Norwegian School of Economics

Bergen, Spring 2020

Impact of Brexit: Evidence from Stock Markets

An event study analysis of the Oslo Stock Exchange and the London Stock Exchange

Serhiy Deva and Anish Madhuchandra

Supervisor: Jan I. Haaland

Master's Thesis, MSc in Economics and Business Administration,

Majors - Business Analytics, International Business

NORWEGIAN SCHOOL OF ECONOMICS

This page has been left blank intentionally.

Abstract

On the 24th June 2016, 52% of the UK population voted in favor of leaving the European Union, also branded as "Brexit". Since then, speculation has been rife surrounding the impact of Brexit on the global economy. Existing research on this topic does not cover what the effects will be for Norway and what will happen to the bilateral trade between the two countries. Hence, this thesis investigates the impact of the Brexit announcement on the Oslo Stock Exchange (OSE) and the London Stock Exchange (LSE) with STOXX 600 as the market proxy and tests the level of dependence that exists between the British and Norwegian economy. The immediate short-term effects on these two stock markets have been shown via cumulative average abnormal returns (CAAR) with the use of an event study for a sample of 93 and 451 companies listed on the OSE and the LSE, respectively. We also test whether different economic sectors, particularly those involved in high international trade, reacted differently than the rest. This is followed by a discussion about the anticipated long-term risks posed by Brexit for the Norwegian economy. Therefore, this study is aimed at identifying the risks that pose for Norway and its economic sectors.

The results showed that the immediate impact was greater for the LSE than the OSE. The LSE experienced a rapid and severe shock with average abnormal returns (AAR) of -1.47% on the event day, as well as CAAR of -2.98% on the 10th day after the event. STOXX 600 was also negatively affected by Brexit, therefore it is important to keep that in mind when interpreting results for the OSE. With regards to the OSE, its AAR showed a positive response on the day of the event, but we argue it is due to the smaller effect Brexit had on the Norwegian stock market in comparison to the market proxy. On the other hand, we saw that the sectors that are highly reliant on the trade of exports were the ones most vulnerable to Brexit. *Consumer cyclicals* and *industrials* were the ones that showed a significant negative reaction on the day of the event. This is also why we detail the importance of other broader issues with respect to international trade such as market access, value chain trade, investment and trade policies to understand the risks that may arise in a post-Brexit world.

Key words: Brexit, Event study analysis, Oslo Børs, Norwegian economy, Uncertainty, Economic sectors

This page has been left blank intentionally.

Acknowledgment

This master's thesis was written as a part of our Master of Science in Economics and Business Administration degree at the Norwegian School of Economics (NHH), with majors in International Business and Business Analytics.

We would like to thank our supervisor, Professor Jan I. Haaland, for all his valuable comments and directions, for his close cooperation and engagement in this research, and for being patient with us throughout the semester. His positive reception, even during the lockdown through online video calls and emails, kept us motivated and committed to the project. We would also like to express gratitude to Professor Jonas Andersson for helping us out with his expertise.

We would also like to thank our parents, family, and friends for their continuous support and encouragement throughout the study period. This accomplishment would not have been possible without them.

June 2020, Bergen

Anish Madhuchandra & Serhiy Deva

Contents

List of Figures

List of Tables

List of Abbreviations

AAR – Average Abnormal Return

Brexit – withdrawal of the United Kingdom from the European Union

CAAR – Cumulative Average Abnormal Return

CAR – Cumulative Abnormal Return

EEA – European Economic Area

EMH – Efficient Market Hypothesis

ESM – Event Study Methodology

EU – European Union

EU-27 – the 27 European Union countries after Britain's exit

FTSE 100 – share index of the 100 companies listed on the LSE with the highest market cap

GBP – British pound sterling

GDP – Gross Domestic Product

GICS – Global Industry Classification Standard

GVC – Global Value Chain

ICB – Industry Classification Benchmark

ICT – Information & Communication Technology

IT – Information Technology

LSE – London Stock Exchange

MNOK – Million Norwegian Krone

no-deal Brexit – potential withdrawal of the UK from the European Union without a withdrawal agreement

NOK – Norwegian Krone

OECD – Organisation for Economic Co-operation and Development

OSE – Oslo Stock Exchange or the Oslo Børs

RTD – Research and Technological Development

Single Market – trade bloc, which guarantees the free movement of goods, capital, services and labor within the European Union. The market includes the EU-27, Norway, Iceland and Liechtenstein through EEA, Switzerland through bilateral treaties, and the UK until the end of the Brexit transition period

STOXX 600 – stock index of European stocks with 600 components from 17 European countries

TRBC – Thomas Reuters Business Classification

UK – the United Kingdom

US – the United States of America

1. Introduction

Several major events have been affecting the world economy in the last few years, and one such highly influential event that impacted Europe was the United Kingdom leaving the European Union and speculations around what the subsequent outcomes will be. The economic consequences of this event, also popularized as Brexit, have already been estimated to be substantial, with total economic costs amounting up to 130 billion pounds by the end of 2019 and set to reach 200 billion pounds by the end of 2020 (Bloomberg Economics 2020). Financial markets, mainly stock markets react strongly to many such events, and evaluating these reactions will give us a clearer picture of what to expect in the future. Estimating stock market reactions to major political, economic, and other events will prove beneficial to two parties: It is important for policymakers to adjust the (macro)economic policy measures regarding the stability of the financial markets as well as the national economy; and for foreign investors to help them in the process of portfolio and risk management (Škrinjarić, 2019). This way of linking public information to variations in stock markets has been identified as one of the well-established empirical facts.

On 23rd June 2016, the world was caught off-guard by the long-pending decision of the United Kingdom to exit the European Union (EU). This decision was of so much concern globally, because of the impact it would have on other global markets. The effects of the Brexit vote have been explored in the last couple of years for different stock markets. However, there exists a gap in the literature when it comes to the effects on the Norwegian stock market. A majority of the available research, which is as it is scarce, observed how the stock markets in EU countries and those with significant trade relations to the UK (e.g., the US, China, India, Australia, etc.) reacted to the Brexit vote. Since research and numbers show that Norway also is well integrated with the United Kingdom in terms of trade, it is reasonable to assume that the Brexit vote had its spillover effects on the Norwegian stock market as well. The size and nature of the Norwegian stock market could be one of the reasons why there exists a gap in the literature. The Norwegian stock market is thinly traded and highly volatile when compared to other developed markets. And this is mainly why less liquid markets have become decreasingly popular for investors and detailed research. Thus, the purpose of this paper is to empirically evaluate the effects of the Brexit vote on the Norwegian stock market. This way, we can also see how efficient the market is, as well as how much connected the market is to the happenings in and around Europe.

The usual approach for the evaluation of such effects is the event study methodology (ESM), derived from the concept of Efficient Market Hypothesis (EMH). This method has been proven to be a reliable and helpful tool in finance. The Efficient Market Hypothesis, which has been an integral part of every finance literature since the 1970's states that an asset's current price fully reflects all available information. The idea is that if stock prices reflect all currently available information, then price changes must reflect new information. If capital markets are efficient, any political or economic price altering event should be incorporated almost immediately in stock prices (Fama, 1991).

The Norwegian market differs significantly from other well-developed markets around the world. For example, while the US stock market has multiple exchanges, there is only one in Norway, the Oslo Børs or the Oslo Stock Exchange (OSE). The OSE is relatively small, with only 178 listed stocks (as of June 2020), and a regulatory body that also differs from the one in the US. The Norwegian government regulates business in an attempt to ensure stockholder rights. It also is known for significant government ownership. The Norwegian government owns approximately 32% of the market value on the OSE (Verdipapirsentralen, 2020). This suggests that Norwegian firms may experience fewer problems due to the high degree of government ownership. Another key aspect of having higher government ownership is that governments reduce the chances of going bankrupt, by bailing out firms. Norway also has a dual tax system, which is based on the type of income. Higher tax rates are imposed on all non-capital income, whereas all capital income is taxed at a flat 23% (Ministry of Finance, Norway, 2019), a move aimed at attracting more investors. These differences between the Norwegian market and other well-developed markets suggest that the results documented in other research papers involving other stock markets may not apply or could be minor when it comes to the substantially smaller Norwegian stock market. Strict government rules and regulations, an important level of government ownership and a different tax system may reduce the spillover effects of a significant event that happened elsewhere in the world.

The question this paper tries to answer is, if the stock market in Oslo was affected by the Brexit vote and if the stock market in London reacted differently. In addition, this study also tests whether different sectors of the economy were affected differently by Brexit. We would think sectors involved in high trade and commerce with the UK would show volatility and the others, not so much. This hypothesis of different sectors reacting in different magnitudes is something most of the existing literature does not examine. This will be tested by calculating the cumulative average abnormal returns using the market model of the event study methodology.

We begin with calculating the abnormal returns per company, and then the average for sectors and the whole of the stock market. Summing up the average abnormal returns will give us cumulative average abnormal returns, which should give us a picture of whether Brexit was a shock for the Oslo Stock Exchange and the London Stock Exchange (LSE). After analyzing the immediate effects on stock markets, we also look at the big picture, by trying to explain some of the long-term effects and risks for the Norwegian economy. Brexit will be affecting all sectors from petroleum to agriculture to industries and its subsequent economic activities such as trade, commerce, and employment. As companies prepare their strategies for the future in a post-Brexit world, there remains great uncertainty about the UK's future trading relationship with the EU as well as Norway. Our findings reflect the immediate reaction Brexit had on these stock markets and will uncover details about the level of dependency that exists between the UK and Norway.

The contribution of this study is threefold. First, to examine the immediate response of the OSE and the LSE to Brexit vote to understand if they reacted differently. Second, to provide theoretical and empirical explanations relating to the varying magnitude of reactions generated by the abnormal returns. And finally, to shed light on broader economic issues that arise from Brexit and to understand the trade relationship that exists between the UK and Norway. This paper also raises awareness on the significance of market return and how that changes the interpretation of an event study. Choosing a market proxy that is independent of the "event" is crucial to get accurate results in such type of studies, but since every market proxy is an overall representation of the stock market, effects of an "event" will be seen on the market proxy as well, and therefore the way we interpret the results of an event study has to be adjusted accordingly.

The rest of this paper is structured as follows. In the next section, we introduce a literature review of the fundamental theories and dive further into previous research on the topic. Chapter 3 entails some trade numbers for the UK and Norway and the bilateral trade relationship between the two countries. Considering all this, in Chapter 4, the research question for the paper is proposed. Chapters 5 and 6 present data collection, sampling as well as the methodology applied, along with the hypotheses. Chapter 7 examines the empirical results of the short-term impact on stock markets. This is followed by a discussion on the broader and long-term effects and risks for the Norwegian economy. Finally, Chapter 9 draws a conclusion on the findings, along with the limitations of the current study and future research ideas.

2. Literature Review

2.1 Efficient Market Hypothesis

The efficient market hypothesis (EMH), popularized by Fama (1970), is a hypothesis that states that an asset's current share price fully reflects all the available information. According to the efficient market hypothesis, asset prices will only change when new information occurs. And because new information is uncertain and unpredictable, price changes will also be unpredictable, meaning that asset prices will develop and progress randomly. And because of this random nature, no investor will benefit from trying to predict how a stock performs in an efficient market. The announcement of Britain leaving the EU was a random event, and since this conveys new information to the market, the efficient market hypothesis is relevant with regards to predicting the effects of this new information.

Fama (1970) provided a detailed description of the efficient market hypothesis and explained three informational subsets of market efficiency based on how much information was reflected on the asset prices: weak form, semi-strong form, and strong form.

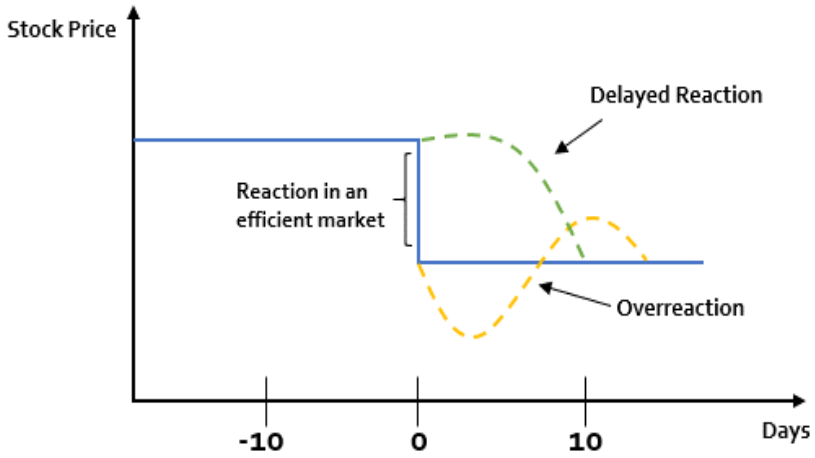
- The ***weak form*** of market efficiency postulates that historical prices and trends cannot predict future prices. The argument is that current share prices reflect all information contained in historical returns, and therefore future prices are independent of historical stock price movements. Therefore, any technical analysis is pointless since the benefit of analyzing previous data is already reflected in the price. It instead calls for the practice of fundamental analysis to increase an investor's chances of making higher profits. (Bodie, Kane, & Marcus, 2009)
- The ***semi-strong form*** of market efficiency states that current share prices reflect all the publicly available information about the firm's prospects. Hence, investors can use neither historical prices nor fundamental data to predict and gain higher profits. Bodie et al. (2009) further state that only information that is not readily available to the public can help investors boost their returns.
- The ***strong form*** of market hypothesis states that current stock prices reflect all information, even the ones not available to the public (insiders information), and there is no more information that can give an investor an advantage over the market. Any amount of research done could be fruitless in this extreme market. Fama (1970)

suggests looking at this model only as a benchmark since the market is informationally efficient in this case.

2.1.1 Anomalies to the Efficient Market Hypothesis

Contrary to the definition of the hypothesis, previous research has revealed price movements that are not consistent with the EMH model. A study done by De Bondt and Thaler (1990) implied that markets overreact to new information, causing prices to variate dramatically beyond the true value before returning to equilibrium. This is caused by an emotional response of investors to new information, which leads to a stock being either overbought or oversold. Another research done by Bernard and Thomas (1989), implied at a delayed market reaction, where prices not immediately, fully respond to new information.

Figure 2.1 Stock market reactions to new information



2.2 Efficient Market Hypothesis and Event Studies

The efficient market hypothesis has led to an important financial research methodology that is the event studies. If share prices reflect all currently available information, then price changes must reflect new information. Hence, the event study methodology helps one to evaluate the impact of a particular event on a firm's stock price by examining the price variations during the period in which the event occurs (Bodie et al., 2009). Fama (1991) states that event studies are the cleanest form of evidence we have on market efficiency.

Fama (1970), in his previous work, referred to the event study as a semi-strong-form test of market efficiency. The purpose is to assess how fast share prices reflected new information. In the past, newly relayed information related to, e.g., dividend announcements or mergers and acquisitions, have been examined to test the semi-strong form of market efficiency.

Over the past two decades, the event study methodology has become popular in the field of financial research, and the literature on event studies have become an important part of financial economics. New and improved methods and applications are defined every year, however, according to Kothari and Warner (2007), "the basic statistical format of event studies has not changed over time"; and the purpose is still to measure the mean and the cumulative mean return around the time of the event.

Market efficiency is an important aspect to consider when investigating the effects of an event on a stock price. In an efficient market, new information will change the firm value. Hence, factors affecting individual stock prices and, more importantly, the market as a whole can be identified by performing an event study (Strøm, 2013).

2.3 Overview of the Event Study Methodology

Financial economics relies on econometrics to provide models and methods from which statistical evidence or results can be obtained. Application of ESM for the analysis of stock market behavior is a common technique in finance and has been around since the 1970s. Even though many other financial economists are credited for the seminal work and popularity of this method, Dolley (1933) was the one who identified that ESM can be successfully applied for examining stock price patterns (MacKinlay, 1997). The methodology has evolved since then, and now the structure for conducting an event study on stock market returns, using the market model has been meticulously laid out by MacKinlay (1997) and Brooks (2014). The following outlines the basic steps of an event study analysis by MacKinlay (1997):

- Event Definition: Determining the event of interest and the period over which stock prices will be examined. This is also called the event window. The size of the event window should be enough to account for any price fluctuations that may have occurred before or after that event.

- Selection Criteria: Determining what firms to include in the sample, and criteria for the same should be noted and justified. Data sample characteristics such as market capitalization, sector representation should also be noted.
- Expected and abnormal returns: The impact of the event is determined by measuring abnormal returns. This is the actual ex-post return of the stock price over the event window minus the expected return over the event window. The market model is one of the popular choices for the expected return. The market model, although not perfect, assumes a stable relationship between the market return and actual stock price return.
- Estimation Window: Used to determine the normal performance period. It preferably should be just prior to the event window, as the estimation window should not include any portion of the event period itself since it might skew the normal performance model.
- Testing procedure: Abnormal returns can be calculated once the normal performance model is developed. A framework should be developed for defining the null hypothesis and aggregating the individual firm's abnormal returns.
- Empirical results: Presentation of results along with the diagnostics is key. It is also important to gauge whether a single or a small number of firms may have influenced the results.
- Interpretation: Ultimate goal is to understand insights regarding how the event affected the stock prices. Ideally, the results will lead to a conclusion on the sources and causes of the effect. Additional differences that highlight differences can also be included.

2.4 Previous Research

The topic of how Brexit affects economies of the world has been of interest to many parties, particularly investors, policymakers, and other agents involved in international trade. Below are the results of some of the existing research regarding the effects of Brexit on global stock markets. Some authors employ the Event Study Methodology to evaluate the short-term effects on stock market returns after the Brexit vote. Another group of authors has examined the effects of Brexit vote on return series or volatilities, however, here they use different methods such as regression analysis, frequency domain analysis, panel data analysis, etc.

Amewu, Mensah & Alagidede (2016) applied the ESM approach by using a market model measure the impact of Brexit on the stock markets of the following countries: USA, UK,

China, Japan, Germany and South Africa. They used daily stock prices and estimated the abnormal return series for the standardized test. Their results showed that only the Chinese market reacted positively to the event, while other markets experienced a significant decline in return. All the markets, with the exception of the German and UK, ones re-bounced to the value before the event day at day +2, probably because of their direct role in the event.

Stolp (2017) investigated the impact of Brexit on the stock markets in six countries, i.e., the UK, Germany, Ireland, the Netherlands, Switzerland and France. The usual ESM approach was applied to a sample of 1824 companies across the six countries. The results showed that the effect was the largest for Ireland, followed by France, Germany, the Netherlands and the UK, with Switzerland showing no significant effects. This paper also studied the reactions of different economic sectors to the event. The results stated that Oil & Gas was the most affected sector, followed by consumer goods and services, industrials and financials. He concluded that the sectors that depend on trade are the most exposed to negative effects and that those reliant on the free movement of labor also experience significant negative returns.

A study by Škrinjarić (2019) focused on the impact of Brexit on Central and South-Eastern European stock markets. The usual ESM approach was applied to the stock indices of the 11 sample stock markets with regional indices kept as a market proxy. Mixed results were observed on the return series, i.e., negative CAAR was observed but insignificant. However, significant results were found in the volatilities (greater volatilities after Brexit).

Burdekin, Hughson & Gu (2018) examined different stock returns around the world (64 countries) for the period from January until June 2016. They used each country's stock indices and the world market index as a factor to use in the model to estimate the abnormal returns. They applied regression analysis with the inclusion of a binary variable for the day of the Brexit vote. The results showed negative abnormal returns for a majority of the countries analyzed, with countries in Southern Europe, i.e., Portugal, Spain, Italy, Greece as well as Ireland being affected the most.

The results are somewhat mixed, with a majority of the research finding that the Brexit vote harmed global stock market returns. Since there exists a gap in the literature regarding the stock market reactions in Norway, this research will focus on that, particularly to obtain first insights.

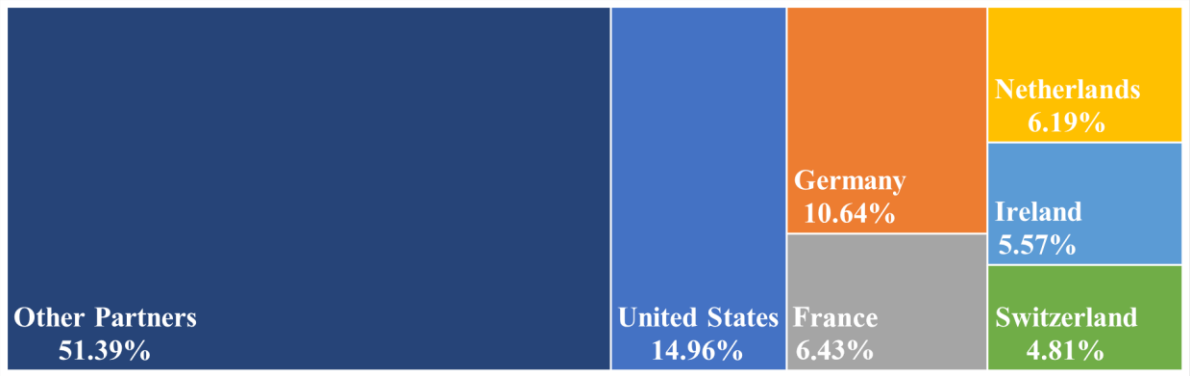
3. External Trade Statistics for the United Kingdom and Norway

The United Kingdom has had strong trade relations with other countries since the second industrial revolution, and since then, there has been a constant increase in its shares of imports and exports. According to the data from the World Bank (2020), the UK's exports were 30% of GDP, while another 31.77% totaled to its imports. A similar trade pattern has been documented for decades showing that the UK has primarily been a net import country, running with a trade deficit. The UK is an import oriented country in terms of goods, but export-oriented in terms of services. This picture, however, is the opposite for Norway, in particular, 38.44% of Norway's GDP constituted its exports, while 32.63% imports (World Bank, 2020). Norway mainly runs with a trade surplus, importing more services and exporting more goods. The UK's exports mainly consist of cars, pharmaceutical drugs, gold, gas turbines and aircraft parts and, on the other hand, imports crude oil, electrical machinery, gold and automobile parts (OEC, 2020). Norway's top exports are petroleum gas, crude oil, refined petroleum, fresh fish, while the top imports include cars, refined petroleum, ships and machinery (OEC, 2020).

The fact that we see the same type of commodities prevailing both in exports and imports explains the importance of the global value chain (GVC) in international trade. A value chain can be defined as the "full range of activities that firms and workers do to bring a product from its conception to its end use and beyond" (Gereffi & Fernandez-Stark, 2011). It comprises of essential business activities such as design, production, marketing, customer support, etc. each being performed by different firms in different countries. For example, the UK imports gold and exports gold, what is happening here, is that they are bringing together materials and exporting off a finished product. This is done so that countries can explore and make use of their comparative advantages but also sometimes to bring down the cost of a finished product. For example, Norway is a part of the European Economic Area (EEA) agreement through which they can trade freely in the Single Market, but this does not cover the trade of fish and agriculture (Protocol 9, EEA Agreement, 2020). Hence, while Norway pays for exporting fish and products to the EU, they pay more to export processed fish than fresh or raw fish. Therefore, Norway exports raw fish to third countries like Poland or Denmark, which is processed there and then sold to other markets. GVCs cover a wide array of dimensions such as tariffs, technical measures, service measures and, therefore, should not be neglected when discussing bilateral trade between countries.

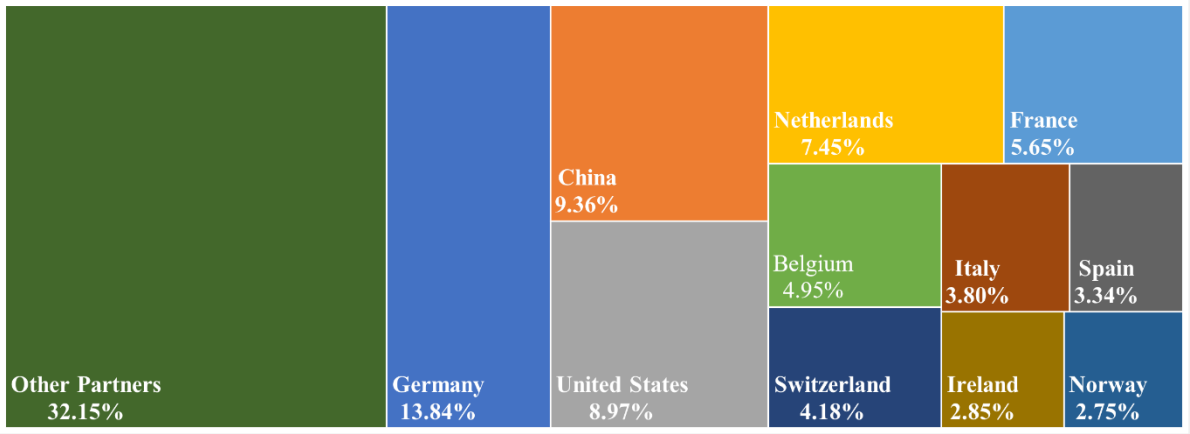
A study by PwC (2016) states that nations that have extensive trade relations with the UK are the most exposed to the direct economic influence of Brexit. Those countries include Germany, France, the Netherlands, Ireland and Switzerland (as illustrated in Figure 3.1). The US, with the largest share of exports, will probably see smaller direct economic effects, however, they might still be affected by the macroeconomic development in the UK and the EU, as well as by the changing trade relations in Europe. In fact, the reverberations of these "indirect" issues will be seen on all of the global markets, a testament to the fact that all economies are closely knit in terms of trade.

Figure 3.1 Top export destinations of the UK in 2016



Source: The World Integrated Trade Solution (WITS).
Note: "Other Partners" account for 222 other countries and states.

Figure 3.2 Top import origins of the UK in 2016



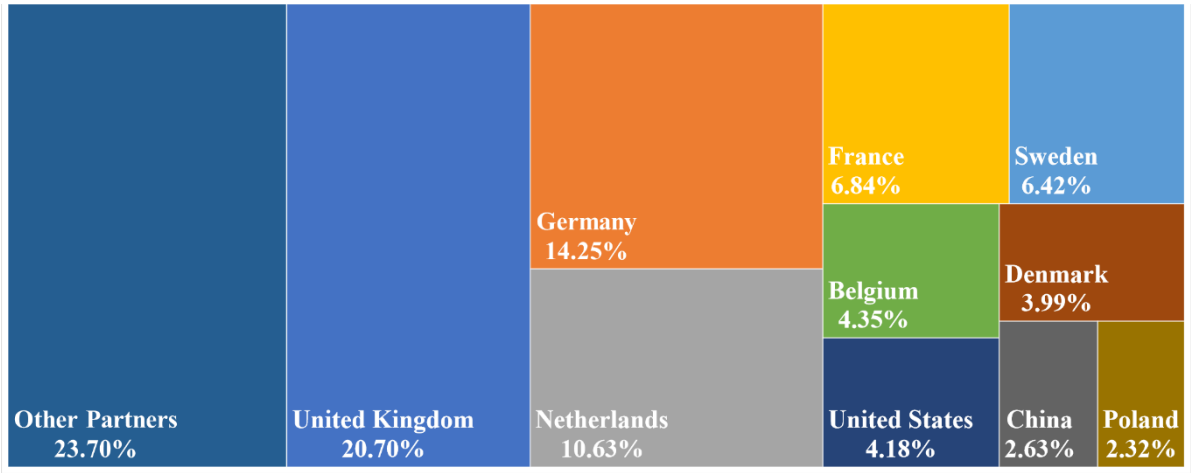
Source: The World Integrated Trade Solution (WITS).
Note: "Other Partners" account for 217 other countries and states.

On the other hand, the UK's main sources of imports are Germany, China, the US (now in third place), the Netherlands, France, Belgium, Switzerland, Italy, Spain, Ireland, and Norway (see Figure 3.2). When it comes to small countries like Ireland, the numbers above might be

insignificant for the UK, because a 2.85% share of all the imports is quite negligible. But in Ireland's perspective, this is very important as that constitutes almost 12% of their exports (World Bank, 2020).

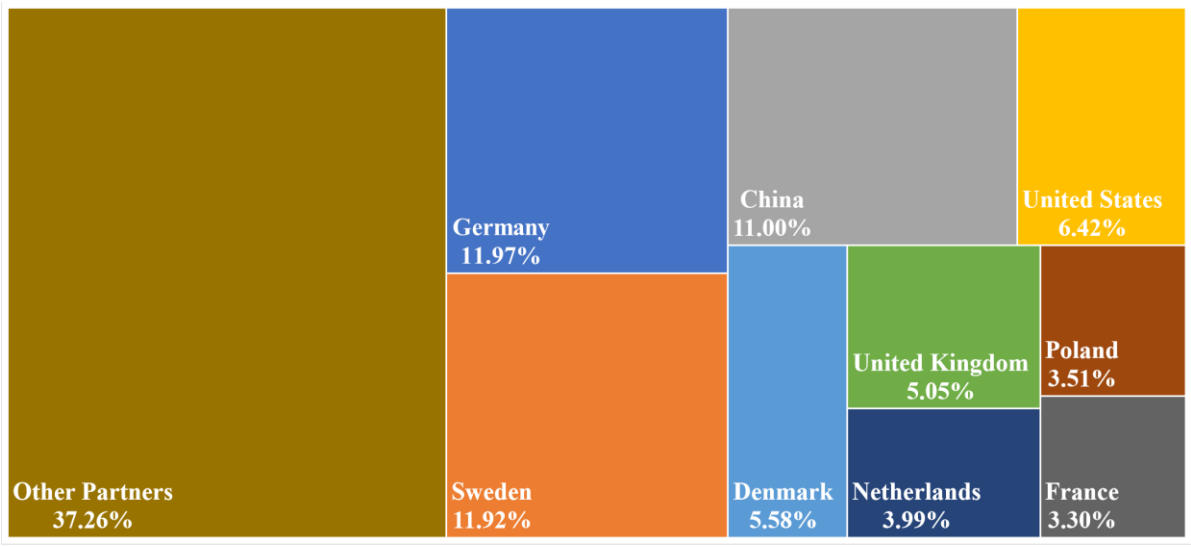
Similarly, Norway is extremely reliant on trade with the UK, as it has a great predilection to exports, considering its large energy sector. For instance, in 2016, (refer to Figures 3.3 and 3.4), only 5.05% of Norway's imports came from the UK, compared to the 20.70% of Norway's exports that went to the UK, signifying a trade surplus for Norway (in bilateral trade with the UK).

Figure 3.3 Top export destinations of Norway in 2016



Source: The World Integrated Trade Solution (WITS).
Note: "Other Partners" account for 218 other countries and states.

Figure 3.4 Top import origins of Norway in 2016



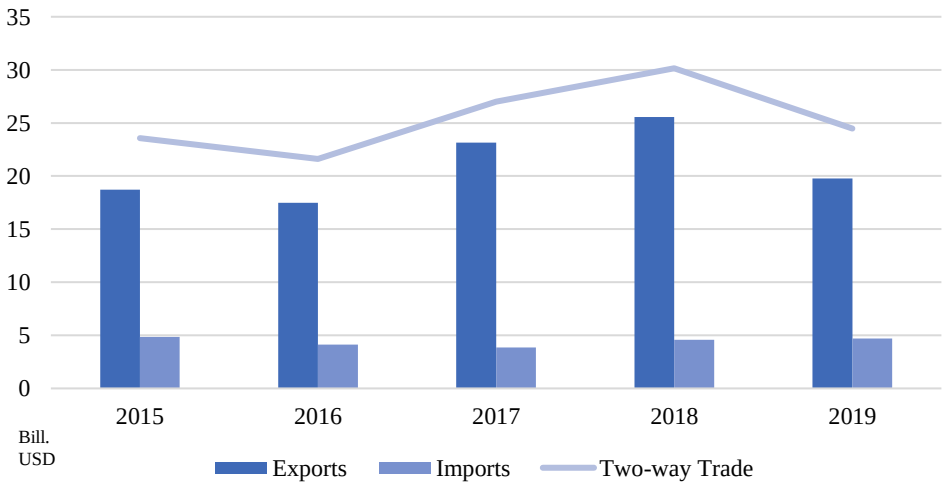
Source: The World Integrated Trade Solution (WITS).
Note: "Other Partners" account for 219 other countries and states.

3.1 Bilateral Trade between Norway and the UK

British and Norwegian ships have been crossing paths over the North Sea trade routes for centuries now. Today, both the countries are close political allies and cooperate by placing emphasis on bilateral trade despite having different forms of affiliations to the European Union. The United Kingdom is Norway's largest trading partner with two-way trade of around $ 24 billion in 2019 (UN Comtrade, 2020). The UK is Norway's largest export market (20.7% of total exports) and is the fourth largest European market for imports to Norway after Germany, Sweden and Denmark. The European Economic Area, of which both the UK and Norway are members, paved the way for a common framework for trade and economic relations based on the provisions governing the EU's Single Market. Through this agreement, Norway, Iceland and Liechtenstein were granted access to the internal market of the EU for free movement of goods, services, capital, and persons. This way, British companies exported to Norway, with the same rules and regulations that applied to say Germany, and in the same manner, Norway to other EU countries.

Figure 3.5 explains the bilateral trade relationship between the two countries in monetary terms. As mentioned before, the UK is an import-oriented market, and the picture is the same for this case as well. Because of Norway's huge energy sector, the country runs in a trade surplus with the UK.

Figure 3.5 Norway's bilateral trade with the UK



The UK is Norway's most important export market for oil and gas, off-shore related products, seafood, metal, cardboard, paper, iron and steel. Norway also exports industrial machinery, electronic equipment, scientific instruments, medical supplies and furniture. British exports to Norway include machinery, data and office equipment and electronic and scientific equipment. British companies are among the largest foreign investors in the OSE, investing particularly in shipping, banking and insurance. Several Norwegian companies have been set up in the UK, either directly or through offshoot companies. Norsk Hydro, Kværner and Equinor are some of the well-established Norwegian companies in the British market. The two countries also cooperate successfully in research and technology. Many of the Norwegian companies that have branches in Britain are in the information and communications technology (ICT) sector. The fishing sector is the main area for both the countries and particularly for exports.

Table 3.1 gives us a brief picture of the size and value of each sector between the two countries. The Norwegian economy is highly dependent on international trade, mainly exporting raw materials and semi-processed goods. It is rich in natural resources such as petroleum, hydropower, fish and minerals. The *energy* sector is the largest of all in terms of exports, the two commodities that account for the largest share of this sector, and in fact of the whole of exports are crude oil and natural gas. Another important sector to consider is the *consumer non-cyclicals*, which includes food and beverages, particularly fish. The value of exports might not be crucial to the UK, but an important point to note is that this table covers only bilateral trade and does not include trade via the third country. The EEA agreement does not cover the trade of salmon for goods liable for waived customs duty. Hence, raw fish is exported from Norway to, e.g., Poland or Denmark, processed there and then forwarded to the UK. Hence, food consumed in the UK, that originated in Norway is also a large chunk of exports that is to be considered when looking at this sector. *Basic materials* sector is also popular because of the vast number of exports of Aluminum, Paper, Iron and Steel. Norway also exports services, mainly *technology* (software) and shipping services. The export of these services is growing day by day, and particularly international shipping (*industrials* sector) accounts for the greatest share in income from the trade of services. Talking about imports from the UK, *consumer cyclicals* is the largest sector with a huge influx of cars and electronic equipment, as well as consumer goods such as textiles, footwear, etc., into Norway. Even though the consumption of fish in Norway is covered by domestic supply, Norway still imports some fresh and frozen fish and fish meals, and oils which are used as feed in salmon farming. The UK also exports

technology services to Norway and has helped with building Norway's ICT infrastructure. *Healthcare* is a developing sector for imports with Norway sourcing in pharmaceutical drugs and healthcare equipment. The Norwegian government has been constantly reforming and reorganizing the transportation infrastructure (railways and road connectivity). This has allowed opportunities for British firms to take part in construction projects through planning and engineering services. This accounts for another important sector in terms of imports, i.e., the *industrials*. A lot of British investment firms and credit institutions provide services and perform activities in Norway, and that is the reason the financial sector is the third largest in terms of imports to Norway.

Table 3.1 Norway's external trade with the United Kingdom in 2019, by sectors

Sectors	**Exports** *(in MNOK)*	**Imports** *(in MNOK)*
Basic Materials Chemicals, Metal, Paper, etc.	9708.3	5343.3
Consumer Cyclicals Cars, Leisure products, etc.	6975.9	19252.8
Consumer Non-Cyclicals Food & Beverages, Fish, etc	3194.1	2603.7
Energy Coal, Oil & Gas, etc.	153453.6	5454.9
Health Pharmaceuticals, Equipment, etc.	314.1	672.3
Industrials Machinery, Shipping, Transportation, etc.	12053.7	16512.3
Financials Banking, Insurance, etc.	631.8	7101.9
Utilities Water, Waste, Sewage services, etc.	4013.1	8061.3
Telecommunications Wireless, Integrated services, etc.	514.8	6587.1
Technology Software, Computers, etc.	9734.4	18275.4

Source: UN Comtrade, 2020; Office for National Statistics, 2020.

4. Research Problem

The purpose of this paper is to examine the relation between the Brexit referendum announcement and the subsequent stock market reaction of the firms listed on the Oslo Stock Exchange and the London Stock Exchange. Employing the event study methodology, this study seeks to investigate if the stock market in Norway was affected by Brexit and if the stock market in the United Kingdom was affected differently. In addition, the paper also looks at the differences between sectors to understand the magnitude of Brexit on each sector and if the volatility, size and trade patterns of that sector had any impact on how that particular sector reacted.

The paper also intends to shed light on some economic risks about how Brexit influences Norway, a broader picture to understand what the effects will be beyond the stock market. Now, even after four years and the official exit, the speculations and uncertainties surrounding Brexit continue and have become a global concern. A transition period for fruitful transfer of trade has been agreed upon till the end of 2020, but even after that if the uncertainty continues and no agreement is reached by then, we could be looking at a "no-deal" Brexit which could have negative effects for all arrays of business sectors in all global markets. The EEA agreement allowed Norway, Iceland and Liechtenstein to be a part of the EU's Single Market for free movement goods and people. With the UK out of the EU, access to the UK will become difficult for Norwegian traders and citizens. The UK shall soon draft new economic, social, and political rights and will have to adjust their laws accordingly. The main question that arises in this scenario is if free trade and travel continue even after the transition period. Will the removal of free trade and travel induce huge costs to all companies in the UK, the EU and Norway that are involved in cross-border trade. It is also crucial for the UK to keep these travel and trade costs low since an increase in costs means companies would want to move their businesses abroad. These issues determine the magnitude of the impact Brexit will have on countries and sectors involved in high international trade with the UK. This includes Norway also since a fifth of all of Norway's exports are to the UK.

5. Data

In this section, we provide an overview of a collection, as well as a description of the data used for all sectors and countries in the event study.

5.1 Collection of Data

This study is based on the data collected from two stock exchanges: the London Stock Exchange (LSE) and the Oslo Stock Exchange (OSE). The following information was retrieved from Thomson Reuters Eikon[1] for the period starting from 10th July 2015 and ending at 8th July 2016: daily stock prices, particularly, the official closing prices, market value, names of the companies along with their respective Thomson Reuters Business Classification (TRBC) economic sector codes and names. TRBC is an industry classification of worldwide businesses, analogous to the Global Industry Classification Standard (GICS) and the Industry Classification Benchmark (ICB). TRBC economic sector codes and names will allow us to group firms and eventually perform analysis of each of the following ten sectors: *basic materials*, *consumer cyclicals*, *consumer non-cyclicals*, *energy*, *financials*, *healthcare*, *industrials*, *technology*, *telecommunication services*, and *utilities*.[2]

According to Kopp (2019), the *basic materials* sector comprises firms that produce building materials and chemicals and those engaged in the process of exploration and development of raw products. *Consumer cyclicals* incorporate companies related to housing, entertainment, retail, and car industries, specifically those that are sensitive to business cycles (Hayes, 2020). *Non-cyclicals*, on the contrary, encompass businesses that deal with essential goods and are sustainable to different economic conditions. Companies engaged in energy production, as well as extraction, manufacturing, and refining, are commonly related to the *energy* sector. The *financial* sector is the sector of the economy that covers banks, investment funds, insurance, and real estate companies, etc. The *healthcare* sector refers to a category of companies that specialize in products and services associated with health and medical care. As it also includes hospitals, medical centers, etc., it is not quite evident how the stock market

[1] Accessed via Eikon-computers in the library. It can also be found at https://eikon.thomsonreuters.com/index.html.

[2] For a detailed elaboration on the composition of each of 10 economic sectors, please see a quick guide on TRBC, which can be found at https://www.refinitiv.com/en/financial-data/indices/trbc-business-classification.

will react to the *healthcare* sector, considering it is managed rather differently in different countries. The *industrials* are, among others, aerospace, tools, wood production, construction, waste management, and defense companies (Chappelow, 2018). They usually revolve around industrial services and supply commercial equipment. The *technology* sector is made up of firms, providing services related to IT, involved in software invention, electronics production, research and technological development (RTD) of products (Frankenfield, 2019). The *telecommunications* sector covers all internet and telecom service providers, and the *utilities* include firms that provide gas, electric, water, and sewage services.

A large part of the stocks traded on the exchanges was included, as we aim to show the effect on all firms, including the smallest ones. However, it was not possible to use all stocks, as in some cases, stock's price remained static for a few weeks or even months. This could occur because there was simply no trading to record, either due to the fact that the firm was delisted from the stock exchange or it was a small firm without considerable volume. In addition, some of the data were incomplete or missing due to various unknown to us reasons. Considering the beforementioned arguments, 83 and 172 companies were excluded from the OSE and LSE samples, respectively.[3]

Finally, a proxy for the overall impacts of the market on stock returns, i.e., a market index, is needed. MacKinlay (1997) argues that a broad market index shall be applied. For example, most European event studies use Europe-wide benchmarks, such as EURO STOXX 50 (see, Bonchev & Pencheva, 2017; Stolp, 2017). However, 50 companies may not be enough to fully reflect market behavior. Hence, in this paper, we will make use of the STOXX 600, which is also downloaded from Eikon. Incorporating nearly 90% of the European market capitalization, this index has 600 constant elements that represent small, mid and large companies in practically the whole of Europe.

5.2 Descriptive Statistics

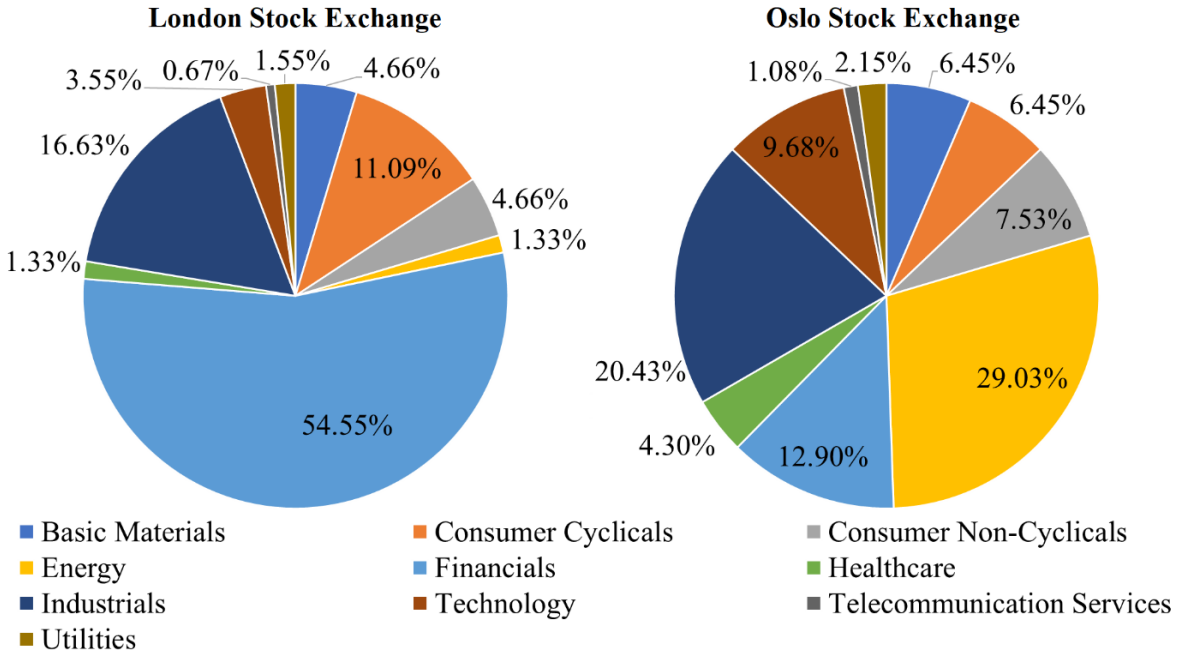
Pie charts of the sectoral distribution of the 544 companies listed on the London Stock Exchange (451 companies) and the Oslo Stock Exchange (93 companies), used in our study, are depicted in Figures 5.1 and 5.2. On the LSE, the financial sector is the biggest with 54.55%

[3] Complete List of Firms used for the sample can be found in Appendix F & G

and consists of 246 firms, followed by the *industrials* and *consumer cyclicals*, which constitute 16.63% and 11.09% of the exchange, respectively. The *basic materials* and *consumer non-cyclicals* each represent 4.66% of the sample of the LSE. In turn, only 3.55% are taken by *technology* sector firms. The remaining 4.88% are represented by the *utilities*, *energy*, *healthcare*, as well as *telecommunication services* sectors. In total, the LSE is approximately five times larger than the OSE in terms of the number of companies listed.

The picture changes when we look at the market capitalization of companies listed on the exchanges. For the LSE, the financial sector is the largest, with over £528 billion in market value. This is followed by *industrials*, *consumer cyclicals* and *non-cyclicals* with £186 billion, £169 billion and £133 billion, respectively. The *telecommunications* sector, which was minute in terms of the number of companies, actually has a large market value of over £103 billion. For our sample, the market value of all the companies listed on the LSE comes up to £1312.5 billion, which is almost nine times the market value of all the companies on the OSE (£145.5 billion or NOK 1712 billion).

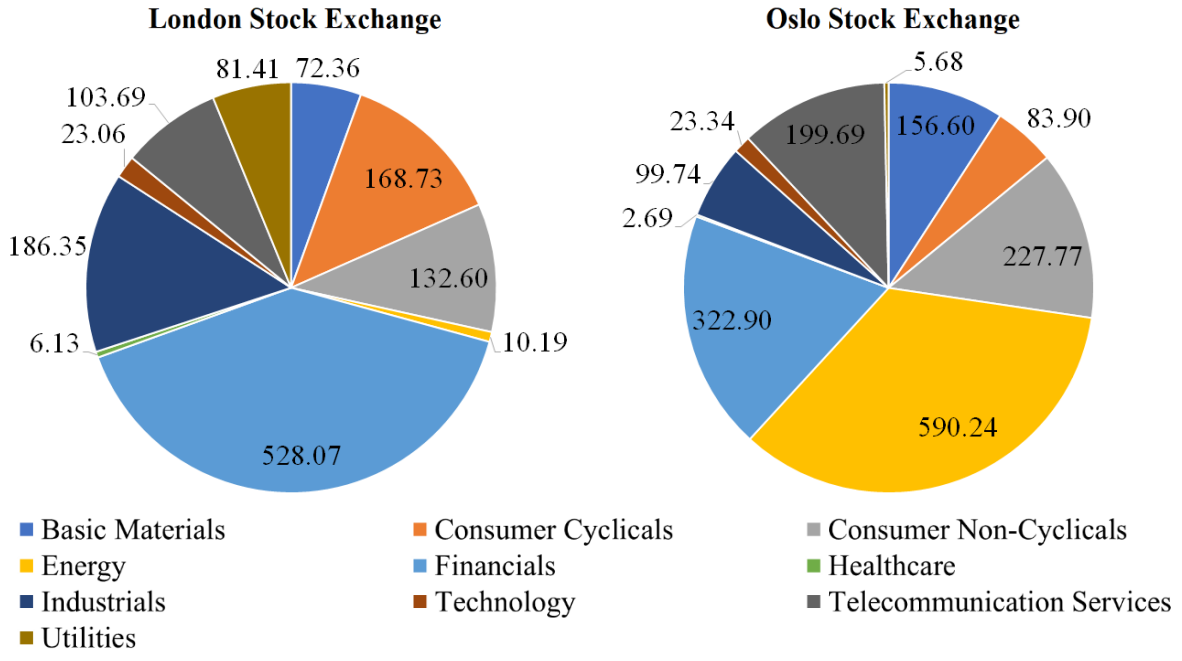
Figure 5.1 Percentage of companies listed on the London Stock Exchange and the Oslo Stock Exchange, by sector, as of 23rd June 2016



Note: 255 companies were excluded. Pie charts of the actual sectoral distribution of all 799 companies listed on the LSE and OSE are available in Appendix A.

On the OSE, *energy* and *industrials* are the biggest sectors, with 27 and 19 companies respectively, making up for almost half of the exchange. About 12.9% are represented by *financials*, which is followed by the *technology* sector, with 9.68%. *Consumer non-cyclicals* and cyclicals account for 7.53% and 6.45%, respectively. The smallest sector on the OSE is the *telecommunication* services sector, which comprises of only one company – Telenor. Similar to LSE, the picture somewhat changes in terms of the market value of the companies. The *energy* sector still is largest with NOK 590 billion. This is followed by *financials*, *consumer non-cyclicals*, which primarily includes companies involved in fisheries and *basic materials*, with NOK 323 billion, NOK 228 billion and NOK 157 billion, respectively. The *industrials* sector, which was pretty huge in terms of the number of companies sizes down to only NOK 99.74 billion, which indicates that a majority of companies in the sector are still developing.

Figure 5.2 Combined market value of the companies listed on the London Stock Exchange *(in billion GBP)* and the Oslo Stock Exchange *(in billion NOK)*, by sector, as of 23rd June 2016



Note: 255 companies were excluded. Pie charts of the actual combined market value of all 799 companies listed on the LSE and OSE are available in Appendix B.

6. Methodology

In this study, we examine the impact of Brexit on both the London Stock Exchange and the Oslo Stock Exchange. The event study methodologies outlined in MacKinlay (1997) and Brooks (2014) will be our main sources to find the solution to the research problem and perform the respective empirical analysis. Sections 6.1 and 6.2 shed light on the background, definition, and framework of the event study used, while Section 6.3 specifies hypotheses.

6.1 Background and Definition

The event study is one of the most suitable techniques for the quantitative measurement of the impact of a predetermined event on a particular indicator (Cuthbertson & Nitzsche, 2005). The history of event studies goes back to the 1930s (Dolley, 1933), and it is now effectively used in the analysis of mergers and acquisitions (M&A), stock issuance, analysis of the reaction to the announcement of a significant macroeconomic event, etc. For example, an event study was done by Ederington & Lee (1993), who were attempting to find out if macroeconomic indicators of the United States are affecting Treasury bonds. Fama et al. (1969), in another study, evaluated the market reaction to stock splits on the New York Stock Exchange (NYSE), Teplova (2008) – to dividend payments of Russian companies in the oil and gas sector, whereas Engelberg and Parsons (2011) – to announcements of profit of companies from the S&P 500 index.

The event study in research is generally applied in four cases: one company and one type of event, one company and several events (time-series aggregation), many companies and one type of event (cross-sectional aggregation), many companies and several events. In this paper, we consider the third alternative.

The set of tools used to examine the impact of events within the framework of the event study method is very extensive. Cumulative Abnormal Return (CAR), Buy-and-Hold Abnormal Return (BHAR) and Calendar Time Abnormal Return (CTAR) are among those that gained quite big popularity (see, Brown & Warner, 1985; Ritter, 1991; Fama 1998). In the case of cross-sectional aggregation, the most common, appropriate, flexible and reliable tool to use is CAR (Kothari & Warner, 2007). Its principle is to identify the excessive or abnormal reaction of individual stocks relative to the market as a whole to the event occurrence or release of a certain type of news.

6.2 Event Study Framework

6.2.1 Event Date

Carrying out an event study requires defining the event date. The Brexit Referendum, which was held on 23rd of June 2016 with the outcome coming in late on the very same day, was a completely unprecedented event in recent history. However, when estimating the influence of Brexit, in fact, the reaction of the market to the news about the outcome of the Brexit referendum is tested. Hence, it is necessary to specify as the event date not the date of the Brexit vote itself, but the date when the market reacted to it for the first time, i.e., the 24th of June. Generally, it is more convenient to indicate it as day 0, with the preceding days denoted as -1, -2, etc., and the subsequent days as 1, 2, etc.

6.2.2 Event Window

An important step in creating CAR model is the event window selection – the time span during which the influence of the outcome of the event on the dynamics of stock prices is estimated. The event window may be symmetric or asymmetric with regards to the day the event occurred. The length of the event window depends on the type of event studied. For example, changes in the structure of companies (M&As) or dividend payments may have a more lasting impact on stock returns than changes in the ratings of a company or its production and, therefore, may require longer event windows, such as [-10,10] (e.g., Teplova, 2008). Ramiah, Moosa & Pham (2016) performed an event study on the sectoral effects of Brexit and used [0,10] window, Stolp (2017) applied [-10,10], while Tabeshian (2018) – [-5,5]. However, one needs to be cautious as the total impact of the event might not be captured if the event window is too short, whereas, if it is too long, the significance test might be less effective (Brooks, 2014; MacKinlay, 1997).

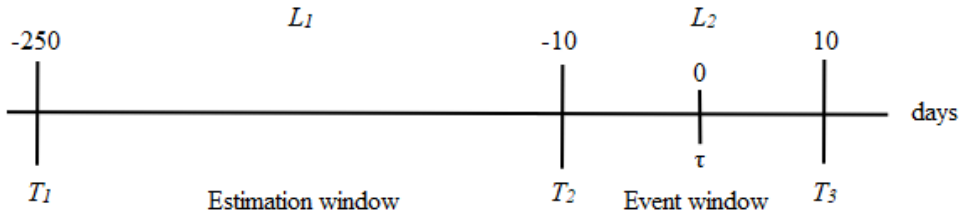
Overall, the event window must capture some days after the event of interest as the reaction from stocks to recent information is quick, but not instantaneous (Fama et al., 1969). In addition, it is important to take into account the days prior to the event of interest because an event can be caused by increased uncertainty in the market, or the event itself can create such uncertainty, as it is in our case. Hence, in this study, it was decided to use ten days before and after the event day ([-10,10] window). Later, we will sometimes refer to them as the pre-event and post-event periods, respectively.

6.2.3 Estimation Window

In addition to the event window, an estimation window is selected – the time interval before the event date, which is applied to identify the general performance of stocks and determine the expected return for each of them. Even though the estimation period is important, as it defines the amount of price history of securities for the event study method, there is no coherence among scholars regarding its length. For instance, MacKinlay (1997) suggests applying a 250 trading days estimation window, while Litvak (2007) and Cox & Peterson (1994), suggest 500 and 100 days, respectively. Generally, it is widely accepted to use approximately one trading year (Benninga, 2008). However, the main point is that the estimation window shall be long enough to allow us appropriately estimate the parameters of the model. Consequently, for our model, we choose an interval corresponding to 240 trading days. This is sufficient to measure the short-term influence of Brexit and is consistent with the common practice of conducting similar event studies.

Figure 6.1 summarizes previous subsections by portraying the timeline of the event study, which equals to 261 days.

Figure 6.1 Event study timeline



Note: The estimation window shall neither cover the event date nor days prior to it, which are part of the event window.

Assuming that the event date is denoted as $\tau = 0$, then the lengths of the estimation window and the event window are $L_1 = T_2 - T_1$, $L_2 = T_3 - T_2$, respectively.

6.2.4 Actual and Normal Returns

The current study, which aims at investigating the influence of Brexit, is based on returns, rather than on stock prices. This is because stock prices are, in most cases, a non-stationary time series (Pristley, 1965; Harvey, 1982). Unfortunately, they cannot be predicted or

modeled. Consequently, to obtain robust results and make the right conclusions, non-stationary series shall be converted into stationary (Sapate, 2017). One distinguishes two types of stationarity: weak and strict. Strict stationarity is a time series characteristic at which when moved in time, joint probability distribution remains constant; in other words, at each moment, the distribution of the data of the series remains unchanged (Gagniuc, 2017; Verbeek, 2004). However, in practice, strict stationarity never exists. That is why the definition of weak stationarity is used. Weak stationarity states that it is sufficient to require that the mean, variance, and covariance of the series do not vary over time, rather than the whole distribution (Verbeek, 2004). The shift to stock returns makes our series stationary in a weak form.

The simple return on a stock can be defined as the ratio between the closing price on a given day to that on the previous day, minus one (Fan & Yao, 2015). [4] However, we will use an approximation of the previous formula of actual daily return on stocks ($R_{i,t}$), which is written as the natural logarithm of the price ratio (see, e.g., Tabeshian, 2018; Teplova; 2008):

$$R_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right) \tag{6.1}$$

where P_t and P_{t-1} are closing prices for stock i on day t, and on the previous day t_{-1}, respectively. In a similar manner, market returns ($R_{m,t}$) were calculated using the STOXX 600 market index. The principal benefits of using log return are twofold: its mathematical convenience, and its time additive attribute (Ruppert, 2004). In addition, the return calculated by Formula 6.1 will be slightly lower than the simple return (Hudson & Gregoriou, 2010). Because the analysis will be conducted on daily returns, the calculation of the return by Formula 6.1 will not lead to a possible overestimation of the impact of the event.

Applying Cumulative Abnormal Return model also requires determining normal stock returns since the foundation of this model is embedded in comparing the actual return on stocks with normal. The latter is the return that would be anticipated if the event did not occur (Campbell, Lo & MacKinlay, 1997). There are several different models that are used to determine normal returns. The most common ones are the Market Model (MM), the Capital Asset Pricing Model

[4] Note that only trading days are taken into account, and not calendar ones.

(CAPM), the Market Adjusted Model (MAM), and the Mean Adjusted Returns Model (MRM).

According to Brown & Warner (1980), simplistic models such as the constant mean model, which assumes that the average daily return is unchanged in time, actually provide more reliable and robust results. Hence, "normal return" is the average perceived return for a chosen period of the company's analysis before the start date of the event period (Teplova, 2008). This premise, however, is not quite compatible with the dynamics of stocks.

Hence, Cable & Holland (1999), comparing the presence of constraints on the data used and the significance and performance of the beforementioned models, suggested that in most cases in the event studies, preference should be given to the regression-based models, in particular, market model. In addition, it is widely used in similar kinds of studies (see, e.g., Sorokina, Booth & Thornton, 2013; Bonchev & Pencheva, 2017; Agtmaal, 2018). Therefore, we decided to opt for the market model, which assumes the joint normality of asset returns (see Equation 6.2):

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \epsilon_{i,t} \tag{6.2}$$

where $\epsilon_{i,t}$ is the disturbance term, which has a mean of zero and is assumed to be non-correlated across companies, and other symbols are identical to the ones described above. Parameters β_i and α_i are estimated based on the data from the estimation window using the ordinary least squares (OLS) regression (see Equations 6.3 – 6.7) (MacKinlay, 1997):

$$\hat{\beta}_i = \frac{\sum_{t=T_1+1}^{T_2}(R_{i,t} - \hat{\mu}_i)(R_{m,t} - \hat{\mu}_m)}{\sum_{t=T_1+1}^{T_2}\left(R_{m,t} - \hat{\mu}_m\right)^2} \tag{6.3}$$

$$\hat{\alpha}_i = \hat{\mu}_i - \hat{\beta}_i \hat{\mu}_m \tag{6.4}$$

$$\hat{\sigma}_{\epsilon_i}^2 = \frac{1}{L_1 - 2} \sum_{t=T_1+1}^{T_2} \left(R_{i,t} - \hat{\alpha}_i - \hat{\beta}_i R_{m,t}\right)^2 \tag{6.5}$$

where $\hat{\mu}_i$ – the average of the $R_{i,t}$ for estimation period:

$$\hat{\mu}_i = \frac{1}{L_1} \sum_{t=T_1+1}^{T_2} R_{i,t} \tag{6.6}$$

and $\hat{\mu}_m$ – the average of the $R_{m,t}$ for estimation period:

$$\hat{\mu}_m = \frac{1}{L_1} \sum_{t=T_1+1}^{T_2} R_{m,t} \tag{6.7}$$

6.2.5 Abnormal Returns

The abnormal return represents the deviation of the actual stock return during the event window from the normal return, calculated according to the market model (see Subsection 6.2.4). Consequently, we can argue that the abnormal return is such a return, which is realized due to the event of interest. As in MacKinlay (1997), and many other articles, we express the abnormal return ($AR_{i,t}$) by applying the subsequent formula:

$$AR_{i,t} = R_{i,t} - (\hat{\alpha}_i + \hat{\beta}_i R_{m,t}) \tag{6.8}$$

where $(\hat{\alpha}_i + \hat{\beta}_i R_{m,t})$ is expected normal return.

6.2.6 Aggregation

From an event study point of view, the average abnormal return is of our primary interest, as they will allow us to get rid of measurement idiosyncrasies, which can be due to some specific securities. Aggregation is normally done along two dimensions, either across securities or time (in the event period) or both. Hence, we averaged the observations of abnormal returns for all securities incorporated in the sample for each of the days included in the event window. In this case, the average abnormal return will be estimated using the following formula:

$$AAR_t = \frac{1}{N} \sum_{i=1}^{N} AR_{i,t} \tag{6.9}$$

where $AR_{i,t}$ is calculated in Equation (6.8), and N is the number of companies in the sample.

As returns in the event window can considerably variate, making it hard to detect some unusual patterns, performing aggregation across time is useful (Brooks, 2014). This forms cumulative average abnormal return (CAAR), which is the sum of the average abnormal returns for the previous days of the event window. According to MacKinlay (1997), CAAR is determined from τ_2 to τ_3, where τ_2 and τ_3 are lower and upper boundaries of the event window (see Formula 6.10):

$$CAAR(\tau_2, \tau_3) = \sum_{t=\tau_2}^{\tau_3} AAR_t \tag{6.10}$$

6.2.7 Statistical Significance

The final step of our event study framework is testing the statistical significance of average abnormal returns, as well as cumulative average abnormal returns. Generally, testing may be performed using non-parametric or parametric tests. In this paper, null hypotheses were tested using the most known parametric test – Student's t-test. T-tests for AAR and CAAR are computed by the following formulas (Brooks, 2014):

$$t_{AAR_t} = \frac{AAR_t}{[\hat{\sigma}^2_{AAR}]^{\frac{1}{2}}} \tag{6.11}$$

$$t_{CAAR(\tau_2,\tau_3)} = \frac{CAAR(\tau_2, \tau_3)}{\left[\hat{\sigma}^2\big(CAAR(\tau_2, \tau_3)\big)\right]^{\frac{1}{2}}} \tag{6.12}$$

where AAR_t is the average abnormal return across all companies on day *t* of the event window, *CAAR* is the cumulative average abnormal return for the selected event period, and $\hat{\sigma}^2_{AAR}$ is the variance of *AAR* in the estimation window, calculated by the subsequent formula (Brooks, 2014):

$$\hat{\sigma}^2_{AAR} = \frac{1}{N^2}\sum_{i=1}^{N} \hat{\sigma}^2_{\epsilon_i} \tag{6.13}$$

where *N* is the number of firms.

The variance of $CAAR(\tau_2, \tau_3)$ is given by the number of observations in the event window plus one multiplied by the variance of *AAR* in the estimation window (MacKinlay, 1997).

$$\hat{\sigma}^2\big(CAAR(\tau_2, \tau_3)\big) = \big((\tau_3 - \tau_2 + 1)\hat{\sigma}^2_{AAR}\big) \tag{6.14}$$

In addition to country-level analyses, Formulas 6.11 and 6.12 are also applied to calculate the statistical significance of sector-level average abnormal returns on the 24th of June, as well as cumulative average abnormal returns on the 8th of July.

Thus, if critical values of t-statistics are less than calculated values of test statistics $t > t_{critical}$, then null hypotheses are rejected at a 1%, 5%, or 10% significance level, and we can presume that event of interest had a significant impact (H_1). In turn, if values of test statistics do not exceed critical values $t \leq t_{critical}$, then null hypotheses are confirmed at the corresponding level of significance, and we can conclude that event had no significant effect.

6.3 Hypotheses

Two tests will be performed in order to analyze the short-term shock due to Brexit. At first, we will consider this impact solely country-based, both for Norway and the UK. We will then proceed with the initial impact estimation of the sectors of each country.

It is important to specify that the market reaction to a positive event shall be uttered in the increase of abnormal return on a particular stock, and to a negative in its decrease, respectively. We classify Brexit as a negative event, thus, anticipating that Brexit will affect the UK and Norway, as well as their sectors in a negative way (H_1). In addition, we expect sectors that rely heavily on trade and especially on value chain trade to be the most vulnerable to the negative effect of Brexit.

7. Empirical Results

Using evidence from stocks of the LSE and OSE, this section of our study presents the outcome in the discussion of whether Brexit was a shock for them and their sectors of economies. Average abnormal returns and cumulative average abnormal returns for these two exchanges are estimated in the [-10,10] event period.

7.1 Effects on Stock Exchanges

Table 7.1 gives us details on AAR and CAAR per exchange in the event window, as well as their respective T-values. Even though we have anticipated getting primarily negative results, AAR for Norway is positive on the day of the event. This does not hold for the United Kingdom, which, on the same day, was negatively influenced by -1.47%. In turn, CAAR findings imply that on the event day, both countries experienced negative and statistically significant effects at 1%, 5% and 10% significance levels.

In the pre-event period, average abnormal returns for the OSE are mainly negative. When it comes to AAR for the LSE in the period before the event, it was mainly swinging between -1 and 1%, being positive for days -2, -1 before the event day. This suggests that the UK was most likely expecting another result of the referendum.

In the period after the event day, we may observe that the highest negative AAR for the LSE is on day 1. The negative effect was also recorded on the Oslo Stock Exchange on the same day, but much smaller. This might indicate that the reaction of markets was not immediate and manifested itself already on the following trading day. From the last row of Table 7.1, it is apparent that the OSE and the LSE have large significant negative CAAR.

It is also worth to mention that our CAAR computation starts from day -10, incorporating possible responses before the event day. The upcoming Brexit vote created a lot of uncertainty, and including the pre-event window allows us to capture effects of this market uncertainty as well as expectations regarding the event (see Subsection 6.2.2.) A possible reason for the negative Norwegian CAAR in the days leading up to the referendum could be related to this increased uncertainty if OSE is more volatile than other stock exchanges. Besides, since NOK is also more volatile, that might have also added to the fall.

Table 7.1 AAR and CAAR and respective T-values for the Oslo Stock Exchange (OSE) and the London Stock Exchange (LSE) in the event period

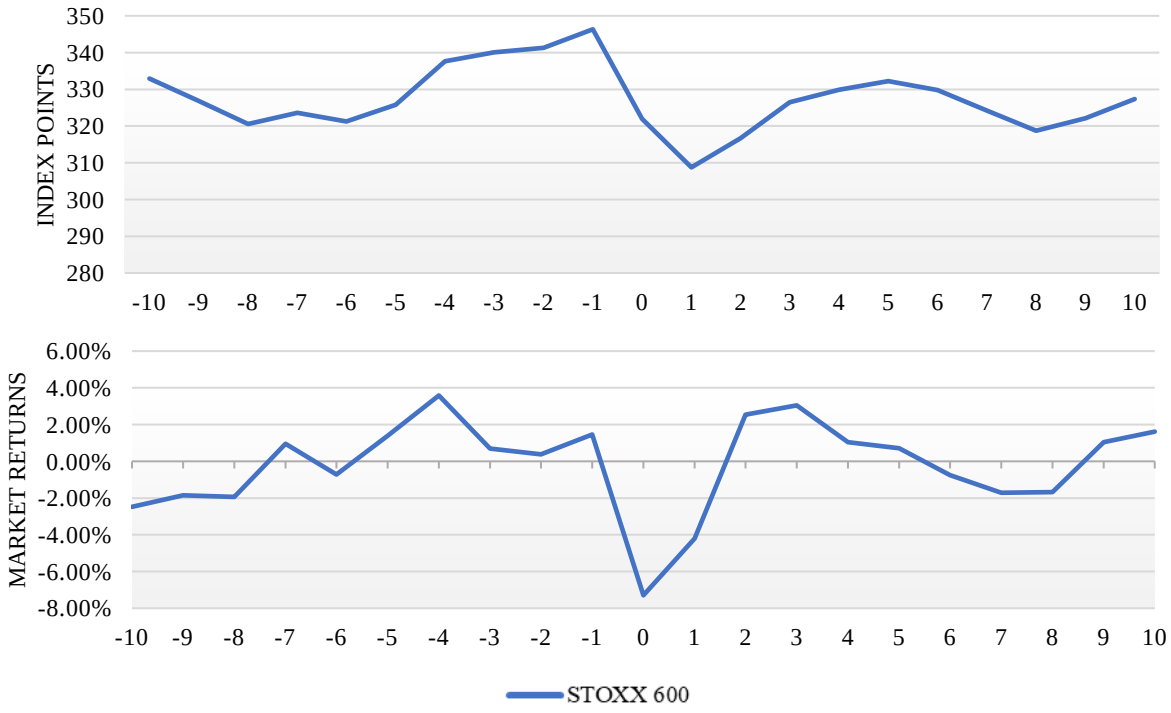
Date	T	OSE		LSE	
		AAR	***CAAR***	***AAR***	***CAAR***
2016-06-10	-10	0.09% (0.25)	0.09% (0.25)	-0.02% (-0.20)	-0.02% (-0.20)
2016-06-13	-9	-0.90% (-2.44)**	-0.81% (-1.55)	-0.39% (-5.17)***	-0.41% (-3.80)***
2016-06-14	-8	-1.04% (-2.84)**	-1.85% (-2.91)***	-0.81% (-10.69)**	-1.22% (-9.28)***
2016-06-15	-7	-0.41% (-1.13)	-2.26% (-3.08)***	0.01% (0.16)	-1.21% (-7.95)***
2016-06-16	-6	-3.15% (-8.59)***	-5.42% (-6.60)***	-1.32% (-17.35)***	-2.53% (-14.87)***
2016-06-17	-5	2.00% (5.46)***	-3.41% (-3.79)***	1.20% (15.72)***	-1.34% (-7.16)***
2016-06-20	-4	-0.88% (-2.39)**	-4.29% (-4.42)***	0.48% (6.27)***	-0.86% (-4.26)***
2016-06-21	-3	-1.22% (-3.32)***	-5.51% (-5.31)***	-0.34% (-4.46)***	-1.20% (-5.56)***
2016-06-22	-2	-0.60% (-1.63)	-6.11% (-5.55)***	0.23% (3.04)***	-0.97% (-4.23)**
2016-06-23	-1	-0.04% (-0.12)	-6.15% (-5.30)***	0.43% (5.64)***	-0.54% (-2.23)**
2016-06-24	**0**	**2.11% (5.76)*** **	**-4.04% (-3.32)*** **	**-1.47% (-19.32)*** **	**-2.01% (-7.95)*** **
2016-06-27	1	-0.74% (-2.02)**	-4.78% (-3.76)***	-3.62% (-47.54)***	-5.63% (-21.33)***
2016-06-28	2	0.40% (1.09)	-4.38% (-3.31)***	1.10% (14.44)***	-4.53% (-16.49)***
2016-06-29	3	-0.25% (-0.68)	-4.63% (-3.37)***	1.07% (14.00)***	-3.46% (-12.15)***
2016-06-30	4	-0.15% (-0.42)	-4.78% (-3.36)***	0.72% (9.45)***	-2.74% (-9.30)***
2016-07-01	5	-0.22% (-0.59)	-5.00% (-3.41)***	0.80% (10.46)***	-1.95% (-6.38)***
2016-07-04	6	0.72% (1.96)**	-4.28% (-2.83)***	-1.07% (-14.11)***	-3.02% (-9.62)***
2016-07-05	7	-0.48% (-1.32)	-4.76% (-3.06)***	-0.98% (-12.90)***	-4.00% (-12.39)***
2016-07-06	8	0.24% (0.65)	-4.52% (-2.83)***	-0.02% (-0.22)	-4.02% (-12.10)**
2016-07-07	9	1.61% (4.38)***	-2.92% (-1.78)*	0.70% (9.21)***	-3.32% (-9.74)***
2016-07-08	**10**	-1.15% (-3.14)***	**-4.07% (-2.42)** **	0.34% (4.43)***	**-2.98% (-8.54)*** **

Note: With *** is denoted significance at 1%, with ** – at 5% and with * – at 10%.

Uncertainty and the event itself can affect not only the return of companies in each sector but also the return of the market proxy. This may lead to a bias in estimates of abnormal returns and, accordingly, their variance. Since it was not possible to choose a market index, which was not influenced by Brexit because it is a truly rare occurrence, which had an impact on the entire market, it is important to keep in mind this bias in order to interpret the results correctly.

Figure 7.1 provides two charts depicting fluctuations of the STOXX 600 curve, i.e., the market index within the 21-trading day timespan, where the event of interest is denoted as day 0. The top chart makes it clear that the STOXX 600 experiences a sharp drop on the event day and the day after it, losing 38 points. Eventually, the index somewhat stabilizes until the fifth trading day following the Brexit vote, before it falls again from 332 to 318 points. The bottom chart, which illustrates the performance of the index using the returns, follows the same trend as the index points. On day -8, the market return was almost -2%, which is not surprising, taking into account the fact that polls on that day revealed that Brexit is rather more likely to happen than not. On day -4, polls showed Britain inclining towards the "Remain" option. This was reflected in the market returns, which completely recovered from the previous negative shock on day -4, before falling significantly on the event day.

Figure 7.1 STOXX 600 index (*top*) and its performance (*bottom*) in the [-10,10] event window

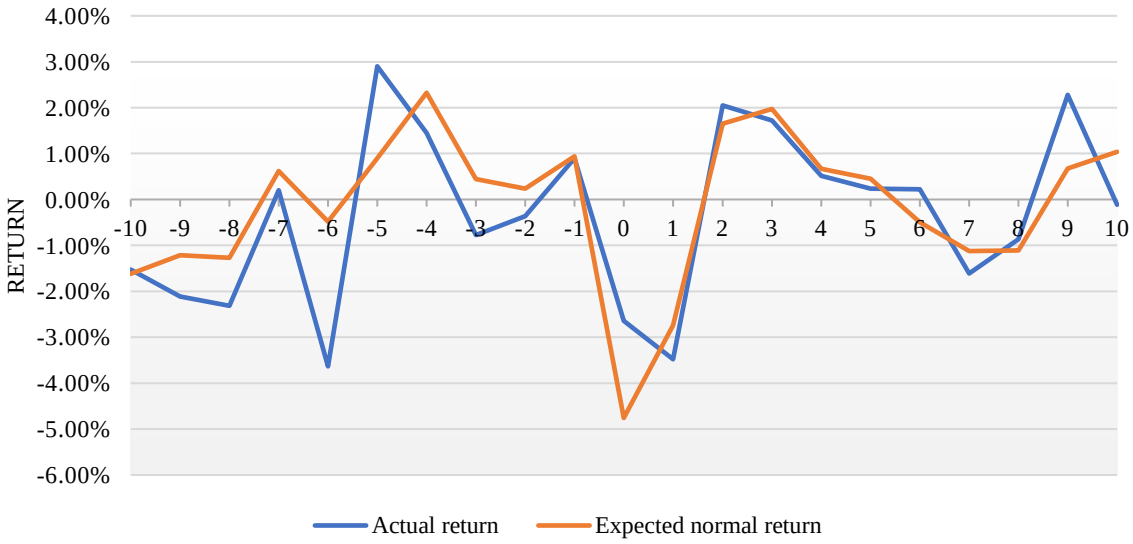


Note: Market returns were calculated using Formula 6.1.

As a result, based on Figure 7.1, we can affirm that expectations, uncertainties regarding the event, and the event itself had an impact on the return of the market index, thereby affecting our market model.

Generally, the results presented in the table confirmed our expectations concerning the Brexit referendum, proving the point in the reviewed literature, except for the fact that AAR for Norway was affected significantly in a positive way on the day of the event. This, however, does not imply that the referendum had a positive influence on Norway. According to Figure 7.2, the effect was rather more diminutive for the Norwegian market than it was for the STOXX 600 index. It is not that surprising since Norway has a different trade pattern and industry structure, which makes it less vulnerable to Brexit. A large part of Norwegian exports are natural resources, which may be affected due to global demand but certainly less so by an event like Brexit. Energy export is of great importance to Norway, which would expect to export as much oil and gas to the UK after Brexit as it did before. On the other hand, in accordance with Figure 7.3, the effect was more substantial for the LSE than it was for the STOXX 600 index.[5]

Figure 7.2 Difference between the average of the actual return of the OSE (R_t) in the event window [-10,10] and the return predicted by the market model ($\hat{\alpha} + \hat{\beta}R_{m,t}$)



Eventually, CAAR for both countries was negative on the last day of our event window, which might suggest a small delay in the reaction of markets. However, keeping in mind the positive result of the difference between T = 10 and T = 1, this does not seem to be the case, at least for the whole post-event window. The delay seems to hold solely until day 1. Instead, more appropriate reasons are the following. The OSE appears to not follow the trend of STOXX

[5] See Appendix C for finding precise numbers.

600, in the way that it was not increasing as much as the latter in the pre-event window. For the LSE, the effect of the referendum seems to be quick, but extremely sharp, thereby CAAR did not fully recover even until day 10.

Figure 7.3 Difference between the average of the actual return of the LSE (R_t) in the event window [-10,10] and the return predicted by the market model ($\hat{\alpha} + \hat{\beta}R_{m,t}$)

The results from Table 7.1 are visualized in Figures 7.4 and 7.5, which display windows of 21-trading days for AAR and CAAR, respectively, for both the London Stock Exchange and the Oslo Stock Exchange, where the day of the event is the 24th of June 2016 (day 0).

We can clearly see that in the pre-Brexit period, both exchanges appear to have negative AAR, which eventually produced a negative CAAR, in particular, for the OSE. Exceptions to this are days -10, -5 for the OSE and days -7, -5, -4, -2, -1 preceding the event for the LSE, during which actual returns were higher than expected normal returns (see Figures 7.2, 7.3). Besides, as Figure 7.5 shows, CAAR for the LSE almost moved to the positive zone on day -1, before a huge slump near the event of interest. It then recovered quite sharply, before another drop on day 5, ending at approximately -3%. Figure 7.5 also depicts that CAAR for the OSE was fluctuating much lower in a negative zone, than the UK's. This might be due to the fact that Norway somewhat anticipated and prophesied the negative outcome of the event day, therefore, being impacted by the referendum before the UK. Still, the result, in no case, suggests that Brexit has the largest effect on it. Instead, it is more related to the trend of the STOXX 600 index, depicted in Figure 7.1., which explains a large deviation on days -6, -5, -4, -3, -2, and, consequently, the subsequent CAAR.

Figure 7.4 Average abnormal returns for the Oslo Stock Exchange (OSE) and the London Stock Exchange (LSE) in the event window [-10,10]

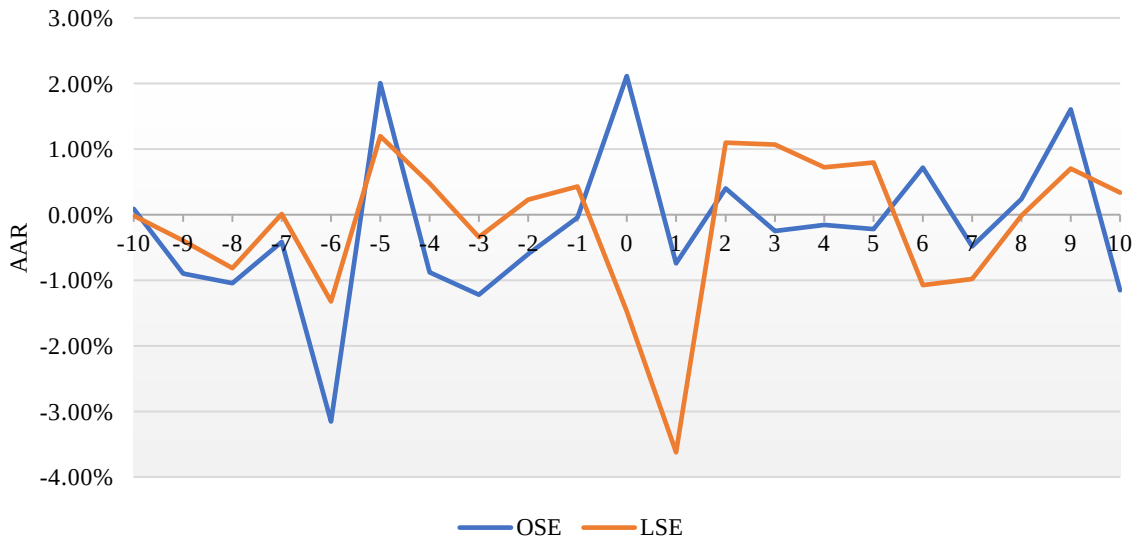
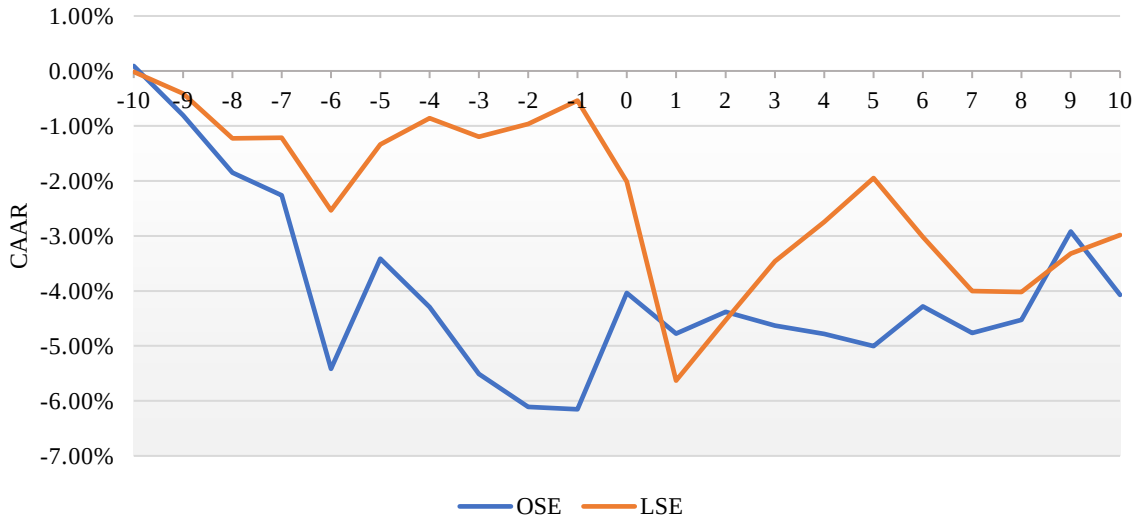


Figure 7.5 Cumulative average abnormal returns for the Oslo Stock Exchange (OSE) and the London Stock Exchange (LSE) in the event window [-10,10]



All in all, in the pre-event period, we observe quite similar AAR curves between the OSE and LSE, except that Norway has smaller actual returns than expected normal returns. In the post-event window, AAR curves between the OSE and LSE deviate quite largely. The same holds for the day of the event. Brexit appears to originally effect AAR for the OSE in a positive way. However, the basis for our model is a market index or the STOXX 600, which means that it is rather more correct to say that Norway was affected less negatively, in comparison to those companies incorporated in the index. Based on Figures 7.2 and 7.3, it is apparent that when the OSE increases (for example, on the event day), it simply does not decrease as much as the

LSE and STOXX 600 and vice versa. This again reflects how different macroeconomic development and industry structure of Norway is. For the UK, the outcome is a complete opposite, showing a more prolonged negative reaction from day -1 to day 1. It appears that the companies in the UK were hit harder than those in Europe and Norway, which is expected.

7.2 Effects on Sectors

In this section, we estimate the initial impact on the economical sectors of the LSE and OSE, diving deeper into the market of each country. Table 7.2 presents AAR per sector within both the OSE and the LSE on the event day and the day after. The rationale behind choosing to illustrate the day after is linked to the assumption we introduced in the previous section about the possible delayed response for the OSE. Not to mention, the more extensive reaction is observed on the LSE on the day following the event of interest. Therefore, it is interesting to study both $T = 0$ and $T = 1$.

As presented in the first column of Table 7.2, all but *consumer cyclicals* sector within Norway have positive AAR. Among them, *basic materials, consumer non-cyclicals, energy*, and *technology* sectors are affected with significance. *Basic materials* and *technology* had the largest positive average abnormal returns accounting for 4.56% and 4.28%, respectively. Overall, the effect of Brexit on the event day, as we see, is positive. Although, in fact, the effect was simply much less negative on practically all sectors of the OSE, than on the STOXX 600 index.[6]

The second column of Table 7.2 indicates that AAR eventually fell into the negative zone for all sectors of the OSE, except for *telecommunication services*. *Technology* and *healthcare* had the largest negative AAR. However, for day 1, no significant results are observed, except for the *technology* sector.

When it comes to the impact estimated for the sectors within the LSE, the outcome is the complete opposite of what we observed for the OSE on the day of interest. All the sectors, except for *energy* and *basic materials*, undergo negative AAR. *Consumer cyclicals, financials,*

[6] Appendix D contains the average of the actual return of the sectors of the OSE and the return predicted by the market model, which confirms that the effect was actually negative.

industrials, technology, and *telecommunication services* experience significant negative AAR, where *consumer cyclicals* sector has the most negative AAR – -3.87%. Since the value chain concept is essential for this sector to function efficiently, this result may not be that surprising, in the end. Moreover, it was the only negatively affected sector on the OSE on day 0. This means that Norwegian companies producing parts and components for British companies could be directly affected by changes in the UK.

Table 7.2 AAR and respective T-values per sector of each exchange for day 0 and day 1 in the event window

Sectors	**AAR**			
	OSE		***LSE***	
	T = 0	***T = 1***	***T = 0***	***T = 1***
Basic Materials	4.56% (2.75)***	-0.21% (-0.13)	0.19% (0.33)	-2.45% (-4.14)***
Consumer Cyclicals	-0.37% (-0.34)	-0.23% (-0.21)	-3.87% (-16.20)***	-5.99% (-25.06)***
Consumer Non-Cyclicals	2.16% (3.36)***	-0.96% (-1.49)	-0.46% (-1.08)	-2.55% (-6.01)***
Energy	3.10% (3.67)***	-0.63% (-0.74)	3.53% (2.26)**	-0.37% (-0.24)
Financials	0.27% (0.48)	-0.30% (-0.53)	-1.08% (-13.78)***	-3.17% (-40.28)***
Healthcare	1.60% (1.01)	-2.29% (-1.45)	-1.42% (-1.56)	-4.17% (-4.59)***
Industrials	1.03% (1.53)	-0.26% (-0.39)	-2.25% (-11.27)***	-5.02% (-25.10)***
Technology	4.28% (2.58)***	-2.73% (-1.65)*	-2.14% (-4.38)***	-3.38% (-6.93)***
Telecommunication Services	1.33% (0.97)	0.07% (0.05)	-2.20% (-2.12)**	-0.05% (-0.04)
Utilities	1.78% (1.24)	-0.14% (-0.10)	-0.09% (-0.16)	1.21% (2.08)**
Overall	2.11% (5.76)***	-0.74% (-2.02)**	-1.47% (-19.32)***	-3.62% (-47.54)***

Note: With *** is denoted significance at 1%, with ** – at 5% and with * – at 10%.

As we move onto the last column of Table 7.2, we can see that, again, all but the *utilities* sector have negative AAR. However, now, the effect on day 1 is more vigorous and significant in comparison to the event day. What might be of great interest is the *financials*. Out of all of the sectors on the LSE, the *financial* sector is extremely important for the British economy. According to the Office for National Statistics of the UK (Office for National Statistics, 2020), it creates at least two million workplaces. It is also the biggest sector on the LSE in terms of the number of companies listed (see Figure 5.1). Nevertheless, in the insightful analysis of the effect of Brexit on the stock market of Europe, Stolp (2017) suggested that the hypothesis that

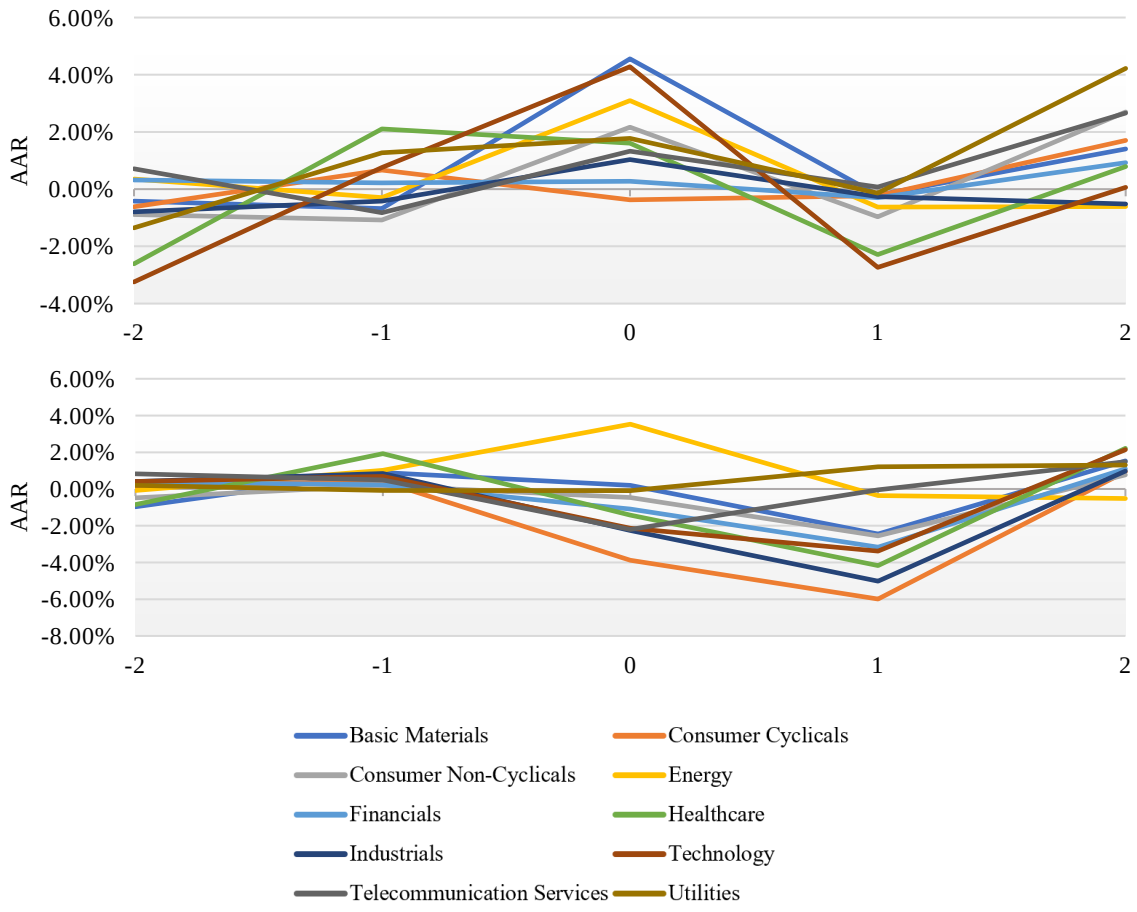
the *financial* sector on the LSE experiences the biggest decline does not hold. His finding is actually in line with our result, which shows that *financials* came in fifth with – 3.17%.

Due to Brexit, the UK may lose advantages that every member of the EU receives, such as visa-free movement, trouble-free access to the labor market in any EU country, and in general, access to the Single Market. Freedom of movement enables firms to conduct business in the UK, engaging the most qualified experts in various sectors, in particular, the *financial*. According to Rolfe & Hudson-Sharp (2016), in 2016, solely in London, approximately 12% of all labor reserves were people from the EU. Consequently, bringing back visas may hinder the way of employing the best professionals. Hence, export-oriented sectors that profit from the unrestricted movement of labor, as well as being part of the Single Market, would experience the largest negative effect. This is precisely what our AAR results reveal. *Industrials, technology, and consumer cyclicals* sectors are massively export-oriented, while the latter is also especially reliant on the unrestricted movement of workers within the European Union. As a result, *consumer cyclicals* had an average abnormal return of almost -6%, whereas *industrials* slightly more than -5%.

Figure 7.6 extends Table 7.2, illustrating two windows, each with the length of five trading days for AAR for the sectors on the OSE and LSE. Note that all the calculations were performed based on the event window [-10,10]. Windows [-2,2] presented in Figure 7.6 are "close-ups" of original event windows. The Brexit referendum is denoted as day 0.

First, considering the OSE (*top graph*), we can certainly observe that most of AAR curves have a triangular waveform, except for *consumer cyclicals* and *financials*, as their curves are flat. Two days before $T = 0$, there are only three sectors that reach above AAR of zero, namely, *financials, energy, and telecommunication* services. On the following day, AAR of a majority of sectors starts to rise. For some of them, even reaching a threshold of 2%, as the *healthcare* sector's curve indicates. As we mentioned earlier, the day of the referendum revealed a positive reaction, compared to the index, as most of the curves started to increase sharply from day -1. However, already on the subsequent day, all but *telecommunication* sectors plunged below AAR of zero before increasing again on day 2. Again, same as it was for the overall country impact, this result implies that even if there was a delayed reaction from the side of the OSE, which occurred on day 1, it was not prolonged, as the decreasing trend in the returns of each sector did not last. The latter seems to not hold for the two biggest sectors on the OSE in terms of the number of companies listed, particularly, *industrials* and *energy*.

Figure 7.6 AAR for sectors for the Oslo Stock Exchange (*top*) and the London Stock Exchange (*bottom*) in the event window [-2,2]



Note: All the computations were done based on the event window [-10,10]. We have diminished the event window to [-2,2] solely for purposes of better visualization of the day of interest.

With regards to the LSE (*bottom graph*) in the days -2 and -1 before the event day, all sectors appear to have fairly constant AAR, fluctuating around zero. These sectors then undergo large drops on the day of interest, except for *utilities*, which seems to be almost unaffected by Brexit. Its curve is primarily flat throughout the window. As it was with the case of the OSE, nearly all of the sectors recovered rapidly and turned back to their pre-Brexit AAR values or even larger on day 2. The *energy* sector is rather an exception to this.

In order to capture the full short-term shock Brexit caused, AAR in [-2,2] windows with a range of five trading days, is clearly not enough. This is why we will move onto examining Table 7.3, which shows CAAR per sector within both the OSE and the LSE for 10, 11 and 21 trading days windows, ending one day before the event of interest ($T = -1$), right after the event day ($T = 0$) and 10 trading days after the event day ($T = 10$), respectively. In Subsection

6.2.7, we mentioned that we would be only examining the ten trading days' cumulative impact of the Brexit vote (*T = 10*). However, if we compare column 3 and column 6, one might get a faulty sense that Brexit had a larger negative impact on the OSE than on the LSE. Now all pre-referendum effects are in *T = -1* columns, which showed that CAAR for sectors of the OSE was already considerably low before Brexit occurred. Therefore, all of the sectors have large negative CAAR up to the day of interest, while *consumer non-cyclicals, energy, financials* and *industrials* statistically significant. As we discussed in Section 3.1, the *energy* sector is the largest of all in terms of exports, while sectors that depend on exports suffer bigger damages. *Industrials*, in turn, is an important sector from the point of view of both exports and imports, taking into consideration the fact that British firms participate in construction projects through planning and engineering services. It is not surprising that they had both the highest and the most significant negative AAR on day -1, as we stressed several times that industries that rely on trade and exports would be the ones most vulnerable to the negative effect of Brexit.

When it comes to the event day, again, *energy* and *industrials* sectors are the biggest sufferers, with significant results of CAAR -5.52% and -5.19%, respectively. However, relative to *T = -1*, they are positive, so are the rest of the sectors, except for *consumer cyclicals*. We would also like to pay attention to the fact that whilst CAAR for a large part of sectors is not significant on the event day, AAR, in particular, for *basic materials, consumer non-cyclicals, energy* and *technology* is. The main reason lies behind the time factor since $\hat{\sigma}^2\big(CAAR(\tau_2, \tau_3)\big)$ increases with time.

As we move towards the third column (*T = 10*) of Table 7.3, we can see that the only sector which has a significant result is the *telecommunication services*, which has a remarkably large and positive CAAR that accounts for 10.61%. The rest of the sectors experience negative CAAR up to the last day of the even window inclusive. In general, a few sectors undergo larger negative CAAR on day 10 than on day -1, suggesting a somewhat negative effect of Brexit in the post-event period. These include *utilities* and *consumer cyclicals* sectors.

Concerning CAAR for the sectors on the LSE, on day -1, most of the sectors were fluctuating between -0.54% and 0.37%, while *healthcare, energy, basic materials* and *consumer non-cyclicals* were much lower into the negatives. The latter two, along with the *financials*, have significant CAAR results for this day. In turn, on day 0, the one with the biggest, and significant, at the same time, negative CAAR is the *consumer cyclicals* sector. This result

corresponds to the same finding we obtained in Table 7.2. Because of the value chain trade concept, regulations, market access, trade and investment policies are at least as important as free movement of workers for this type of sector, which is why it may be influenced the most.

Table 7.3 CAAR and respective T-values per sector of each exchange for day 0 and day 10 in the event window

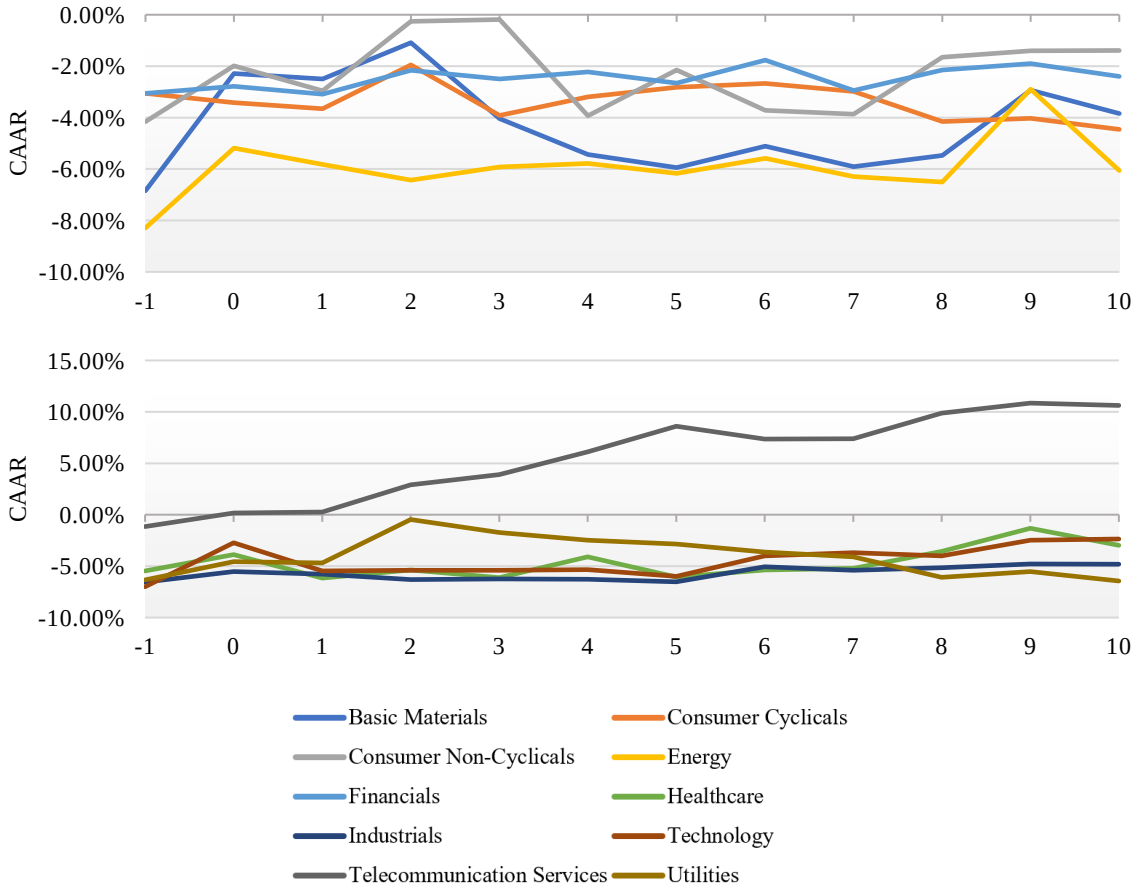
Sectors	CAAR					
	OSE			*LSE*		
	T = -1	***T = 0***	***T = 10***	***T = -1***	***T = 0***	***T = 10***
Basic Materials	-6.84% (-1.30)	-2.29% (-0.42)	-3.84% (-0.50)	-3.22% (-1.72)*	-3.03% (-1.54)	-0.34% (-0.13)
Consumer Cyclicals	-3.05% (-0.88)	-3.42% (-0.95)	-4.46% (-0.89)	0.25% (0.32)	-3.63% (-4.58)***	-8.42% (-7.69)***
Consumer Non-Cyclicals	-4.16% (-2.04)**	-1.99% (-0.93)	-1.38% (-0.47)	-2.38% (-1.77)*	-2.84% (-2.02)**	-0.07% (-0.03)
Energy	-8.29% (-3.11)***	-5.19% (-1.85)*	-6.05% (-1.56)	-3.69% (-0.75)	-0.16% (-0.03)	0.94% (0.13)
Financials	-3.06% (-1.70)*	-2.79% (-1.48)	-2.40% (-0.92)	-0.51% (-2.07)**	-1.60% (-6.13)***	-2.36% (-6.55)***
Healthcare	-5.47% (-1.09)	-3.87% (-0.74)	-2.97% (-0.41)	-2.17% (-0.75)	-3.59% (-1.19)	-2.24% (-0.54)
Industrials	-6.55% (-3.06)**	-5.52% (-2.46)*	-4.82% (-1.55)	0.37% (0.59)	-1.88% (-2.83)***	-4.59% (-5.01)***
Technology	-7.00% (-1.34)	-2.72% (-0.50)	-2.36% (-0.31)	-0.12% (-0.08)	-2.25% (-1.39)	-2.12% (-0.95)
Telecommunication Services	-1.15% (-0.27)	0.18% (0.04)	10.61% (1.70)*	-0.46% (-0.14)	-2.67% (-0.77)	-0.60% (-0.13)
Utilities	-6.33% (-1.39)	-4.55% (-0.96)	-6.44% (-0.98)	-0.02% (-0.01)	-0.11% (-0.06)	7.61% (2.86)***
Overall	-6.15% (-5.30)***	-4.04% (-3.32)***	-4.07% (-2.42)**	-0.54% (-2.23)**	-2.01% (-7.95)*	-2.98% (-8.54)***

Note: With *** is denoted significance at 1%, with ** – at 5% and with * – at 10%.

From the last column in Table 7.3, it becomes clear that the *consumer cyclicals* sector has the most negative CAAR among all other sectors on day 10 – -8.42%. The second and third most negatively hit sectors are the *industrials* and *financials*, which CAAR arrive at -4.59% and -2.36%. The only positively affected sector on day 10 is the *utilities*, while the remaining sectors had an insignificant negative CAAR.

The results of Table 7.3 are clearly illustrated in Figures 7.7 and 7.8, which present [-1, 10] windows for CAAR for the sectors on the OSE and the LSE, respectively. The windows of such lengths were determined specifically for better visualization of the transition to the post-Brexit period and post-event period itself. Again, they are only zoomed-in versions of the initial [-10,10] event windows, where the event day is the 24th of June 2016 (day 0).

Figure 7.7 CAAR for sectors for the Oslo Stock Exchange in the event window [-1,10]



Note: All the computations were done based on the event window [-10,10]. We have diminished the event window to [-1,10] solely for purposes of better visualization of post-Brexit period.

In Figure 7.7 (*bottom chart)*, the *telecommunication services* sector is the smallest sector on the OSE in terms of the number of companies and comprises of only one Norwegian company, namely, Telenor (see Section 5.1).[7] It is the only sector, which fluctuates above an axis of zero CAAR in the post-event period. Nevertheless, Appendix D shows that the return predicted by the market model and the actual return of the *telecom* sector are negative, while the latter is simply not that negative as $\left(\hat{\alpha} + \hat{\beta}R_{m,t}\right)$ on day 0 and -1. This, in fact, shows that telecom companies in other European countries had more severe immediate effects than Telenor. For the rest of the post-event window, Telenor actually had positive actual returns, except for days 6 and 7. The same applies to the expected normal return, except days 6, 7 and 8 (see Appendix

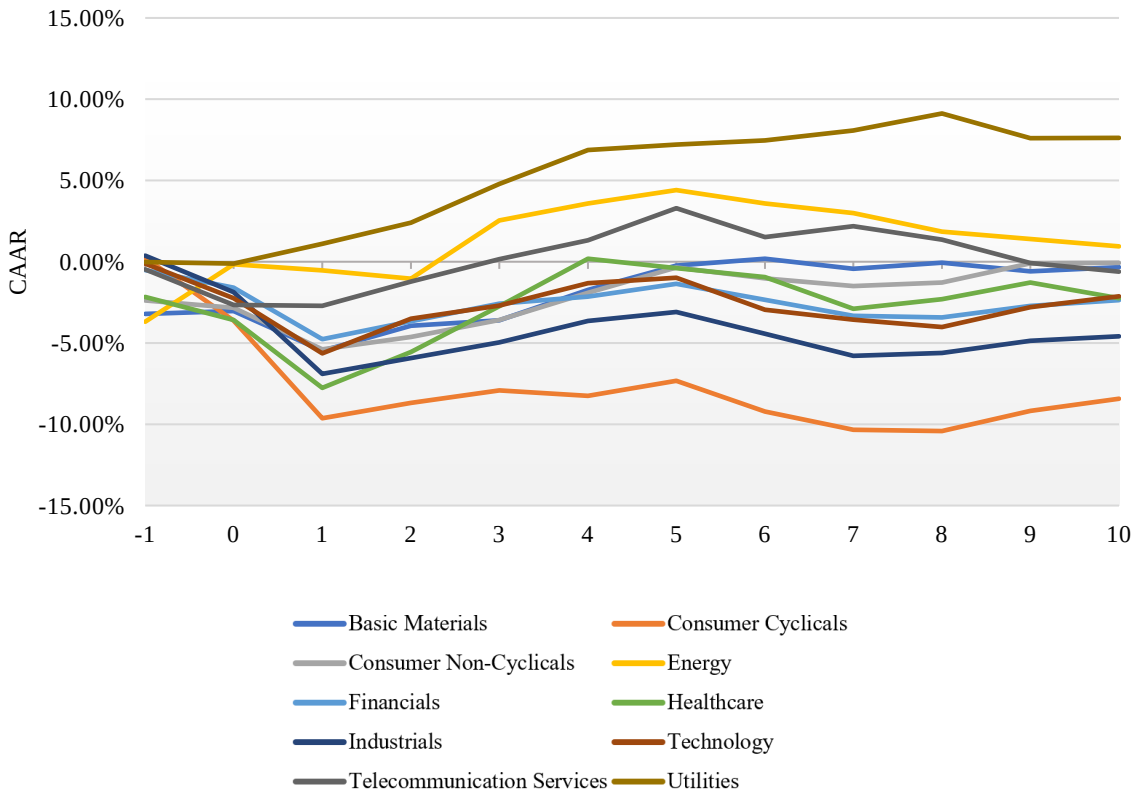
[7] Nevertheless, its market value is enormous within the OSE (11.66 %).

D). It is also worth to mention that the UK mobile operators committed to not changing mobile and fixed charges for EU users (including Norway) when traveling around the UK and vice versa for the UK users in the EU. This means that no roaming charges will be introduced, and everything will stay the same, at least until the transition period is over, i.e., until the 31st of December 2020.

The remaining sectors, within the OSE, show some steadiness and do not vary much, remaining in the negative zone throughout the whole window. It is somewhat difficult to single out the trend of each of the sectors, as they overlap significantly. Nevertheless, it is obvious that the impact of the referendum between days 0 and 1 is diminutive since most of the CAAR curves increase in the subsequent day. *Healthcare, technology, energy,* and *industrials* have roughly identical trends with unexpected growth at the end of the event window, except for the *industrials* sector, which seems fairly flat. The *utilities* sector has the biggest negative CAAR after ten trading days following the event of interest. *Energy* and *industrials* appear to have the lowest CAAR curves throughout the window. However, these sectors had lower CAAR values before the post-event window, which implies that they had a negative effect before $T = 0$.

Finally, as we shift to Figure 7.8, which depicts CAAR for sectors for the LSE in the event window [-1,10], we can see that the story for this one is completely different, in comparison to the OSE. First of all, it is much easier to distinguish the trend of each of the curves now, as they move in different directions. *Utilities, energy, telecommunication services, healthcare,* and *basic materials* sectors, anyhow, at some point in the post-event window pass above the axis of CAAR of zero. Among them, the last two seem to barely pass the line, having a positive CAAR of 0.19% on days 4 and 6, respectively. The *utilities* sector appears to not be influenced by Brexit at all. However, if we take a look at Appendix E, it seems that the actual returns were lower than the expected normal returns on the event day while increasing gradually up until day 6. This suggests that Brexit was a definite shock even for the most "unaffected-looking" sectors. For the *energy* and *telecommunication services* sectors, the impact also looks ambiguous, as they show a decreasing trend after day 5, while the *telecom* sector moves into the negative zone on day 10.

Figure 7.8 CAAR for sectors for the London Stock Exchange in the event window [-1,10]



Note: All the computations were done based on the event window [-10,10]. We have diminished the event window to [-1,10] solely for purposes of better visualization of post-Brexit period.

Nearly all of the sectors, follow the same trend: on day 1, they face the biggest decrease of CAAR, which revert moderately until day 5, experiencing another drop after this day. According to Prakash & Smout (2016), on day 5, the FTSE 100 index has actually seen its biggest increase in one single week since 2011, following the previous fall on the event day. The FTSE 100 makes up a hundred companies with the largest market cap on the LSE. But why did the returns of companies listed on the LSE and the index itself stabilize that rapidly? One of the possible reasons could be an anticipation of the Bank of England's announcement regarding an extra stimulus measures realization, in order to support the UK's market. Additionally, an increase in the price of gold made mining firms on the FTSE 100 more stable, which helped recover the index faster. In turn, based on our results, *consumer cyclicals* and *industrials* are the biggest losers on the LSE, being the most negatively affected sectors. This is not surprising since, as we already noted, export-oriented sectors experience bigger costs, additionally, related to the possible introduction of tariffs. However, it is also worth noting that following the referendum results, sterling was at its lowest value against the dollar since

1985 (Monaghan, 2016), counteracting some of those negative effects for export and import-competing industries. Lastly, the fall after day 5 could be due to the renewed concerns about Brexit, following the European Council conclusions, which were mainly concerning the result of the UK referendum. This could drag most of the indexes down, including the STOXX 600 (see Figure 7.1), consequently, triggering a drop in bond yields and oil prices. The *energy* sector on the OSE proves it as its CAAR started to decline on day 6 in Figure 7.7, whereas on day 5, actual returns were lower than the expected (see Appendix D). Starting from day 6 until day 8, for most of the sectors on the LSE, the situation was no better, as a majority of sectors had actual returns lower than the returns predicted by the market model (see Appendix E). On day 8, the *consumer cyclicals* sector was characterized by the largest drop in CAAR throughout the whole event window, slightly more than -10%.

All in all, the fact that the market proxy, and, consequently, the calculation of normal performance was affected by Brexit, it has to be taken into account when assessing the effects in the event study. As a result, the OSE's CAAR sector and country curves seem to not be that volatile and negative, compared to the LSE's, which suggests that the LSE, OSE, and STOXX 600, were negatively influenced by Brexit. However, the impact was the largest for the LSE and the smallest for the OSE.

8. Discussion: Long-Term Risks for Norway

On 24th June 2016, the United Kingdom voted to leave the European Union, a move towards becoming more independent and taking back control over issues such as regulations and immigration. And on 31st January 2020, the UK left the EU officially, shifting the balance of power in the EU and bringing an end to 47 years of European integration. Since the announcement of the referendum, a lot of speculations and controversies surrounded this divorce deal, regarding trade and commerce and how this event would change the current chain of operations. And now, even after four years and the official exit, the speculations and uncertainties surrounding Brexit continue and have become a global concern. The sentiments are the same in Norway too, what will the implications be for the country? Unfortunately, this is not an easy question to answer, given how complex the situation is. Since we have discussed the immediate short-term effects of Brexit on the stock market in the previous sections, it might be practical to look at what could be some of the long-term effects of Brexit in a broader sense, risks for international trade and what it means for each sector and for the economy as a whole.

The UK has been Norway's largest trading partner for years. In 2019, 20% of all Norwegian exports were to the United Kingdom and another 45% to the rest of the EU (UN Comtrade, 2020). Owing to this dependency, Norway will most likely feel the economic effects, although it cannot be said definitively how large the repercussions will be. The withdrawal agreement during the official exit stated that a transition period until the 31st December 2020 is planned for the UK during which the country will continue to be treated as part of the EU and the EEA. One such agreement was also signed between the UK and Norway to establish the transition period. This was done to ensure a frictionless trade until a long-term trade relationship is established. This, in turn, implied that 2020 will not see much change in business relations between the EU and the UK, as well as Norway and the UK and that business activities in 2020 will resume as normal, so Norwegian citizens and companies will be unaffected by the change. Trade between the two countries will also remain unaffected, with same rules and regulations to stay in place for the remainder of 2020. However, as of June 2020, no agreement detailing the trade relationship between the EU and the UK after the transition period has been established, and if no such agreement is reached by the end of 2020 and the transition period is not extended, a "no-deal" Brexit will be the outcome. Such an event is expected to have significant negative effects globally, primarily through the weakened economic development

in Europe, followed by a domino effect on other economies. Even if an agreement is reached as to what will happen after 2020, that is only the first phase of interaction since, other EEA countries such as Norway and Iceland will still need to negotiate their terms with the UK.

Economic effects and risks predicted for the EU-27 countries after the exit of the UK can be stretched to analyze the consequences of the Norwegian economy as well. In several ways, Norway is integrated into the EU as much as any member country is. In relative terms, Norway has more EU labor immigrants than does the UK. Norway is a part of the Schengen area agreement and implements more than three-quarters of EU legislation. Norway regularly aligns itself with the EU's positions on foreign, transport and security policies, and even contributes financially. Essentially, with the exception of agricultural and fisheries policies and not getting to vote in Europe, Norway is part of the same European integration process as any other member is. Thus, Norway's relationship with the EU and the EEA will not be changed by Brexit. However, the UK's exit from the EU and the change in EU's international agreements will have major consequences for Norway's relationship with the UK. The EEA agreement generally ensures the free flow of goods and services, with most goods exempt from customs duties. The Single Market called for mutual recognition of standards between all member countries. This meant that fish could be exported from Norway to the United Kingdom without any veterinary controls at the border and also that Norwegian ships have the freedom to carry goods and passengers to and from the UK. Therefore, with a "no-deal" Brexit, all of these provisions could be at risk. Tariff rates could be increased. Goods must be cleared through customs and VAT must be collected, while cross border trading.

If the UK leaves the EU without a deal, or if the trade conflicts escalate any further, growth abroad (in the UK, as well as in the EU) and in Norway can be lower than projected. Norway's trade with the EU countries accounts for a greater share of foreign trade than of UK's alone (20% to the UK and 45% to the EU). Slower growth in the EU-27 countries' economy will eventually reduce demand for Norwegian export companies. Reduced demand in the UK and the EU could lead to a decreased demand for oil globally. And since oil is the largest exported commodity from Norway, even a slight decrease in oil prices may reduce investment in the oil sector both in Norway and internationally. A report from Norges Bank (Norges Bank, 2019), however, estimated that under a "no-deal" scenario, the price of oil and other commodities could decline but will be sustained by continued growth in the US and other larger emerging economies. Norway, on the other hand, will risk weakening its currency's exchange rate,

which will curb the development of Norway's economy. And the reduced demand in UK and EU-27 would also affect the trade of other commodities and services, and if it is not compensated by increased export to other markets, Norway would be looking at reduced investment and higher unemployment. During the period between the referendum and the official exit, increasing uncertainty in the world economies had already taken a toll on the value of the Norwegian Krone. The uncertainty, along with some factors of Brexit, affected the demand for the trade of commodities and services, weakening the krone, while investors opted for more stable currencies.

The fisheries sector is important for both Norway as well as the UK. In 2019, the British received Norwegian fish worth over NOK 1.5 billion (UN Comtrade, 2020). Fresh salmon makes up a large proportion, just over half the number of total tonnes of fish exported in 2019. The UK also imports a significant amount of Norwegian haddock and cod, which is probably used for fish and chips. Value-chain trade for this sector is crucial since the UK's consumption of food originating in Norway but imported from Poland and Denmark, constitutes over a third of the value that Norway exports directly (OECD.Stat, 2020). The EEA agreement does not cover the trade of salmon under goods liable for waived customs duty. Therefore, customs duty applies for the trade of salmon, and this is higher for processed fish than unprocessed fish (Protocol 9, EEA Agreement, 2020). Hence, raw fish is exported from Norway to, for example, Poland or Denmark, processed there and then forwarded to other countries for consumption. This way, a lot of the Norwegian goods that end up in the UK, travel through third countries. A "no-deal" Brexit would put all this at risk by shrinking the size of operations in the sector.

Oil and Gas is another important sector to note. The gas and oil pipelines are regulated by bilateral agreements between the UK and Norway, so with respect to the transportation of the commodity, Brexit will have smaller effects on it. But as mentioned earlier, reduced demand for oil in a slowed down UK and EU due to a "no-deal" Brexit will have its consequences on Norway. A decline in oil prices will lead to fewer investments and which will eventually weaken the Norwegian Krone. Oil and gas are also important for machine exports. Parts of drilling machines, pipes for oil and gas pipelines and construction materials for oil platforms account for a quarter of these exports and again emphasizes the importance of oil and gas for trade between the two countries.

A significant part of the services trade between Norway and the UK is linked to oil and maritime operations on Norwegian and British continental shelves and the North Sea. The

shipping industry exports the most in terms of value, about NOK 13 billion in 2019 (UN Comtrade, 2020). Most of these services concern freight of goods, but a small proportion of Norwegian exports of shipping services to the UK are also related to offshore operations. Being part of the Single Market part meant that no taxes or duties were levied on goods moving internally. A hard Brexit would likely mean that tax and customs check will be applicable for goods moving between mainland Europe and the UK, which will, in turn, affect trade, increasing the time and cost for exporters in both the countries. A "no-deal" Brexit would also require increased capital investment by ports in both countries, in order to facilitate the potential customs and regulatory checks.

The financial sector in the UK is important for the financial services offered both in Norway and in the rest of Europe. London is one of two global full-service financial centers (New York being the other one). A significant number of the EU countries' capital market transactions go via London. Key Norwegian parties use the financial market in London to obtain funding and channel investments. Much of the trade in Norwegian kroner (NOK) takes place in London. Under the conditions of the Single Market, financial undertakings from an EEA country are free to establish operations in other EEA countries, and can also freely offer their services in the other EEA countries. This is made possible by the common EEA passporting rules, which mean that a single authorization from a financial institution's national regulatory authority is sufficient to sell their products and services in the rest of the EEA (Clarence-Smith, 2020). Whether or not passporting will continue is still unclear and will be a key outcome of the exit agreement. Many British companies have subsidiaries or branch offices in Norway or provide cross-border services in Norway. And in the same way, some Norwegian companies provide services in the UK. As long as the UK financial market continues to be an influential international financial hub, access to it will be important for the Norwegian financial sector and financial market, and by extension, for the Norwegian economy. This issue is a hurdle to the UK as well, as it might risk a potential exodus of financial firms from London if the country loses its passporting rights. O'Brien (2019) from The Irish Times reported that at least 30 firms have already relocated their staff and services from London to Dublin, Frankfurt and Luxembourg to maintain their position in the Single Market.

And regarding immigration, the UK is one of the countries that receive a large number of immigrants, particularly from Eastern Europe and creates jobs for them. But when the EU no longer has the UK, the pressure falls the home countries of the immigrants and on other

countries like Norway, Finland, etc. which also see a high number of seasonal immigration to accommodate them and create adequate jobs.

Value creation in the UK for 2017 was estimated at $2628 billion. A one percent change in value creation (GDP) will result in a negative $26 billion (Norsk Industri, 2020). Since the UK is a net exporter of services, effects on this issue will have a domino effect on other economies as well. Overall, Norges Bank (Norges Bank, 2019) forecasts for Norway, indicate that GDP growth will not decrease by more than 0.1 percentage points in 2020. Alternatively, the bank forecasts that the Norwegian economy will grow by 2.7 percent this year, and then will decline by 1.9 percent and 1.3 percent in 2021 and 2022, respectively. The bank here has assumed that the UK will leave the EU without a deal, and these forecasts are from before the current situation that is even more dampened by the COVID-19 pandemic.

The disintegration of the EU will have an impact on Europe for a long time. The EU losing its second-largest economy will weaken its position in the world in terms of trade as well as political power. Other global economies would benefit from this and make a certain profit due to changes in the trade pattern that will arise after the transition period. It will be crucial for the UK to maintain strong economic relations with countries in Europe to reduce negative effects and produce a positive outcome that will justify its purpose of exiting the EU.

9. Conclusion

Britain's departure from the EU has left the region with uncertainty regarding the economic position, political affairs, budget, employment issues and free trade. And in the last few years, great debates pertain to the topic of Brexit and its influence on financial markets, particularly stock markets around the globe. In this study, we examined the impact of the Brexit referendum on the Oslo Stock Exchange and London Stock Exchange, presenting the outcome in the discussion of whether Brexit was a shock for each of them and their economic sectors. We applied the event study methodology described in works written by MacKinlay (1997) and Brooks (2014) as the main approach to solve the research problem and perform the respective empirical analysis. Daily stock prices (closing prices) of the STOXX 600 market index, as well as companies listed on OSE and LSE, including their names along with their respective TRBC economic sector names, were retrieved from Thomson Reuters Eikon. A sample of 544 firms, 93 from OSE and 451 from LSE, was used for the analysis.

The results revealed that the immediate impact was the greatest for the LSE. Its largest and significant AAR were registered on the event day and the day after, -1.47% and -3.62%, respectively. Taking into consideration that AAR was positive for days -2, -1, the UK was most likely inclining towards the Remain option. Hence, experiencing rapid, but extremely severe shock, CAAR did not fully recover even until day 10, accounting for -2.98%. When it comes to the impact estimated for the sectors within the LSE, we saw that sectors that are highly reliant on trade and exports were the ones most vulnerable to the negative effect of Brexit. In particular, *consumer cyclicals* and *industrials* had the most negative and significant AAR on the event day, -3.87% and -2.25%, respectively. In turn, the effect on day 1 was again more severe in comparison to the event day. On the last day of our event window, CAAR of *consumer cyclicals* was -8.42%, while for *industrials*, it was -4.59%. That is why we emphasized on the fact that since the value chain trade concept, market access, free movement of workers, investment and trade policies are especially critical for these types of sectors, and that is why these were influenced the most.

We also showed that the STOXX 600 was affected by Brexit, thereby it was crucial to keep that in mind when interpreting the results. Hence, in terms of the OSE, even though its AAR was affected significantly in a positive way on the day of the event (2.11%), we argued that it was due to the smaller effect of Brexit on the Norwegian market, in comparison to the market proxy. Although, already on the following day, there was a significant negative reaction,

accounting for -0.74%. Besides, we saw that the OSE did not follow the trend of STOXX 600, in the way that it was not increasing as much as the latter in the pre-event period, which confirmed how distinctive macroeconomic development and sectoral composition of Norway is. Regarding the results of sector-level average abnormal returns, they were not that different from the average. In particular, AAR of all the sectors, except for *consumer cyclicals*, was positive on the day of the event, again, pointing to much less negative effect on sectors of the OSE, than on the STOXX 600 index. Our results presented that CAAR for sectors of the OSE was already considerably low before Brexit occurred. While *consumer non-cyclicals*, *energy*, *financials*, and *industrials* had statistically significant negative CAAR on day -1. On the last day of the event period, the *energy* sector, the largest of all in terms of exports and companies listed on the OSE, had the most negative CAAR after the *utilities* sector. However, not significant. Again, the sectors that are reliant on trade, as we see, suffer bigger damages than sectors that are not.

The short- and long-term repercussions of Brexit on the world economy are unpredictable and are based on what kind of new relationships develops between the UK and the EU. These issues cause great concern for every country in Europe. With so many issues still open for debate and negotiation, businesses in all economic sectors need to consider how they would be affected by a hard Brexit, whether through the imposition of new trade barriers or disruption in the supply chain. As mentioned earlier, companies in Norway are less exposed to risk due to Brexit because of the high level of government ownership that exists in the country. The exact answer to what happens to the trade relationship between the UK and the EU and the UK and Norway after the transition period is something that is yet to be announced, and even after that, there is work for Norway and the UK to draft their new terms of the relationship.

9.1 Limitations

Some of the shortcomings we observed in this research were that we considered only one event, the Brexit referendum vote. This was done so that we could get the first insights into whether this milestone event affected the LSE and OSE. The results were promising and generally in line with previous research on the topic. As per our knowledge, since there was no research on the Norwegian stock market, there was nothing to take precedence from. If we found out that this particular event did not affect the market at all, we could put forth a question if other minor events surrounding Brexit, leading up to or after the referendum day could have

meaningful impacts. Thus, future work should extend the analysis by observing other political and economic events regarding the whole uncertainty in the Brexit process. Future works could also extend the model we have used or apply new models on the topic and augment it with new market factors to see if any changes occur in the results. Since this is, to our knowledge, the first study which focuses on the Norwegian stock market and their reactions to the Brexit uncertainties, we hope that it will invoke more future analysis regarding this market. Ambivalent results for the OSE from our paper suggest that further research is needed on Brexit and its impact on the Norwegian stock market.

References

Agtmaal, T. V. (2018). *An Event Study on the Brexit Referendum.* Bachelor Thesis, Erasmus University Rotterdam.

Amewu, G., Mensah, J. O., & Alagidede, P. (2016). Reaction of Global Stock Markets to Brexit. *Journal of African Political Economy and Development, 1*.

Benninga, S. (2008). *Financial Modelling, 3rd Edition.* Cambridge, Massachusetts: MIT Press.

Bernard, V. L., & Thomas, J. K. (1989). Post-Earnings-Announcement Drift: Delayed Price Response or Risk Premium? *Jounal of Accounting Research, 27*, 1-36.

Bloomberg Economics. (2020, January 10). *$170 Billion and Counting: The Cost of Brexit for the U.K.* Retrieved June 18, 2020, from Bloomberg Economics: https://www.bloomberg.com/news/articles/2020-01-10/-170-billion-and-counting-the-cost-of-brexit-for-the-u-k

Bodie, Z., Kane, A., & Marcus, A. (2009). *Investments (8th Edition).* McGraw-Hill.

Bonchev, L., & Pencheva, M. (2017). *The Impact of Brexit Vote on Stock Returns.* Master Thesis, Lund University.

Brooks, C. (2014). *Introductory Econometrics for Finance, 3rd Edition.* Cambridge University Press.

Brown, S. J., & Warner, J. B. (1985). Using Daily Stock Returns. *Journal of Financial Economics, 14*.

Brown, S., & Warner, J. (1980). Measurity Security Price Performance. *Journal of Financial Economics, 8*.

Cable, J., & Holland, K. (1999). Modelling normal returns in event studies: a model-selection approach and pilot study. *The European Journal of Finance, 5*.

Capmbell, J. Y., Lo, A. W., & MacKinlay, C. (1997). Chapter 4: Event Study Analysis. In *The Econometrics of Financial Markets* (pp. 149-180). Princeton University Press.

Chappelow, J. (2018, July 22). *Industrials Goods Sector*. Retrieved from Investopedia: https://www.investopedia.com/terms/i/industrial-goods-sector.asp

Clarence-Smith, T. (2020, June 19). *The Impact of Brexit on the Financial Services Sector*. Retrieved from Toptal - Finance: https://www.toptal.com/finance/market-research-analysts/brexit-and-its-effect-on-the-uk-european-and-global-financial-sector

Cox, D. R., & Peterson, D. R. (1994). Stock Returns Following Large One-Day Declines. *The Journal of Finance, 49*.

Cuthbertson, K., & Nitzsche, D. (2005). *Qunatitative Financial Economics - Stocks, Bonds and Foreign Exchange.* John Wiley & Sons, Ltd.

De Bondt, W. F., & Thaler, R. H. (1990). Do Security Analysts Overreact? *The American Economic Review, 80 (2)*, 52-57.

Dolley, J. C. (1993). Characterstics and Procedure of Common Stock Split-Ups. *Harvard Business Review, 11*.

Ederington, L. H., & Lee, J. H. (1993). How Markets Process Information: News Releases and Volatility. *Journal of Finance, 48*.

Engelberg, J., & Parsons, C. A. (2009). *The Causal Impact of Media in Financial Markets.* University of North Carolina.

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

Fama, E. F. (1991). Efficient Capital Markets: II. *Journal of Finance, 45*, 1575-1617.

Fama, E. F. (1998). Market Efficiency, Long-term Returns and Behavioral Finance. *Journal of Financial Economics, 49*.

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

Fan, J., & Yao, Q. (2015). *Elements of Financial Econometrics.* Beijing: Science Press.

Frankenfield, J. (2019, July 13). *Technology Sector*. Retrieved from Investopedia: https://www.investopedia.com/terms/t/technology_sector.asp

Gagniuc, P. A. (2017). *Markov Chains: From Theory to Implementation to Experimentation.* New Jersey: John Wiley & Sons.

Gereffi, G., & Fernandez-Stark, K. (2011). *Global Value Chain Analysis: A Primer.* North Carolina, USA: CGGC, Duke University.

Griffiths, J. (2001). *Norway and the United Kingdom.* Oslo: Royal Norwegian Ministry of Foreign Affairs.

Harvey, D. (1982). *The Limits to Capital.* Oxford: Basil Blackwell.

Hayes, A. (2020, April 15). *Consumer Cyclicals Sector*. Retrieved from Investopedia: https://www.investopedia.com/terms/c/consumer_cyclicals.asp

Hudson, R. S., & Gregoriou, A. (2010). *Calculating and Comparing Security Returns is harder than you think: A Compaerison between Logarithmic and Simple Returns.* Newcastle University Business School.

Kopp, C. M. (2019, April 24). *Basic Materials Sector*. Retrieved from Investopedia: https://www.investopedia.com/terms/b/basic_materials.asp

Kothari, S., & Warner, J. (n.d.).

Kothari, S., & Warner, J. B. (2007). *Econometrics of Event Studies (Chapter 1, Handbook of Corporate Finance).* Tuck School of Business at Dartmouth.

Litvak, K. (2007). The Effect of the Sarbanes-Oxley Act on Non-US Companies Cross-Listed in the US. *Journal of Corporate Finance*.

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

Ministry of Finance, Norway. (2019). *Skattesatser 2019*. Retrieved from Regjeringen: https://www.regjeringen.no/no/tema/okonomi-og-budsjett/skatter-og-avgifter/skattesatser-2019/id2614444/

Monaghan, A. (2016, July 6). *Sterling hits new 31-year low against the dollar*. Retrieved from The Guardian: https://www.theguardian.com/business/2016/jul/06/brexit-pound-plunges-to-30-year-lows-as-eu-fears-bite-into-global-markets-again

Norges Bank. (2019). *Pengepolitisk Rapport med Vurdering av Finansiell Stabilitet* . Oslo: Norges Bank.

Norsk Industri. (2020, June 19). *Brexit, økonomien og norsk EØS-debatt*. Retrieved from Norsk Industri: https://www.norskindustri.no/dette-jobber-vi-med/internasjonalt/eos---noe-langt-mer-enn-en-handelsavtale/finnes-det-alternativer-til-eos/brexit-okonomien-og-norsk-eos-debatt/

O'Brien, C. (2019, September 17). *Brexit: Almost 30 financial groups move operations from London to Dublin*. Retrieved from The Irish Times: https://www.irishtimes.com/business/financial-services/brexit-almost-30-financial-groups-move-operations-from-london-to-dublin-1.4023599

OEC. (2020, June 19). *Norway*. Retrieved from The Observatory of Economic Complexity: https://oec.world/en/profile/country/nor

OEC. (2020, June 19). *United Kingdom*. Retrieved from The Observatory of Economic Complexity: https://oec.world/en/profile/country/gbr/#:~:text=In%202018%20United%20Kingdom%20exported,to%20%24464B%20in%202018.

OECD.Stat. (2020, June 2020). *Trade in Value Added (TiVA): Origin of value added in gross exports*. Retrieved from OECD Stats: https://stats.oecd.org/Index.aspx?DataSetCode=TIVA_2018_C2

Office for National Statistics. (2020, June 7). *UK trade in services: service type by partner country, non-seasonally adjusted*. Retrieved from Office for National Statistics: https://www.ons.gov.uk/businessindustryandtrade/internationaltrade/datasets/uktradeinservicesservicetypebypartnercountrynonseasonallyadjusted

Prakash, A., & Smout, A. (2016, July 1). *Post-Brexit rebound sees FTSE setting biggest weekly rise since 2011*. Retrieved from Market Screener: https://www.marketscreener.com/news/Post-Brexit-rebound-sees-FTSE-setting-biggest-weekly-rise-since-2011--22608868/

Priestley, M. B. (1965). Evolutionary Spectra and Non-Stationary Processes. *Journal of the Royal Statistical Society, Series B, 27*.

Protocol 9, EEA Agreement. (2020, June 19). *Fishery Products.* Retrieved from EFTA: https://www.efta.int/media/documents/legal-texts/eea/the-eea-agreement/Protocols%20to%20the%20Agreement/protocol9.pdf

PwC. (2016). *Brexit Monitor - The Impact of Brexit on (Global) Trade.* PwC.

Ramiah, V., Moosa, I., & Pham, H. N. (2016). The Sectoral Effects of Brexit on the British Economy. *Applied Economics*.

Richard Burdekin, E. H., & Gu, J. (2018). A First Look at Brexit and Global Equity Markets. *Applied Economics Letters, 25*.

Ritter, J. R. (1991). The Long-Run Performance of Initial Public Offerings. *The Journal of Finance*.

Rolfe, H., & Hudson-Sharp, N. (2016). *The Impact of Free Movement on the Labour Market.* National Institute of Economic and Social Research.

Ruppert, D. (2004). *Statistics and Finance.* Springer Science & Business Media.

Sapate, U. B. (2017). *Econometric Analysis of Weak Form of Market Efficiency.* Educreation Publishing.

Škrinjarić, T. (2019). Stock Market Reactions to Brexit: Case of Selected CEE and SEE Stock Markets. *International Journal of Financial Studies*.

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

Stolp, J. (2017). *The Effect of Brexit on the European Stock Market.* Master Thesis, University of Amsterdam.

Strøm, E. (2013). *Stock Market Reactions to Dividend Announcements: An Event Study of the Norwegian Capital Market.* Master Thesis, University of Stavanger.

Tabeshian, A. (2018). *Effects of Brexit on the Financial Markets.* Master Thesis, Norwegian University of Science and Technology.

Teplova, T. V. (2008). The Effect of Divident Payments on the Market Valuation of Russian Companies. *Audit and Financial Analysis, 2*, 1-15.

UN Comtrade. (2020, June 3). Retrieved from UN Comtrade DataBase: https://comtrade.un.org/data/

Verbeek, M. (2004). *A Guide to Modern Econometrics.* Rotterdam: John Wiley & Sons.

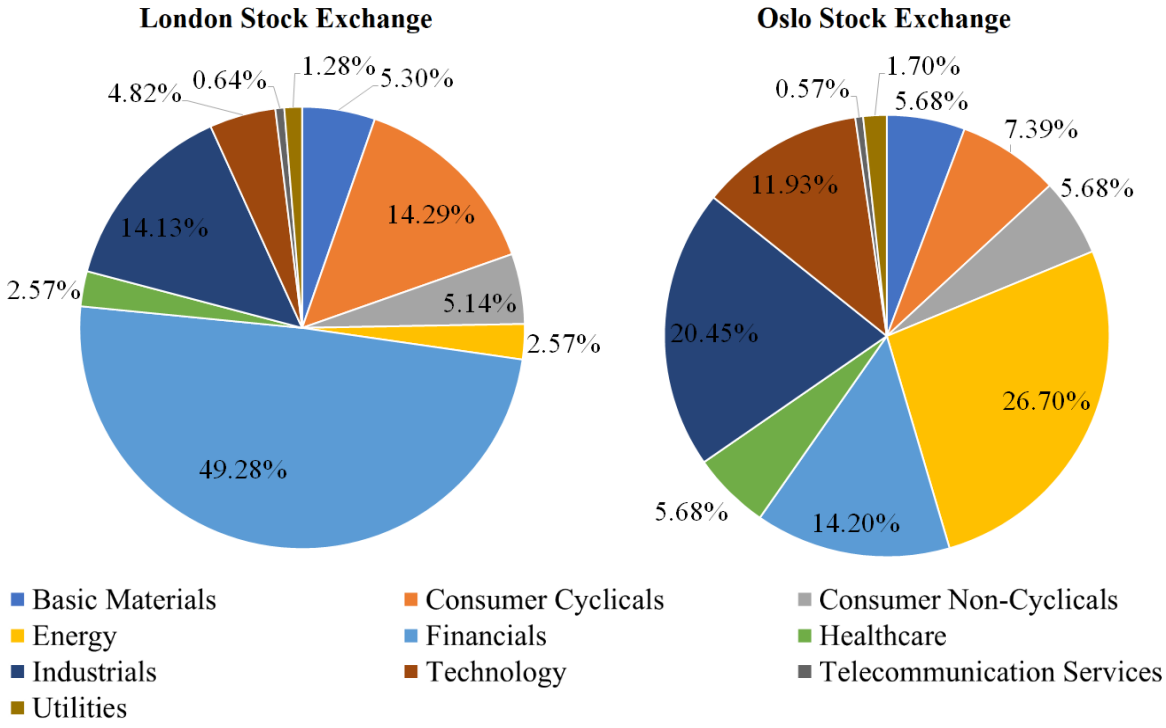
Verdipapirsentralen. (2020, March). *Ownership distribution in listed companies*. Retrieved from VPS: http://vpsinfo.manamind.com/sectorstats/stockListsInvestorLists.do?f=p&d=2020-03&l=en

WITS. (2020, June 19). *Trade Stats by Country*. Retrieved from World Integrated Trade Solution: https://wits.worldbank.org/countrystats.aspx?lang=en

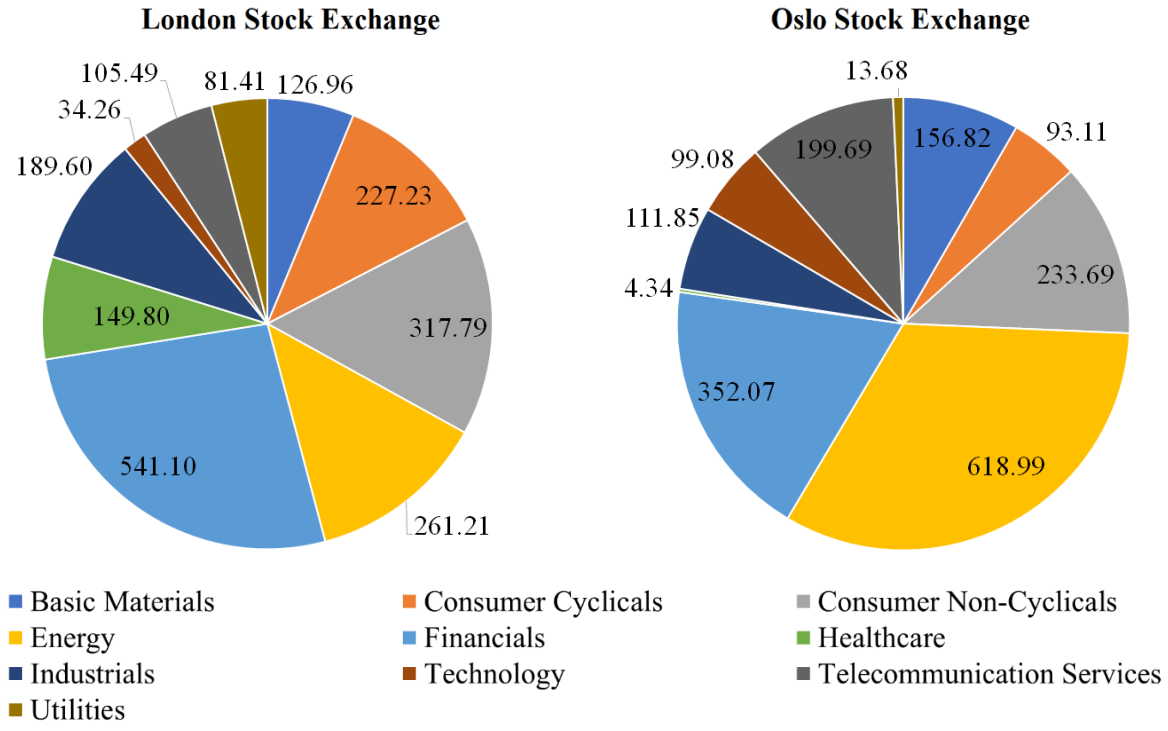
World Bank. (2020, June 7). *Data - United Kingdom*. Retrieved from https://data.worldbank.org/country/united-kingdom

Appendices

Appendix A. Percentage of companies listed on the London Stock Exchange and the Oslo Stock Exchange as of 2016, by sector



Appendix B. Combined market value of the companies listed on the London Stock Exchange (in mill. GBP) and the Oslo Stock Exchange (in mill. NOK) as of 2016, by sector



Appendix C. Difference between the average of the actual return of the OSE and LSE (R_t) and the return predicted by the market model ($\hat{\alpha} + \hat{\beta}R_{m,t}$)

T	Sectors			
	OSE		*LSE*	
	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$
-10	-1.53%	-1.62%	-1.30%	-1.28%
-9	-2.11%	-1.22%	-1.36%	-0.96%
-8	-2.31%	-1.27%	-1.82%	-1.01%
-7	0.20%	0.62%	0.53%	0.51%
-6	-3.63%	-0.48%	-1.69%	-0.37%
-5	2.90%	0.90%	1.93%	0.74%
-4	1.45%	2.32%	2.36%	1.89%
-3	-0.77%	0.45%	0.04%	0.38%
-2	-0.36%	0.24%	0.44%	0.21%
-1	0.90%	0.94%	1.20%	0.77%
0	-2.64%	-4.76%	-5.28%	-3.81%
1	-3.48%	-2.74%	-5.81%	-2.19%
2	2.05%	1.65%	2.44%	1.34%
3	1.72%	1.97%	2.67%	1.60%
4	0.51%	0.67%	1.27%	0.55%
5	0.24%	0.45%	1.18%	0.38%
6	0.23%	-0.49%	-1.46%	-0.38%
7	-1.61%	-1.12%	-1.87%	-0.89%
8	-0.87%	-1.11%	-0.89%	-0.87%
9	2.28%	0.67%	1.26%	0.56%
10	-0.11%	1.04%	1.19%	0.85%

Appendix D. Difference between the average of the actual return of the sectors of the OSE (R_t) and the return predicted by the market model ($\hat{\alpha} + \hat{\beta}R_{m,t}$)

T	Sectors							
	Basic Materials		*Consumer Cyclicals*		*Consumer Non-Cyclicals*		*Energy*	
	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$
-10	-2.70%	-1.96%	-2.01%	-1.24%	-1.16%	-1.19%	-1.69%	-2.50%
-9	-2.60%	-1.48%	-1.66%	-0.90%	-1.63%	-0.83%	-3.22%	-1.92%
-8	-2.68%	-1.54%	-2.04%	-0.94%	-1.74%	-0.88%	-3.04%	-1.99%
-7	2.78%	0.71%	0.49%	0.66%	1.74%	0.78%	-1.72%	0.76%
-6	-4.68%	-0.60%	-1.73%	-0.27%	-2.88%	-0.19%	-5.52%	-0.84%
-5	4.04%	1.04%	1.71%	0.89%	0.98%	1.02%	5.62%	1.17%
-4	0.82%	2.75%	2.71%	2.10%	2.26%	2.28%	1.28%	3.25%
-3	-1.29%	0.51%	0.23%	0.51%	1.86%	0.63%	-1.61%	0.51%
-2	-0.16%	0.26%	-0.28%	0.33%	-0.45%	0.44%	0.56%	0.21%
-1	0.42%	1.10%	1.59%	0.93%	-0.02%	1.06%	0.94%	1.23%
0	-1.15%	-5.70%	-4.26%	-3.89%	-1.78%	-3.95%	-3.99%	-7.09%
1	-3.50%	-3.30%	-2.42%	-2.19%	-3.14%	-2.17%	-4.77%	-4.14%
2	3.35%	1.94%	3.23%	1.53%	4.38%	1.69%	1.66%	2.27%
3	-0.63%	2.33%	-0.16%	1.80%	2.04%	1.97%	3.24%	2.74%
4	-0.63%	0.77%	1.42%	0.70%	-2.92%	0.82%	0.97%	0.83%
5	0.01%	0.52%	0.89%	0.52%	2.41%	0.64%	0.14%	0.52%
6	0.22%	-0.61%	-0.14%	-0.28%	-1.76%	-0.20%	-0.27%	-0.86%
7	-2.17%	-1.37%	-1.13%	-0.82%	-0.91%	-0.75%	-2.49%	-1.78%
8	-0.90%	-1.35%	-1.97%	-0.80%	1.48%	-0.74%	-1.96%	-1.75%
9	3.31%	0.78%	0.84%	0.70%	1.09%	0.83%	4.45%	0.85%
10	0.31%	1.22%	0.58%	1.01%	1.16%	1.15%	-1.78%	1.38%

T	Sectors							
	Financials		*Healthcare*		*Industrials*		*Technology*	
	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$
-10	-1.31%	-1.23%	-0.78%	-0.55%	-1.00%	-1.18%	-2.03%	-1.32%
-9	-1.24%	-0.91%	1.30%	-0.39%	-2.61%	-0.88%	-1.04%	-0.99%
-8	-1.30%	-0.96%	-3.51%	-0.41%	-1.72%	-0.92%	-2.77%	-1.03%
-7	-0.02%	0.52%	-0.33%	0.34%	0.77%	0.50%	1.94%	0.51%
-6	-2.65%	-0.34%	-1.99%	-0.10%	-3.22%	-0.32%	-1.88%	-0.39%
-5	1.87%	0.74%	3.04%	0.46%	1.40%	0.71%	1.21%	0.74%
-4	1.48%	1.86%	-1.41%	1.03%	1.88%	1.79%	1.19%	1.90%
-3	-0.35%	0.39%	-0.62%	0.28%	-0.75%	0.38%	-1.36%	0.37%
-2	0.54%	0.22%	-2.42%	0.19%	-0.58%	0.22%	-3.05%	0.20%
-1	0.99%	0.77%	2.58%	0.47%	0.33%	0.75%	1.53%	0.77%
0	-3.41%	-3.68%	-0.21%	-1.82%	-2.51%	-3.54%	0.40%	-3.88%
1	-2.41%	-2.11%	-3.30%	-1.00%	-2.28%	-2.02%	-4.97%	-2.24%
2	2.25%	1.33%	1.55%	0.76%	0.76%	1.28%	1.41%	1.35%
3	1.24%	1.58%	0.14%	0.89%	1.57%	1.52%	1.62%	1.61%
4	0.84%	0.56%	2.40%	0.36%	0.51%	0.54%	0.61%	0.55%
5	-0.04%	0.39%	-1.69%	0.28%	0.15%	0.38%	-0.27%	0.37%
6	0.54%	-0.35%	0.58%	-0.10%	1.13%	-0.33%	1.57%	-0.40%
7	-2.02%	-0.84%	-0.20%	-0.36%	-1.15%	-0.81%	-0.61%	-0.92%
8	-0.04%	-0.83%	1.31%	-0.35%	-0.54%	-0.79%	-1.19%	-0.90%
9	0.82%	0.56%	2.61%	0.37%	0.90%	0.55%	2.07%	0.55%
10	0.35%	0.85%	-1.14%	0.51%	0.79%	0.82%	0.97%	0.85%

T	Sectors			
	Telecommunication Services		*Utilities*	
	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$
-10	-1.50%	-1.85%	-1.28%	-1.20%
-9	-1.60%	-1.41%	-1.06%	-0.91%
-8	-2.18%	-1.47%	-1.62%	-0.95%
-7	1.33%	0.62%	0.86%	0.41%
-6	-2.28%	-0.60%	-5.03%	-0.38%
-5	2.35%	0.93%	1.05%	0.61%
-4	2.15%	2.50%	1.14%	1.64%
-3	-0.15%	0.43%	-0.76%	0.29%
-2	0.91%	0.20%	-1.21%	0.14%
-1	0.15%	0.97%	1.91%	0.65%
0	-3.99%	-5.32%	-1.69%	-3.46%
1	-3.02%	-3.09%	-2.15%	-2.01%
2	4.42%	1.76%	5.38%	1.16%
3	3.11%	2.11%	0.14%	1.39%
4	2.88%	0.67%	-0.31%	0.45%
5	2.94%	0.44%	-0.06%	0.30%
6	-1.85%	-0.61%	-1.17%	-0.39%
7	-1.30%	-1.31%	-1.30%	-0.84%
8	1.23%	-1.29%	-2.83%	-0.83%
9	1.64%	0.68%	1.00%	0.45%
10	0.85%	1.09%	-0.20%	0.72%

Appendix E. Difference between the average of the actual return of the sectors of the LSE (R_t) and the return predicted by the market model ($\hat{\alpha} + \hat{\beta}R_{m,t}$)

T	Sectors							
	Basic Materials		*Consumer Cyclicals*		*Consumer Non-Cyclicals*		*Energy*	
	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$
-10	-1.94%	-1.88%	-1.95%	-1.23%	-0.68%	-1.03%	-2.47%	-2.47%
-9	-1.42%	-1.41%	-1.87%	-0.93%	-1.28%	-0.77%	-2.04%	-1.85%
-8	-2.58%	-1.48%	-1.66%	-0.97%	-2.02%	-0.80%	-3.05%	-1.93%
-7	1.23%	0.73%	1.08%	0.48%	-0.54%	0.44%	0.37%	0.99%
-6	-2.77%	-0.55%	-1.45%	-0.36%	-0.71%	-0.28%	-4.26%	-0.71%
-5	1.73%	1.06%	2.84%	0.69%	0.44%	0.63%	3.47%	1.43%
-4	2.39%	2.72%	2.89%	1.78%	2.63%	1.57%	5.60%	3.64%
-3	-0.07%	0.53%	-0.41%	0.35%	0.15%	0.33%	-2.40%	0.73%
-2	-0.68%	0.28%	0.35%	0.18%	-0.29%	0.19%	0.33%	0.40%
-1	2.00%	1.11%	1.13%	0.72%	0.84%	0.65%	2.50%	1.49%
0	-5.36%	-5.55%	-7.50%	-3.63%	-3.56%	-3.10%	-3.81%	-7.34%
1	-5.65%	-3.19%	-8.08%	-2.09%	-4.32%	-1.77%	-4.58%	-4.21%
2	3.46%	1.93%	2.20%	1.26%	1.89%	1.12%	2.07%	2.59%
3	2.67%	2.31%	2.28%	1.51%	2.37%	1.33%	6.68%	3.09%
4	2.64%	0.79%	0.18%	0.51%	2.16%	0.47%	2.11%	1.07%
5	2.05%	0.54%	1.28%	0.35%	1.88%	0.33%	1.56%	0.74%
6	-0.15%	-0.57%	-2.26%	-0.37%	-0.96%	-0.29%	-1.54%	-0.73%
7	-1.92%	-1.31%	-1.99%	-0.85%	-1.18%	-0.71%	-2.30%	-1.71%
8	-0.91%	-1.28%	-0.91%	-0.84%	-0.48%	-0.69%	-2.82%	-1.68%
9	0.26%	0.80%	1.76%	0.52%	1.65%	0.48%	0.63%	1.08%
10	1.47%	1.22%	1.55%	0.80%	0.76%	0.72%	1.19%	1.65%

T	Sectors							
	Financials		***Healthcare***		***Industrials***		***Technology***	
	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$
-10	-1.11%	-1.24%	-1.01%	-1.08%	-1.40%	-1.29%	-1.31%	-1.10%
-9	-1.21%	-0.93%	-3.24%	-0.81%	-1.45%	-0.97%	-0.60%	-0.82%
-8	-1.68%	-0.97%	-1.74%	-0.84%	-1.86%	-1.02%	-2.20%	-0.86%
-7	0.49%	0.50%	1.07%	0.42%	0.56%	0.51%	-0.49%	0.46%
-6	-1.67%	-0.36%	-3.17%	-0.31%	-1.73%	-0.38%	-1.58%	-0.30%
-5	1.65%	0.71%	2.95%	0.61%	2.63%	0.73%	2.18%	0.66%
-4	1.93%	1.82%	1.89%	1.57%	2.83%	1.88%	2.84%	1.66%
-3	0.39%	0.37%	-0.11%	0.31%	-0.61%	0.37%	0.00%	0.35%
-2	0.57%	0.20%	-0.67%	0.17%	0.60%	0.20%	0.60%	0.20%
-1	0.99%	0.75%	2.56%	0.64%	1.60%	0.77%	1.38%	0.69%
0	-4.76%	-3.67%	-4.61%	-3.19%	-6.08%	-3.83%	-5.43%	-3.29%
1	-5.28%	-2.11%	-6.00%	-1.83%	-7.22%	-2.20%	-5.26%	-1.88%
2	2.39%	1.30%	3.33%	1.12%	2.31%	1.34%	3.32%	1.18%
3	2.64%	1.55%	4.15%	1.34%	2.57%	1.60%	2.22%	1.41%
4	0.96%	0.53%	3.38%	0.46%	1.86%	0.55%	1.86%	0.50%
5	1.15%	0.37%	-0.26%	0.32%	0.93%	0.38%	0.69%	0.35%
6	-1.35%	-0.37%	-0.87%	-0.32%	-1.73%	-0.39%	-2.28%	-0.31%
7	-1.84%	-0.86%	-2.70%	-0.75%	-2.25%	-0.90%	-1.36%	-0.75%
8	-0.93%	-0.84%	-0.14%	-0.73%	-0.72%	-0.88%	-1.18%	-0.74%
9	1.25%	0.54%	1.49%	0.46%	1.31%	0.55%	1.73%	0.50%
10	1.18%	0.82%	-0.26%	0.71%	1.12%	0.85%	1.42%	0.76%

T	Sectors			
	Telecommunication Services		***Utilities***	
	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$	R_t	$(\hat{\alpha} + \hat{\beta}R_{m,t})$
-10	-0.91%	-1.84%	-1.53%	-1.54%
-9	-2.45%	-1.40%	-0.80%	-1.14%
-8	-2.06%	-1.46%	-2.58%	-1.20%
-7	0.55%	0.66%	0.61%	0.66%
-6	-0.58%	-0.57%	-0.96%	-0.42%
-5	0.27%	0.97%	1.00%	0.93%
-4	3.92%	2.56%	3.78%	2.34%
-3	-1.15%	0.47%	0.46%	0.49%
-2	1.06%	0.23%	0.48%	0.28%
-1	1.51%	1.02%	0.89%	0.98%
0	-7.56%	-5.35%	-4.71%	-4.62%
1	-3.14%	-3.10%	-1.43%	-2.64%
2	3.29%	1.81%	2.98%	1.67%
3	3.56%	2.17%	4.39%	1.99%
4	1.88%	0.71%	2.78%	0.71%
5	2.44%	0.47%	0.83%	0.50%
6	-2.37%	-0.59%	-0.17%	-0.43%
7	-0.61%	-1.29%	-0.43%	-1.05%
8	-2.11%	-1.27%	0.01%	-1.03%
9	-0.72%	0.72%	-0.81%	0.71%
10	0.61%	1.13%	1.10%	1.07%

Appendix F. List of sample firms for the OSE

Company Name	Economic Sector	Company Name	Economic Sector
ABG Sundal Collier	Financials	Norwegian Air Shuttle	Industrials
AF Gruppen 'A'	Industrials	Norwegian Energy Co.	Energy
Akastor	Energy	Norwegian Property	Financials
Aker BP	Energy	NRC roup	Industrials
Aker Solutions	Energy	Ocean Yield	Energy
Akva Group	Industrials	Odfjell A	Industrials
American Shipping Co.	Industrials	Odfjell B	Industrials
Archer	Energy	Odfjell rilling	Energy
Atea	Technology	Olav Thon Eiep.	Financials
Austevoll Seafood	Consumer Non-Cyclicals	Orkla	Consumer Non-Cyclicals
Avance Gas	Energy	Otello Corporation	Consumer Cyclicals
B2holding	Financials	Panoro Energy	Energy
Bakkafrost	Consumer Non-Cyclicals	PGS	Energy
Biotec Pharmacon	Healthcare	Photocure	Healthcare
Bonheur	Utilities	Prosafe	Energy
Borregaard	Basic Materials	Protector Forsikring	Financials
BW LPG	Energy	Q-free	Technology
Bw Offshore	Energy	Questerre Energy (OSL)	Energy
DNB	Financials	REC Silicon	Basic Materials
DNO International	Energy	Salmar	Consumer Non-Cyclicals
DOF	Energy	SAS (OSL)	Industrials
Element	Basic Materials	Scatec Solar	Utilities
Endur	Industrials	Schibsted A	Consumer Cyclicals
Entra	Financials	Schibsted B	Consumer Cyclicals
Equinor	Energy	Seadrill (OSL)	Energy
Frontline	Energy	Selvaag Bolig	Financials
Funcom	Technology	Solstad Offshore	Energy
Gaming Innovation Group	Consumer Cyclicals	Sparebank 1 SR-Bank	Financials
Gjensidige Forsikring	Financials	Stolt-Nielsen	Industrials
Golden Ocean Group (OSL)	Industrials	Storebrand	Financials
Grieg Seafood	Consumer Non-Cyclicals	Strongpoint	Technology
Havila Shipping	Energy	Subsea 7	Energy
Hexagon Composites	Basic Materials	Techstep	Technology
Hiddn Solutions	Financials	Telenor	Telecommunications
Hoegh ong Holdings	Energy	TGS-NOPEC Geophysical Co.	Energy
Idex Biometrics	Technology	Tietoevry	Technology
Interoil Exp Prdn.	Energy	Tomra Systems	Industrials
Jinhui Ship. & Trans.	Industrials	Veidekke	Industrials
Kitron	Technology	Vistin Pharma	Healthcare
Kongsberg Autv. holding	Consumer Cyclicals	Wallenius Wilhelmsen	Industrials
Kongsberg Gruppen	Industrials	Wilh Wilhelmsen Holding A	Industrials
Kvaerner	Energy	Wilh Wilhelmsen Holding B	Industrials
Leroy Seafood Group	Consumer Non-Cyclicals	XXL	Consumer Cyclicals
Medistim	Healthcare	Yara International	Basic Materials
Mowi	Consumer Non-Cyclicals	Zalaris	Industrials
Norsk Hydro	Basic Materials		

Appendix G. List of sample firms for the LSE

Company Name	Economic Sector	Company Name	Economic Sector
3I Group	Financials	JPmorgan smaller cos.	Financials
3I Infrastructure	Financials	JPmorgan us smcos.it.	Financials
4Imprint Group	Consumer Cyclicals	Jupiter Fund Management	Financials
888 Holdings	Consumer Cyclicals	Jupiter US smaller cos.	Financials
AA	Consumer Non-Cyclicals	Just Group	Financials
Aberdeen Asian inc. fund	Financials	Kaz Minerals	Basic Materials
Aberdeen Divr. i&g. tst.	Financials	Keller	Industrials
Aberdeen New Dawn it.	Financials	Keystone Investment	Financials
Aberdeen New India it.	Financials	Kier Group	Industrials
Aberdeen Std. Asia Focus	Financials	Kingfisher	Consumer Cyclicals
Aberdeen Std. Eq. Inc. Tst	Financials	Lancashire Holdings	Financials
Aberforth Smcos.	Financials	Land Securities Group	Financials
Aberforth Spl. Inc. Tst.	Financials	Law Debenture	Financials
Admiral Group	Financials	Legal & General	Financials
Aggreko	Industrials	Liontrust Asset Man.	Financials
Alliance Trust	Financials	Lloyds Banking Group	Financials
Allianz Technology tst.	Financials	London Stock ex.group	Financials
Allied Minds	Financials	Londonmetric Property	Financials
Anglo-Eastern Pltns.	Consumer Non-Cyclicals	Lowland inv.	Financials
Antofagasta	Basic Materials	LS Property ervices	Financials
Arrow Global Group	Financials	Macau pr.oppor.fund	Financials
Artemis Alpha Trust	Financials	Majedie Invs.	Financials
Ashmore Group	Financials	Man Group	Financials
Ashtead Group	Industrials	Manchester & London it.	Financials
Asia Dragon Trust	Financials	Marshalls	Basic Materials
Associated Brit. Foods	Consumer Non-Cyclicals	Marston's	Consumer Cyclicals
Assura	Financials	Martin Currie glb.prtf.	Financials
Aveva Group	Technology	McBride	Consumer Non-Cyclicals
Avi Global Trust	Financials	McColl's Retail Gp.	Consumer Non-Cyclicals
Aviva	Financials	McKay Securities	Financials
Avon Rubber	Industrials	Mears Group	Industrials
B&M European Val. Ret.	Consumer Cyclicals	Meggitt	Industrials
Babcock International	Industrials	Melrose Industries	Industrials
BAE Systems	Industrials	Mercantile it.	Financials
Baillie giff.eur.gw.tst.	Financials	Merchants Trust	Financials
Baillie giff.japan	Financials	Micro Focus intl.	Technology
Baillie giff.shin nippon	Financials	Middlefield cdn.inc.	Financials
Baillie giff.uk gw.fd.	Financials	Mitchells & Butlers	Consumer Cyclicals
Balfour Beatty	Industrials	Mitie Group	Industrials
Bank of Georgia Group	Financials	Mondi	Basic Materials
Bankers Inv. Trust	Financials	Moneysupermarket com gp.	Technology
Barclays	Financials	Monks Investment rust	Financials
Barr (AG)	Consumer Non-Cyclicals	Montanaro eur.smcos.tst	Financials
BBGI SICAV SA	Financials	Montanaro uk smcos.it.	Financials
Beazley	Financials	Morgan Advanced mra.	Industrials
BH Macro	Financials	Morgan Sindall Group	Industrials
BHP Group	Basic Materials	Morrison (WM) Spmkts.	Consumer Non-Cyclicals
Big Yellow Group	Financials	Murray Income	Financials
Blackrock Frontiers	Financials	Murray Intl.	Financials
Blackrock gtr.eu.it.	Financials	National Express gp.	Industrials
Blackrock lnamer.it.	Financials	National Grid	Utilities
Blackrock nth.amer.inc.it.	Financials	NB global fr.inc.fd.	Financials
Blackrock smcos.tst.	Financials	NB Private Equity	Financials
Blackrock throg.tst.	Financials	NCC Group	Technology
Blackrock world mng.	Financials	Newriver Reit (Reg S)	Financials
Bloomsbury Pbl.	Consumer Cyclicals	Next	Consumer Cyclicals

Bluefield Solar Inc. fd.	Financials
BMO cap.&.inc.it.	Financials
BMO commercial pr.trust	Financials
BMO glb. Smcos.	Financials
BMO priv.eq.tst.	Financials
BMO rlst. Invs.	Financials
Bodycote	Industrials
Boot (Henry)	Industrials
Brewin Dolphin	Financials
British Land	Financials
Britvic	Consumer Non-Cyclicals
Brown Group	Consumer Cyclicals
Brunner Investment Trust	Financials
Bt Group	Telecommunications
Bunzl	Industrials
Burberry Group	Consumer Cyclicals
C&C Group	Consumer Non-Cyclicals
Cairn Energy	Energy
Caledonia Investments	Financials
Capita	Industrials
Capital & Cnts. props.	Financials
Capital & Regional	Financials
Capital Gearing tst.	Financials
Card Factory	Consumer Cyclicals
Carnival	Consumer Cyclicals
Centrica	Utilities
Chemring Group	Industrials
Chesnara	Financials
Cineworld Group	Consumer Cyclicals
City Merchants hi.yield	Financials
City of London inv.gp.	Financials
City of London it.	Financials
Clarkson	Industrials
Clipper Logistics	Industrials
Close Brothers Group	Financials
CLS Holdings	Financials
Coca-Cola HBC	Consumer Non-Cyclicals
Compass Group	Consumer Cyclicals
Computacenter	Technology
Connect Group	Consumer Cyclicals
Costain Group	Industrials
Cranswick	Consumer Non-Cyclicals
CRH	Basic Materials
Croda International	Basic Materials
Daejan Holdings	Financials
DCC	Energy
De La Rue Ord	Industrials
Dechra Pharmaceuticals	Healthcare
Derwent London	Financials
Devro	Consumer Non-Cyclicals
Dialight	Industrials
Diploma	Industrials
Direct Line in.group	Financials
Diverse Income Trust	Financials
Dixons Carphone	Consumer Cyclicals
Domino's Pizza Group	Consumer Cyclicals
Drax Group	Utilities
Dunedin inc.growth	Financials
Dunelm Group	Consumer Cyclicals
Easyjet	Industrials
Norcros	Consumer Cyclicals
North American inc.tst.	Financials
North Atlantic smcos.	Financials
Northgate	Industrials
Ocado Group	Consumer Cyclicals
Onesavings Bank	Financials
Oxford Biomedica	Healthcare
Oxford Instruments	Technology
Pacific Assets	Financials
Pacific Horizon	Financials
Pagegroup	Industrials
Pantheon International	Financials
Paragon Banking Group	Financials
Paypoint	Industrials
Pearson	Consumer Cyclicals
Pennon Group	Industrials
Perpetual inc.& gw.	Financials
Personal Assets	Financials
Petra Diamonds	Basic Materials
Petrofac	Energy
Petropavlovsk	Basic Materials
Pets at Home Group	Consumer Cyclicals
Phoenix roup hdg.	Financials
Photo-me Tntl.	Consumer Cyclicals
Picton pProperty inc.	Financials
Playtech	Technology
Plus500	Financials
Polar cap.glb.finls.tst.	Financials
Polar capital tech.tst.	Financials
Polarcap.glb.hlthcr.tst.	Financials
Pollen str.secd.lend.	Financials
Polypipe Group	Consumer Cyclicals
Porvair	Industrials
Premier Foods	Consumer Non-Cyclicals
Premier Oil	Energy
Primary Health props.	Financials
Provident Financial	Financials
Prudential	Financials
PZ Cussons	Consumer Non-Cyclicals
Qinetiq Group	Industrials
Rank Group	Consumer Cyclicals
Rathbone Brothers	Financials
Raven Property Group Ltd.	Financials
RDI eit	Financials
Reach	Consumer Cyclicals
Real state credit invs.	Financials
Reckitt Benckiser Group	Consumer Non-Cyclicals
Relx	Industrials
Renishaw	Industrials
Rentokil Initial	Industrials
Ricardo	Industrials
Rightmove	Technology
RIT Capital Partners	Financials
Riverstone Energy	Financials
Robert Walters	Industrials
Rolls-royce Holdings	Industrials
Rotork	Industrials
Royal Bank of sctl.gp.	Financials
Royal Mail	Industrials
RPS Group	Industrials

Edinburgh it.	Financials
Edinburgh worldwide it.	Financials
EI Group	Consumer Cyclicals
Electra Private Equity	Financials
Electrocomp.	Technology
Elementis	Basic Materials
Empiric Student Property	Financials
Enquest	Energy
EP Global opps.trust	Financials
Essentra	Basic Materials
Euromoney Instl. Investor	Industrials
European Assets rust	Financials
European Opportunities	Financials
Evraz	Basic Materials
Experian	Industrials
F&C it.	Financials
Ferguson	Consumer Cyclicals
Ferrexpo	Basic Materials
Fidelity asian values	Financials
Fidelity china spstn.	Financials
Fidelity eur.values	Financials
Fidelity japan trust	Financials
Fidelity spc.values	Financials
Finsbury gw.& inc.tst.	Financials
First group	Industrials
Fisher (James) & Sons	Industrials
Flutter Entertainment	Consumer Cyclicals
Foxtons Group	Financials
Frasers Group	Consumer Cyclicals
Fuller Smith & Turnr.	Consumer Cyclicals
Fundsmith Emrg.eq.trust	Financials
G4S	Industrials
Galliford Try	Industrials
Games Workshop	Consumer Cyclicals
GCP Infrastructure invs.	Financials
Gem Diamonds (DI)	Basic Materials
Genesis Emrg.mkts.fd.	Financials
Genus	Healthcare
Go-ahead Group	Industrials
Goodwin	Industrials
Grainger	Financials
Great Portland Estates	Financials
Greencore Group	Consumer Non-Cyclicals
Greggs	Consumer Cyclicals
Halfords Group	Consumer Cyclicals
Halma	Industrials
Hammerson	Financials
Harbourvest Global	Financials
Hargreaves ansdown	Financials
Hays	Industrials
Headlam Group	Consumer Cyclicals
Helical rReit	Financials
Henderso eurotr. ord.	Financials
Henderson alt.stgis.tst.	Financials
Henderson eur.focus tst.	Financials
Henderson far east inc.	Financials
Henderson high inc.new	Financials
Henderson intl.inc.tst.	Financials
Henderson smaller cos.	Financials
Herald iInvestment	Financials
RSA Insurance Group	Financials
S & U	Financials
Safestore Holdings	Financials
Saga	Financials
Sage Group	Technology
Sainsbury J	Consumer Non-Cyclicals
Sanne Group	Financials
Savills	Financials
Schroder an.tor.inv.co.	Financials
Schroder asia pac.fd.	Financials
Schroder income gw.fd.	Financials
Schroder japan gw.fd.	Financials
Schroder orntl.inc.fd.	Financials
Schroder real estate it.	Financials
Schroder uk mid cap.fd.	Financials
Schroder uk pub.priv.tst.	Financials
Schroders	Financials
Scottish inv.tst.	Financials
Scottish merican	Financials
Scottish mortgage	Financials
SDL	Technology
Securities tst.of sctl.	Financials
Segro	Financials
Senior	Industrials
Serco Group	Industrials
Severfield	Industrials
Severn Trent	Utilities
Shaftesbury	Financials
Sig	Consumer Cyclicals
Signature Aviation	Industrials
Sirius Real Estate	Financials
Smith (DS)	Basic Materials
Smiths Group	Industrials
Smurfit Kappa Gp. (LON)	Basic Materials
Sophos Group	Technology
Spectris	Technology
Speedy Hire	Industrials
Spirax-Sarco Engr.	Industrials
Spire Healthcare gp.	Healthcare
Spirent Communications	Technology
Sqn asset finance infd.	Financials
SSE	Utilities
SSP Group	Consumer Cyclicals
St modwen props.	Financials
St.james's place ord	Financials
Stagecoach Group	Industrials
Standard Chartered	Financials
Standard Life aberdeen	Financials
Standard Life inv.pr.inc.tst.	Financials
Standard Life priv.eq.tst.	Financials
Standard Life uk sm.cos.	Financials
Starwood eur.rlst.fin.	Financials
Sthree	Industrials
Stobart Group ord.	Industrials
Stock Spirits Group	Consumer Non-Cyclicals
Strategic Equity Cap.	Financials
Superdry	Consumer Cyclicals
Syncona	Financials
Synthomer	Basic Materials
Talktalk Telecom Group	Telecommunications

HG Capital Trust	Financials
Hicl infrastructure	Financials
Highbridge tac.cr.fd.	Financials
Hill & Smith	Basic Materials
Hilton Good Group	Consumer Non-Cyclicals
Hiscox DI	Financials
Homeserve	Consumer Non-Cyclicals
HSBC Holdings	Financials
Hyve Group	Industrials
ICG Enterprise Trust	Financials
Icg-longbow sen.secd.uk	Financials
Ictl. Htls. Gp.	Consumer Cyclicals
IG Group Holdings	Financials
IMI	Industrials
Impax env.mkts.	Financials
Imperial Brands	Consumer Non-Cyclicals
Inchcape	Consumer Cyclicals
Informa	Consumer Cyclicals
Intermediate capital gp.	Financials
International pbpart.	Financials
International psnl.fin.	Financials
Intertek Group	Industrials
Intl. Biotechnology	Financials
Intl. cons.airl.gp.	Industrials
INTU roperties	Financials
Invesco asia trust	Financials
Invesco income growth	Financials
Invesco perp.uk smcos.	Financials
Investec	Financials
IP group	Financials
ITV	Consumer Cyclicals
IWG	Industrials
Jlen env.assets group	Financials
John Laing Group	Industrials
Johnson Matthey	Basic Materials
JPmor.gemm.inu.	Financials
JPmorgan american it.	Financials
JPmorgan asian	Financials
JPmorgan china	Financials
JPmorgan claverhouse	Financials
JPmorgan emerging mkts.	Financials
JPmorgan eur.it.inc.	Financials
JPmorgan eur.smcos.	Financials
JPmorgan european it.	Financials
JPmorgan glb.g&i.	Financials
JPmorgan indian it.	Financials
JPmorgan jap.smcos.tst.	Financials
JPmorgan japanese	Financials
JPmorgan mid cap it.	Financials
JPmorgan russian	Financials
Ted Baker	Consumer Cyclicals
Telecom Plus	Utilities
Temple Bar	Financials
Templeton emrg.mkts.it.	Financials
The Biotech Growth Tst.	Financials
The Renewables infr.gp.	Financials
The scot.orntl. Smcos.	Financials
Town Centre Securities	Financials
TP Icap	Financials
TR European Growth	Financials
TR Property inv.	Financials
Tritax Big Box reit	Financials
Troy Income & gw.tst.	Financials
TT Electronics	Technology
TUI (LON)	Consumer Cyclicals
Twentyfour income fund	Financials
Twentyfour slt.mh.inc.fd	Financials
Tyman	Consumer Cyclicals
U and group	Financials
UDG Healthcare public	Healthcare
UK commercial pr.reit	Financials
Ultra Electronics hdg.	Industrials
Unite Group	Financials
United Utilities Group	Utilities
Urban Civic	Financials
Utilico Emm.tst.	Financials
Value and inc.tst.	Financials
Vectura Group	Healthcare
Vesuvius	Industrials
Victrex	Basic Materials
Vinacapital vtm.opf.	Financials
Vitec Group	Technology
Vodafone Group	Telecommunications
Volution Group	Industrials
Weir Group	Industrials
Wetherspoon (JD)	Consumer Cyclicals
WH Smith	Consumer Cyclicals
Whitbread	Consumer Cyclicals
William Hill	Consumer Cyclicals
Wincanton	Industrials
Witan inv.trust	Financials
Witan Pacific it.	Financials
Wizz Air Holdings	Industrials
Wood Group (John)	Energy
Workspace Group	Financials
Worldwide hlthcr.tst.	Financials
WPP	Consumer Cyclicals
XP Power (di)	Industrials
Zotefoams	Basic Materials