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Department of Finance

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A SECTORAL REVIEW OF THE NORDIC STOCK MARKETS' REACTION TO EVENTS ASSOCIATED WITH BREXIT

Author: Beulah Kavitha A (41028@student.hhs.se)

Advisor: Prof. Michael Halling

Abstract

This study provides a review of the sectoral reactions in the stock markets of the three Nordic member states of the EU to the announcement of the Brexit referendum and the subsequent events associated with Brexit on a country-by-country basis by employing an event study methodology. The results show that Brexit has varying effects across sectors and that the Financials sector was the most negatively affected in all three markets.

Keywords:

Brexit, Event Study, Nordic Stock Markets

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List of abbreviations:

Brexit – Britain's withdrawal from the European Union

UK – United Kingdom of Great Britain and Northern Ireland

EU – European Union

EC – European Commission

TEU - Treaty on European Union

CJEU - Court of Justice of the European Union

SITC - Standard International Trade Classification

ICB - Industry Classification Benchmark

AR – Abnormal Return

CAR – Cumulative Abnormal Return

EMH – Efficient Market Hypothesis

CAPM – Capital Asset Pricing Model

MM – Market Model

MAM – Market Adjusted Model

Table of Contents

List of Tables

List of Figures

1. Introduction

1.1 Motivation and Objectives

Brexit is considered as one of the most significant economic events in the recent years. Since the announcement of the referendum results in June 2016, many researchers have examined its impact on the various stock markets. While most studies have focused on the UK stock market, quite a few have examined the effect on the other markets as well. For example, outside the EU region, the stock markets that have been studied include the USA, India, China, Japan, Russia, Australia, South Africa, etc. Within the EU, the stock markets in Ireland, France, Germany, Spain, the Netherlands, Poland, Hungary, Italy, Czech Republic, Slovakia, Slovenia, etc., have been studied. A review of the available literature is presented in section 2.2.2 of this thesis. However, studies focusing on the Nordic countries are hardly available in the current literature. While one recent thesis has examined the immediate impact by looking at the price movements of the Nordic indices Helsinki 25, Stockholm 30, Copenhagen 20, Oslo 20 and Iceland 8 (Hartikainen, 2018), to the best of my knowledge, no one has assessed the impact on the Nordic stock markets on a sectoral basis. Further, no study has been conducted to assess the impact of the subsequent events in the negotiation process. Therefore, this study aims to fill these gaps. The focus will be on the stock markets in the three Nordic members states of the EU, namely Nasdaq Copenhagen, Nasdaq Helsinki and Nasdaq Stockholm.

Firstly, the sectoral response of stock markets on a country by country basis is examined by looking primarily at the price reactions to the initial shock caused by the referendum results. Then, a brief review of the reactions to the subsequent events in the Brexit process is provided. A standard event study methodology is employed to study the returns around the event dates and to measure the abnormal returns and cumulative abnormal return of the sectors within each market. Finally, the statistical relevance of the observed abnormal returns will be tested.

The thesis is structured as follows. The remaining parts of Section 1 provide a background on Brexit and its importance in the Nordic region. Section 2 contains a review of the theoretical and empirical literature related to the topic. Section 3 provides information about the data and methodology used. Section 4 presents the results and finally, Section 5 gives concluding remarks, limitations and recommendations for future research.

1.2 Background Information

1.2.1 The Brexit Referendum

On 23 June 2016, the people in the UK voted to leave the EU in a referendum commonly known as the Brexit referendum. The historic decision is seen as an event that would cause dramatic shifts in UK government policy and has heightened concerns about the prospects of many global institutions and their regulatory environment. The announcement of the results produced knee-jerking responses across stock markets because the outcome of the referendum was an unexpected one. Of 168 polls carried out since September 2015, eight months prior to the referendum, fewer than a third predicted a leave vote (The Guardian, 2016). Statistics by capital market participants and bookmakers on days leading up to the referendum showed a high likelihood that the UK would remain in the EU (Bloomberg, 2016). As the outcome of the referendum was quite shocking, the immediate reaction to it was observed in several markets. The pound sterling plunged to its lowest level in 31 years, from $1.50 against the US dollar to just $1.33. The global stock markets skidded, and the panic wiped $2 trillion off the markets (The Telegraph, 2016).

In the 24 hours following the announcement of results, stock markets across the world plummeted closing with record lows on 24 June 2016. In the UK, the FTSE 100 began the day by falling more than 8 percent and ended the day at 3.15 percent lower than the previous day. The FTSE 250 fell by 7.2 percent. In the Asia Pacific region, the Japanese indices were hit the most with the Topix index falling by 7.3 percent and the Nikkei 225 index going down 8 percent. The market index of South Korea, Kospi lost 3.09 percent and the Hang Seng in Hong Kong lost 2.9 percent. The Shanghai Composite, however, lost only 1.3%. The ASX 200 index in Australia lost 3.2 percent In Europe, the most representative index of European stocks, the Euro Stoxx 600 index, declined 7 percent. The Spanish IBEX and Italy's FTSE MIB both suffered their worst daily losses on record, with nearly 11 percent and 12 percent drops respectively. The DAX (Germany) index, was down 7 percent and CAC 40 (France) index tumbled by 8.6 percent. The US stock market sunk by more than 3 percent with the Dow Jones industrial average that went down by 3.4 percent, which was the ninth biggest one day plunge in the history of the Dow Jones; the Nasdaq composite dropped by 4.12 percent, the biggest crash since 2011, and the S&P 500 finished 3.5% lower.

1.2.2 The Negotiation Process

Three years after the referendum, Brexit is yet to happen and the uncertainty surrounding the form the exit would take is still high. The task of negotiating the exit has been long and winding, and so far, the UK has seen two prime ministers and many MPs resign due to division and discord in parliamentary discussions over Brexit. This delay is due to hard-to-reach agreements on account of the differences of opinion about the type of Brexit, the complex border issue in Northern Ireland, and fears arising from predictions about the after-effects of Brexit on economies. Many analysts have estimated that Brexit would create severe economic instabilities and that a no-deal Brexit could trigger an economic downturn (OECD, 2016), (Begg & Mushövel, 2016), (Brinded, 2017), (Giles & Samson, 2018), (Treanor, 2018), (The Guardian, 2018), (The Guardian, 2019). These political and economic considerations are on the minds of policy makers in both the EU and the UK when they come to decide or vote on the various proposals. In addition, the British parliament seems deeply divided, not only between parties, but also within parties, making it more difficult to reach any kind of agreement.

The main outcomes under their consideration, can be grouped into three forms of scenarios, namely a 'no-deal', a 'hard-Brexit' and a 'soft-Brexit'. These are terms used to refer to the position of the country's relationship with the EU when the divorce is set. A 'hard-Brexit' will be a clean break from the EU, which means the UK will leave the EU's single market, the customs union and the EU Courts of Justice. However, it could include some form of agreements and possibly set forth a transition period to negotiate trade deals with other countries. A 'no-deal' scenario is an extreme scenario which theoretically means that the standard international trading rules by the WTO will be applied soon after the exit. There will be border checks between the UK and EU causing shortages and delays in food and drug supply, among other goods, and increase in expenses for businesses. It will also create a hard boarder between Northern Ireland and the Republic of Ireland. With an extreme case of a 'soft-Brexit', fewer things will change causing minimal disruption to businesses. The UK will remain in the single market and the customs union, thereby avoiding new tariffs, and there will be no need for new trade deals to be negotiated with other countries. A deal with a high alignment of rules with the EU is associated with faster growth compared to a no-deal situation which is expected to be extremely disruptive to businesses and can cause a stagnant growth climate. The other possible outcome that does not fit into the above grouping is a second referendum with the prospect of Britain staying in the EU.

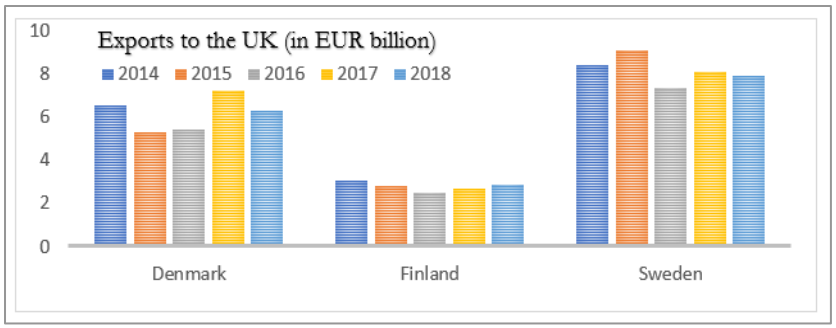
1.2.3 The Nordic States of the EU and Britain

The Nordic countries, as we know, exhibit much commonalties in their societies, such as with their political systems. Interestingly, when it comes to European integration, they share some common traits with a country outside their region, Britain. A recent policy paper jointly written by senior researchers from the Nordic states (Fägersten, et al., 2018), notes that the approach of these countries to the European integration was similar to Britain and were often described together as 'reluctant' integrationists. Along with Britain, they were the founding member states of the European Free Trade Association (EFTA) in 1960. After becoming a part of the EU, the three Nordic member states (Denmark, Finland and Sweden), and Britain were seen as like-minded counterparts voicing similar opinions and voting together on many occasions. Britain's exit will therefore reduce the relative power of the cluster of the northern European states in the EU.

In addition to losing a powerful reform partner in the EU, the three member states could lose strength in their trade relationship with Britain, one of their largest trading partners, triggered by tariff and non-tariff barriers on trade between the countries with the possibility of a hard Brexit. Although the countries have expressed interest in maintaining good bilateral trade relations with Britain, they have indicated that the relations with the EU will take a higher priority.

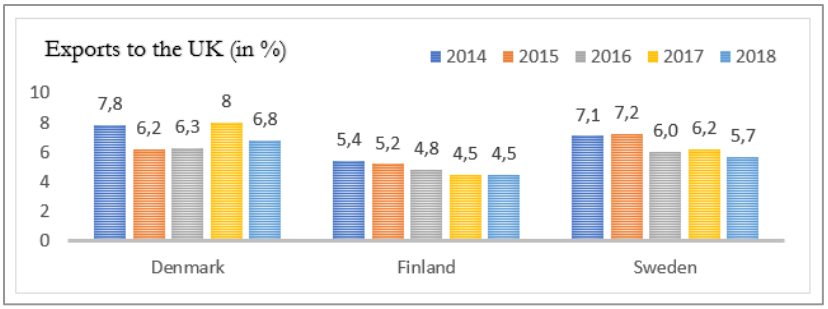
Figures 1 to 4 show that, in the five years period ending 2018, the import and export of goods in the countries have not reduced in terms of overall value. However, considering the effect of inflation over the prices of goods, when it comes to the value of goods exported and imported, to and from the UK, as a percentage of the total value of goods exported and imported (to and from all countries), the data suggests that, the countries are gradually reducing their reliance on Britain. Denmark, however, has relatively increased its exports to Britain.

Figure 1: Total value of export of goods to the UK between 2014 and 2018, in EUR billion



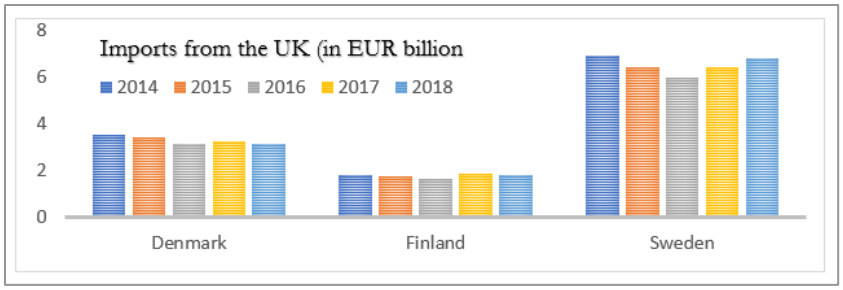
Data source: scb.se; statbank.dk; tulli.fi

Figure 2: Percentage of total export of goods to the UK between 2014 and 2018



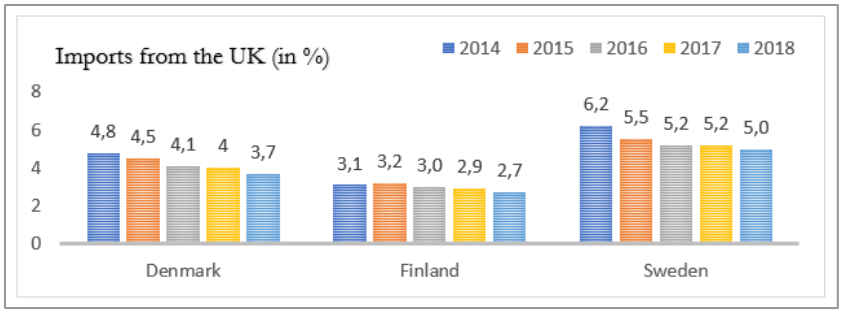
Data source: scb.se; statbank.dk; tulli.fi

Figure 3: Total value of import of goods from the UK between 2014 and 2018, in EUR billion



Data source: scb.se; statbank.dk; tulli.fi

Figure 4: Percentage of total import of goods from the UK between 2014 and 2018

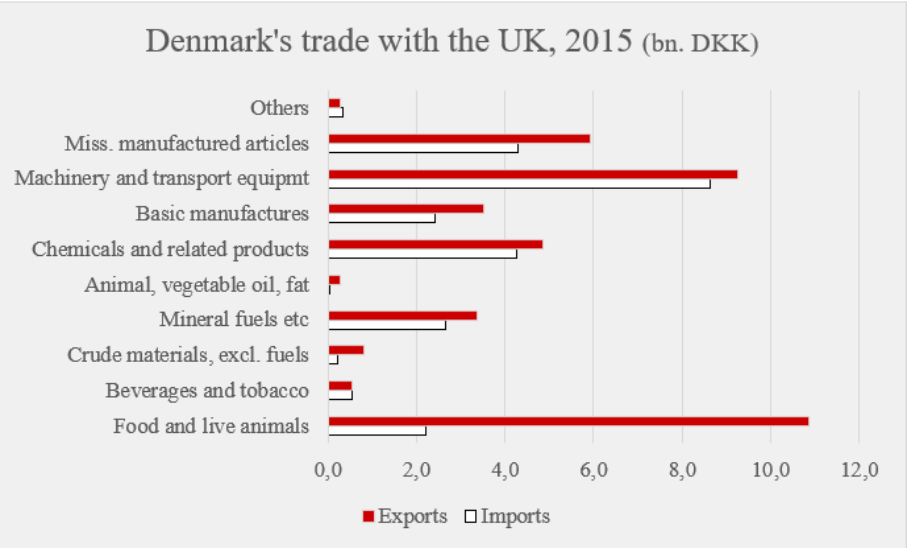


Data source: scb.se; statbank.dk; tulli.fi

Denmark

The UK was Denmark's fourth largest export market in 2015. The total value of goods exported to the UK from Denmark was approximately DKK 40bn (EUR 5.3bn) and the key goods exported to the UK include food and live animals for DKK 10.9bn, machinery and transportation equipment for DKK 9.3bn and manufacturing articles such as furniture, fixtures and scientific equipment, etc., for DKK 5.9bn. The total value of imports from the UK was approximately DKK 26bn (EUR 3.4bn) and the key goods imported from the UK include machinery and transportation equipment for DKK 8.6bn, miscellaneous manufacturing articles such as furniture, fixtures and scientific equipment for DKK 4,3bn and chemical products for DKK 4,3 bn. The figure below gives an overview about the value of goods traded between the two countries grouped according to the Standard International Trade Classification of goods (see Appendix 8) at level 1.

Figure 5: Denmark's trade (of goods) with the UK in 2015



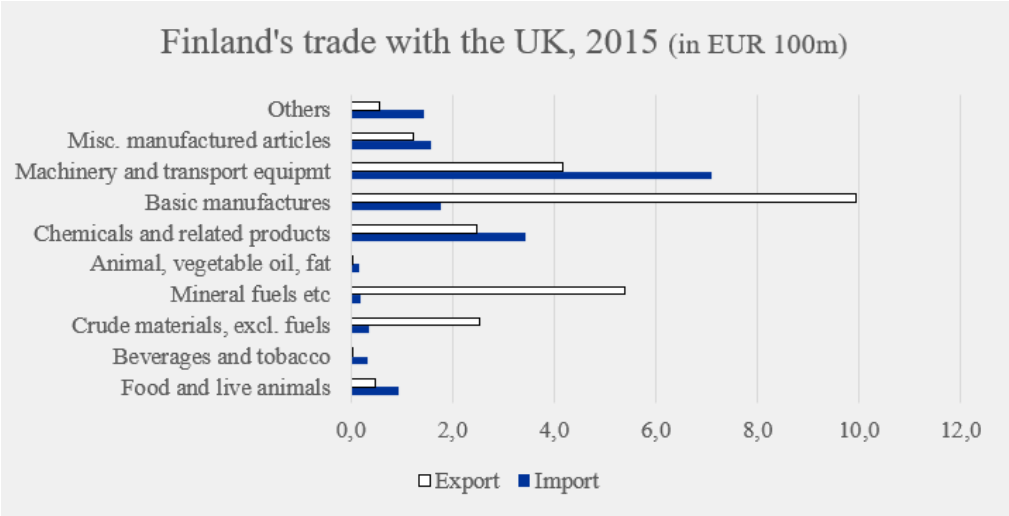
Data source: statbank.dk

Finland

The UK was Finland's sixth largest export market in 2015. The total value of goods exported to the UK was approximately EUR 2.8bn and the key goods exported to the UK include basic manufacturing goods such as leather, paper, textile, iron & steel, etc., mineral fuels, and machinery & transport equipment. The total value of imports from the UK was approximately EUR 1.7bn and the

key goods imported from the UK include machinery and transportation equipment, chemical products and miscellaneous manufacturing articles such as furniture, fixtures and scientific equipment. The figure below gives an overview about the value of goods traded between the two countries grouped according to the Standard International Trade Classification (SITC) of goods at level 1 (Appendix 8)

Figure 6: Finland's trade (of goods) with the UK in 2015



Data source: tulli.fi

Sweden

In 2015, the total value of goods exported to the UK from Sweden was approximately SEK 83bn (EUR 9.1bn) and the key goods exported to the UK include basic manufacturing goods, machinery and transportation equipment, and minerals fuels accounting for approximately SEK 19.8bn, SEK 19.3bn and 15.5bn respectively. The total value of imports from the UK was approximately SEK 59bn (EUR 6.4bn) and the key goods imported from the UK include machinery and transportation equipment for SEK 24.8bn, misc. chemical products for SEK 8.7bn and basic manufacturing goods for SEK 8bn. The figure below gives an overview about the value of goods traded between the two countries grouped according to the Standard International Trade Classification of goods at level 1 (Appendix 8).

Figure 7: Sweden's trade (of goods) with the UK in 2015

Data source: scb.se

1.3 Event Studies

Event Studies are generally conducted to assess the stock price reaction to new information and also as a direct test of market efficiency. It is based on the claim that investors change their expectation and behavior based on the new information available about the firm and the market, even if there are only rumours. The first study using the approach, was conducted by Dolley (1933) who demonstrated the effect of stock-splits on stock prices. In a sample of 95 splits from 1921 to 1931, he finds that the price went up in 57 splits and dropped in only 26 cases. The complexity of event studies slowly grew over the decades until the late 1960s with changes that include the elimination and isolation of confounding events (Myers & Bakay, 1948), (Baker, 1956), (Baker, 1958), (Ashley, 1962), (Ball & Brown, 1968).

The classic event study format that is currently in use was invented in 1969 by Fama, Fisher, Jensen and Roll as defined in their first paper that applies event-studies (Fama, Fisher, Jensen, & Roll, 1969). It uses the market model patterned after the capital asset pricing model (CAPM) that was developed by Sharpe (1964). After two decades, (Brown & Warner, 1980) and (Brown & Warner, 1985) review short-term event studies and discuss the practical importance of modifications to Fama (1969), however, there haven't been major changes to the basic format as such. The use of daily or intraday returns rather than monthly return data for estimating expected returns became widespread, allowing for more accurate measurement of abnormal returns. The use of new expected return models, such

as with Scholes-Williams beta estimation, GARCH and EGARCH error estimation, Fama-French 3 Factor Model and Fama-French-Momentum 4 Factor Model, were also tested by several researchers (Batchelor & Orakcioglu, 2003) (Savickas, 2003); (Saeed, Riaz, & Ayub, 2013); (Lundgren & Olsson, 2010). Numerous other studies have been conducted since then. In one report it was noted that in a search for event study papers in five leading financial journals, 565 articles were found to be published containing event study results (Kothari & Warner, 2006).

With regards to areas of application, event studies have mostly been applied in accounting and financial analysis to determine the impact of an announcement on the wealth of shareholders. By employing the event study methodology, one can examine the stock price effects to firm-specific events such as the announcements of dividend payments, stock splits, mergers and acquisitions, earnings announcements, issues of new debt or equity, etc., Event studies are also regularly used outside of mainstream accounting scenarios, to economy-wide events. Certain events may be beyond a firm's control but still have an impact on its operations and therefore affect stock prices. The event could be a macroeconomic announcement changes such as changes in trade deficit, a political change such as an election result or policy change, or even broader events such as a natural disasters and terrorist attacks. For example, in the field of law and economics, Schwert (1981) studied the effects of unanticipated changes in regulatory environment. Other authors have used it to measure the effect of the announcements of macroeconomic variables (Frankel & Lee, 1998), (Bhandari, 1988), (Cybo-Ottone & Murgia, 2000), (Chong, Liu, & Tan, 2006), (Chen & Zhang, 2006), (Veronesi & Pastor, 2012), (Dilshad, 2013). It seems apparent that event studies will continue to be popular and remain a part of capital market research in the coming years. Key to an event study analysis is the measurement of abnormal returns. The methodology for calculating the abnormal returns using an ESM is described in section 3.2 of this document.

2. Literature Review

2.1 Theoretical Framework

The theoretical concepts and models most appropriate for this study include the efficient market hypothesis and the expected return models. Therefore, these are presented in the following sections.

2.1.1 The Efficient Market Hypothesis

The efficient market hypothesis (EMH) has been subject to academic consideration for many years. Finding its roots in the pioneering study by Bachelier (1990) who first demonstrated that stock prices follow a random walk, a phenomenon that is said to imply market efficiency, which was later popularized by Kendall (1953), the EMH asserts that, when a market is efficient, prices reflect all available information and it is impossible to beat the market when it is truly efficient as all stocks are perfectly priced. In other words, the value of stocks at any point is said to reflect the company's fair value which is equal to the value of its discounted future cash flows. Therefore, in an efficient market, stock prices would change as a reflection of the flow of information available to market participants (Fama E. F., 1970).

Fama (1970) in his paper also introduces the concept of three forms of market efficiency: the weak form, the semi-strong form and the strong form. He explains that when a market is weak form efficient, the information set is only historical prices and since historical data is fully factored into the price, excess returns cannot be earned by using technical analysis as the randomness of prices make it impossible to find patterns from past data. The semi-strong form of the EMH asserts that stock prices reflect all publicly available information, and it is not possible to earn excess returns by conducting a fundamental analysis or by using analysts' reports containing firm-specific data such as accounting data of the firm or its competitors or by using publicly available industry-specific or market-wide information. The strong form of the EMH, which is the extreme form of efficiency, asserts that stock prices not only reflect all publicly available information but also incorporate private information, and therefore trading on any form of information is not a possibility.

A number of empirical studies have been conducted since then to test market efficiencies. Most of those conducted in the 70s supported the semi-strong form. However, anomalies such as the 'small-firm effect' and the 'January-effect' and challenges such as 'mean reversion' and the 'momentum

effect' were identified. Attempts to explain these anomalies led to the emergence of a relatively new school of thought, Behavioral Finance, which opposes the view about rationality in markets with evidence from the field of psychology pointing to cognitive errors and irrationality in human behavior. Fama and French (1988) countered this argument by providing an explanation for the mean-reverting pattern in stock returns and suggested that the behavioral errors by individuals would cause mispricing in assets which will in turn make rational investors react and thereby defuse the effect of irrational behavior. However, the adherents of behavioral economics have constantly contradicted this view and the arguments for and against the EMT is an ongoing debate.

Though the evidence for EMH has been ambiguous, it remains a common part of modern research. Despite its known problems, the tests for market efficiencies enhance our understanding of the behavior of returns across markets and securities. So, with the assumption that information drives markets and stock prices adjust immediately to new information, I use the event study methodology to test how markets react to new information.

2.1.2 Expected Return Models

In the context of event studies, MacKinlay (1997) classifies methods available to measure expected normal returns into two categories, statistical and economic. Statistical methods do not depend on any economic arguments, while economic methods are based on assumptions about investors' behavior in addition to statistical assumptions. Economic methods include models such as the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT). Statistical methods include the Constant Mean Return Model, the Market Model (MM), the Market Adjusted Model (MAM) and multi-factor models such as the Fama and French 3 Factor Model. The following parts of this section provide a description of each model along with their usage benefits.

Constant Mean Return Model

The constant mean return model is the simplest available model. For instrument i, the constant mean return model can be expressed as

$$R_{i,t} = \mu_i + \varepsilon_t$$

where $R_{i,t}$ represents the period t return on any asset i, μ_i is the mean return on i and $\varepsilon_t \sim N(0, \sigma_{\varepsilon_i}^2)$.

The Market Model

The market model takes into account market-wide factors and is one of the most commonly used models in event studies. It reduces the variation in the abnormal return by eliminating the part of the return pertaining to the variation in the market's return (Campbell, Lo , & MacKinlay, 1997). Even though more sophisticated models have been developed, many researches still prefer to use it. Brown & Warner (1985) find that the results from the market model are not very different to those arrived at using more complex models. Campbell, Lo & MacKinlay also suggest using the market model, as they find that the variance reduction in abnormal returns barely improves when using more sophisticated methods.

To examine the relationship between the returns on assets and the market return, the market model assumes a stable linear relationship between the two. For stock i, the market model can be expressed as

$$R_{i,t} = \alpha_i + \beta_i R_{M,t} + \varepsilon_t$$

where $\varepsilon_t \sim N(0, \sigma_{\varepsilon_i}^2)$

$R_{i,t}$ represents the period t return on any asset and is the explained variable, while $R_{M,t}$ represents the period t return on the regional market index which is the explanatory variable. In general, a broad-based value-weighted stock index is used for the market index. The coefficients α and β relating to R_i and R_M are estimated by running an ordinary least-square regression on the returns of the security and the market index.

The fitted value for the return on the asset is then described as

$$\hat{R}_{i,t} = \hat{\alpha}_i + \hat{\beta}_i R_{M,t}$$

where $\hat{R}_{i,t}$ is the return we predict for the asset given its estimated coefficients. The abnormal return of asset i at t is then the residual for observation shown as the difference between the actual $R_{i,t}$ and $\hat{R}_{i,t}$

$$\hat{\varepsilon}_{i,t} = R_{i,t} - \hat{R}_{i,t}$$

i.e. $\hat{\varepsilon}_{i,t} = R_{i,t} - \hat{\alpha}_i - \hat{\beta}_i R_{M,t}$

Capital Asset Pricing Model (CAPM)

The CAPM is similar to the market model but uses the excess returns over risk free rate. For instrument i, the return can be expressed as:

$$R_{i,t} = R_{f,t} + \beta_i(R_{M,t} - R_{f,t}) + \varepsilon_t$$

where $\varepsilon_t \sim N(0, \sigma_{\varepsilon_i}^2)$

CAPM is a theoretically robust model and was used commonly in event studies during the 1970s. However, the validity of the restrictions imposed by the CAPM was questionable creating the possibility that the results from the event studies may be sensitive to the such restrictions, which could be avoided by using simpler models such as the market model. The CAPM as a model of expected returns has been criticized as a result of the many identified anomalies (Kothari & Warner, 2006) and therefore the use of the CAPM in event studies is not recommended.

Arbitrage Pricing Theory (APT)

The APT assumes that a set of K factors influence the returns on all assets. It is theoretical model whereby the main factor is like the market factor and additional factors, in the form of factor mimicking portfolios, add to the explanatory power of the model.

$$R_{i,t} = \lambda_0 + \sum_{k=1}^{K} \beta_{i,k}\lambda_k$$

where λ_0 is the risk free rate and β_i is the risk premium corresponding to the kth factor.

The gain from using a model based on the APT is to reduce the biases imposed by CAPM. However, the statistical models also reduce such biases, and are used more often in event studies.

The Market Adjusted Model

The market adjusted model takes into account market-wide movements, whereby the abnormal returns are calculated as the difference between the return on the security and the return on the market index. The market adjusted model is a market model made simpler by fixing α_i as zero and β_i as one.

$$R_{i,t} = R_{M,t} + \varepsilon_t$$

As the coefficients α and β are fixed, the estimation period returns are not required to calculate the abnormal returns. The model is generally used when there is a possibility of biases arising from estimates obtained from noisy returns during the estimation period.

The Fama-French 3 Factor Model

The Fama-French 3 Factor Model is a multi-variate regression model which can be expressed in the following way

$$R_{i,t} = \alpha_i + \beta_i R_{M,t} + s_i SMB_t + h_i HML_t + \varepsilon_t$$

$$\text{where } \varepsilon_t \sim N(0, \sigma_{\varepsilon_i}^2)$$

$R_{i,t}$ represents the period t return on any asset and is the explained variable, while $R_{M,t}$, SMB_t and HML_t represent the explanatory variables, these are the period t return on the market index, the return of the size factor which captures risk related to size (given by market capitalisation) and the return of the BE/ME factor which captures risk associated with book-to-market characteristics. The coefficients α, β, s and h relating to R_i and R_M are estimated by running an ordinary least-square regression. The fitted value for the return on the asset is then described as

$$\hat{R}_{i,t} = \hat{\alpha}_i + \hat{\beta}_i R_{M,t} - \hat{s}_i SMB_t - \hat{h}_i HML_t$$

Where $\hat{R}_{i,t}$ is the return we predict for the asset given its estimated slope and intercept. The abnormal return of asset i at t is the residual for observation shown as the difference between the actual $R_{i,t}$ and $\hat{R}_{i,t}$

$$\hat{\varepsilon}_{i,t} = R_{i,t} - \hat{R}_{i,t}$$

i.e.

$$\hat{\varepsilon}_{i,t} = R_{i,t} - \hat{\alpha}_i + \hat{\beta}_i R_{M,t} - \hat{s}_i SMB_t - \hat{h}_i HML_t$$

The purpose of an event study is to isolate the impact of an event on the price performance of an instrument. Using the factor-models help distinguish the performance associated with the event, from other known determinants of performance (Kothari & Warner, 2006). Further, these models could help increase the R^2 of the regression. The higher the R^2, the greater the variance reduction of the abnormal return, which will carry over into all the aggregated abnormal returns. However, the

benefits from using a multifactor model are little as the marginal explanatory power of new factors may be so small that there is hardly any reduction in the variance of the abnormal returns (Campbell, Lo , & MacKinlay, 1997).

2.2 Empirical Framework

2.2.1 Previous Studies on Political and Economic Events Affecting Stock Markets

Political Elections and Stock Markets

Substantial empirical evidence suggest that stock markets are influenced by political changes such as elections. For example, Nippani & Medlin (2002) note considerable negative returns on the grounds of delay in declaration of the U.S. presidential election winner of 2000. Santa-Clara & Valkanov (2003) study stock returns in U.S. presidential elections and identify that the observed abnormal returns were higher under Democratic presidents than under Republican presidents. While most of the studies are connected to U.S. political events, there are also those with a wider frame of reference or other geographic insistence. Vuchelen (2003), examined the significance of election results in Belgium and conclude that parliamentary elections and news about the composition of government coalitions act as a source of information on future economic and financial policies, thereby affecting stock prices. Gemmill (1992), verified the behavior of stock and options markets in London during the 1987 election and established that during the last week of the election, the option prices showed inefficiency large enough to grant for a volatility arbitrage. Pantzalis, Stangeland, & Turtle (2000), research stock market behavior around elections among 33 countries and conclude positive abnormal returns in the two weeks before the election week, specifically, when the incumbent government loses the election. Bialkowski, Gottschalk, & Wisniewski (2006) analyse the stock market volatility around national elections in 27 OECD countries and conclude that failure to form a government with parliamentary majority greatly contribute to the strength of an election shock. Herbst & Slinkman (1984), analyse month-end stock market prices from January 1926 to December 1977 displaying proof of four-year stock market cycles that peak in the November of presidential election years, therefore rendering a foothold for politically induced market cycles and peaks.

Government Policies and Stock Markets

Various researchers have studied the impact on stock markets caused by changes in government policy. Veronesi & Pastor (2012) in their analysis conclude that announcement of government policy changes cause stock prices to fall on average and that if the ambiguity about the policy change is huge, the price fall is anticipated to be huge. Aharony, Saunders, & Swary (1986) have focused on the effect of the changes of monetary policies, the operational losses or interest rates alteration, showing a raise in the cumulative abnormal returns after the event. Gupta & Kundu (2006), Thomas & Singh (2002) and Babu & Venkateswarlu (2013) have assessed the impact of the union budget on stock market. Cook & Hahn (1989), Hamilton (2009), Kim & Nguyen (2008), Gasbarro & Monroe (2004) discuss the Macro-economic variables such as inflation, money supply and its impact on stock prices for example treasury yield. Bernanke & Kuttner (2005) investigate consequence of monetary policy announcements on stock market. Ramiah & Moosa (2013) examine the effect of 19 announcements of environmental regulation on ASX equities between 2005 & 2011 and note that they have yielded varying abnormal returns with obvious sector-by-sector differences.

Trade Policies and Stock Markets

In the context of trade policies, Brander (1991); J. Thompson (1994) and Breinlich (2014) verify stock price movements around the enactment of the US-Canada Free Trade Agreement of 1989. Moser & Rose (2014) study the impact of regional trade agreements on stock market indices. Some have studied the impact of sector-specific trade policies (often for the US) on the returns in the affected industries. For example, Ries (1993) examines the U.S. voluntary export limitation in the automobile industry. (Bhagwati & Mahdavi, 1994) examine the effects of trade agreements between the U.S. and Japan on the semiconductor industry using the U.S. stock market data.

Other Economy-Wide Events

Armstrong, Barth, Jagolinzer, & Riedl (2010) analyse the European stock market reaction to 16 events associated with the adoption of the IFRS in Europe. G. William (1981) study the reaction of daily returns of the S&P's composite portfolio around Consumer Price Index (CPI) announcement dates and conclude that unforeseen inflation causes negative reactions in stock market in the 15 trading days surrounding the CPI announcements. Sascha & Schiereck (2016) examined the stock price reaction to the Paris and Brussels terrorist attacks by looking at the data of 27 largest airlines in Canada,

the U.S., and Europe. They find that the stock price adjustment was obvious and showed that the larger companies are more disturbed by the attacks than the smaller ones, implying that size is a factor influencing stock price movements. Similarly, Simkins (2004) focus on the September 9/11 attacks, Maloney & Mulherin (2003) on the space shuttle Challenger disaster, Angbazo & Narayanan (1996) study the impact of hurricane Floyd, and Shelor (1990) on the impact of the Californian earthquake. Some have also noted positive effects on stock markets. For example, Dick & Wang (2010) who examine the effect on Olympic Games host countries, and find significant and positive announcement effect on countries hosting the summer Olympic games.

2.2.2 Previous Studies on the Effect of Brexit on Stock Markets

In the previous section, we saw that the changes in the political arena, changes in government policy and other economy-wide events affect stock prices. The effect is more prominent when the anxiety over such change is greater. Brexit is viewed as one such event, causing not just minor changes, but major shifts in UK government policy relating to trade, security, fiscal, regulation, labour market, migration, investments, environment, agriculture, etc. There are on-going concerns about Brexit induced policy divergence and uncertainty at the global level (Davis, 2016) (OECD, 2016) (Lightfoot, Mawdsley, & Szent-Iványi, 2017) (Hepburn & Teytelboym, 2017) (Burns & Carter, 2018) (Belke, Dubova, & Osowski, 2018) (Tetlow & Stojanovic, 2018) (Steinberg, 2019). Therefore, the impact of the Brexit referendum on the different stock markets has been studied by several people.

Studies Providing Regional Analysis (Country-Level)

In the UK, several empirical studies on the subject of financial markets response to Brexit referendum have been performed. Studnicka & Davies (2018) study the effect on the stocks included in the FTSE 350 and find heterogeneity in their reaction which could be explained by their global value chain, with companies exposed to the EU and UK and those relying on imported intermediates performing worse. Oehler, Horn, & Wendt (2017) conduct an event study by using five-minute return data of stocks included in the FTSE 100, and find that the abnormal returns, on the trading day after the referendum, can be explained in a large part by firm-level internationalization, i.e. companies with lower percentage of sales abroad showed more negative abnormal returns than those with more sales abroad suggesting that higher international diversification helps mitigate the detrimental influences of Brexit on stock abnormal returns. Bacon & Cannon (2018) examine the effect of the Brexit

announcement on 10 large cap companies in UK with significant economic ties to the EU and observe significant abnormal returns up to 14 days following the announcement followed by a rebound Bousselmi, Sentis, & Willinger (2018) conduct the analysis using daily data on listed companies (805 UK and 2,210 non-UK) and find that negative effects on long-run market performance of companies that conduct most of their business activities in the UK.

In the European region, Škrinjaric (2019) studied the reactions of Central and Eastern European (CEE) and South and Eastern European (SEE) stock markets to the Brexit referendum result by employing the ESM using daily data over a six-year time span and found mixed results in each market regarding the measured abnormal return. Some have studied the effect along with other international markets. Burdekin, Hughson, & Gu (2018) looked at the returns of stock indices in 64 countries against the world market index by conducting a regression analysis to estimate the abnormal returns. The results indicate negative abnormal returns for most countries, with more severe effects in countries with higher debt-to-GDP ratios. Particularly, they report that the debt ridden PIIGS countries (Portugal, Ireland, Italy, Greece, and Spain) as having been affected the most. Belke, Dubova, & Osowski (2018) also study the impact on the international stock markets and show that Brexit-induced policy uncertainty causes instability in all of Europe, with the most affected countries being Greece, Ireland, Italy, Portugal and Spain, confirming the findings of Burdekin, Hughson, & Gu (2018). Sathyanarayana & Gargesha (2016) study the effect on the Indian Stock Market by observing the reaction in two national indices and find significant abnormal return on the event day and on twelve days after the event. Amewu, Jones, Mensah, & Alagidede (2016) study the effect of Brexit on companies listed in the USA, UK, China, Japan, Germany, and South Africa and find that only the Chinese market reacted positively to the event; while the other markets registered a negative reaction and rebounded to the value before the event day within two trading days, Germany and the UK took longer to rebound.

Studies Providing Sectoral Analysis

The Brexit vote caused concerns regarding the outlook of the operations of specific sectors and their regulatory environment due to the uncertainty as to whether the UK-based institutions will continue to have full access to EU markets and vice versa. Therefore, some studies look at how the different sectors in the UK reacted to the referendum result. The findings suggest that the referendum results produced varying effects on the different sectors of the British economy. For example, Ramiah,

Huy N A, & Moosa (2016) observe sharp sector-by-sector differences in their study and show that banks and financial services were the most affected, with a cumulative abnormal return (CAR) of almost 15%. They also find that the travel and leisure sectors were significantly affected. Bouoiyour & Selmi (2018) adopt an event-study methodology to examine the responses of seven sectors of the British equity market to the Brexit referendum and find that the results for the Financials, Real estate, Defence and Airlines, and Technology sectors were more severe than the reactions of the Oil and Gas, Pharmaceuticals and Consumer goods sectors.

Some focus more narrowly on specific sectors and asset types. For example, Cazan (2017) conducted an event study on a panel of 11 financial institutions listed on the London Stock Exchange. The other important sector that was most affected was the logistics sector. Tielmann & Schiereck (2016) examined 21 UK-based companies and 86 EU-based companies in the remaining 27 EU member states and found an overall negative reaction to the referendum results and that the performance of the UK companies was significantly lower than those in the rest of the EU. Raddant (2016) conducted review of the performance and volatility of European market stocks and indices, and found that the volatility in financial sector had a severe increase in Italy. Schiereck, Kiesel, & Sascha (2016) analyse the share price reaction of banks after referendum results and compare it with the reaction after the Lehman Brother's bankruptcy. They find that the share prices of EU banks dropped more severely than they did after the Lehman's bankruptcy event.

Studies Focusing on Subsequent Brexit Related Events

While most empirical studies are confined to the investigation of the effect of a single event (i.e., the announcement of the Brexit referendum result) on the stock markets, few investigate the effects in relation to subsequent events that change the expectation of investors. For example, Breinlich, Leromain, Novy, Sampson, & Usman (2018) study the behavior of the UK stock market in relation to the announcement of the referendum result and two subsequent government statements clarifying the possible Brexit type, by estimating the abnormal returns and regressing those returns on firm-level and sector-level variables capturing exposure to the potential effects of a future exit. The firm-level variables include firm size, profitability, export-import status, reporting currencies and the sector-level variables include future EU tariff and non-tariff barriers, business-cycle sensitivity and the share of EU immigrants in the workforce of an industry. They find that for each event, the abnormal returns are best explained by a different set of variables and that the two subsequent events

were more correlated with possible changes to trade barriers, suggesting that investors either did not have the necessary knowledge about barriers earlier or they may have changed their market expectations in view of the higher probability of a hard Brexit. Shahzad, Rubbaniy, Lensvelt, & Bhatti (2019) study the UK's stock market response to the Brexit process by looking at 27 Brexit related events and find that an analysis by slicing the events into the pre and post Brexit referendum events, shows that the market reaction is negative and significant in the pre-Brexit referendum period and rather positive in the post-Brexit referendum period suggesting that, in the beginning, the market reacted negatively to the Brexit, but as the future economic relations between the UK and EU began to take a shape, the market started to see the positive side of Brexit. They find no notable reaction to firms that depend more on the European labour force and that where a negative market reaction was observed, much had to do with companies that had openly stated a negative impact of Brexit on their operations. They also identify significantly positive effects on companies that are more engaged in international trade. Kurecic & Kokotovic (2018) looked at the reaction of 12 different stock indexes of different countries and found that the reaction to the referendum result produced a structural break that was visible in every stock index studied but did not find the same outcome from subsequent events, namely the decision to call the snap election and the outcome of the election itself.

3. Data and Methodology

3.1 Data

To proxy the market returns, I use the regional NASDAQ OMX All-Share Indices which are comprised of all shares listed on the respective stock exchanges in Denmark, Finland and Stockholm. To proxy the sector returns, the NASDAQ OMX sector indices within each market are used. The sectors are value-weighted indices that are comprised of all shares listed on Nasdaq in its respective industry category based on the ICB classification at level 1 (Appendix 7), which is maintained and operated by the FTSE Group (Nasdaq, 2018). The ICB is a globally utilized standard for the categorization and comparison of companies by industry across four levels of classification offering a robust system for performance measurement, analysis and comparison. The industry classification at level 1 include the following sectors: Financials, Oil and Gas, Real Estate, Defence and Airlines, Pharmaceuticals and Biotechnology, Consumer Goods and Technology. The Copenhagen market does not include the Telecommunications sector index as the index is currently inactive. A sector index is active when it includes one or more eligible securities. Tables 1,2 and 3 below show the list of indices evaluated in this study and their respective identifiers and the no. of shares that constitute the respective indices.

Table 1: Nasdaq OMX Copenhagen Indices

This table provides the list of Nasdaq OMX Copenhagen Indices used in this study for the analysis

Sector Name	Ticker	ISIN	No. of Units
Oil & Gas	CX0001GI	DK0060369882	4
Basic Materials	CX1000GI	DK0060370468	1
Industrials	CX2000GI	DK0060371433	33
Consumer Goods	CX3000GI	DK0060372597	13
Health Care	CX4000GI	DK0060373801	19
Consumer Services	CX5000GI	DK0060374296	13
Utilities	CX7000GI	DK0060375699	2
Financials	CX8000GI	DK0060376077	41
Technology	CX9000GI	DK0060379683	6
All-Share Index	**OMXCGI**	**DK0060488112**	**132**

Table 2: Nasdaq OMX Helsinki Indices

This table provides the list of Nasdaq OMX Helsinki Indices used in this study for the analysis

Index Name	Ticker	ISIN	No. of Units
Oil & Gas	HX0001GI	FI4000033295	1
Basic Materials	HX1000GI	FI4000033345	14
Industrials	HX2000GI	FI4000033436	41
Consumer Goods	HX3000GI	FI4000033535	16
Health Care	HX4000GI	FI4000033642	9
Consumer Services	HX5000GI	FI4000033683	14
Telecommunications	HX6000GI	FI4000033766	2
Utilities	HX7000GI	FI4000033808	1
Financials	HX8000GI	FI4000033840	19
Technology	HX9000GI	FI4000033980	18
All-Share Index	**OMXHGI**	**FI0008900220**	**135**

Table 3: Nasdaq OMX Stockholm Indices

This table provides the list of Nasdaq OMX Stockholm Indices used in this study for the analysis

Sector Name	Ticker	ISIN	No. of Units
Oil & Gas	SX0001GI	SE0004382588	6
Basic Materials	SX1000GI	SE0004382646	24
Industrials	SX2000GI	SE0004382711	93
Consumer Goods	SX3000GI	SE0004382810	38
Health Care	SX4000GI	SE0004382927	57
Consumer Services	SX5000GI	SE0004382950	38
Telecommunications	SX6000GI	SE0004383032	5
Utilities	SX7000GI	SE0004383073	2
Financials	SX8000GI	SE0004383115	71
Technology	SX9000GI	SE0004383222	35
All-Share Index	**OMXSGI**	**SE0002416156**	**369**

The historical adjusted end-of-day price data of the indices within each region are extracted in local currency from the Nasdaq Nordic website. More specifically, the close price which is the adjusted price at the end of the trade day is used. The 'GI' version of the indices contains price data adjusted to account for corporate actions such as dividends, stock splits and new stock offerings, thereby making the prices in a time series, comparable over time. The adjusted price can be viewed as the true price and is often used when evaluating historical returns. Using daily data instead of monthly data makes it possible to calculate the abnormal returns more accurately (Kothari & Warner, 2006).

3.2 Methodology

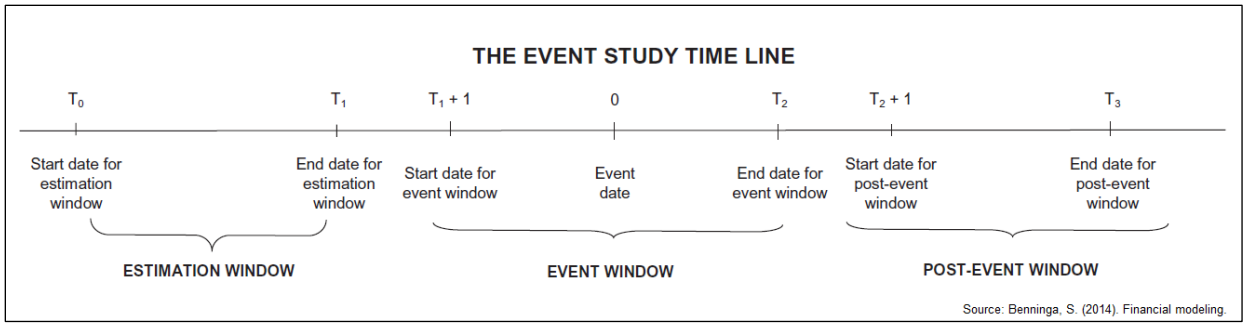
The Event Study Methodology outlined by (Brown & Warner, 1980), (Brown & Warner, 1985) is used and the structure summarized in (Campbell, Lo , & MacKinlay, 1997) is followed, whereby the abnormal returns (ARs) and cumulative abnormal returns (CARs) for sectors during the specified event window surrounding the events are measured by deviations from predictions and then the estimated abnormal returns are tested for significance. Excel is used as the tool for analysis and the functions and techniques employed are based on the guidelines in Chapter 14 of the book titled Financial Modelling by (Benninga, 2014).

For the primary event, the Market Model is used to calculate the predicted returns and the results are tested for robustness using the Market Adjusted Model predictions. For studying the subsequent events, the estimation period needs to be a floating one if the Market Model is used, as normally the estimation window ends right before the event window. However, using a floating estimation window may cause biases arising from estimates obtained based on returns generated during the estimation period that may contain contaminated data generated from the preceding events associated with Brexit. Therefore, to avoid such biases, the Market Adjusted Model is used to obtain the predicted returns of the subsequent events, as the model does not rely on the estimation period returns for the calculation of abnormal returns.

3.2.1 Timeline and Definitions

Event studies are usually comprised of three timeframes: the estimation window, the event window and the post-event window. The illustration below provides a broad overview of the timeline.

Figure 8: The Event Study Timeline



Source: (Benninga, 2014)

Event Dates

An event date, $\tau = 0$, is the date on which the news about an event was announced or became public. The announcement day of the referendum results is considered as the primary event. In addition, since the market behavior could change depending on investor's expectations about the form Brexit could take, the subsequent events that were perceived to increase or decrease the likelihood of a 'hard Brexit' or a 'no-deal Brexit 'are considered as subsequent events. The master list of events is taken from the British House of Commons' briefing paper dated 24 October (2019). Out of a total of 351 events documented therein, 12 key events are selected and grouped into two categories. The first group includes events that were anticipated to cause a negative reaction in the stock markets and the second group includes those that were anticipated to cause a positive reaction (Table 4).

If the date identified as an event date is not a trading day, the next trading day is considered the event date. For example, the referendum results were announced late on Thursday, 23 June 2016, and the markets reacted on the next trading day. Therefore, 24 June 2016 is chosen as the event day in Denmark. The markets in Sweden and Finland were closed on Friday, 24 June 2016 on the account of Midsummer Eve. Therefore, the following trading day, 27 June 2016 is chosen as the event day in these markets. Events were selected with at least six days of difference between two events.

If two or more events occur on consecutive days and the cumulative effect of those events were anticipated to be either 'all-positive' or 'all-negative', then the first day is considered as the event date. For example, the Hilary Benn's EU Bill that would force the Prime Minister to seek a 3-month Brexit extension from the EU was introduced on the 2 September 2019. In the next few days it passed the second and third readings in the House of Commons and the House of Lords. Therefore, in such a case, the first day will be considered as the event date. If the effects were anticipated to be mixed, then such events are excluded from the study. Additionally, confounding events that had an impact on the markets have also been removed. For example, 8 February 2018, when the global stock markets plunged on account of fears about the bond market, inflation and interest rates, is removed. However, it is not guaranteed that all the such events have been identified and eliminated from the study.

Table 4: List of Subsequent Events

This table provides the list of subsequent events associated with the Brexit process used for analysis in this study

S.No	Date	Description	Anticipated Reaction
E1	2017-03-29	The Prime Minister triggers Article 50 of the Treaty on EU	Negative
E2	2017-06-21	At the State Opening of Parliament, the Queen's Speech includes a 'Great Repeal Bill'.	Negative
E3	2017-09-22	The Prime Minister delivers her key Brexit speech in Florence, setting out the UK's position - outlining a 'soft exit, hard Brexit' approach.	Negative
E4	2018-11-14	The Withdrawal Agreement is agreed and published. The UK and the EU negotiating teams reach an agreement in principle.	Negative
E5	2018-11-25	The EU27 leaders endorse the Withdrawal Agreement and approve the political declaration on future EU-UK relations.	Negative
E6	2019-03-27	The Commons votes on eight indicative votes, to find a Brexit plan that wins the support of the majority of MPs. All options are defeated.	Negative
E7	2016-11-03	High Court gives its judgment in the Gina Miller case, finding in favour of the claimants.	Positive
E8	2018-12-10	CJEU issues its judgment on the Wightman case, finding unilateral revocation of Article 50 TEU is a sovereign right for any Member State to pursue.	Positive
E9	2019-01-15	The Prime Minister loses the 'Meaningful Vote'	Positive
E10	2019-03-20	The Prime Minister writes to EC President Donald Tusk, asking to extend Article 50. The next day, after a meeting of the EC, the EU27 leaders agree to grant an extension.	Positive
E11	2019-04-03	Yvette Cooper's EU Bill (designed to prevent a no-deal Brexit) passes its Second and Third Reading in Commons. The Government's amendment, ensuring the bill does not limit the power of the Brexit secretary in seeking an Article 50 extension, suffers a heavy defeat, with 400 votes against it.	Positive
E12	2019-04-10	The European Council meets. The UK and EU27 agree to extend Article 50 until 31 October 2019	Positive

Estimation Window

Let the length of estimation window, L_1, be $T_1 - T_0$. Previous studies indicate that, where the daily data are used, the estimation period T_0 to T_1, tends to be around 100 days to 300 days, and that the trade-off between longer and shorter estimation period is that one can have higher precision with a longer estimation period but have out of date data (Armitage, 1995). I employ an estimation period of 252 days. However, in the latter part of the analysis, I reduce the no. of days in the estimation period from 252 to 100, in order to test for robustness. The words 'estimation window' and 'estimation period' mean the same thing and are used interchangeably in this document.

Event Window

Let the length of event window $[T_1 + 1\ , T_2\ ]$ be $L_2 = T_2 - T_1$. The event window should be long enough to capture the significant impact of the event. We stick to a range of -10 to 10 which is normally the case for short-term event studies. For the primary event, the abnormal returns over the event windows of [0, 0], [0, 1] [0, 2], [0, 5], [0, 10] and [-10, 10] are examined.

For the subsequent events, I only examine the immediate impact for the sake of simplicity. As the impact on stock prices may change depending on what time during the day the news was made public, if the announcement was made in the morning, the effect will be visible on the same day. However, if it was made public in the evening, then the impact will be observed only on the next trading day. Since it isn't clear at what time during the day the news relating to the subsequent events were made public, to examine the immediate impact, I look at the cumulative results from the event day and the next day, i.e. the event window [0,1]. In addition, since there may have been leakage of information on account of the open discussions in the British parliament as well as the European Commission, I also look at the cumulative results for the 3-day event window of [-1,1].

3.2.2 Abnormal Returns (ARs) and Cumulative Abnormal Returns (CARs)

The daily log returns are calculated as:

$$R_{i,t} = ln(\frac{P_{i,\tau}}{P_{i,\tau-1}})$$, where

$P_{i,\tau}$ is the closing price of current day τ,

$P_{i,\tau-1}$ is the closing price of previous day.

The abnormal returns of a sector index i at time τ can be measured as:

$$AR_{i,\tau} = R_{i,\tau} - \hat{\alpha}_i + \hat{\beta}_i R_{M,\tau}$$

$$\text{where } \tau = T_1 + 1, T_1 + 2, \ldots, T_2$$

Where $R_{i,\tau}$ represents the return of the index and $R_{M,\tau}$ represents the period τ return on the broad-based value-weighted index which is the explanatory variable. $\hat{\alpha}_i + \hat{\beta}_i R_{M,\tau}$ is the return we predict for the sector given its estimated coefficients α and β estimated by running an ordinary least-square regression on the timeseries R_i and R_M for the estimation period. When using the Market Adjusted Model, the α_i is fixed as zero and β_i as one.

The $AR_{i,\tau}$ on days in the event window is the difference between the actual return $R_{i,\tau}$ and predicted return. As mentioned previously, I use the Nasdaq's value-weighted GI sector indices for the calculating the sector returns and the Nasdaq's value-weighted GI All Share Index of sector i's country of origin for the market index.

The cumulative abnormal returns over a period, $CAR_{i,[\tau_1,\tau_2]}$, is calculated by summing up the included abnormal returns from τ_1 to τ_2, where $T_1 < \tau_1 \leq \tau_2 \leq T_2$. Aggregating the results over time helps to get a sense of aggregate effect of the abnormal returns. It captures the effect of the event over the event window and not just on the event date.

$$CAR_{i,[\tau_1,\tau_2]} = \sum_{t=\tau_1}^{\tau_2} (AR_{i,\tau})$$

$$CAR_{i,[\tau_1,\tau_2]} = \sum_{t=\tau_1}^{\tau_2} (R_{i,\tau} - \hat{\alpha}_i + \hat{\beta}_i R_{M,\tau})$$

3.2.3 Statistical Significance of the Abnormal Returns

The next step is to measure the significance of the Abnormal Returns. We apply the parametric test statistic, the t-test, which standardizes the event window abnormal returns by the standard deviation of the estimation period abnormal returns. We check if the absolute values of the t-statistic are greater than the critical values. The critical values are 1.65, 1.96 and 2.58 at the 90%, 95% and 99% confidence levels respectively. The t-statistic of the $AR_{i,\tau}$ is given by:

$$t_{AR} = \frac{AR_{i,\tau}}{\sigma_{AR_i}}$$

where $\sigma^2_{AR_i} = \frac{1}{L_1 - 2}\sum_{\tau=T_0}^{T_1}(AR^2_\tau)$

The t-statistic of the abnormal returns cumulated over L_2, the length of the event window, is the ratio of the Cumulative Abnormal Returns (CARs) to the estimated standard deviation of the cumulated abnormal returns measured over the estimation period.

$$t_{CAR} = \frac{CAR_{i,[\tau_1,\tau_2]}}{\sigma_{CAR_i}}$$

where

$$\sigma^2{}_{CAR_i} = L_2\ \sigma^2{}_{AR_{i,[T_0,T_1]}}$$

4. Analysis and Results

This section presents the results of the event study conducted using the empirical methods described in the previous sections. Firstly, the summary statistics of the returns of the indices under the study are presented. Then a sectoral review of the reactions to the primary event is presented on a country-by-country basis whereby the abnormal returns and cumulative abnormal returns calculated by employing the Market Model and tested using the Market Adjusted model are discussed. Finally, a review of the immediate reactions of the sectors to the subsequent events are presented and discussed.

4.1 Summary Statistics

The table below shows the descriptive statistics of the returns on the market indices for the 252-day estimation period. We see that the mean of the stock market is close to zero as is usually expected for a time series of returns. The standard deviation is approximately 0.014 in all markets with the minimum and maximum return values ranging between -0.515 and 0.036 altogether.

Table 5: Summary Statistics of the Market Indices

This table reports an overview of the summary statistics for the market index returns calculated from the daily return series generated over the estimation period (23-06-2015 to 23-06-2016)

Sector Name	Mean	S.D.	Kurtosis	Skewness	Min	Max
OMX Copenhagen GI	6E-05	0.0140	1.4	-0.3	-0.0515	0.0489
OMX Helsinki GI	-8E-05	0.0136	0.6	-0.3	-0.0528	0.0420
OMX Stockholm GI	-0.0002	0.0134	0.7	-0.1	-0.0465	0.0362

In all three markets, we observe that the kurtosis values are lower than 3 and the skewness values are negative ranging between -0.1 and -0.3 indicating that the returns distribution in these markets during the period is reasonably symmetric and that the tails are thin. The market index of Sweden has the least Skewness value with the least difference between the minimum and maximum values. Based on this observation it can be said that the market in Sweden was the least volatile among the three markets in the period under consideration.

Table 6: Summary Statistics of the Sector Indices

This table reports an overview of the summary statistics for each regional sector index returns calculated from the daily return series generated over the estimation period (23-06-2015 to 23-06-2016)

Sector Name	Mean	S.D.	Kurtosis	Skewness	Min	Max
Denmark						
Oil & Gas	0.0014	0.0217	3.3	-0.5	-0.1010	0.0720
Basic Materials	0.0020	0.0184	4.8	0.2	-0.0737	0.0918
Industrials	-0.0003	0.0153	1.9	0.2	-0.0561	0.0603
Consumer Goods	0.0006	0.0150	1.5	-0.2	-0.0509	0.0455
Health Care	0.0002	0.0167	1.0	-0.3	-0.0599	0.0562
Consumer Services	0.0001	0.0090	2.3	-0.7	-0.0374	0.0236
Utilities	-0.0011	0.0225	10.7	-0.8	-0.1581	0.1040
Financials	-0.0004	0.0147	1.8	-0.2	-0.0548	0.0505
Technology	0.0015	0.0169	3.0	-0.2	-0.0709	0.0699
Finland						
Oil & Gas	0.0014	0.0200	4.2	-1.1	-0.0927	0.0492
Basic Materials	-0.0002	0.0194	0.6	-0.3	-0.0698	0.0511
Industrials	0.0002	0.0151	-0.1	-0.3	-0.0421	0.0380
Consumer Goods	0.0002	0.0144	1.6	0.1	-0.0432	0.0611
Health Care	0.0004	0.0157	4.4	0.1	-0.0721	0.0801
Consumer Services	0.0007	0.0133	4.0	-0.4	-0.0748	0.0453
Telecom	0.0003	0.0158	1.7	0.3	-0.0577	0.0591
Utilities	-0.0002	0.0204	9.1	-1.5	-0.1418	0.0537
Financials	-0.0004	0.0140	1.1	-0.1	-0.0569	0.0438
Technology	-0.0006	0.0203	4.9	-0.2	-0.1082	0.0858
Stockholm						
Oil & Gas	0.0001	0.0248	5.2	1.0	-0.0868	0.1497
Basic Materials	-0.0002	0.0177	0.9	-0.1	-0.0600	0.0491
Industrials	0.0000	0.0152	0.4	-0.1	-0.0526	0.0428
Consumer Goods	0.0004	0.0129	1.0	-0.1	-0.0442	0.0512
Health Care	0.0002	0.0139	3.5	0.2	-0.0499	0.0758
Consumer Services	-0.0005	0.0135	0.8	-0.1	-0.0444	0.0383
Telecom	-0.0009	0.0150	0.4	0.0	-0.0539	0.0443
Utilities	-0.0013	0.0180	2.7	0.6	-0.0632	0.0781
Financials	-0.0003	0.0146	0.6	0.0	-0.0469	0.0419
Technology	-0.0004	0.0174	3.5	-0.6	-0.0949	0.0564

The data suggests that the Oil & Gas sector indices in Finland and Sweden are highly skewed, with heavy tails. This is followed by the Utilities sector in Denmark and Finland having similar observations.

4.2 Review of the Sectoral Reactions to the Referendum Results

4.2.1 Reactions in Denmark

Table 7: Regression Estimates of the Copenhagen Sector Indices

This table reports the regression estimates of the Copenhagen sector indices against the market index based on the 252-day estimation period return series (23-06-2015 to 23-06-2016).

Sector Name	No. of stocks	Alpha	Beta	R^2	Std. Error
Oil & Gas	4	0.0013	1.0758	0.4823	0.0156
Basic Materials	1	0.0020	0.3639	0.0768	0.0177
Industrials	33	-0.0004	0.8399	0.5908	0.0098
Consumer Goods	13	0.0006	0.8627	0.6457	0.0090
Health Care	19	0.0001	1.1347	0.9099	0.0050
Consumer Services	13	0.0001	0.3780	0.3451	0.0073
Utilities	2	-0.0011	0.3511	0.0479	0.0220
Financials	41	-0.0004	0.9059	0.7430	0.0075
Technology	6	0.0014	0.6983	0.3343	0.0138

The market model regression estimates of each of sector indices reported in the above table are used to calculate the predicted returns for each sector. For example, the regression model of the OMX Copenhagen Oil & Gas sector index is $\hat{R}_{Oil\,\&\,Gas,t}$= 0.0013 + 1.0758 * $R_{M,t}$. The R^2 value shows what percentage of variation in the returns of the individual sector indices is explained by the broad market index. The Health Care and Financials sectors have the higher R^2 values compared to the other sectors. The Basic Materials, Consumer Services and the Utilities sectors have low R^2 values.

Figure 9: Plot of the 11-day Cumulative Abnormal Returns [-10 to 10] per sector in Denmark

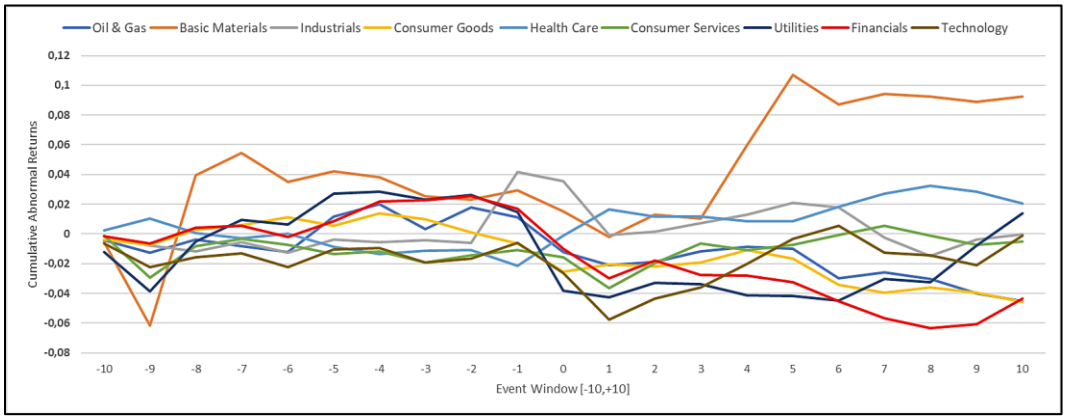


Table 8: Sectoral Reactions to the Referendum Results in Denmark

Summary of the abnormal returns and cumulative abnormal returns generated per sector index on the days following the referendum results, calculated using the Market Model with an estimation period of 252 days.

Sector Name	AR [0,0] Event day	CAR [0,1] 2-day	CAR [0,2] 3-day	CAR [0,5] 6-day	CAR [0,10] 11-day	Days to rebound
Oil & Gas	-0.0235	-0.0322	-0.0302	-0.0214	-0.0568	23
Basic Materials	-0.0144	-0.0314	-0.0167	0.0776	0.0628	6
Industrials	-0.0065	**-0.0426*** **	**-0.0404** **	-0.0209	-0.0419	26
Consumer Goods	**-0.0190** **	-0.0145	-0.0155	-0.0105	-0.0396	20
Health Care	0.0200**	0.0378***	0.0330***	0.0297**	0.0419**	4
Consumer Services	-0.0051	**-0.0259** **	-0.0088	0.0035	0.0058	6
Utilities	**-0.0530** **	**-0.0575** *	-0.0478	-0.0566	-0.0011	19
Financials	**-0.0268*** **	**-0.0466*** **	**-0.0348*** **	**-0.0492*** **	**-0.0604** **	33
Technology	-0.0206	**-0.0517*** **	-0.0378	0.0026	0.0046	6

* significant at 90% confidence level ** significant at 95% confidence level *** significant at 99% confidence level.

When considering the overall effect of the event, I look at the cumulative abnormal returns over the event window [-10,10] as illustrated in Figure 9 which provides an overview of the movements in cumulative returns during this period. Table 8 shows the CAR calculated over four different event windows [0, 1], [0, 2], [0, 5] and [0, 10]. The last column in the table shows the no. of days it took for the close price of the index to rebound to the level it had reached prior to the event day. We see that with the exception of the Health Care sector, all sectors in the Denmark stock market experienced negative abnormal returns on the event day. However, only the Consumer Goods, Utilities and Financials sectors recorded significant negative abnormal returns. The Financials sector was the most affected sector in the market, with abnormal returns on the event day measured at -0.0268, significant at the 99% confidence level. The CAR calculated over the event windows [0,1], [0,2] and [0,5] were -0.0466, -0.0348, and -0.0492, also significant at the 99% confidence level. The CAR calculated over a longer event window of [0,10] was as high as -0.0604, significant at the 98% confidence level. Further, the sector took 33 days to rebound to its previous level, the longest time when compared to the other sectors. Similar negative effects were observed within the Industrials, Consumer Goods and Utilities sectors which took longer to rebound. The CAR observed in the Industrials sector over the [0,1] event window was -0.0426 at the 99% confidence level. The Technology and Consumer Services sectors generated significant negative abnormal returns over shorter event window and rebounded faster.

4.2.2 Reactions in Finland

Table 9: Regression Estimates of Returns of the Helsinki Sector Indices

This table reports the regression estimates of the Helsinki sector indices against the market index based on the 252-day estimation period return series (26-06-2015 to 23-06-2016).

Sector Name	No. of stocks	Alpha	Beta	R^2	Std. Error
Oil & Gas	1	0.0015	0.8967	0.3739	0.0159
Basic Materials	14	-0.0001	1.2221	0.7371	0.0100
Industrials	41	0.0003	0.9986	0.8111	0.0066
Consumer Goods	16	0.0003	0.8551	0.6515	0.0085
Health Care	9	0.0005	0.7434	0.4170	0.0120
Consumer Services	14	0.0008	0.6664	0.4687	0.0097
Telecommunications	2	0.0004	0.9347	0.6528	0.0093
Utilities	1	-0.0002	1.0298	0.4720	0.0149
Financials	19	-0.0003	0.9094	0.7897	0.0064
Technology	18	-0.0005	1.1534	0.6006	0.0128

The above table shows the descriptive statistics and the regression estimates for the sector indices in Finland. The Basic Materials, Industrials, and Financials sectors have higher R^2 values compared to the other sectors.

Figure 10: Plot of the 11-day Cumulative Abnormal Returns [-10 to 10] per sector in Finland

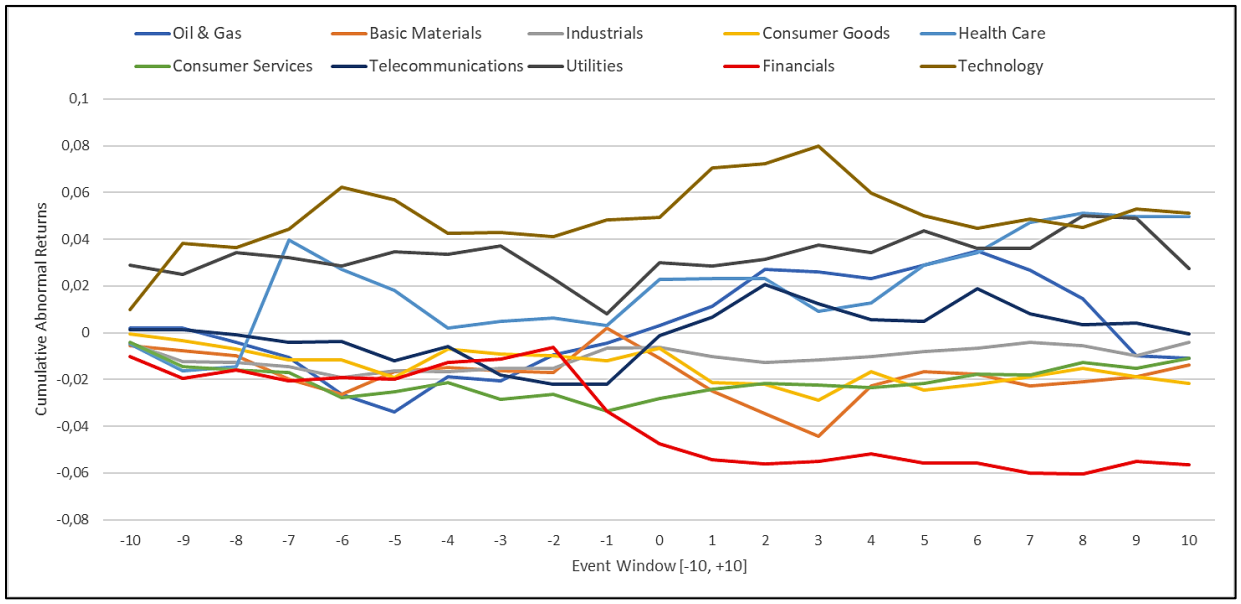


Table 10: Sectoral Reactions to the Referendum Results in Finland

Summary of the abnormal returns and cumulative abnormal returns generated per sector index on the days following the referendum results, calculated using the Market Model with an estimation period of 252 days.

Sector Name	AR [0,0] Event day	CAR [0,1] 2-day	CAR [0,2] 3-day	CAR [0,5] 6-day	CAR [0,10] 11-day	Days to rebound
Oil & Gas	0.0076	0.0157	0.0317	0.0334	-0.0065	3
Basic Materials	-0.0129	**-0.0271***	**-0.0367****	-0.0186	-0.0158	12
Industrials	0.0004	-0.0036	-0.0059	-0.0012	0.0027	11
Consumer Goods	0.0054	-0.0096	-0.0103	-0.0127	-0.0097	12
Health Care	0.0198*	0.0200	0.0200	0.0259	0.0465	5
Consumer Services	0.0054	0.0093	0.0118	0.0118	0.0228	4
Telecom	0.0210**	0.0289**	0.0427***	0.0269	0.0215	3
Utilities	0.0217	0.0205	0.0234	0.0354	0.0192	4
Financials	**-0.0139****	**-0.0208****	**-0.0226****	-0.0221	-0.0228	18
Technology	0.0008	0.022	0.0238	0.0015	0.0025	4

* significant at 90% confidence level ** significant at 95% confidence level *** significant at 99% confidence level

Figure 10 shows the plots for the cumulative abnormal returns observed across sectors in Finland over the 21-day trading window [-10,10]. Table 10 shows the AR [0,0] and CARs calculated over the event windows [0, 1], [0, 2], [0, 5] and [0, 10]. It is clear from these observations that it was the Financials sector that was the most negatively affected in Finland, recording a negative abnormal return of -0.0139 on the event date, significant at the 95% confidence level and cumulative abnormal returns of -0.0208 and -0.0226 generated over the event windows of [0,1] and [0,2] respectively, also significant at the 95% confidence level. In addition, the Financials sector took the longest to rebound when compared to the other sectors in the market. This is followed by the Basic Materials sector where we observe significant negative abnormal returns over the event windows of [0,1] and [0,2].

While the actual returns recorded on the event day were negative for all sectors, we see that the abnormal returns were slightly positive for many since their predicted returns were lower than the actuals. However, only the Health Care and Telecommunications sectors recorded significant positive abnormal returns around the event date. While it initially seemed fair to assume that the referendum results came as a surprise to the market, we see that significant negative abnormal returns were observed within many sectors on the day before the event, suggesting that the market participants may have already anticipated the outcome of the referendum.

4.2.3 Reactions in Sweden

Table 11: Regression Estimates of Returns of the Stockholm Sector Indices

This table reports the regression estimates of the Stockholm sector indices against the market index based on the 252-day estimation period return series (26-06-2015 to 23-06-2016).

Sector Name	No. of stocks	Alpha	Beta	R^2	Std. Error	S.D.
Oil & Gas	6	0.0003	0.9623	0.2729	0.0212	0.0248
Basic Materials	24	0.0001	1.1429	0.7505	0.0089	0.0177
Industrials	93	0.0002	1.0740	0.9033	0.0047	0.0152
Consumer Goods	38	0.0006	0.8610	0.8094	0.0056	0.0129
Health Care	57	0.0003	0.7687	0.5489	0.0094	0.0139
Consumer Services	38	-0.0004	0.8849	0.7774	0.0064	0.0135
Telecommunications	5	-0.0007	0.9793	0.7680	0.0072	0.0150
Utilities	2	-0.0012	0.4474	0.1117	0.0170	0.0180
Financials	71	-0.0001	1.0406	0.9228	0.0041	0.0146
Technology	35	-0.0002	1.0520	0.6608	0.0101	0.0174

The above table presents the regression estimates for the sector indices in Sweden estimated using the return series of the indices against market index. The Financials, Industrials and Consumer Goods sectors have higher R^2 value, while it is quite low for the Oil & Gas and Utilities sectors.

Figure 11: Plot of the 11-day Cumulative Abnormal Returns [-10 to 10] per sector in Sweden

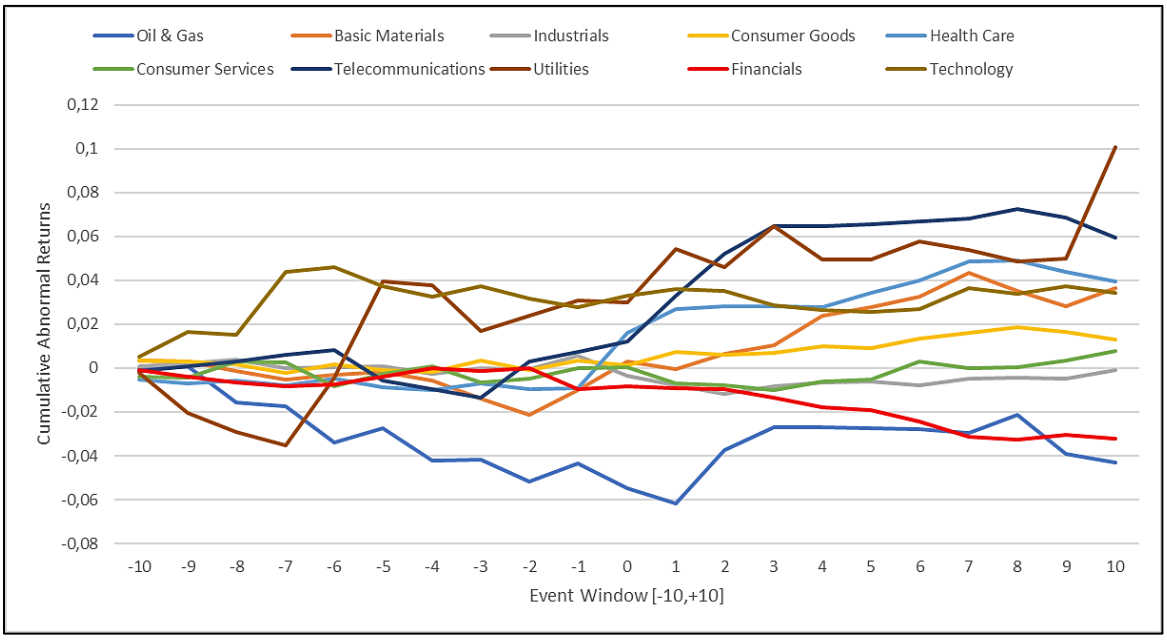


Table 12: Sectoral Reactions to the Referendum Results in Sweden

Summary of the abnormal returns and cumulative abnormal returns generated per sector index on the days following the referendum results, calculated using the Market Model with an estimation period of 252 days.

Sector Name	AR [0,0] Event day	CAR [0,1] 2-day	CAR [0,2] 3-day	CAR [0,5] 6-day	CAR [0,10] 11-day	Days to rebound
Oil & Gas	-0.0114	-0.0184	0.0059	0.0160	0.0001	5
Basic Materials	0.0130	0.0098	0.0166	0.0378	0.0468	5
Industrials	**-0.009***	**-0.0134****	**-0.0174****	-0.0120	-0.0068	13
Consumer Goods	-0.0023	0.0038	0.0028	0.0056	0.0096	10
Health Care	0.0250***	0.0358***	0.0372**	0.0431*	0.0486	3
Consumer Services	0.0003	-0.0072	-0.0079	-0.0052	0.0078	11
Telecom	0.0048	0.0255**	0.0447***	0.0583***	0.0524**	3
Utilities	-0.0005	0.0238	0.0152	0.0189	0.0699	4
Financials	0.0014	0.0005	-0.0001	-0.0097	**-0.0225***	17
Technology	0.0052	0.008	0.0071	-0.0025	0.0065	13

* significant at 90% confidence level ** significant at 95% confidence level *** significant at 99% confidence level

Based on the results in Figure 11 and Table 12, we see that only the Industrials sector was negatively affected by the event generating significant negative abnormal returns of -0.009, -0.0134 and -0.0174 over the event windows of length shorter than 3 days. With regards to the Financials sector, we see that the announcement of the referendum results did not have an immediate and significant negative impact on the sector. However, we notice that there was a steady decline in the cumulative abnormal returns following the event causing a slightly longer-term impact. The 11-day CAR is observed to be negative and significant. The sector was the most negatively affected in the longer event window and took about 17 days to rebound to its previous levels. We also find that negative abnormal returns were observed within Financials sector on the day before the event, suggesting that the market participants may have already anticipated the outcome of the referendum and that it was not a surprise to the market.

The Health Care and Telecommunications sectors recorded significant positive abnormal returns. The Telecom sector showed significant positive results of 0.0255, 0.0447, 0.0583, and 0.0524 generated over the event windows of [0,1], [0,2], [0,5] and [0,10] respectively.

4.2.4 Robustness Tests

To test if the results from the initial analysis using the Market Model over the 252-day estimation period are reliable, I re-estimate the abnormal returns and their level of significance, by changing the no. of days in the estimation period from 252 to 100. Additionally, I test the results using the Market Adjusted Model which does not rely on the estimation period returns for the calculation of abnormal return. The results from both the analysis are presented in the table below.

OMX Copenhagen Sector Indices

Table 13: Results of Robustness Tests for the OMX Copenhagen Sector Indices

This table provides a summary of abnormal returns and cumulative abnormal returns generated per sector index in Denmark following the announcement of the referendum results calculated using the Market Adjusted Model and the Market Model with the estimation period reduced to 100 days.

	AR [0,0] Event day	**CAR [0,1] 2-day**	**CAR [0,2] 3-day**	**CAR [0,5] 6-day**	**CAR [0,10] 11-day**
MM with a 100-day estimation period					
Oil & Gas	**-0.0289***	**-0.0431***	-0.036	-0.0155	-0.0483
Basic Materials	-0.0196	-0.0417	-0.0242	0.0756	0.0574
Industrials	-0.0051	**-0.0398****	**-0.0407****	-0.0285	-0.055
Consumer Goods	**-0.0211****	-0.0187	-0.0185	-0.011	-0.0412
Health Care	0.0208	0.0394**	0.035***	0.0329**	0.0477**
Consumer Services	-0.0040	**-0.0238*****	-0.0066	0.0065	0.0114
Utilities	**-0.0585*****	**-0.0684*****	**-0.0565***	-0.0612	-0.0111
Financials	**-0.0280*****	**-0.0489*****	**-0.0368****	**-0.0509****	**-0.0637****
Technology	-0.0143	**-0.0390****	-0.0277	0.0075	0.0157
Market Adjusted Model					
Oil & Gas	-0.0247	-0.0346	-0.0296	-0.0132	-0.0426
Basic Materials	0.0083	0.0143	0.0166	0.0857*	0.085
Industrials	-0.0017	**-0.0328****	**-0.0347****	-0.0241	-0.0459
Consumer Goods	-0.014	-0.0043	-0.0079	-0.0081	-0.0335
Health Care	0.0157***	0.0292***	0.0275***	0.0311**	0.0428**
Consumer Services	0.0154	0.0152	0.0182	0.0005	0.0076
Utilities	-0.0329	-0.017	-0.0232	-0.067	-0.0125
Financials	**-0.0242*****	**-0.0412*****	**-0.032****	**-0.0523*****	**-0.0649*****
Technology	-0.0094	-0.0291	-0.0205	0.0094	0.0206

* significant at 90% confidence level ** significant at 95% confidence level *** significant at 99% confidence level

In general, the t-stat values reduce with the new models. For example, the t-stat value of the 2-day [0,1] cumulative abnormal return observed in the Industrials sector reduces from -3.07 to -2.38 when the estimation window is reduced and to -2.31 when the Market Adjusted Model is used. With the Market Adjusted Model, the negative values observed within the Oil & Gas, Consumer Goods, Consumer Services and Utilities sectors change from being 'significant' to 'not significant'. Regardless

of these changes, we find that the results from the tests are consistent with the initial findings in that, the two most negatively affected sectors are the Financials and the Industrials. The sector that recorded significant positive abnormal returns remains to be the Heath Care sector. Additionally, the signs of the observed abnormal returns do not change, only the levels of significance change.

OMX Helsinki Sector Indices

Table 14: Results of Robustness Tests for the OMX Helsinki Sector Indices

This table provides a summary of abnormal returns and cumulative abnormal returns generated per sector index in Finland following the announcement of the referendum results calculated using the Market Adjusted Model and the Market Model with the estimation period reduced to 100 days.

	AR [0,0] **Event day**	**CAR [0,1]** **2-day**	**CAR [0,2]** **3-day**	**CAR [0,5]** **6-day**	**CAR [0,10]** **11-day**
MM with a 100-day estimation period					
Oil & Gas	0.0050	0.0146	0.0322	0.0363	-0.0004
Basic Materials	-0.0107	**-0.0271***	**-0.0388****	-0.025	-0.0282
Industrials	0.0023	-0.0026	-0.0058	-0.0025	0.0000
Consumer Goods	0.0052	-0.0098	-0.0105	-0.0130	-0.0102
Health Care	0.0104	0.0130	0.0152	0.0221	0.0415
Consumer Services	0.0021	0.0076	0.0115	0.0136	0.0270
Telecom	0.0183**	0.0278**	0.0431***	0.0297	0.0272
Utilities	0.0370**	0.0298	0.0270	0.0322	0.0098
Financials	**-0.0131*****	**-0.0194*****	**-0.0205*****	-0.0179	-0.0153
Technology	-0.007	0.0176	0.0225	0.0043	0.0096
Market Adjusted Model					
Oil & Gas	0.0175	0.0244	0.0393	0.043	0.0094
Basic Materials	**-0.0311*****	**-0.0394*****	**-0.0435****	-0.0204	-0.0151
Industrials	0.0009	-0.0029	-0.005	0.0005	0.0059
Consumer Goods	0.01750**	-0.0011	-0.0053	-0.0103	-0.0078
Health Care	0.0412***	0.0352**	0.0291	0.0306	0.0505
Consumer Services	0.0334***	0.0293*	0.0241	0.0187	0.0295
Telecom	0.0267**	0.0333**	0.0459**	0.0298	0.0255
Utilities	0.0191	0.0185	0.022	0.0343	0.0176
Financials	-0.0068	**-0.0165***	**-0.0208***	-0.0234	-0.0269
Technology	-0.0123	0.0125	0.0177	-0.0027	-0.0023

By comparing the results in the above table with those from the initial analysis, we see that the new estimations are consistent with the previous findings with regards to the Financials, Telecom and Basic Materials sectors. The Financial Sector continues to be the most negatively affected sector with significant abnormal returns observed for both the shorter and longer event windows. This is followed by the Basic Materials sector which generates negative abnormal returns over the event windows of [0,0], [0,1] and [0,2]. Here again, we find that the signs of the observed abnormal returns do not change when the model is changed, only the levels of significance change.

OMX Stockholm Sector Indices

Table 15: Results of Robustness Tests for the OMX Stockholm Sector Indices

This table provides a summary of abnormal returns and cumulative abnormal returns generated per sector index in Sweden following the announcement of the referendum results calculated using the Market Adjusted Model and the Market Model with the estimation period reduced to 100 days.

	AR [0,0] Event day	CAR [0,1] 2-day	CAR [0,2] 3-day	CAR [0,5] 6-day	CAR [0,10] 11-day
MM with a 100-day estimation period					
Oil & Gas	-0.0027	-0.0136	0.0068	0.0116	-0.0123
Basic Materials	0.0147	0.0098	0.0149	0.0327	0.0361
Industrials	**-0.0090****	**-0.0138*****	**-0.0181*****	-0.0135	-0.0096
Consumer Goods	**-0.0110****	-0.0026	-0.0011	0.0032	0.009
Health Care	0.0069	0.0225	0.0291	0.038	0.0471
Consumer Services	0.0046	-0.0034	-0.0047	-0.0011	0.0137
Telecom	0.0066	0.026***	0.0438***	0.0549***	0.0452**
Utilities	-0.0148	0.014	0.0101	0.0179	0.0745*
Financials	0.0056	0.0038	0.0022	-0.0076	-0.0203
Technology	0.0019	0.0063	0.0071	-0.0001	0.0127
Market Adjusted Model					
Oil & Gas	-0.00810	-0.0156	0.00812	0.01855	0.00353
Basic Materials	0.00155	0.0015	0.01173	0.0353	0.04717
Industrials	**-0.0147*****	**-0.0173****	-0.0193	-0.012	-0.0042
Consumer Goods	0.00955	0.01313	0.00951	0.01195	0.01629
Health Care	0.04396***	0.04994***	0.0463**	0.04959**	0.05226
Consumer Services	0.00928	-0.0011	-0.0049	-0.0051	0.00399
Telecom	0.00576	0.0253**	0.04325***	0.05429***	0.04441*
Utilities	0.04283**	0.05367**	0.0309	0.02257	0.05692
Financials	-0.0020	-0.0021	-0.0019	-0.0112	**-0.0238***
Technology	0.00075	0.00445	0.00449	-0.005	0.00377

The abnormal returns and cumulative abnormal derived by changing the estimation methods are consistent with the results from the initial analysis for the Industrials and Telecom sectors. The Industrials sector remains to be the most negatively affected sector with significant negative abnormal returns observed for shorter event windows and the Telecom sector remains to be the most positively affected sectors. However, when it comes to the other sectors, we see that the estimates from the initial results match more closely with the estimates derived by using market adjusted model. Firstly, we see that the negative abnormal returns observed within the Financials sector for longer event windows of 11 days [-5,5] and 21 days [-10,10] remain to be significant when using the market adjusted model, but changes from being 'significant' to 'not significant' when the length of the estimation window is reduced. Similarly, the t-statistic values show that the positive returns observed in the

Health Care sector, remain significant when using the market adjusted model but changes from being 'significant' to 'not significant' when using the market model with a shorter estimation period.

4.3 Review of the Sectoral Reactions to Subsequent Events

This section provides a brief review of the immediate sectoral reactions observed in the three markets to key events in the Brexit process. As mentioned previously, the events are grouped into two categories. The first group includes significant events that were anticipated to cause a negative reaction in the stock markets and the second group includes those that were anticipated to cause a positive reaction (see Table 4). Only the immediate impact on the stock market returns are looked at when reviewing the stock market behaviour around the event dates. As the impact on stock prices may change depending on what time during the day the news was made public, i.e. if an announcement is made in the morning, the effect would reflect on the prices on the same day. However, if it is made public after the market close, then the impact will be observed only on the next trading day. Since it isn't clear at what time during the day the news relating to the subsequent events under consideration were made public, I look at the cumulative results from the event day and the next day, i.e. the event window [0,1] to examine the immediate impact.

4.3.1 Reactions to Negative Events

The key subsequent events that were perceived to increase the likelihood of a 'Hard Brexit' or a 'No-deal Brexit', causing the UK to leave the EU's single market and the customs union, are considered as negative events. For example, Teresa May's key Brexit speech in Florence on 22 September 2017, setting out the UK's position, outlining a 'soft exit, hard Brexit' approach is considered a negative event as there is a clear indication of a possibility of a hard-Brexit. Similarly, on 27 March 2019, the Commons voted on eight indicative votes, to find a Brexit plan best suited for the majority. While the proposal for a no-deal Brexit was defeated, the proposals to remain in the single market were also defeated, thereby increasing the likelihood of a 'Hard-Brexit'. Therefore, this event is also perceived to cause a negative effect. The full list of events is presented in Table 4.

Table 16: Sectoral Reactions to Negative Events

Summary of 2-day cumulative abnormal returns generated per sector index following Brexit related events that were anticipated to cause negative reactions, calculated using the Market Adjusted Model.

Sector Name	E1 2017-03-29	E2 2017-06-21	E3 2017-09-22	E4 2018-11-14	E5 2018-11-25	E6 2019-03-27	ACAR [0,1]
Denmark							
Oil & Gas	0.0193	0.0051	-0.0252	-0.0040	0.0191	0.0198	0.0057
Basic Materials	0.0090	-0.0099	-0.0099	-0.0419	0.0033	**0.0463***	-0.0099
Industrials	0.0134	-0.0001	0.0165	0.0024	0.0176	-0.0029	0.0078
Consumer G.	-0.0048	-0.0194	-0.0016	0.0196	-0.0086	0.0112	-0.0006
Health Care	-0.0021	0.0110	-0.0018	-0.0068	-0.0122	-0.0022	-0.0024
Consumer S.	-0.0111	-0.0014	-0.0063	0.0027	-0.0145	0.0052	-0.0042
Utilities	-0.0029	-0.0128	0.0151	0.0131	**0.0338***	0.0066	0.0038
Financials	-0.0138	-0.0150	-0.0145	0.0012	-0.0026	-0.0110	**-0.0093****
Technology	0.0034	-0.0009	0.0003	-0.0007	-0.0147	**0.0291***	-0.0025
Finland							
Oil & Gas	0.0131	-0.0158	0.0257	0.0073	0.0167	0.0128	0.0100
Basic Materials	0.0019	-0.0100	0.0017	0.0096	**-0.0502*****	0.0125	-0.0058
Industrials	-0.0012	0.0025	-0.0084	-0.0038	**0.0170****	0.0141	0.0034
Consumer G.	-0.0003	-0.0017	0.0036	**0.0261****	0.0010	0.0025	0.0052
Health Care	-0.0087	**0.0274****	-0.0008	0.0299	-0.0245	0.0126	0.0060
Consumer S.	-0.0073	0.0155	0.0021	0.0100	-0.0151	0.0070	0.0020
Telecom	-0.0046	-0.0028	-0.0011	0.0038	**-0.0290***	0.0059	-0.0046
Utilities	0.0057	-0.0039	0.0170	-0.0055	0.0150	-0.0089	0.0032
Financials	-0.0006	-0.0057	0.0058	-0.0069	0.0119	**-0.0202****	-0.0026
Technology	0.0003	0.0061	-0.0080	-0.0102	-0.0020	-0.0081	-0.0037
Sweden							
Oil & Gas	**0.0314***	-0.0007	-0.0011	-0.0011	0.0096	-0.0143	0.0040
Basic Materials	0.0030	0.0069	-0.0079	0.0165	**-0.0282****	0.0185	0.0015
Industrials	0.0037	0.0055	-0.0038	-0.0046	-0.0042	**0.0139****	0.0018
Consumer G.	-0.0014	-0.0073	0.0049	0.0030	-0.0029	**0.0144****	0.0018
Health Care	0.0047	0.0110	0.0026	0.0035	**-0.0198*****	-0.0070	-0.0008
Consumer S.	**-0.0277*****	0.0023	0.0085	0.0183	-0.0073	0.0149	0.0015
Telecom	-0.0003	0.0011	-0.0034	0.0118	**0.0407*****	0.0040	0.0090
Utilities	-0.0065	0.0066	0.0083	-0.0199	-0.0256	-0.0037	-0.0068
Financials	0.0004	**-0.0099****	-0.0009	0.0008	**0.0122****	**-0.0256*****	**-0.0038***
Technology	0.0120	0.0211	0.0118	**-0.0269****	-0.0185	0.0060	0.0009

The above table shows the results of the cumulative abnormal returns calculated over the event window [0,1] for each sector and event. In addition, Tables 1 to 3 in the appendix provides the results calculated over the event windows of [-1,1] and [-2,2] on a country-by-country basis. The

results from these tables indicate that events 5 and 6 caused the most impact on the stock market. However, a closer look at the results for each event does not provide any useful findings. Further, the effect on the different sectors is not consistent across events. Therefore, to assess the overall effect of all six events that were perceived to create a negative impact on the sectors, I aggregate the CARs generated across events by calculating the average cumulative abnormal returns (ACARs). The t-statistic of the ACARs is then estimated based on the standard deviation estimate for each event included in the aggregation. The ACARs generated for each sector are tested for significance and the results are shown in the last column of the table. We see that when the average is taken, the events that indicated an increase in the likelihood of a hard-Brexit or a no-deal Brexit, had a significant effect on the Financials sectors in Denmark and Sweden.

4.3.2 Reactions to Positive Events

The subsequent events in the Brexit process that were perceived to decrease the likelihood of a 'Hard Brexit' or a 'No-deal Brexit', are considered as positive events. For example, the two dates on which the extension of Article 50 was granted by the EU are considered as positive events. This is because without the extension the UK would have left the EU without a deal, causing the them to leave the single market and customs union without any intervening time. Another such positive event is 3 April 2019, the day when the Yvette Cooper's EU Bill that was designed to prevent a no-deal Brexit was passed in the Commons.

Table 17: Sectoral Reactions to Positive Events

Summary of 2-day cumulative abnormal returns generated per sector index following Brexit related events that were anticipated to cause positive reactions, calculated using the Market Adjusted Model.

Sector Name	E7 2017-03-29	E8 2017-06-21	E9 2017-09-22	E10 2018-11-14	E11 2018-11-25	E12 2019-03-27	ACAR [0,1]
Denmark							
Oil & Gas	-0.0027	-0.0118	-0.0038	-0.0011	0.0220	-0.0011	0.0003
Basic Materials	0.0224	-0.0163	-0.0198	-0.0058	-0.0182	0.0089	-0.0048
Industrials	0.0018	-0.0090	0.0027	-0.0121	**0.0281****	0.0174	0.0048
Consumer G.	-0.0076	-0.0034	-0.0016	-0.0084	-0.0026	0.0083	-0.0026
Health Care	-0.0009	0.0052	0.0001	0.0093	**-0.0187****	**-0.0131***	-0.0030
Consumer S.	0.0070	0.0044	0.0000	-0.0072	0.0029	-0.0010	0.0010
Utilities	-0.0021	0.0159	0.0090	-0.0060	0.0147	-0.0138	0.0030
Financials	0.0072	-0.0105	-0.0065	-0.0097	0.0146	**0.0306****	0.0043
Technology	-0.0002	0.0119	-0.0086	0.0048	0.0097	0.0021	0.0033

Sector Name	E7 2017-03-29	E8 2017-06-21	E9 2017-09-22	E10 2018-11-14	E11 2018-11-25	E12 2019-03-27	ACAR [0,1]
Finland							
Oil & Gas	-0.0166	-0.0082	0.0174	-0.0086	0.0058	-0.0105	-0.0035
Basic Materials	0.0048	-0.0016	**0.0313****	-0.0204	0.0142	0.0029	0.0052
Industrials	0.0042	-0.0061	0.0040	0.0001	-0.0070	0.0026	-0.0004
Consumer G.	0.0058	-0.0119	-0.0070	-0.0093	-0.0027	0.0090	-0.0027
Health Care	0.0024	0.0043	-0.0306	0.0104	-0.0218	**-0.0362***	-0.0119
Consumer S.	-0.0079	-0.0175	0.0041	0.0019	-0.0178	-0.0171	-0.0091
Telecom	-0.0017	0.0095	-0.0162	0.0185	-0.0091	-0.0181	-0.0029
Utilities	0.0168	-0.0072	-0.0044	0.0055	0.0091	-0.0270	-0.0012
Financials	-0.0004	-0.0074	-0.0040	0.0091	0.0024	**0.0165***	0.0027
Technology	-0.0142	**0.0391****	-0.0234	-0.0009	-0.0014	0.0010	0.0000
Sweden							
Oil & Gas	-0.0061	-0.0353	0.0099	0.0206	-0.0274	-0.0157	-0.0090
Basic Materials	-0.0064	0.0117	**0.0278****	-0.0005	0.0152	0.0021	0.0083
Industrials	-0.0050	0.0049	-0.0014	-0.0039	0.0023	0.0067	0.0006
Consumer G.	-0.0020	0.0006	-0.0029	0.0016	**-0.0129***	-0.0019	-0.0029
Health Care	-0.0018	0.0012	0.0034	-0.0004	**-0.0150***	-0.0142	-0.0045
Consumer S.	0.0095	-0.0005	-0.0020	-0.0012	-0.0059	-0.0076	-0.0013
Telecom	-0.0060	0.0085	-0.0032	0.0056	-0.0158	-0.0130	-0.0040
Utilities	0.0101	-0.0039	-0.0237	0.0000	-0.0077	-0.0027	-0.0047
Financials	0.0017	-0.0074	-0.0021	0.0010	0.0064	0.0000	-0.0001
Technology	0.0110	0.0051	0.0027	0.0035	0.0093	0.0038	0.0059

The above table shows the results of the cumulative abnormal returns calculated over the event window [0,1] for each sector and event. In addition, Tables 4 to 6 in the appendix provides the results calculated over the event windows of [-1,1] and [-2,2] on a country-by-country basis. Based on the observations, we see that when the average is taken, the events that indicated a decrease in the likelihood of a hard-Brexit or a no-deal Brexit, did not have a significant effect on any of the sectors. When looking at specific events, we note that the events 11 and 12 created the most impact, if any. The Heath Care sectors in Denmark and Sweden reacted negatively to the events. The Financial sector in Denmark and Finland reacted positively to event 11. However, since the effect is not consistent across events, we are unable to draw useful conclusion from the results.

5. Conclusion

The main objective of the study was to examine the effect of the Brexit referendum and the subsequent events associated with Brexit on the stock markets in Denmark, Finland and Sweden at a sectoral level. This was achieved by conducting an event study analysis. Using the observations of the daily stock price movements of Nasdaq Nordic's regional sector indices and market indices, the abnormal returns and cumulative abnormal returns generated around the event dates were estimated for the sector indices using the market model with a 252-day estimation period and tested for robustness, first by reducing the estimation period to 100 days and then by changing the estimation method to use the market adjusted model. The results indicate that the reaction varies across sectors and countries.

In Denmark, significant negative abnormal returns were observed across many sectors over very short event windows of less than three days. The negative effect was predominant in the Financials and Industrials sectors. The Financials sector yielded significant negative abnormal returns over longer event windows such as [0,10]. The Health Care sector yielded significant positive abnormal returns. However, when looking closely at the market capitalisation weights of the composites, we see that the sector index is dominated by Novo Nordisk. Therefore, the returns noted within the sector might have been driven by idiosyncratic risks not captured by the market model. In Finland, the Financials and Basic Materials sectors yielded significant negative abnormal returns. While in Sweden, significant negative abnormal returns are observed in the Industrials sector over shorter event windows and in the Financials sector over the event window of [0,10]. In both Finland and Sweden, the Telecommunications sector yielded significant positive abnormal returns. However, we see that the sector indices are dominated by the Telia Company shares in terms of market capitalisation weights. Therefore, the returns noted within these indices may have been driven by firm-specific risks rather than market risks. In general, we note that the reactions were relatively lower in Sweden and Finland compared to Denmark, possibly due to the market closure on 24 June 2016 in the two countries on account of Midsummer, which was then followed by the weekend, thereby restricting sales in the markets. In terms of commonalities across markets, we observe that the Financials sector took the longest to rebound in all three markets, thereby producing a lingering effect when compared to the other sectors that rebounded over shorter periods. Additionally, negative abnormal returns were

observed within many sectors on the day before the event, suggesting that the market participants may have anticipated the outcome of the referendum and that the results were not a surprise in these markets.

With regards to the effect of the subsequent events, we find that the negative reaction observed in the Financials sector spans over these events that were perceived to cause a negative reaction, whereby, the abnormal returns calculated for the sector is significantly negative when the average is taken. No other sector yielded significant abnormal returns when the average was taken. However, when looking at the results on an event by event bases and then comparing them with each other, we find that the effects of specific events are not consistent across events. Therefore, we are unable to draw more useful conclusions regarding the effect of the subsequent events. Nevertheless, understanding the broad effects on the various sector indices based on reactions to past events could provide some indication about the future behaviour of market participants following the actual exit. To enhance the understanding of the consequences of the events, observing the dynamics of intraday returns rather than daily returns might prove to be useful. Further, identifying the antecedent factors influencing abnormal returns by looking at industry-specific and country-specific factors can be interesting for future study. In addition, examining the cross-sectional variation in stock returns at the firm-level can be used to identify firm-specific factors that drive the observed abnormal returns.

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7. Appendices

Appendix 1: Sectoral Reactions in Denmark to the Negative Events

Summary of the Abnormal Returns and Cumulative Abnormal Returns observed for the OMX Copenhagen sector indices around events anticipated to cause a negative impact, using the Market Adjusted Model.

Sector Name	E1 2017-03-29	E2 2017-06-21	E3 2017-09-22	E4 2018-11-14	E5 2018-11-25	E6 2019-03-27
[0,1]						
Oil & Gas	0.0193	0.0051	-0.0252	-0.0040	0.0191	0.0198
Basic Materials	0.0090	-0.0099	-0.0099	-0.0419	0.0033	**0.0463***
Industrials	0.0134	-0.0001	0.0165	0.0024	0.0176	-0.0029
Consumer Goods	-0.0048	-0.0194	-0.0016	0.0196	-0.0086	0.0112
Health Care	-0.0021	0.0110	-0.0018	-0.0068	-0.0122	-0.0022
Consumer Services	-0.0111	-0.0014	-0.0063	0.0027	-0.0145	0.0052
Utilities	-0.0029	-0.0128	0.0151	0.0131	**0.0338***	0.0066
Financials	-0.0138	-0.0150	-0.0145	0.0012	-0.0026	-0.0110
Technology	0.0034	-0.0009	0.0003	-0.0007	-0.0147	**0.0291***
[-1,1]						
Oil & Gas	0.0148	-0.0094	-0.0319	0.0114	0.0138	0.0270
Basic Materials	0.0138	0.0074	-0.0093	**-0.0817****	-0.0069	0.0343
Industrials	0.0134	-0.0070	0.0166	0.0104	-0.0001	-0.0166
Consumer Goods	-0.0027	-0.0085	-0.0114	**0.0304***	-0.0113	0.0122
Health Care	-0.0031	0.0120	-0.0008	-0.0152	0.0001	0.0065
Consumer Services	-0.0152	0.0069	-0.0042	0.0163	-0.0183	-0.0057
Utilities	-0.0053	-0.0104	0.0160	0.0206	0.0277	-0.0026
Financials	-0.0108	-0.0123	-0.0090	0.0025	-0.0117	-0.0223
Technology	0.0097	0.0005	-0.0093	-0.0006	-0.0186	0.0256
[-2,2]						
Oil & Gas	0.0160	-0.0195	-0.0264	-0.0113	0.0278	0.0283
Basic Materials	0.0080	0.0072	-0.0180	**-0.0824***	0.0360	0.0377
Industrials	-0.0038	-0.0079	0.0139	0.0106	0.0052	-0.0207
Consumer Goods	0.0104	-0.0094	-0.0214	0.0236	-0.0075	0.0049
Health Care	0.0043	0.0136	-0.0029	-0.0052	0.0014	0.0101
Consumer Services	-0.0208	-0.0044	-0.0052	0.0119	-0.0146	-0.0128
Utilities	0.0017	-0.0282	0.0329	0.0200	-0.0185	-0.0123
Financials	-0.0132	-0.0057	-0.0024	-0.0114	-0.0027	-0.0217
Technology	0.0074	-0.0002	-0.0192	**-0.0812*****	-0.0267	0.0399

Appendix 2: Sectoral Reactions in Finland to the Negative Events

Summary of the Abnormal Returns and Cumulative Abnormal Returns observed for the OMX Helsinki sector indices around events anticipated to cause a negative impact, using the Market Adjusted Model.

Sector Name	E1 2017-03-29	E2 2017-06-21	E3 2017-09-22	E4 2018-11-14	E5 2018-11-25	E6 2019-03-27
[0,1]						
Oil & Gas	0.0131	-0.0158	0.0257	0.0073	0.0167	0.0128
Basic Materials	0.0019	-0.0100	0.0017	0.0096	**-0.0502*** **	0.0125
Industrials	-0.0012	0.0025	-0.0084	-0.0038	**0.0170** **	0.0141
Consumer Goods	-0.0003	-0.0017	0.0036	**0.0261** **	0.0010	0.0025
Health Care	-0.0087	**0.0274** **	-0.0008	0.0299	-0.0245	0.0126
Consumer Services	-0.0073	0.0155	0.0021	0.0100	-0.0151	0.0070
Telecom	-0.0046	-0.0028	-0.0011	0.0038	**-0.0290** *	0.0059
Utilities	0.0057	-0.0039	0.0170	-0.0055	0.0150	-0.0089
Financials	-0.0006	-0.0057	0.0058	-0.0069	0.0119	**-0.0202** **
Technology	0.0003	0.0061	-0.0080	-0.0102	-0.0020	-0.0081
[-1,1]						
Oil & Gas	0.0171	-0.0140	0.0416	0.0000	0.0006	0.0180
Basic Materials	-0.0007	-0.0157	0.0144	-0.0037	**-0.0543*** **	0.0026
Industrials	0.0025	0.0013	-0.0048	-0.0029	0.0093	**0.0177** *
Consumer Goods	-0.0031	0.0006	0.0036	**0.0250** *	-0.0046	-0.0067
Health Care	-0.0055	**0.0300** *	-0.0088	0.0307	-0.0200	0.0219
Consumer Services	0.0057	0.0216	-0.0012	-0.0070	-0.0164	0.0029
Telecom	-0.0007	-0.0035	-0.0086	-0.0008	**-0.0366** *	0.0014
Utilities	0.0115	0.0047	-0.0174	**-0.0416** **	0.0210	-0.0034
Financials	-0.0021	-0.0073	0.0102	0.0089	0.0208	-0.0176
Technology	-0.0094	0.0086	-0.0156	0.0009	0.0075	-0.0136
[-2,2]						
Oil & Gas	0.0001	-0.0239	0.0493	0.0209	0.0153	0.0208
Basic Materials	-0.0176	-0.0023	0.0118	-0.0273	**-0.0625*** **	0.0257
Industrials	-0.0008	0.0058	-0.0081	-0.0075	0.0168	**0.0236** *
Consumer Goods	-0.0113	-0.0061	0.0126	0.0214	0.0151	-0.0116
Health Care	-0.0096	0.0262	-0.0228	0.0246	-0.0071	0.0159
Consumer Services	0.0136	0.0169	0.0018	-0.0020	0.0022	0.0073
Telecom	0.0019	-0.0098	-0.0083	0.0192	**-0.0605** **	0.0088
Utilities	0.0227	0.0109	0.0219	-0.0160	-0.0088	-0.0089
Financials	0.0044	-0.0109	0.0074	0.0099	0.0256	**-0.0324** **
Technology	0.0065	-0.0009	-0.0244	-0.0003	-0.0069	-0.0184

Appendix 3: Sectoral Reactions in Sweden to the Negative Events

Summary of the Abnormal Returns and Cumulative Abnormal Returns observed for the OMX Stockholm sector indices around events anticipated to cause a negative impact, using the Market Adjusted Model.

Sector Name	E1 2017-03-29	E2 2017-06-21	E3 2017-09-22	E4 2018-11-14	E5 2018-11-25	E6 2019-03-27
[0,1]						
Oil & Gas	**0.0314***	-0.0007	-0.0011	-0.0011	0.0096	-0.0143
Basic Materials	0.0030	0.0069	-0.0079	0.0165	**-0.0282****	0.0185
Industrials	0.0037	0.0055	-0.0038	-0.0046	-0.0042	**0.0139****
Consumer Goods	-0.0014	-0.0073	0.0049	0.0030	-0.0029	**0.0144****
Health Care	0.0047	0.0110	0.0026	0.0035	**-0.0198*****	-0.0070
Consumer Services	**-0.0277*****	0.0023	0.0085	0.0183	-0.0073	0.0149
Telecom	-0.0003	0.0011	-0.0034	0.0118	**0.0407*****	0.0040
Utilities	-0.0065	0.0066	0.0083	-0.0199	-0.0256	-0.0037
Financials	0.0004	**-0.0099****	-0.0009	0.0008	**0.0122****	**-0.0256*****
Technology	0.0120	0.0211	0.0118	**-0.0269****	-0.0185	0.0060
[-1,1]						
Oil & Gas	**0.0439***	-0.0020	-0.0077	**-0.0527****	-0.0323	0.0014
Basic Materials	0.0089	0.0018	-0.0128	0.0131	**-0.0410*****	0.0160
Industrials	0.0093	0.0055	-0.0006	-0.0042	-0.0087	**0.0161***
Consumer Goods	-0.0046	0.0001	-0.0008	-0.0048	0.0007	0.0093
Health Care	0.0025	0.0157	0.0027	0.0010	-0.0078	0.0042
Consumer Services	**-0.0307****	0.0058	0.0012	0.0218	-0.0106	0.0072
Telecom	-0.0019	0.0011	-0.0159	0.0097	**0.0407*****	-0.0062
Utilities	-0.0148	0.0144	0.0273	0.0252	-0.0460	-0.0059
Financials	-0.0010	**-0.0127****	0.0029	0.0056	**0.0123****	**-0.0231***
Technology	-0.0008	0.0204	0.0058	-0.0267	0.0028	-0.0036
[-2,2]						
Oil & Gas	0.0137	0.0086	-0.0046	-0.0286	-0.0337	-0.0098
Basic Materials	-0.0202	0.0049	-0.0050	-0.0014	**-0.0515*****	0.0174
Industrials	0.0024	0.0079	-0.0024	-0.0061	-0.0142	**0.0185***
Consumer Goods	0.0012	-0.0014	0.0042	-0.0010	0.0044	0.0011
Health Care	0.0088	0.0080	-0.0099	-0.0060	0.0066	-0.0149
Consumer Services	-0.0197	0.0051	0.0042	0.0249	-0.0009	**0.0531****
Telecom	-0.0016	0.0000	**-0.0245***	0.0122	**0.0340***	-0.0180
Utilities	-0.0286	-0.0070	0.0189	-0.0066	-0.0419	-0.0280
Financials	0.0018	**-0.0131****	0.0051	0.0095	0.0124	**-0.0283*****
Technology	0.0094	0.0173	0.0001	**-0.0360***	0.0076	-0.0047

Appendix 4: Sectoral Reactions in Denmark to the Positive Events

Summary of the Abnormal Returns and Cumulative Abnormal Returns observed for the OMX Copenhagen sector indices around events anticipated to cause a positive effect, using the Market Adjusted Model.

Sector Name	E7 2016-11-03	E8 2018-12-10	E9 2019-01-15	E10 2019-03-20	E11 2019-04-03	E12 2019-04-10
[0,1]						
Oil & Gas	-0.0027	-0.0118	-0.0038	-0.0011	0.0220	-0.0011
Basic Materials	0.0224	-0.0163	-0.0198	-0.0058	-0.0182	0.0089
Industrials	0.0018	-0.0090	0.0027	-0.0121	**0.0281****	0.0174
Consumer Goods	-0.0076	-0.0034	-0.0016	-0.0084	-0.0026	0.0083
Health Care	-0.0009	0.0052	0.0001	0.0093	**-0.0187****	**-0.0131***
Consumer Services	0.0070	0.0044	0.0000	-0.0072	0.0029	-0.0010
Utilities	-0.0021	0.0159	0.0090	-0.0060	0.0147	-0.0138
Financials	0.0072	-0.0105	-0.0065	-0.0097	0.0146	**0.0306****
Technology	-0.0002	0.0119	-0.0086	0.0048	0.0097	0.0021
[-1,1]						
Oil & Gas	-0.0220	-0.0061	0.0072	-0.0113	0.0452	-0.0044
Basic Materials	0.0318	-0.0062	-0.0125	0.0008	-0.0093	-0.0120
Industrials	-0.0214	-0.0083	0.0141	-0.0107	**0.0414*****	0.0234
Consumer Goods	0.0150	-0.0139	-0.0002	-0.0118	-0.0111	0.0026
Health Care	0.0096	0.0036	-0.0090	**0.0165***	**-0.0248*****	-0.0146
Consumer Services	0.0149	-0.0027	0.0244	-0.0128	-0.0006	0.0058
Utilities	-0.0047	0.0195	0.0040	-0.0348	0.0027	-0.0176
Financials	0.0014	-0.0013	0.0074	-0.0137	**0.0282***	**0.0340****
Technology	-0.0027	-0.0045	0.0007	0.0017	-0.0085	0.0109
[-2,2]						
Oil & Gas	-0.0069	0.0063	0.0062	-0.0327	0.0578	0.0035
Basic Materials	0.0559	-0.0378	-0.0399	-0.0048	0.0159	-0.0068
Industrials	-0.0208	-0.0230	0.0115	-0.0145	**0.0448****	0.0255
Consumer Goods	-0.0009	**-0.0399***	0.0131	-0.0172	-0.0124	0.0046
Health Care	0.0087	0.0102	-0.0089	0.0169	**-0.0294****	-0.0161
Consumer Services	0.0131	0.0142	0.0294	-0.0236	-0.0091	0.0175
Utilities	-0.0159	0.0405	0.0020	-0.0087	-0.0026	-0.0119
Financials	0.0138	-0.0080	0.0041	-0.0175	**0.0393****	0.0271
Technology	-0.0071	0.0313	0.0033	0.0074	0.0049	0.0131

Appendix 5: Sectoral Reactions in Finland to the Positive Events

Summary of the Abnormal Returns and Cumulative Abnormal Returns observed for the OMX Helsinki sector indices around events anticipated to cause a positive effect, using the Market Adjusted Model.

Sector Name	E7 2016-11-03	E8 2018-12-10	E9 2019-01-15	E10 2019-03-20	E11 2019-04-02	E12 2019-04-10
[0,1]						
Oil & Gas	-0.0166	-0.0082	0.0174	-0.0086	0.0058	-0.0105
Basic Materials	0.0048	-0.0016	**0.0313****	-0.0204	0.0142	0.0029
Industrials	0.0042	-0.0061	0.0040	0.0001	-0.0070	0.0026
Consumer Goods	0.0058	-0.0119	-0.0070	-0.0093	-0.0027	0.0090
Health Care	0.0024	0.0043	-0.0306	0.0104	-0.0218	**-0.0362***
Consumer Services	-0.0079	-0.0175	0.0041	0.0019	-0.0178	-0.0171
Telecom	-0.0017	0.0095	-0.0162	0.0185	-0.0091	-0.0181
Utilities	0.0168	-0.0072	-0.0044	0.0055	0.0091	-0.0270
Financials	-0.0004	-0.0074	-0.0040	0.0091	0.0024	**0.0165***
Technology	-0.0142	**0.0391****	-0.0234	-0.0009	-0.0014	0.0010
[-1,1]						
Oil & Gas	-0.0289	-0.0058	0.0222	-0.0060	-0.0045	-0.0117
Basic Materials	0.0085	**-0.0303***	0.0275	-0.0161	**0.0350***	0.0067
Industrials	0.0033	-0.0156	-0.0041	0.0067	0.0040	0.0072
Consumer Goods	-0.0003	**0.0255***	0.0067	-0.0152	0.0024	0.0058
Health Care	0.0159	-0.0096	-0.0102	0.0180	-0.0254	**-0.0437***
Consumer Services	-0.0110	-0.0198	0.0078	0.0005	**-0.0272***	-0.0148
Telecom	0.0093	0.0091	-0.0132	0.0150	-0.0134	-0.0135
Utilities	0.0071	-0.0012	-0.0087	0.0029	0.0009	-0.0055
Financials	-0.0055	-0.0124	0.0002	0.0029	-0.0047	0.0108
Technology	-0.0033	**0.0752*****	-0.0268	-0.0027	-0.0117	-0.0099
[-2,2]						
Oil & Gas	-0.0154	0.0215	0.0181	0.0150	-0.0128	-0.0127
Basic Materials	0.0111	-0.0193	0.0382	-0.0292	**0.0575****	-0.0057
Industrials	-0.0007	**-0.0210***	-0.0091	0.0066	0.0076	0.0137
Consumer Goods	**0.0381****	0.0109	-0.0033	-0.0124	0.0021	0.0144
Health Care	0.0118	-0.0143	**-0.0752****	0.0476	-0.0240	-0.0337
Consumer Services	-0.0210	**-0.0361***	0.0247	0.0195	-0.0290	0.0028
Telecom	-0.0090	0.0170	-0.0001	0.0367	-0.0240	0.0180
Utilities	-0.0035	0.0150	0.0014	0.0079	-0.0187	0.0087
Financials	-0.0075	-0.0177	0.0017	0.0121	-0.0088	0.0160
Technology	-0.0018	**0.0687*****	-0.0265	**-0.0442***	-0.0097	**-0.0454***

Appendix 6: Sectoral Reactions in Sweden to the Positive Events

Summary of the Abnormal Returns and Cumulative Abnormal Returns observed for the OMX Stockholm sector indices around events anticipated to cause a positive effect, using the Market Adjusted Model.

Sector Name	E7 2016-11-03	E8 2018-12-10	E9 2019-01-15	E10 2019-03-20	E11 2019-04-03	E12 2019-04-10
[0,1]						
Oil & Gas	-0.0061	-0.0353	0.0099	0.0206	-0.0274	-0.0157
Basic Materials	-0.0064	0.0117	**0.0278****	-0.0005	0.0152	0.0021
Industrials	-0.0050	0.0049	-0.0014	-0.0039	0.0023	0.0067
Consumer Goods	-0.0020	0.0006	-0.0029	0.0016	**-0.0129***	-0.0019
Health Care	-0.0018	0.0012	0.0034	-0.0004	**-0.0150***	-0.0142
Consumer Services	0.0095	-0.0005	-0.0020	-0.0012	-0.0059	-0.0076
Telecom	-0.0060	0.0085	-0.0032	0.0056	-0.0158	-0.0130
Utilities	0.0101	-0.0039	-0.0237	0.0000	-0.0077	-0.0027
Financials	0.0017	-0.0074	-0.0021	0.0010	0.0064	0.0000
Technology	0.0110	0.0051	0.0027	0.0035	0.0093	0.0038
[-1,1]						
Oil & Gas	-0.0111	0.0142	0.0085	0.0404	-0.0290	-0.0144
Basic Materials	-0.0074	0.0091	**0.0288***	0.0081	0.0276	0.0033
Industrials	-0.0071	-0.0011	-0.0014	0.0010	0.0109	0.0064
Consumer Goods	-0.0010	-0.0002	-0.0003	-0.0012	**-0.0215****	0.0024
Health Care	0.0088	-0.0068	-0.0097	-0.0029	**-0.0187***	-0.0159
Consumer Services	0.0077	-0.0009	-0.0030	-0.0009	-0.0204	-0.0093
Telecom	-0.0066	0.0149	-0.0133	-0.0041	-0.0242	-0.0087
Utilities	0.0187	-0.0070	-0.0172	-0.0001	-0.0330	-0.0025
Financials	0.0001	-0.0057	0.0021	-0.0037	0.0042	-0.0013
Technology	0.0286	0.0156	0.0004	0.0036	0.0096	0.0041
[-2,2]						
Oil & Gas	0.0086	-0.0279	0.0314	0.0275	-0.0422	-0.0311
Basic Materials	0.0033	0.0032	**0.0336***	0.0054	0.0308	-0.0097
Industrials	0.0024	-0.0022	-0.0005	-0.0078	0.0137	0.0055
Consumer Goods	0.0006	-0.0082	0.0064	0.0035	**-0.0334****	0.0044
Health Care	0.0076	-0.0075	-0.0086	-0.0048	**-0.0387*****	**-0.0249***
Consumer Services	0.0102	-0.0270	-0.0004	0.0127	0.0242	-0.0207
Telecom	-0.0144	0.0166	-0.0147	0.0036	**-0.0418***	-0.0040
Utilities	0.0253	0.0087	-0.0250	0.0131	-0.0520	0.0187
Financials	-0.0085	0.0016	-0.0003	0.0054	0.0026	0.0090
Technology	0.0257	**0.0400***	-0.0114	-0.0133	0.0032	-0.0046

Appendix 7: ICB Sector Classification Matrix
Data source: FTSE Russel website

Industry	Supersector	Sector	Subsector
0001 Oil & Gas	0500 Oil & Gas	0530 Oil & Gas Producers	0533 Exploration & Production
			0537 Integrated Oil & Gas
		0570 Oil Equipment, Services & Distribution	0573 Oil Equipment & Services
			0577 Pipelines
		0580 Alternative Energy	0583 Renewable Energy Equipment
			0587 Alternative Fuels
1000 Basic Materials	1300 Chemicals	1350 Chemicals	1353 Commodity Chemicals
			1357 Specialty Chemicals
	1700 Basic Resources	1730 Forestry & Paper	1733 Forestry
			1737 Paper
		1750 Industrial Metals & Mining	1753 Aluminium
			1755 Nonferrous Metals
			1757 Iron & Steel
		1770 Mining	1771 Coal
			1773 Diamonds & Gemstones
			1775 General Mining
			1777 Gold Mining
			1779 Platinum & Precious Metals
2000 Industrials	2300 Construction & Materials	2350 Construction & Materials	2353 Building Materials & Fixtures
			2357 Heavy Construction
	2700 Industrial Goods & Services	2710 Aerospace & Defense	2713 Aerospace
			2717 Defense
		2720 General Industrials	2723 Containers & Packaging
			2727 Diversified Industrials
		2730 Electronic & Electrical Equipment	2733 Electrical Components & Equipment
			2737 Electronic Equipment
		2750 Industrial Engineering	2753 Commercial Vehicles & Trucks
			2757 Industrial Machinery

Industry	Supersector	Sector	Subsector
		2770 Industrial Transportation	2771 Delivery Services
			2773 Marine Transportation
			2775 Railroads
			2777 Transportation Services
			2779 Trucking
		2790 Support Services	2791 Business Support Services
			2793 Business Training & Employment Agencies
			2795 Financial Administration
			2797 Industrial Suppliers
			2799 Waste & Disposal Services
3000 Consumer Goods	3300 Automobiles & Parts	3350 Automobiles & Parts	3353 Automobiles
			3355 Auto Parts
			3357 Tires
	3500 Food & Beverage	3530 Beverages	3533 Brewers
			3535 Distillers & Vintners
			3537 Soft Drinks
		3570 Food Producers	3573 Farming & Fishing
			3577 Food Products
	3700 Personal & Household Goods	3720 Household Goods & Home Construction	3722 Durable Household Products
			3724 Nondurable Household Products
			3726 Furnishings
			3728 Home Construction
		3740 Leisure Goods	3743 Consumer Electronics
			3745 Recreational Products
			3747 Toys
		3760 Personal Goods	3763 Clothing & Accessories
			3765 Footwear
			3767 Personal Products
		3780 Tobacco	3785 Tobacco
4000 Health Care	4500 Health Care	4530 Health Care Equipment & Services	4533 Health Care Providers
			4535 Medical Equipment
			4537 Medical Supplies

Industry	Supersector	Sector	Subsector
		4570 Pharmaceuticals & Biotechnology	4573 Biotechnology
			4577 Pharmaceuticals
5000 Consumer Services	5300 Retail	5330 Food & Drug Retailers	5333 Drug Retailers
			5337 Food Retailers & Wholesalers
		5370 General Retailers	5371 Apparel Retailers
			5373 Broadline Retailers
			5375 Home Improvement Retailers
			5377 Specialized Consumer Services
			5379 Specialty Retailers
	5500 Media	5550 Media	5553 Broadcasting & Entertainment
			5555 Media Agencies
			5557 Publishing
	5700 Travel & Leisure	5750 Travel & Leisure	5751 Airlines
			5752 Gambling
			5753 Hotels
			5755 Recreational Services
			5757 Restaurants & Bars
			5759 Travel & Tourism
6000 Telecommunications	6500 Telecommunications	6530 Fixed Line Telecommunications	6535 Fixed Line Telecommunications
		6570 Mobile Telecommunications	6575 Mobile Telecommunications
7000 Utilities	7500 Utilities	7530 Electricity	7535 Conventional Electricity
			7537 Alternative Electricity
		7570 Gas, Water & Multiutilities	7573 Gas Distribution
			7575 Multiutilities
			7577 Water
8000 Financials	8300 Banks	8350 Banks	8355 Banks
	8500 Insurance	8530 Nonlife Insurance	8532 Full Line Insurance
			8534 Insurance Brokers
			8536 Property & Casualty Insurance
			8538 Reinsurance
		8570 Life Insurance	8575 Life Insurance

Industry	Supersector	Sector	Subsector
	8600 Real Estate	8630 Real Estate Investment & Services	8633 Real Estate Holding & Development
			8637 Real Estate Services
		8670 Real Estate Investment Trusts	8671 Industrial & Office REITs
			8672 Retail REITs
			8673 Residential REITs
			8674 Diversified REITs
			8675 Specialty REITs
			8676 Mortgage REITs
			8677 Hotel & Lodging REITs
	8700 Financial Services	8770 Financial Services	8771 Asset Managers
			8773 Consumer Finance
			8775 Specialty Finance
			8777 Investment Services
			8779 Mortgage Finance
	8900 Investment Instruments	8980 Equity Investment Instruments	8985 Equity Investment Instruments
		8990 Nonequity Investment Instruments	8995 Nonequity Investment Instruments
9000 Technology	9500 Technology	9530 Software & Computer Services	9533 Computer Services
			9535 Internet
			9537 Software
		9570 Technology Hardware & Equipment	9572 Computer Hardware
			9574 Electronic Office Equipment
			9576 Semiconductors
			9578 Telecommunications Equipment

Appendix 8: Standard International Trade Classification (SITC) of Traded Goods
Data source: scb.se

Code	Level 1	Level 2
0	Food and live animals	Live animals
		Meat and meat preparations
		Dairy products and bird eggs
		Fish crustaceans, molluscs, prep. thereof
		Cereals and cereal preparations
		Vegetables and Fruit
		Sugars, sugar preparations and honey
		Coffee, tea, cocoa, spices, manuf. thereof
		Feeding stuff for animals, excl.unmil.cer
		Miscellaneous edible products and prep.
1	Beverages and tobacco	Beverages
		Tobacco and tobacco manufactures
2	Crude materials, inedible, except fuels	Hides, skins and furskins, raw
		Oil seeds and oleaginous fruit
		Crude rubber (incl.synth. And reclaimed)
		Cork and wood
		Pulp and wastepaper
		Textile fibres and their wastes
		Crude fertilizers and crude minerals
		Metalliferous ores and metals
		Crude animal and vegetable mtr
3	Mineral fuels etc	Coal, Coke and Briquettes
		Petroleum, petrol. products
		Gas, natural and manufactured
		Electric current
4	Animal, vegetable oil, fat	Animal oils and fats
		Fixed vegetable fats and oils
		Process. anim/veg. Fats and oil
5	Chemicals and related products	Organic chemicals
		Inorganic chemicals
		Dyeing, tanning and colouring materials
		Medicinal and pharmaceutical
		Essential oils, perfume, clean. preparat
		Fertilizers
		Plastics in primary forms

Code	Level 1	Level 2
		Plastics in non-primary forms
		Chemical materials and product
6	Basic manufactures	Leather, leather manuf., dressed furskins
		Rubber manufactures, n.e.s.
		Cork and wood manufact., excl furniture
		Paper and paperboard, articles thereof
		Textile yarn, fabrics, made-up
		Non-metallic mineral manufactu
		Iron and steel
		Non-ferrous metals
		Manufactures of metal, n.e.s.
7	Machinery, transport equipment	Power generating machinery and equipment
		Metalworking machinery
		General indust. machinery
		Office mach., autom. Data-processing equip.
		Telecom, sound recording and reprod. App.
		Electr. machines, apparatus and appliances
		Road vehicles (incl.air cushion)
		Other transport equipment
8	Miscellaneous manufactured articles	Prefabr. buildings, sanit./heat. /light fixt
		Furniture and parts thereof
		Travel goods, handbags and sim. Containers
		Articles of apparel, clothing accessories
		Footwear
		Professional, scientific, controls
		Photogr. apparatus, optical goods, watches
		Miscellaneous manufactured art
9	Goods not classified elsewhere	Industrial plants, Goods of CN Chapters 1-26 and 28-97 delivered to vessels, aircraft and offshore installations, Personal movables etc.
		Coin (excl. Gold coin) not legal tender
		Non-monetary gold