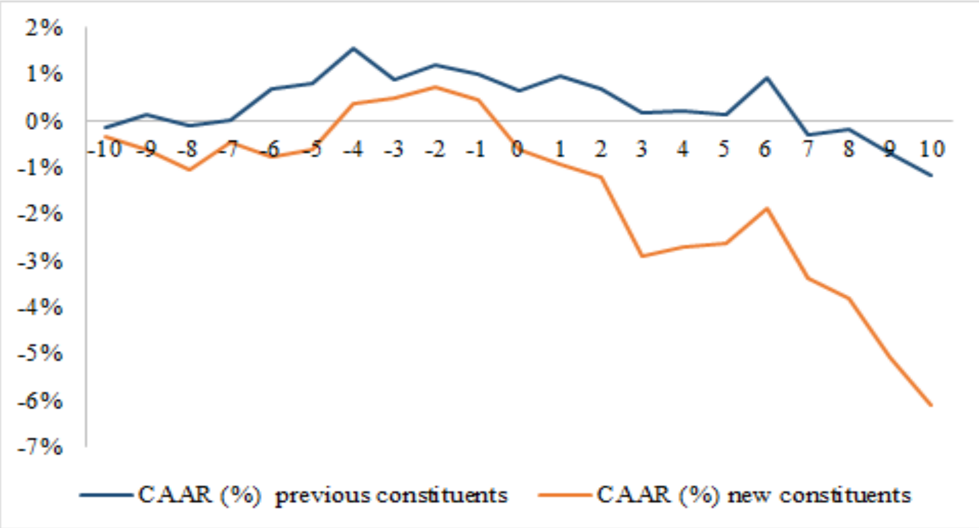

Figure 6
CAARs around the announcement and inclusion dates for new and previous constituents
Cumulative average abnormal returns, CAARs (%) for new and previous constituents included in the FTSE 100 index from March 2005 to December 2013. The effective announcement date is day 0, and the effective inclusion date is day +7.

Figure 7 shows the AAV for both groups. The results are similar to the AAV found for the full sample. For the pre-inclusion period (days +3 to +6) the AAV is marginally higher for new constituents. For the post-inclusion period (days +7 to +12) the picture is reversed.

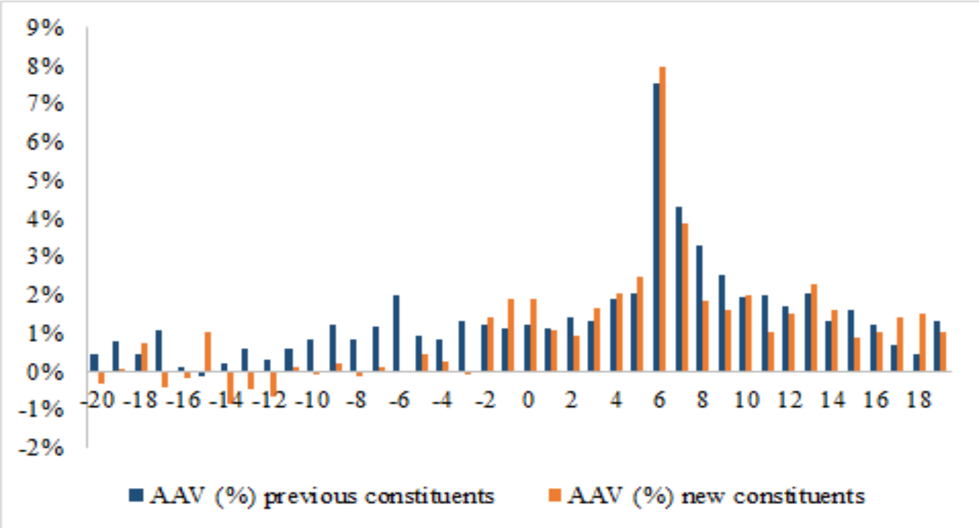

Figure 7

AAV around the announcement and inclusion dates for new and previous constituents

Average abnormal volume, AAV (%) for new and previous constituents for stocks included in the FTSE 100 index from March 2005 to December 2013. The effective announcement date is day 0, and the effective inclusion date is day +7.

Overall, there is no evidence supporting higher investor awareness for new constituents that results in higher AARs compared with previous constituents. This is in accordance with the findings of Mase (2007). Therefore, we cannot reject the null hypothesis in regard to new versus previous constituents.

8 Trading strategies based on empirical findings

In this section, we investigate plausible trading strategies in light of our empirical findings, earlier presented. Marginal positive average abnormal return the day before the effective inclusion date was found. The findings are significant from a statistical and economic point of view; the latter being explained by index funds rebalancing their portfolios around this time. Consequently, in light of our empirical findings, index inclusions in the FTSE 100 reflect market inefficiency. In line with traditional economic theory, investors can take advantage of inefficient markets. However, index revisions automatically resulting in investment opportunities is far from the truth. With imperfect markets, taking into consideration transaction costs as well as risk, speculation regarding the index effect might not be profitable. In the following, we present trading strategies from the literature followed by an analysis of plausible trading strategies in regard to our empirical findings.

8.1 Previous studies on trading strategies in regard to the index effect

In October 1989, Standard and Poor's introduced five trading days between the announcement date and the effective change of the index composition, which previously happened on the same trading day. With this new rule, speculators could trade on the index revisions - buying included stocks after the announcement, ahead of index funds, and selling on the day of the inclusion. Based on the new rule, Beneish and Whaley (1996) propose a trading strategy in regard to the changes in the S&P 500 index composition from 1986 to 1994. They discover that going long in stocks after the announcement, with a holding period until the inclusion, as well as going short in futures on the S&P 500, yields an average abnormal return of 4.01% for the assigned period. The authors' trading strategy is based on their findings of a positive permanent price effect.

Studies examining the index effect on FTSE 100 also explore trading strategies based on the quarterly revisions and extraordinary inclusions include Fernandez and Mergulhão (2011) and Opong and Siganos (2013). Fernandez and Mergulhão (2011) present a strategy involving long positions in stocks to be included in the index and short positions in stocks to be excluded from the index. The authors find *"excess returns over the FTSE 100 index (that) are significantly positive even assuming very conservative costs of trading"* (Fernandez & Mergulhão, 2011, p. 23). Opong and Siganos (2013) present two profitable trading strategies:

the first is based on the regular index revisions and the second is based on the irregular additions of reserve companies. To exploit the opportunity from the regular index revisions, the authors suggest trading CFDs[16] if traders *"have a significant negotiation power to trade within the bid and ask spread"* (Opong & Siganos, 2013, p. 131). Nevertheless, the authors argue that their strategies involve large and liquid stocks that have a low bid and ask spread and are available for lending[17].

8.2 Proposed trading strategies

There are several possible trading strategies that exploit the abnormal returns around the change of the index composition. The more transactions a strategy involves, the higher the associated transaction costs. Therefore, we want to present three simple trading strategies that minimise the costly turnover while maximising the expected abnormal return involving long and short positions in stocks.

Strategy 1 involves buying stocks that would be included in the FTSE 100 at the end of day +5 in the event window and selling them at the end of the trading day +6. Since a positive and statistically significant average abnormal return is found on the day before the effective inclusion date, it could be beneficial to hold stocks for this day only. Selling the position on day +6 when most index funds rebalance their portfolio, yields an average abnormal return of 0.83%.

Strategy 2 involves taking a short position in stocks most likely to be included in the index, four days before the effective announcement date. As the change of the index composition is based on market capitalisation, it is possible to predict to a large extent which stocks will be included during the revision. We suggest holding this position until ten days after the effective announcement date. Thereupon the position should be cashed out. The total abnormal return for the holding period is 4.79%.

[16] Contract for differences. In a CFD, differences between the buy and sell price are made without the requirement to trade in a physical market (Opong & Siganos, 2013).

[17] Due to the financial crisis, short-selling was banned for listed financial companies in the UK between September 19th, 2008 and January 16th, 2009.

Strategy 3 involves more transactions and therefore has higher transaction costs. In contrast to the second strategy, we now take advantage of the peak the day before the effective inclusion date. As in the previous strategy, we start by taking a short position in stocks most likely to be included in the index four days before the effective announcement date. We hold this short position until three days after the effective announcement date and then switch to a long position in the same stocks until the day before the effective inclusion date. Switching to a short position and holding it for four more days further increases the expected return. The total abnormal return for the holding period is 6.74%.

Figure 8 summarises the proposed trading strategies.

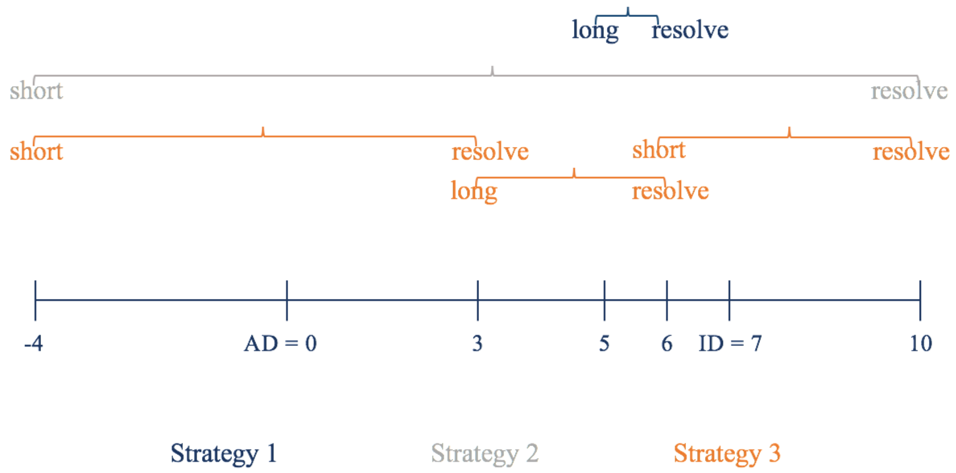

Figure 8
Proposed trading strategies
Proposed trading strategies involving long and short positions in stocks to be included in the FTSE 100. The effective announcement date is day 0, and the effective inclusion date is day +7.

Figure 9 plots the total abnormal return before transaction costs for the three strategies.

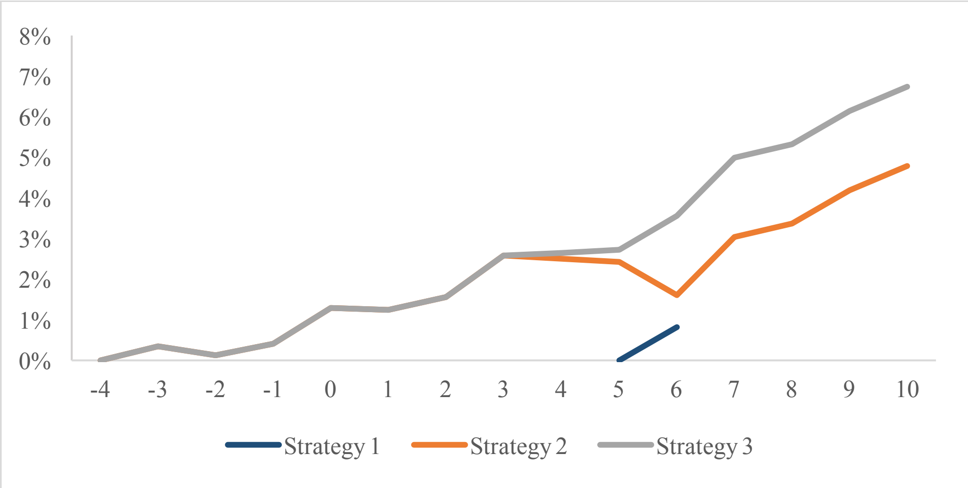

Figure 9
Performance of the trading strategies
Total abnormal return in the event window -4 to +10 for the presented trading strategies, not taking transaction costs into consideration. The effective announcement date is day 0, and the effective inclusion date is day +7.

Figure 10 plots the development of the abnormal returns for each strategy assuming average cost per transaction of 30 bp[18]. Despite the transaction costs, the strategies yield positive abnormal returns. Nevertheless, strategy 1 yields a marginal result of 0.23%, which may not be lucrative enough for investors due to the associated risk. Strategy 2, only involving the short position, yields 4.19% while strategy 3 yields 4.94%. Strategy 2 outperforms strategy 3 before the effective inclusion date due to lower transaction costs. However, strategy 3 outperforms strategy 2 the day before the effective inclusion date.

[18] Fernandez and Mergulhão (2011) suggest that 30 basis points (bp) per transaction on average is a conservative estimate. Nordea Markets confirmed this on June 30th, 2017.

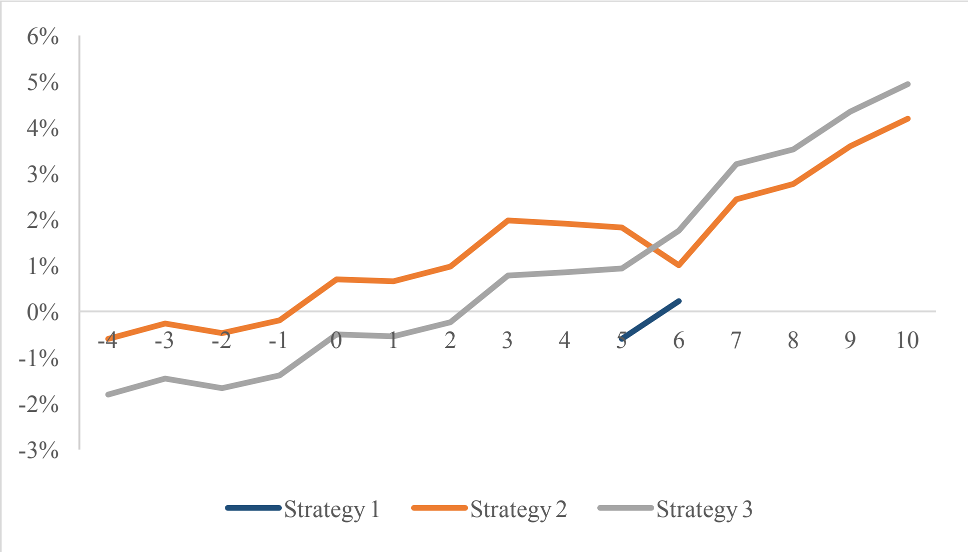

Figure 10
Performance of the trading strategies after transaction costs
Total abnormal return in the event window -4 to +10 for the presented trading strategies, including transaction costs of 30 bp per transaction. The effective announcement date is 0, and the effective inclusion date is +7.

Further strategies involving other instruments, such as derivatives and/or a different number of transactions are also possible.

8.3 Risks associated with the proposed trading strategies

There are several risks associated with trying to outperform the market. Outperforming the market can be explained by either luck or skill (Bodie et al., 2014). Even though investors might base their trading strategy on superior information - which is questionable due to the nature of index revisions in the FTSE 100 and the degree of available public information, some degree of luck will most likely be present. To make a profit, active bets need to be placed, which entails risk. These bets involve investing in a small number of stocks, resulting in low diversification (Bodie et al., 2014). Investors speculating in an index effect might, therefore, be categorised as risk seeking. In addition, the results presented for each strategy represent the average. Therefore, occasional loss is possible. The transactions cost of 30 bp is an estimate. Larger transaction costs due to fixed fees depending on the broker, investor profile and invested amount, might occur.

9 Conclusion

9.1 Summary

This thesis aimed to investigate the impact of the composition changes in the FTSE 100 index, by answering the following research question: *Do positive price and volume effects arise in regard to index inclusions on the FTSE 100?* Furthermore, we wanted to test whether increased awareness caused higher abnormal returns for new constituents compared to previous constituents. Lastly, we wanted to present possible trading strategies based on our empirical results.

We conducted a short run event study investigating stocks included in the quarterly index reviews in the FTSE 100, from March 2005 until December 2013. On the day before the effective inclusion date, we found a positive price effect in connection with a significant increase in trading volume. The positive price effect being temporary, resulted in the price reversal observed on the effective inclusion date.

Our empirical results suggest that positive and significant average abnormal returns and volume exist the day before the effective change of the index composition and thus there is a positive temporary index effect, which is supported by the price-pressure hypothesis. Therefore, we reject the null hypotheses regarding price and volume effects for the full sample. Nonetheless, we do not find an index effect close to the announcement date. The mispricing suggests that the market is not efficient in the semi-strong form.

Furthermore, we tested the awareness hypothesis, conducting a sub-event study - dividing our initial sample in stocks that entered the index for the first time since 1984 (new constituents) and stocks that entered the index for at least the second time since 1984 (previous constituents). The empirical findings did not reveal higher significant abnormal returns for new constituents entering the FTSE 100 for the chosen period, compared to previous constituent. Therefore, we do not find evidence for the awareness hypothesis.

Investigating possible trading strategies based on our findings revealed that the abnormal returns in connection with the index effect could be profitably exploited. Strategies based on long and short positions in the stocks to be included in the index yield positive abnormal returns despite transaction costs.

9.2 Limitations

The empirical analysis in this thesis is subject to different challenges. Specifically, the limited number of companies in the sample, the limited data availability and the lack of robustness tests of the results.

This study focuses on the period 2005-2013 in order to examine the FTSE 100 index effect for a more recent period[19]. In this period, ordinary stock inclusions were limited in number. Clustering the included stocks further reduced the final sample. Although Keller (2005) argues that a sample of 30 is often sufficient, our interpretation of empirical results might be affected by the limited sample. In addition, trading volume data availability was further limited. Our interpretation of the results concerning the sub-event study testing the awareness hypothesis might be especially affected due to a low sample number.

An additional challenge is the data availability. For the empirical analysis, we relied on data from the database Datastream, which may contain errors. Furthermore, Datastream reports stock data for days where the London Stock Exchange has been closed (public holidays). The manual exclusion of these days may have induced errors.

Finally, to test the robustness of our results we could have introduced a post-event estimation window in our event study, in addition to the pre-event estimation window. Nevertheless, we believe that our results are reliable.

9.3 Suggestions for further studies

In regard to further studies, examining the index effect for deletions from the FTSE 100 for the chosen period would be of interest. By investigating stocks going out of the index, we would expect a mirrored effect compared to stocks entering the index. Uncovering the price

[19] As previously mentioned, since March 2014, the period between the effective announcement and inclusion dates is extended to twelve trading days. Therefore, our analysis focuses on the most recent period before this change.

and volume effects for stocks going out of the index might give a better understanding in regard to the hypotheses explaining the index effect.

Furthermore, a possible extension of the examined period for index inclusions, increasing the number of observed events by taking into account less recent data, could improve the validity of the empirical results.

In addition, it would be of interest to conduct an event study on the FTSE All-Share index. Since a large number of index funds follow the FTSE All-Share, one could investigate if an eventual FTSE All-Share index effect would be more prominent, especially around the effective inclusion date.

10 Appendix

10.1 List of figures and tables

Figures

Tables

Table 3: Price and volume effects around FTSE 100 index inclusions, 2005-2013

Average abnormal return (AAR), cumulative average abnormal return (CAAR) and average abnormal volume (AAV), over the event window (-10, +10). The effective announcement date (AD) and the effective inclusion date (ID) represent day 0 and +7 in the event window, respectively. The sample includes 56 additions. Stocks are clustered into equally-weighted portfolios by the date of the quarterly index revisions, resulting in N = 31 clusters[1]. Regressions[2] $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$ and $V_{it} = \alpha_i + \beta_i V_{mt} + \varepsilon_{it}$ are both based on the market model where R_{it} is the return of portfolio i, and R_{mt} is the return of the market, V_{it} is the mean trading volume for portfolio i, and V_{mt} is the market volume. The estimation period, on day t, is estimated using weekly data over a year, including a "quiet period" of 40 trading days between the estimation and event window. The abnormal returns and trading volume are defined as: $\widehat{AR}_{it} = R_{it} - \widehat{\alpha}_i - \widehat{\beta}_i R_{mt}$ and $\widehat{AV}_{it} = V_{it} - \widehat{\alpha}_i - \widehat{\beta}_i V_{mt}$. $\widehat{AR}_{it}$ and $\widehat{AV}_{it}$ have been aggregated through time and across stocks over the event window (-10, +10).

Day	AAR (%)	t-stat	CAAR (-10, +10)(%)	AAV (%)	t-stat
-10	-0.166 %	-0.714	-0.166 %	0.577 %	1.150
-9	-0.002 %	-0.014	-0.168 %	0.690 %	0.918
-8	-0.246 %	-0.960	-0.414 %	0.454 %	1.028
-7	0.404 %	1.392	-0.010 %	0.880 %	1.651 *
-6	0.099 %	0.359	0.090 %	0.947 %	1.627
-5	-0.007 %	-0.025	0.082 %	0.914 %	1.781 *
-4	0.702 %	2.897 ***	0.784 %	0.682 %	1.417
-3	-0.343 %	-1.370	0.441 %	0.933 %	1.453
-2	0.211 %	0.689	0.651 %	1.577 %	2.947 ***
-1	-0.281 %	-1.002	0.370 %	1.845 %	3.415 ***
0 = AD	-0.884 %	-2.954 ***	-0.514 %	1.823 %	4.157 ***
1	0.043 %	0.221	-0.471 %	1.295 %	2.915 ***
2	-0.316 %	-1.253	-0.787 %	1.338 %	3.321 ***
3	-1.011 %	-4.366 ***	-1.798 %	1.613 %	3.910 ***
4	0.073 %	0.278	-1.725 %	2.166 %	5.038 ***
5	0.079 %	0.281	-1.645 %	2.491 %	6.012 ***
6	0.826 %	2.063 **	-0.819 %	7.762 %	13.727 ***
7 = ID	-1.437 %	-4.770 ***	-2.256 %	4.181 %	7.136 ***
8	-0.329 %	-1.089	-2.585 %	2.535 %	4.917 ***
9	-0.820 %	-3.769 ***	-3.405 %	2.142 %	4.126 ***
10	-0.597 %	-2.704 ***	-4.002 %	2.140 %	4.505 ***

Interval	Cumulative average abnormal return	t-stat
(-10, +10)	-4.002 %	-0.457
(+1, +10)	-3.488 %	-1.002
(-6, -1)	0.380 %	0.158
(+1, +6)	-0.305 %	-0.160
(-1, 0)	-1.165 %	-1.821 *
(0, +1)	-0.841 %	-1.553
(+6, +7)	-0.610 %	-1.099
(+7, +10)	-3.182 %	-2.483 **

***, **, * indicate that the results are significant at the 1%, 5%, and 10% levels, respectively

[1]due to missing data for volume, the analysis regarding volume has been conducted on 29 clusters
[2]model specification: Ordinary least squares (OLS)

Table 4: Price and volume effects around FTSE 100 index inclusions, 2005-2016

Average abnormal return (AAR), cumulative average abnormal return (CAAR) and average abnormal volume (AAV), over the event window (-14, +14). Due to the difference in trading days between the effective announcement and inclusion dates for the two periods (2005-2013) and (2014-2016), the event window has been extended. The effective announcement date (AD) and the effective inclusion date (ID) represent day 0 and +7 (2005-2013) and +12 (2014-2016) in the event window, respectively. The sample includes 71 additions. Stocks are clustered into equally-weighted portfolios by the date of the quarterly index revisions, resulting in N = 42 clusters[1]. Regressions[2] $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$ and $V_{it} = \alpha_i + \beta_i V_{mt} + \varepsilon_{it}$ are both based on the market model where R_{it} is the return of portfolio i, and R_{mt} is the return of the market, V_{it} is the mean trading volume for portfolio i, and V_{mt} is the market volume. The estimation period, on day t, is estimated using weekly data over a year, including a "quiet period" of 40 trading days between the estimation and event window. The abnormal returns and trading volume are defined as: $\widehat{AR}_{it} = R_{it} - \widehat{\alpha}_i - \widehat{\beta}_i R_{mt}$ and $\widehat{AV}_{it} = V_{it} - \widehat{\alpha}_i - \widehat{\beta}_i V_{mt}$. $\widehat{AR}_{it}$ and $\widehat{AV}_{it}$ have been aggregated through time and across stocks over the event window (-14, +14).

Day	AAR (%)	t-stat	CAAR (-14, +14)(%)	AAV (%)	t-stat
-14	-0.427 %	-1.959 *	-0.427 %	-0.257 %	-0.551
-13	-0.525 %	-2.404 **	-0.952 %	0.122 %	0.295
-12	-0.245 %	-0.947	-1.197 %	0.011 %	0.022
-11	0.106 %	0.423	-1.091 %	0.589 %	1.594
-10	-0.238 %	-1.204	-1.329 %	0.634 %	1.468
-9	0.121 %	0.703	-1.208 %	0.656 %	1.077
-8	-0.341 %	-1.678 *	-1.549 %	0.599 %	1.418
-7	0.197 %	0.776	-1.352 %	1.003 %	2.234 **
-6	-0.031 %	-0.124	-1.383 %	0.986 %	2.070 **
-5	-0.076 %	-0.313	-1.459 %	1.092 %	2.579 ***
-4	0.426 %	1.607	-1.033 %	0.986 %	2.528 **
-3	-0.366 %	-1.887 *	-1.399 %	1.223 %	2.316 **
-2	-0.030 %	-0.118	-1.429 %	1.729 %	3.652 ***
-1	-0.435 %	-1.613	-1.864 %	1.876 %	4.278 ***
0 = AD	-0.822 %	-3.309 ***	-2.686 %	1.714 %	4.548 ***
1	-0.123 %	-0.635	-2.809 %	1.113 %	2.909 ***
2	-0.543 %	-2.515 **	-3.352 %	1.272 %	3.525 ***
3	-0.877 %	-4.684 ***	-4.229 %	1.459 %	3.944 ***
4	-0.175 %	-0.752	-4.404 %	1.989 %	5.323 ***
5	0.000 %	0.000	-4.404 %	2.223 %	6.008 ***
6	0.227 %	0.612	-4.177 %	6.003 %	9.210 ***
7	-1.214 %	-5.186 ***	-5.391 %	3.323 %	6.603 ***
8	-0.684 %	-2.585 ***	-6.075 %	2.159 %	5.065 ***
9	-0.843 %	-4.322 ***	-6.918 %	2.026 %	4.705 ***
10	-0.591 %	-3.3380 ***	-7.509 %	1.954 %	4.464 ***
11	-0.960 %	-4.2980 ***	-8.469 %	3.451 %	4.905 ***
12	-0.175 %	-0.9480	-8.644 %	1.976 %	4.492 ***
13	-0.780 %	-3.8710 ***	-9.424 %	2.052 %	4.890 ***
14	-0.723 %	-3.2270 ***	-10.147 %	1.519 %	3.749 ***

Intervall	Cumulative average abnormal return	t-stat
(-14, +14)	-10.147 %	-0.787
(+1, +10)	-4.823 %	-1.526
(-6, -1)	-0.512 %	-0.234
(+1, +6)	-1.491 %	-0.813
(-1, 0)	-1.257 %	-2.155 **
(0, +1)	-0.945 %	-1.883 *
(+6, +7)	-0.987 %	-2.036 **
(+7, +14)	-5.970 %	-2.906 ***

***, **, * indicate that the results are significant at the 1%, 5% and 10% level, respectively

[1]due to missing data for volume, the analysis regarding volume has been conducted on 40 clusters
[2]model specification: Ordinary least squares (OLS)

Additional comments for Table 4: Interpretation of results for the extended period 2005-2016

The extension of the period introduces a bias to our interpretation of the results. As mentioned above, a regulation change in March 2014 led to an extension of the period between the effective announcement and inclusion dates - from seven to twelve trading days. Therefore, since March 2014, index funds tracking the FTSE 100 do not rebalance their portfolios close to the day +7 in the event window - the effective inclusion date in the period 2005-2013.

This has implications for the results in the extended analysis. The abnormal return peak found on the day before the effective inclusion date, day +6, is less prominent compared to the peak found in the period 2005-2013. The abnormal volume peak on day +6 is still significant but less prominent compared to the peak found in the period 2005-2013.

A prominent volume peak close to the later effective inclusion date (day +12) is difficult to determine due to a lower number of event portfolios in the period 2014-2016 compared to the period 2005-2013.

Our findings for the extended period confirm that index funds rebalancing their portfolios close to the effective inclusion date play a significant role in the FTSE 100 index effect.

Table 5: Price and volume effects for new constituents around FTSE 100 index inclusions

Average abnormal return (AAR), cumulative average abnormal return (CAAR) and average abnormal volume (AAV), over the event window (-10, +10). The effective announcement date (AD) and the effective inclusion date (ID) represent day 0 and +7 in the event window, respectively. The sample includes 31 additions. Stocks are clustered into equally-weighted portfolios by the date of the quarterly index revisions, resulting in N = 22 clusters. Regressions[1] $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$ and $V_{it} = \alpha_i + \beta_i V_{mt} + \varepsilon_{it}$ are both based on the market model where R_{it} is the return of portfolio i, and R_{mt} is the return of the market, V_{it} is the mean trading volume for portfolio i, and V_{mt} is the market volume. The estimation period, on day t, is estimated using weekly data over a year, including a "quiet period" of 40 trading days between the estimation and event window. The abnormal returns and trading volume are defined as: $\widehat{AR}_{it} = R_{it} - \widehat{\alpha}_i - \widehat{\beta}_i R_{mt}$ and $\widehat{AV}_{it} = V_{it} - \widehat{\alpha}_i - \widehat{\beta}_i V_{mt}$. $\widehat{AR}_{it}$ and $\widehat{AV}_{it}$ have been aggregated through time and across stocks over the event window (-10, +10). The sub-event study is conducted over the period 2005-2013.

Day	AAR (%)	t-stat	CAAR(-10, +10)(%)	AAV (%)	t-stat
-10	-0.346 %	-1.000	-0.346 %	-0.071 %	-0.101
-9	-0.274 %	-1.128	-0.620 %	0.214 %	0.227
-8	-0.446 %	-1.123	-1.066 %	-0.154 %	-0.245
-7	0.625 %	1.766 *	-0.441 %	0.103 %	0.158
-6	-0.352 %	-1.176	-0.793 %	-0.014 %	-0.023
-5	0.176 %	0.398	-0.617 %	0.426 %	0.692
-4	0.978 %	3.022 ***	0.361 %	0.269 %	0.505
-3	0.108 %	0.289	0.469 %	-0.083 %	-0.123
-2	0.239 %	0.530	0.708 %	1.401 %	2.348 **
-1	-0.243 %	-0.515	0.464 %	1.905 %	3.467 ***
0 = AD	-1.082 %	-2.416 **	-0.618 %	1.911 %	3.506 ***
1	-0.318 %	-1.053	-0.936 %	1.054 %	2.129 **
2	-0.287 %	-0.840	-1.223 %	0.948 %	2.012 **
3	-1.694 %	-3.417 ***	-2.917 %	1.669 %	3.262 ***
4	0.218 %	0.531	-2.699 %	2.033 %	4.090 ***
5	0.065 %	0.143	-2.634 %	2.463 %	4.582 ***
6	0.765 %	1.221	-1.869 %	7.960 %	10.487 ***
7 = ID	-1.522 %	-4.828 ***	-3.392 %	3.884 %	6.207 ***
8	-0.434 %	-1.289	-3.826 %	1.848 %	3.512 ***
9	-1.255 %	-2.607 ***	-5.081 %	1.582 %	2.635 ***
10	-1.036 %	-3.222 ***	-6.117 %	1.967 %	3.143 ***

Interval	Cumulative average abnormal return	t-stat
(-10, +10)	-6.117 %	-0.534
(+1, +10)	-5.499 %	-1.257
(-6, -1)	0.905 %	0.276
(+1, +6)	-1.251 %	-0.451
(-1, 0)	-1.326 %	-1.322
(0, +1)	-1.400 %	-1.820 *
(+6, +7)	-0.757 %	-0.907
(+7, +10)	-4.247 %	-2.408 **

***, **, * indicate that the results are significant at the 1%, 5% and 10% level respectively

[1]model specification: Ordinary least squares (OLS)

Table 6: Price and volume effects for previous constituents around FTSE 100 index inclusions

Average abnormal return (AAR), cumulative average abnormal return (CAAR) and average abnormal volume (AAV), over the event window (-10, +10). The effective announcement date (AD) and the effective inclusion date (ID) represent day 0 and +7 in the event window, respectively. The sample includes 25 additions. Stocks are clustered into equally-weighted portfolios by the date of the quarterly index revisions, resulting in N = 19 clusters[1]. Regressions[2] $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$ and $V_{it} = \alpha_i + \beta_i V_{mt} + \varepsilon_{it}$ are both based on the market model where R_{it} is the return of portfolio i, and R_{mt} is the return of the market, V_{it} is the mean trading volume for portfolio i, and V_{mt} is the market volume. The estimation period, on day t, is estimated using weekly data over a year, including a "quiet period" of 40 trading days between the estimation and event window. The abnormal returns and trading volume are defined as: $\widehat{AR}_{it} = R_{it} - \widehat{\alpha}_i - \widehat{\beta}_i R_{mt}$ and $\widehat{AV}_{it} = V_{it} - \widehat{\alpha}_i - \widehat{\beta}_i V_{mt}$. $\widehat{AR}_{it}$ and $\widehat{AV}_{it}$ have been aggregated through time and across stocks over the event window (-10, +10). The sub-event study is conducted over the period 2005-2013.

Day	AAR (%)	t-stat	CAAR (-10, +10) (%)	AAV (%)	t-stat
-10	-0.158 %	-0.525	-0.158 %	0.825 %	1.336
-9	0.302 %	1.109	0.144 %	1.211 %	1.025
-8	-0.239 %	-0.788	-0.095 %	0.825 %	1.345
-7	0.108 %	0.246	0.013 %	1.185 %	1.672 *
-6	0.686 %	1.512	0.699 %	2.010 %	2.644 ***
-5	0.113 %	0.316	0.812 %	0.918 %	1.246
-4	0.752 %	2.018 **	1.564 %	0.850 %	1.207
-3	-0.690 %	-2.329 **	0.873 %	1.294 %	1.227
-2	0.340 %	1.210	1.213 %	1.217 %	1.532
-1	-0.222 %	-0.653	0.992 %	1.098 %	1.258
0 = AD	-0.336 %	-0.895	0.656 %	1.210 %	1.741 *
1	0.299 %	0.968	0.955 %	1.101 %	1.563
2	-0.261 %	-0.743	0.693 %	1.411 %	2.352 **
3	-0.534 %	-1.618	0.159 %	1.305 %	2.235 **
4	0.066 %	0.202	0.225 %	1.882 %	2.833 ***
5	-0.085 %	-0.244	0.140 %	2.031 %	4.250 ***
6	0.788 %	1.920 **	0.928 %	7.542 %	12.588 ***
7 = ID	-1.211 %	-2.338 **	-0.283 %	4.300 %	4.510 ***
8	0.107 %	0.199	-0.177 %	3.271 %	3.653 ***
9	-0.529 %	-1.413	-0.706 %	2.500 %	3.147 ***
10	-0.480 %	-1.720 *	-1.186 %	1.935 %	2.907 ***

Interval	Cumulative average abnormal return	t-stat
(-10, +10)	-1.184 %	-0.088
(+1, +10)	-1.840 %	-0.352
(-6, -1)	0.979 %	0.385
(+1, +6)	0.273 %	0.111
(-1, 0)	-0.558 %	-0.758
(0, +1)	-0.037 %	-0.043
(+6, +7)	-0.423 %	-0.519
(+7, +10)	-2.114 %	-0.991

***, **, * indicate that the results are significant at the 1%, 5% and 10% level, respectively

[1]due to missing data for volume, the analysis regarding volume has been conducted on 15 clusters
[2]model specification: Ordinary least squares (OLS)

Table 7: FTSE 100 index inclusions, 2005-2013

This table presents the FTSE 100 index inclusions for the period 2005-2013 that were used in the empirical analysis. Events have been clustered into event portfolios based on the effective announcement date.

Event Portfolio	Company Name	Ticker	AD	ID
1	International Power*	IPR	10/03/2005	21/03/2005
2	BPB*	BPB	09/06/2005	20/06/2005
2	Hammerson	HMSO	09/06/2005	20/06/2005
3	Cairn Energy	CNE	08/09/2005	19/09/2005
4	Persimmon	PSN	08/12/2005	19/12/2005
5	Lonmin	LMI	08/06/2006	19/06/2006
5	Vedanta Resources	VED	08/06/2006	19/06/2006
6	Whitbread	WTB	07/12/2006	18/12/2006
7	Daily Mail & General Trust*	DMGT	08/03/2007	19/03/2007
8	Barratt Developments	BDEV	07/06/2007	18/06/2007
9	Taylor Wimpey	TW.	13/09/2007	24/09/2007
9	Tullow Oil	TLW	13/09/2007	24/09/2007
10	Admiral Group	ADM	13/12/2007	24/12/2007
10	Cairn Energy	CNE	13/12/2007	24/12/2007
10	First Group	FGP	13/12/2007	24/12/2007
10	G4S	GFS	13/12/2007	24/12/2007
11	Cobham	COB	13/03/2008	26/03/2008
12	Drax Group	DRX	12/06/2008	23/06/2008
12	Ferrexpo	FXPO	12/06/2008	23/06/2008
12	Invensys*	ISYS	12/06/2008	23/06/2008
12	Petrofac	PFC	12/06/2008	23/06/2008
13	Autonomy Corporation*	AU.	11/09/2008	22/09/2008
13	Inmarsat	ISAT	11/09/2008	22/09/2008
13	Stagecoach Group	SGC	11/09/2008	22/09/2008
14	Amlin	AML	11/12/2008	22/12/2008
14	Home Retail Group	HOME	11/12/2008	22/12/2008
14	Randgold Resources	RRS	11/12/2008	22/12/2008
14	Serco Group	SRP	11/12/2008	22/12/2008
14	Tate & Lyle	TATE	11/12/2008	22/12/2008
15	Foreign & Colonial Investment Trust*	FRCL	11/03/2009	23/03/2009
15	Intertek Group	ITRK	11/03/2009	23/03/2009
16	Rentokil Initial	RTO	10/09/2009	21/09/2009
16	Segro	SGRO	10/09/2009	21/09/2009
17	Aggreko	AGK	10/12/2009	21/12/2009
18	Investec	INVP	11/03/2010	22/03/2010
19	Weir Group	WEIR	09/09/2010	20/09/2010
20	IMI	IMI	09/12/2010	20/12/2010
21	Hargreaves Lansdown	HL.	10/03/2011	21/03/2011

21	ITV	ITV	10/03/2011	21/03/2011
21	Wood Group (John)	WG.	10/03/2011	21/03/2011
22	Tate & Lyle	TATE	09/06/2011	20/06/2011
23	Ashmore Group	ASHM	08/09/2011	19/09/2011
23	Bunzl	BNZL	08/09/2011	19/09/2011
24	Aberdeen Asset Management	ADN	08/03/2012	19/03/2012
24	Croda International	CRDA	08/03/2012	19/03/2012
25	Babcock International Group	BAB	07/06/2012	18/06/2012
26	Melrose	MRO	13/09/2012	24/09/2012
26	Wood Group (John)*	WG.	13/09/2012	24/09/2012
27	TUI Travel	TT.	13/12/2012	24/12/2012
28	Easyjet	EZJ	07/03/2013	18/03/2013
28	London Stock Exchange Group	LSE	07/03/2013	18/03/2013
29	Persimmon	PSN	13/06/2013	24/06/2013
29	Travis Perkins	TPK	13/06/2013	24/06/2013
30	Mondi	MNDI	12/09/2013	23/09/2013
30	Sports Direct International	SPD	12/09/2013	23/09/2013
31	Ashtead Group	AHT	12/12/2013	23/12/2013

*indicates that volume data is unavailable

Table 8: FTSE 100 index inclusions, 2014-2016

This table presents the FTSE 100 index inclusions for the period 2014-2016 that were used in the extended empirical analysis. Events have been clustered into event portfolios based on the effective announcement date.

Event Portfolio	Company Name	Ticker	AD	ID
1	Barratt Developments	BDEV	06/03/2014	24/03/2014
1	St. James's Place	STJ	06/03/2014	24/03/2014
2	3i Group*	III	05/06/2014	23/06/2014
2	Intu Properties	INTU	05/06/2014	23/06/2014
3	Direct Line Insurance Group	DLG	04/09/2014	22/09/2014
4	Taylor Wimpey	TW.	10/12/2014	22/12/2014
5	Hikma Pharmaceuticals	HIK	05/03/2015	20/03/2015
6	Inmarsat	ISAT	04/06/2015	22/06/2015
7	Berkeley Group Holdings	BKG	03/09/2015	21/09/2015
8	DCC	DCC	03/12/2015	21/12/2015
8	Provident Financial	PFG	03/12/2015	21/12/2015
9	Informa	INF	03/03/2016	21/03/2016
9	Paddy Power Betfair	PPB	03/03/2016	21/03/2016
10	Polymetal International	POLY	01/09/2016	19/09/2016
11	Smurfit Kappa Group	SKG	01/12/2016	19/12/2016

*indicates that volume data is unavailable

Table 9: Stocks excluded from the event study

This table presents the FTSE 100 index inclusions for the period 2005-2016 that were excluded from the empirical analysis due to various reasons.

Month of Index Inclusion	Company Name	Ticker	Reason
Jun-05	Kelda Group	KEL	Reserve/ Special event
Jun-05	Royal Dutch Shell A&B	RDS	Merger
Sep-05	Partygaming	PRTY	IPO
Dec-05	Brambles Industries	BI.	Reserve/ Special event
Dec-05	Kazakhmys (KAZ Minerals)	KAZ	IPO
Dec-05	P&O Princess Cruises	POC	Reserve/ Special event
Jan-06	British Energy Group	BGY	Reserve/ Special event
Mar-06	Corus Group	CS.	Reserve/ Special event
Jun-06	Drax Group	DRX	Insufficient data
Jun-06	ICAP	TCAP	Reserve/ Special event
Jul-06	Slough Estates	SLOU	Reserve/ Special event
Sep-06	Bradford & Bingley	BB.	Reserve/ Special event
Sep-06	Resolution	RSL	IPO
Sep-06	Standard Life	SL.	IPO
Oct-06	Experian Group	EXPN	Merger
Oct-06	Home Retail Group	HOME	Merger
Nov-06	Cable & Wireless	CW.	Reserve/ Special event
Mar-07	Schroders	SDR	Reserve/ Special event
Apr-07	Mitchells & Butlers	MAB	Reserve/ Special event
Apr-07	Punch Taverns	PUB	Reserve/ Special event
Jun-07	British Energy Group	BGY	Reserve/ Special event
Aug-07	Rentokil Initial	RTO	Reserve/ Special event
Sep-07	Carphone Warehouse	CPWN	Insufficient data
Dec-07	AMEC	AMFW	Reserve/ Special event
Dec-07	Kelda Group	KEL	Insufficient data
Dec-07	London Stock Exchange	LSE	Reserve/ Special event
Dec-07	Thomas Cook Group	TCG	Insufficient data
Dec-07	TUI Travel	TT.	IPO
Feb-08	Alliance Trust	ATST	Reserve/ Special event
Mar-08	Eurasian Natural Resources Corporation	ENRC	IPO
Mar-08	Tate & Lyle	TATE	Insufficient data
Apr-08	Bunzl	BNZL	Reserve/ Special event
Apr-08	Wood Group (John)	WG.	Reserve/ Special event
Sep-08	Fresnillo	FRES	IPO
Mar-09	Fresnillo	FRES	Insufficient data
Mar-09	Lonmin	LMI	Insufficient data
Mar-09	Petrofac	PFC	Insufficient data
Jun-09	3i Group	III	Insufficient data
Jun-09	London Stock Exchange	LSE	Insufficient data
Jun-09	Wolseley	WOS	Insufficient data
Sep-09	Whitbread	WTB	Insufficient data
Jun-10	African Barrick Gold (Acacia Mining)	ACA	IPO
Jun-10	Essar energy	ESSR	IPO
Sep-10	Resolution	RSL	Insufficient data

Sep-10	Tomkins	TOMK	Insufficient data
May-11	Glencore	GLEN	Fast entry
Oct-11	Meggitt	MGGT	Reserve/ Special event
Dec-11	CRH	CRH	IPO
Dec-11	Evraz	EVR	IPO
Dec-11	Polymetal International	POLY	IPO
Jun-12	Pennon Group	PNN	Reserve/ Special event
Sep-13	Coca-Cola HBC AG	CCH	IPO
Dec-13	Royal Mail	RMG	IPO
Apr-14	Merlin Entertainments	MERL	Reserve/ Special event
Sep-14	Dixons Carphone	DC.	IPO
Dec-14	Barratt Developments	BDEV	Insufficient data
Dec-14	TUI AG	TUI	Restructuring
Dec-15	Worldpay Group	WPG	IPO
Mar-16	Mediclinic International	MDC	IPO
Mar-16	Morrison (Wm) Supermarkets	MRW	Insufficient data
Jun-16	Hikma Pharmaceuticals	HIK	Insufficient data
Dec-16	ConvaTec Group	CTEC	IPO

Table 10: New constituents entering the FTSE 100

This table presents the FTSE 100 index inclusions for the period 2005-2013 that were included in the FTSE 100 for the first time since 1984 (new constituents). Events have been clustered into event portfolios based on the effective announcement date.

Event Portfolio	Company Name	Ticker	AD	ID
1	Persimmon	PSN	08/12/2005	19/12/2005
2	Lonmin	LMI	08/06/2006	19/06/2006
2	Vedanta Resources	VED	08/06/2006	19/06/2006
3	Taylor Wimpey	TW.	13/09/2007	24/09/2007
3	Tullow Oil	TLW	13/09/2007	24/09/2007
4	Admiral Group	ADM	13/12/2007	24/12/2007
4	First Group	FGP	13/12/2007	24/12/2007
4	G4S	GFS	13/12/2007	24/12/2007
5	Cobham	COB	13/03/2008	26/03/2008
6	Ferrexpo	FXPO	12/06/2008	23/06/2008
6	Petrofac	PFC	12/06/2008	23/06/2008
7	Inmarsat	ISAT	11/09/2008	22/09/2008
8	Amlin	AML	11/12/2008	22/12/2008
8	Randgold Resources	RRS	11/12/2008	22/12/2008
8	Serco Group	SRP	11/12/2008	22/12/2008
9	Intertek Group	ITRK	11/03/2009	23/03/2009
10	Aggreko	AGK	10/12/2009	21/12/2009
11	Investec	INVP	11/03/2010	22/03/2010
12	Weir Group	WEIR	09/09/2010	20/09/2010
13	IMI	IMI	09/12/2010	20/12/2010

14	Hargreaves Lansdown	HL.	10/03/2011	21/03/2011
15	Ashmore Group	ASHM	08/09/2011	19/09/2011
16	Aberdeen Asset Management	ADN	08/03/2012	19/03/2012
16	Croda International	CRDA	08/03/2012	19/03/2012
17	Babcock International Group	BAB	07/06/2012	18/06/2012
18	Melrose	MRO	13/09/2012	24/09/2012
19	Easyjet	EZJ	07/03/2013	18/03/2013
20	Travis Perkins	TPK	13/06/2013	24/06/2013
21	Mondi	MNDI	12/09/2013	23/09/2013
21	Sports Direct International	SPD	12/09/2013	23/09/2013
22	Ashtead Group	AHT	12/12/2013	23/12/2013

*indicates that volume data is unavailable

Table 11: Previous constituents entering the FTSE 100

This table presents the FTSE 100 index inclusions for the period 2005-2013 that were included in the FTSE 100 for at least the second time since 1984 (previous constituents). Events have been clustered into event portfolios based on the effective announcement date.

Event Portfolio	Company Name	Ticker	AD	ID
1	International Power*	IPR	10/03/2005	21/03/2005
2	Hammerson	HMSO	09/06/2005	20/06/2005
2	BPB*	BPB	09/06/2005	20/06/2005
3	Cairn Energy	CNE	08/09/2005	19/09/2005
4	Whitbread	WTB	07/12/2006	18/12/2006
5	Daily Mail & General Trust*	DMGT	08/03/2007	19/03/2007
6	Barratt Developments	BDEV	07/06/2007	18/06/2007
7	Cairn Energy	CNE	13/12/2007	24/12/2007
8	Drax Group	DRX	12/06/2008	23/06/2008
8	Invensys*	ISYS	12/06/2008	23/06/2008
9	Autonomy Corporation*	AU.	11/09/2008	22/09/2008
9	Stagecoach Group	SGC	11/09/2008	22/09/2008
10	Home Retail Group	HOME	11/12/2008	22/12/2008
10	Tate & Lyle	TATE	11/12/2008	22/12/2008
11	Foreign & Colonial Investment Trust*	FRCL	11/03/2009	23/03/2009
12	Rentokil Initial	RTO	10/09/2009	21/09/2009
12	Segro	SGRO	10/09/2009	21/09/2009
13	ITV	ITV	10/03/2011	21/03/2011
13	Wood Group (John)	WG.	10/03/2011	21/03/2011
14	Tate & Lyle	TATE	09/06/2011	20/06/2011
15	Bunzl	BNZL	08/09/2011	19/09/2011
16	Wood Group (John)*	WG.	13/09/2012	24/09/2012
17	TUI Travel	TT.	13/12/2012	24/12/2012

18	London Stock Exchange Group	LSE	07/03/2013	18/03/2013
19	Persimmon	PSN	13/06/2013	24/06/2013

*indicates that volume data is unavailable

Table 12: Industry overview of stocks included in the FTSE 100

This table presents the industry overview of the FTSE 100 index inclusions for the period 2005-2013. The industry "Business Support Services" is represented by six companies however, the industry itself is very dispersed, and we, therefore, believe that no specific industry is overly represented – resulting in skewness in the sample.

Industry Overview	Number
Aerospace & Defence	1
Chemicals	1
Construction & Materials	2
Electricity	2
Equity Investment Instruments	1
Food Producers	1
Forestry & Paper	1
General Retailers	2
Household Goods & Home Construction	3
Industrial Engineering	2
Industrial Metals & Mining	1
Media	2
Mining	3
Mobile Telecommunications	1
Nonlife Insurance	2
Oil & Gas Producers	2
Oil Equipment & Services	2
Real Estate Investment Trusts	2
Software & Computer Services	2
Capital Goods	2
Asset Managers	3
Investment Services	2
Industrial Suppliers	1
Airlines	1
Travel & Tourism	3
Restaurants & Bars	1
Business Support Services	6

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