ERASMUS UNIVERSITY ROTTERDAM

Erasmus School of Economics

Finance department

Bachelor Thesis

16 July 2018

Final version

An event study on the Brexit Referendum

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Abstract: This study examines the impact of the Brexit Referendum on the British stock market days after the Referendum by using the event study methodology and various regressions. This topic is introduced by describing the price formation process on stock markets and an overview of the possible consequences of the Brexit on the UK. This study concludes that there was an adverse price shock after the Brexit and that this effect was more intense for companies active in certain sectors or regions; or companies which have other industry-specific characteristics. It was not possible to identify other firm-specific characteristics or multiples which causes the cumulative abnormal returns to be significant.

Content

1. Introduction

1.1 Topic introduction and research question

"I hope this victory brings down this failed project and leads us to a Europe of sovereign nation states, trading together, being friends together, cooperating together, and let's get rid of the flag, the anthem, Brussels, and all that has gone wrong. Let June 23 go down in our history as our independence day."
These words were spoken by UKIP leader Nigel Farage, one of the leaders for the leave-camp during the Brexit Referendum, in its speech to claim the victory in the Brexit Referendum on June 24 at 4 a.m. When the stock markets in London and across Europe opened a few hours later, almost all indices and currencies took a big hit (BBC, 2018). Since all polls before the Referendum predicted that the no-camp would win easily, virtually no investor or banker took the risk of a potential Brexit really into account. Consequently, global financial markets had to adjust to new uncertainties since nobody knew what the consequences of the yes vote would be exactly. This uncertainty, is more than two years, after the Referendum still not resolved since the outcome of the negations between the United Kingdom (UK) and the EU (EU) is still not clear (Financial Times, 2018). Nevertheless, it is possible to research the consequences of the Referendum by studying the stock returns on the days after the event. Therefore, it is possible to draw conclusions on the predictions made by the market on the exposure of all stocks listed in the UK. This study aims to give an overview of the abnormal returns, realised per sector, region or other industry-specific characteristic and their statistical relevance by using the event study methodology as defined by Brooks (2014) and MacKinlay (1997). Furthermore, this study tries to identify the firm-specific characteristics and multipliers that causes these abnormal returns to be significant in the significant sectors, regions or other industry-specific characteristics.

The above-described research goal can be formulated into the following research question:

What is the effect of the outcome of the Brexit Referendum on stock prices in the United Kingdom and what causes these effects?

The outcome of this study can be used in many ways and are interesting for a broad scale of individuals and organisations. To give a clear overview of the relevance of this paper the following part is divided into two sections: the social relevance of this study and the scientific relevance of this paper.

1.2 The social relevance of this paper

Since the Referendum was announced in February 2016, many academics, politicians, policymakers, analysts or concerned individuals shed their lights on the (possible) consequences of the United Kingdom leaving the European Union. An overview of their work will be discussed in section 2.5-2.7. However, it is hard to find a full description of the possible consequences of the Referendum from which the writers are not in any way political or financially biased. Examples of such studies are Booth, Howarth, Persson and Swidlicki (2015); and Woodford Investment Management LLP (2016). The authors of the first report are part of Open-Europa, a pro-Europa think-tank. The author of the latter report is an investment fund with many participations in the UK. The results of both studies are discussed in section 2.5-2.7. In contrary to such papers, this research tries to give an independent and unbiased overview of the market reaction after the Referendum

Since this research is designed to test the influence of the Referendum on different sectors,regions or other industry-specific characteristics, this research can be used by (regional) policymakers, representatives from unions or employers' organisations, businessmen or investors for various purposes. This research could, for example, be used by regional policymakers to support their lobby in London to shift the governments' negotiations strategy in their benefit. Furthermore, this study could also be used by investors to change their trading strategy to be less exposed to the consequences of the UK leaving the EU.

1.3 The scientific relevance of this paper

As mentioned above, many academics and other researches gave their view on the possible implications for the UK when they leave the European single market. A brief overview of their work will be given after which the enhancement that this research tries to make will be described.

Ramiah, Pham and Moosa (2017), did an event study on a sector-specific level and found expected and unexpected significant cumulative abnormal returns for specific sectors but could not explain the reseasons that causes these returns to be significant. The results of this research are explained more thoroughly in section 2.5. In addition, Bouoiyour and Selmi (2018) used the same event study methodology and discovered increasing uncertainty for all sectors, whereas the degree of this uncertainty was different per sector. Another study performed by Davies and Studnicka (2017) identified heterogeneity in the relative change of stock prices from firms after the Referendum and explained this heterogeneity via the global value chain of firms. Schiereck, Kiesel and Kolaric (2016) compared the Brexit with the fall of Lehman Brother in 2008 and learnt that the share prices dropped harder during the first event while the Credit Default Swap rate took a more sizeable hit during the latter event.

The studies mentioned above all examined the impact of the Brexit Referendum on various stocks and other products over different time horizons and using different methodologies. This study extends this research field by identifying the firm-specific aspects that cause the cumulative abnormal returns to be significantly different from the rest. Furthermore, this research cross-checks the significant sectors and regions to determine which sectors in which regions are hit the hardest by the outcome of the Brexit Referendum.

1. Theoretical framework and hypotheses

After defining the research question and stating the academic and social relevance of this research, a brief overview of the background of the Brexit Referendum and the existing academic literature will be given. After that, it is possible to define a set of hypothesis which will be tested in chapter 4.

2.1 Background information and the outcome of the Brexit Referendum

On 22 February 2016, Prime Minister David Cameron announced a Referendum where all citizens of the United Kingdom where to be asked to choose between remain in or leave the European Union. The Referendum date was set on 23 June 2016. After a fierce campaign, the leave-camp won by 51.9 per cent to 48.1 per cent, with a turnout ratio of 71.8 per cent. Since the market did not adequately predict this result, stock prices in Europe went down, and the pound dropped compared to the Dollar with more than 10 per cent in the morning after the Referendum. On 29 March 2017 Theresa May, the current Prime Minister, triggered the Article 50 procedure after which the UK was officially on its way out of the EU. The negotiations teams of both parties met three months later for the first time to discuss the terms for the Brexit and eventually try to conclude new treaties. The date on which the United Kingdom has to leave the EU is set at 12 p.m. CT on 29 March 2019, but there is still a lot to discuss left between both parties before a deal on the future relations could be made. At the moment of writing this paper, July 2018, the negation position of the British government is weakened because of internal dissensions in the administration and House of Commons. The position of Theresa May's government took a new beating on July 9 2018, when David Davis and Boris Johnson resigned as respectively Secretary of State for Exiting the European Union and Foreign Secretary (BBC, 2018).

2.2 The efficient market hypothesis

Since it is the topic of this research to identify and explain abnormal returns realised on the stock market in a specific period a good starting point for this literature overview is the process of price formation and efficient markets. One of the most prominent papers written on this topic is written by Fama (1970), in which he explained the Efficient Market Hypothesis (EMH) and stated that there are three levels of market efficiency: the strong form, the semi-strong form and the weak form.

The strong form of the EMH assumes that it is not possible to earn excess returns since all information, public or private, is incorporated into the stock price (Finnerty, 1976). It would be hard to find a stock market which is in this form since almost every county has anti-insider trading laws which prevent investors from using private information (Scholes, 1969). To test for the existence of investors who have private information which is not fully reflected in the price one needs to evaluate abnormal returns from investment managers over long periods (Fama, 1970). This methodology causes many struggles because of the joint-hypothesis problem and contradicting results for different benchmark models. Consequently, the present proof for this form of market efficiency is thin (Fama, 1991).

The semi-strong form of the EMH states that all public information is integrated into the stock price. Hence, it is only possible to realise excess returns by using inside or private information. Consequently, it is not possible to earn a structural profit by using analysts' reports or fundamental analysis since these reports are based on public information, and public information is incorporated in the stock price immediately after the publication of the news (Fama, 1970). To test how quickly the market reacts to new information one can examine for example the stock price effect to a stock split announcement by using the methodology of Fama, Fisher, Jensen and Roll (1969). They laid the groundwork for this type of research which we now call event studies. They found, in accordance with other academics in this research field, strong support for the semi-strong market hypothesis.

The weak form of the EMH assumes that current stock prices reflect all current stock market information available. Since all historical volume and price information is fully incorporated into the price, excess returns cannot be earned by using technical analysis (Poshakwale, 1996). It is possible to test his weak form by examining how well past returns predict future returns, one of the ways of doing so is by testing for a "fair game" or random walk in stock prices (Fama, 1970). One of the first major contributions to this topic was made by Alexander (1961), who delivered proof for the existence of specific trading rules for a system of buy and hold trades. Much more work on this topic was done afterwards which resulted in strong support for the weak form of the EMH. Consequently, the weak form is the most supported form by empirical research of the EMH (Fama, 1991).

2.3 Stock market returns

One of the most sought-after questions in the academic literature on the stock market is: 'Why is the price moving upwards or downwards and when is the sign going to change?' One of the most straightforward answers to this question is: 'demand and supply'. When many investors want to buy a share the demand for that stock increases and when there are at the same time only little shareholders who wish to sell the price moves up. Intuitively¸ this works also the other way around (van der Sar, 2017). However, why is the demand for a particular stock going down at that specific moment? The factors influencing the movement of a stock can be split into three categories: fundamental variables, technical variables and market sentiment.

According to Chen & Zang (2007), accounting variables are a crucial determinant for cross-sectional variation in stock returns. Their model described five significant coefficients which could predict stock returns: earnings yield, capital investment, changes in profitability, growth opportunities and changes in the discount rate. It was also found that the R^2 of this model is substantially higher than the R^2 of models based on common risk factor which are typically used in finance. Another model designed by Frankel & Lee (1998) used an analyst-based residual income model and the resulting value to price ratio to predict stock market returns. The value to price ratio can be calculated via the residual income model with net income, cost of equity, return on equity, price to book ratios and shareholders' equity as input variables. The residual income model and corresponding value to price ratio turned out to be a good predictor for long-term stock returns. Another variable influencing the returns of a particular share is the debt to equity ratio of a company. This ratio is positively related to the stock returns which implicates that a higher leveraged firm has higher stock returns because it is less risky (Bhandari, 1988).

Other variables which might influence the demand and supply and therefore the returns of certain shares are technical variables. Technical variables are variables such as the historical price (movement) of a stock or data about the trading volume on a particular day (Mizrach & Weerts, 2009). Historical price movement data is a good predictor of the movement of today because stock prices tend to move in trends since stocks which are rising might gain momentum (Malkiel, 1973). Research done by Welch and Goyal (2008) supports this claim by showing that historical average excess stocks returns are better capable of predicting future excess stock returns than regressions made on previously defined (fundamental) variables. Another variable that influences the stock returns of a firm is the size of the firm concerned. This size effect is introduced by Fama and French (1992) in their three-factor model to explain superior returns. This effect states that publicly traded companies with a market capitalisation of less than 2 billion tend to outperform larger firms (Fama & French, 1992). However, according to Perez-Quiros and Timmermann (2000), the returns of small firms are more sensitive to changes in interest rates, default premia, and monetary growth during recessions than larger firms. This result implicates that small firms are more vulnerable during periods of economic stagnation.

Next to the firm-specific variables which are based on hard numbers and facts, there is a third factor that could influence supply and demand: market or investor sentiment. According to classical finance theory investors are entirely rational and try to maximise their profit using all information available, but the recent literature on this topic, called behavioural finance, criticises this view (Barberis & Thaler, 2003). Baker and Wurgler (2006) discovered that future stock returns strongly depend on the market sentiment: when the sentiment is high, and investors are optimistic the return on shares which are attractive to optimists such as young, small or extreme growth stocks are relatively low. This relation also holds the other way around. In a subsequent paper, Baker and Wurgler (2007) stated that waves of sentiment have a clear and vital effect on the stock market. This relation holds especially for stocks which are difficult to arbitrage or to value. Theory on investors' sentiment focuses for a sizeable part on over- or under reactions to news events. Overreaction is caused by the psychological effect that investors, without enough solid support, buy winning stocks and sell losing stocks. Underreaction works exactly the other way around (Abarbanell & Bernard, 1992). The overreaction hypothesis, formulated and confirmed by deBondt, and Thaler (1985), states that extreme movements in stock prices will be followed by subsequent price movements in the opposite directions and that the size of the initial movements equals the size of the subsequent movement.

2.4 Political uncertainty and the stock market

Since the democratisation of the (western) world in the twentieth and twenty-first century, the outcomes of elections and referenda have had an impact on the economic policy of the concerned country and therefore influences the stock market. According to Jorion and Goetzmann (1999), 25 countries are affected by market transaction interruptions since approximately the 1920's. The effect of referenda and elections on stock markets is examined for many countries during various periods with different time frames. Examples of such researches are a study of the impact of the 1995 Quebec Referendum which found significant and positive short-term returns for all portfolios investigated (Beaulieu, Cosset, & Essaddam, 2006). Another study on market indices in 33 countries around elections found positive abnormal returns in the two weeks before the event date. These results were more pronounced for elections won by the opposition in tightly controlled countries and elections which were called early and won by the incumbent administration (Pantzalis, Stangeland, & Turtle, 2000). Furthermore, a study done by Białkowskia, Gottschalk and Wisniewski (2008), examined the stock market reaction after elections in 27 OECD countries, the authors discovered that the country-specific component of index return variance could double in size in the week around the election.

Political uncertainty caused by national elections can affect the national economy in many ways. One of these ways is the level of investments. Durnev (2010) showed that for a large panel of countries around the world, investments became 40 per cent less sensitive to stock prices during elections year than in non-election years due to political uncertainty. Because of this, companies could not optimality allocate their capital which leads to a decrease in profitability (Durnev, 2010). These findings are supported by a model designed by Pástor and Veronesi (2012), which predicts that stock prices should fall if the uncertainty on government policy increases and the effect is more prominent when the uncertainty is more severe. Consequently, this uncertainty increase volatilities and correlations among stocks.

The yes vote for leaving the European caused an increase in political uncertainty in both the United Kingdom and the EU. Since the outcome of the Brexit negotiations is unsure to this date, companies and households postpone their investment decisions and therefore affect the British economy and stock market (BBC, 2018). These observations made by the BBC are also found in the US by Baker, Bloom and Davis (2016) who discovered stock price volatility and reduced investments in specific policy dependent sectors (Baker, Bloom, & Davis, 2016).

An interesting remark about the effect of uncertainty on the financial market is made by Brown, Harlow, and Tinic (1988) who introduced the Uncertain Information Hypothesis (UIH). The UIH is an extension to the previously discussed EMH and is based on entirely rational investor behaviour. This hypothesis argues that if the uncertainty on the outcome of an event is resolved before the voting date subsequent price movements tend to be positive on average. When it is not possible to resolve the uncertainty before the event, price changes tend to be positive on average after the event date as well due to the low level of stock variability before the event (Brown, Harlow, & Tinic, 1988).

2.5 The impact of the Brexit on different sectors in the UK

Since the Brexit Referendum was announced in February 2016 many academics, politicians, policymakers, analysts or concerned individuals gave their opinion on the economic impact of the United Kingdom leaving the EU. In the subsequent three sections, an overview of their work will be discussed.

In 2015, about 63 per cent of all the goods exported out of the home countries were going to the EU or other countries with a free trade agreement with the EU. Hence, the possible loss of these trade partners could have an immense impact on the British trade sector and manufacturing industry (Woodford Investment Management LLP, 2016). However, it is not likely that EU will prevent British companies from trading with Europe after the Brexit because the possible downside for the EU is enormous as well (Velthuijsen & Bernard, 2016). Since there is still no trade deal and the further relations between both parties is still unknown, it is tough to make possible predictions on the future of the British trade and manufacturing sector (Woodford Investment Management LLP, 2016). The automotive and aerospace manufacturers, two of British most essential producers, are the most exposed subdivision to the consequences of the Brexit (Booth et al., 2015).

The financial sector and especially the City could face a big hit because banks and brokers could lose their “passporting” rights after the Brexit, which means that financial services providers can no longer deliver their services to EU countries (Financial Times, 2018). Besides this, they could lose talented workers since persons can no longer move freely between the UK and the bloc when Britain leaves the EU (Woodford Investment Management LLP, 2016). However, The Economist Intelligence Unit (2018) expects that London will remain the most important financial hub in Europe and will also continue to be a key driver for the economy of the United Kingdom since the City is more dependent on global trends than on EU trends.

Other sectors that have to deal with uncertainty and a downfall in demand are the producers of consumer goods and the retail industry. Farmers, for example, can no longer export their products without barriers and tariffs to the EU and producers of food could face a shortage of inputs since one-third of all food is imported to the UK (The Economist Intelligence Unit, 2018). However, the exact effect of the Brexit is not sure since the future relationship between the UK and the EU is still not clear (Dhingra, Ottaviano, Sampson, & Van Reenen, 2016). Another potential problem for the producers of consumer goods is the shortage of labour. At the moment nearly one-fourth of the workforce in food and drink manufacturing comes from other countries (The Economist Intelligence Unit, 2018). The retail trade sector will also suffer from a drop in consumer confidence, but they might profit from the weak pound and import tariffs from goods from the EU (The Economist Intelligence Unit, 2018). However, higher fluctuations in foreign exchange rates might also have an adverse effect on companies with subsidiaries abroad because of its effect on the product pricing and increase the competition pressure (Giambrone, 2018).

Leaving the EU will also influence the real estate sector in the UK. First of all (financial) firms want to relocate their offices to other European cities which will cause a downfall in demand for office space and houses (Woodford Investment Management LLP, 2016). Furthermore, this sector has together with the construction sector already experienced a downfall in investments in for example repairs and maintenance; and infrastructure. Consequently, the 2017 Q2 four-quarter growth for the construction sector has dropped to 0.4 per cent which is the same growth rate as five years ago during the last Euro-crisis (Trades Union Congress, 2017).

Ramiah et al. (2017) used the event study methodology to study the cumulative abnormal returns realised around the Referendum for different sectors to find out which sectors were hit the most by the outcome of the Brexit Referendum. They discovered that the following eleven of the forty industries investigated acted in the same way as predicted: alternative energy, banking, chemicals, equity investment instrument, financial services, food producers, life insurance, non-life insurance, oil and gas producers, software and computer services, and travel and leisure. The household goods and home construction sector took the biggest hit with a cumulative abnormal return of 16.8 per cent, ten days after the Referendum. The level of systematic risks increased in seven sectors while it decreased for two, the other thirty-one sectors remained unchanged. The latter two results came as a surprise to the authors.

Another event study was done by Oehler, Horn and Wendt (2017) on short-term cumulative abnormal returns realised after the Brexit. They made a comparison between the abnormal returns of companies with a high level of domestic sales relative to international sales and companies with a low level of domestic sales relative to international sales. The authors discovered that the first group realised higher negative abnormal returns during the first day after the Referendum, but this effects diminished the second day.

2.6 The impact of the Brexit on different regions in the UK

Just as not every sector in the United Kingdom will be hit equally hard by the Brexit not every part of the UK will be hit equally hard. Intuitively, London is one of the first regions that come to mind when thinking about the Brexit consequences for different regions. Iyer et al. (2018) argued that the financial sector would be the most exposed sector by the Brexit and consequently London will face the biggest hit from the Brexit. However, this conclusion is criticised by other researchers such as McCombie and Spreafico (2017), who concluded that the financial sector is more diversified over the UK. One of their arguments what the fact that 400 thousand people are working in finance in London and nearly 200 thousand people are working in the same sector in the North West of England and Scotland alone. Furthermore, Brown and Bosetti (2017) argued that highly specialised clusters such as the financial services centre tend to be sticky and resilient about leaving their home turf.

However, the British government stated in a confidential and leaked document, that the North East of England and the West Midlands are going to suffer the hardest from the Brexit. The authors predict that these regions are more exposed to a change in trade rules because of their export products and their high dependency on trade as a percentage of their regional GDP. The study predicted that the regional GVA, a measure of the value of goods and services produced in a region, could decrease by respectively 16 and 12 per cent in the worst case scenario (House of commons exiting the EU committee, 2018).

Another research done by Chen et al. (2017) studied the regional impact on all EU regions from the outcome of the Brexit negotiations and the future trade relation between the UK and the bloc. Intuitively, the authors concluded that the UK and Northern-Ireland would face the hardest consequences of the Brexit since they are far more exposed to new trade tariffs and barriers. Furthermore, the authors discovered that the following three regions in the UK have their largest share of their GDP exposed to the Brexit: Cumbria, East Riding and North Lincolnshire; and Lancashire. They are respectively part of North West of England, Yorkshire and the Humber and the North West of England again. The overall results of their research predicted that the North of England and the Midlands would be hit the hardest from the consequences of the Brexit.

Another research done by Dvorak and Podpiera (2005) is a bit off topic from the previously discussed papers, but their findings might be interesting to shed a different light on the implications mentioned above about the Brexit. Dvorak and Podpiera investigated the stock market reaction after the European Union enlargement announcement in the concerned countries and found that stock prices increased substantially in the subsequent days. This increase in stock prices is caused by a switch from a segmented domestic market to a more globally integrated market which causes a reduction in firm-specific risk. Hence, this leads to a reduction in the cost of capital for new member states of the EU (Dvorak & Podpiera, 2005).

2.7 The impact of the Brexit on macroeconomic events and consequently the stock market

The past two sections gave a meso- and microeconomic evaluation of the possible consequences of the United Kingdom leaving the single market. However, the home countries are also exposed to these consequences on a more aggregated macroeconomic level. Just like the different sectors, regions or other industry-specific characteristics a great deal of the aftermath of the Brexit depends on the future relationship between the home countries and the bloc. Certain predictions on the possible consequences can be made by making a distinction between a hard and soft Brexit scenario.

A hard Brexit, a scenario in which the UK will lose its access to the EU's single market, will cost the UK 18 per cent of its GDP growth until 2030 compared to the remain-scenario (Erken, 2018). A soft scenario, were the UK keeps its access to the EU's singles market, will only cost 10 per cent of the country's GDP growth (Erken, 2018). However, this shock is partly offset by a lower interest rate and a depreciating Pound, which in turn causes higher inflation (Gudgin, Coutts, & Gibson, 2016). Furthermore, the level of foreign direct investments will drop substantially since a recent survey on 600 major European companies showed that 77 per cent of them will decrease their capacity in the UK (Cluse, et al., 217). As a consequences productivity will drop, and this effect will be strengthened by tighter immigration law which prevents skilled labour from working in the UK (Erken, 2018). The impact of the Brexit on foreign investments will also work the other way around since the subsidiaries of UK parent companies will also suffer from the Brexit. Loyens & Loeff (2017) predicted that, depending on the outcome of the Brexit negotiations, it would be harder for these parent companies to transfer their profits back to the UK. This effect is caused by more complicated dividend tax policies and treaties.

All of the above-described effects affect to a greater or lesser extent the stock market in Europe and notably the United Kingdom. One of the first papers about the relation between macroeconomics and the stock market was written by Chen, Roll and Ross (1986). They identified the following set of variables to have a significant impact on expected stock returns: industrial production, changes in the risk premium, twists in the yield curve, unanticipated inflation and changes in expected inflation. The authors conclude that stock prices are impacted by economic news and that the intensity of this impact is in accordance with their exposure to the news. However, other research done by Cutler, Poterba and Summers (1988) concluded that it was only possible to explain half of the variance in stock prices by using publicly available news about fundament values. The authors gave the following two possible explanations for the other half of the variation: a high level of price volatility can be caused by a high trading volume and investors seems to use prices as an indicator for fundamental value which causes the stock price to react strongly on a small shift in demand.

More research on this topic on a country level basis gave the following results for different countries: The stock market in New Zealand is impacted by the interest rate, money supply and real GDP of the country (Gan, Lee, Yong, & Zhang, 2006). There is a positive relation between share prices in Singapore on one side and inflation, real economic activity, short-term interest rates, money supply and the exchange rate on the other side. Next to this, there also exists a negative relationship between long-term interest rates and share prices (Maysami, Howe, & Rahmat, 2005). Share prices in Ghana are influenced in the short-run by inflation and exchange rates and in the long-run by interest rates and inflation (Adam & Tweneboah, 2008).

2.8 Defined hypothesis

To answer the first part of the research question: '*What is the effect of the outcome of the Brexit Referendum on stock prices in the United Kingdom'* the following set of hypotheses is formulated. The first hypothesis tests the effects of the yes-vote on an aggregated level, whereas the other four hypotheses test the outcome of the Referendum on either a sector-specific, region-specific or other industry-specific level.

H1: The outcome of the Brexit Referendum negatively influenced the stock market in the United Kingdom.

H2: The impact of the outcome of the Brexit Referendum on the cumulative abnormal returns is different per sector.

H3: The impact of the outcome of the Brexit Referendum on the cumulative abnormal returns is different per region.

H4: The impact of the outcome of the Brexit Referendum on the cumulative abnormal returns is different for firms in the tradable sector.

H5: The impact of the outcome of the Brexit Referendum on the cumulative abnormal returns is different for firms which are externally (equity) finance dependent.

The last two hypothesis are formulated to test the last part of the research question: *'What causes the effects on the stock prices in the United Kingdom after the Referendum?'*

H6: The significant abnormal returns realised around the Brexit are caused by firm characteristics.

H7: The significant abnormal returns realised around the Brexit are caused by financial multipliers.

2. Data

To answer the research question data from 1,421 British listed equities in the United Kingdom was collected from Compustat Global and Bloomberg. Those 1,421 firms were found using the 'Equity Screening Function' on Bloomberg. By using the GVKEY code from these equities daily stock price data and quarterly fundamentals data per equity ticker was gathered via Compustat Global. Since the data was not complete for every firm, certain companies had to be excluded from the dataset. First of all, 155 tickers were excluded from the dataset since their stocks did not trade in Pounds or the stock of one company was more than once in the dataset. Another 58 tickers were removed from the resulting list because of stock splits or other reasons that caused the share price to decrease or increase with more than 100 per cent in one day during the period 7 July 2015 to 28 June 2016. Furthermore, 43 securities with missing stock prices or fundamentals data were removed from the dataset as well. These steps resulted in a dataset with information about stock prices and fundamentals of 1,165 firms listed in the United Kingdom.

3. Methodology

4.1 Overview of the methodology

To answer the research question and perform the event study the following steps, as described in *Introductory Econometrics for Finance* (Brooks, 2014) and *Event Studies in Economics and Finance* (MacKinlay, 1997) will be followed*:*

1. Identify the event date
2. Define the event window
3. Define the estimation period
4. Select the sample of firms
5. Calculate the normal returns
6. Calculate the abnormal returns (ARs)
7. Calculate the cumulative abnormal returns (CARs)
8. Determine the statistical significance of the ARs and CARs

These steps are explained more detailed in the subsequent seven sections.

4.2 The event date

The event date is the date on which news about a particular event becomes public for the first time to the market. Since the outcome of the Brexit Referendum became evident on 24 June 2016 before the opening of the stock market, this date is set as the event date. The event date is notated as t=0.

4.3 The event window

The event window is the time frame around the event that the market needs to adjust its prices to the newly available news. According to (Fama, Fisher, Jensen, & Roll, 1969) stock prices tend to react rapidly but not immediately to new information and therefore it is necessary to set the event windows a few days after the event. However, when one makes the event window too large the test of significance will be less powerful (Brooks, 2014). But on the other hand, if the event window is too small, there might be a change that the full effect of the event is not captured in the event study (MacKinlay, 1997). For this research, the same event window is used as in Ramiah et al. (2017), who also did an event study on the Brexit. This event window can be notated as [0,10].

4.4 The estimation period

The estimation period or the controlled period is the period in which no event occurred and can, therefore, be used to identify the regular behaviour of the stocks and calculate the normal returns. Just like the event window, there is no consensus among academics on the length of the estimation period, but MacKilay (1997) recommend to use a one year estimation period (250 trading days). For this research, the estimation period is set on the number of trading days in 2016: 252. This can be notated as [-252,0].

4.5 Select the sample of firms

The methodology used to select the sample of firms used is explained in chapter 3.

4.6 Calculate normal returns

Normal returns can be calculated via numerous ways; these models can loosely be grouped into two categories: statistical models and economic models. Examples of statistical models are the constant mean model, the market model or other versions of factor models (MacKinlay, 1997). The constant mean model is a straightforward and easy to use model which tends to predict the normal returns just as good as more advanced models (Brown & Warner, 1980). Economic models which are used to calculated normal returns are the CAPM and APT (MacKinlay, 1997). However, these economic models are according to MacKinlay (1997), less popular to use in event studies since the CAPM output is very sensitive to the restrictions used and the returns of the APT model are not that much different from the market model while its methodology is much more complicated (MacKinlay, 1997). Following the methodology described in MacKinlay (1997), the market model is used as the model to calculate the normal returns. The market beta is estimated using daily MSCI world return data. The daily MSCI world return data is gathered via the MSCI end of the day index data search tool on the MSCI website (MSCI, 2018). The daily stock return is calculated using the following formula with daily stock price data as input for P as defined by (Koller, Goedhart, & Wessels, 2010).

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

The following formula, defined by MacKinlay (1997), is used to determine the predicted returns per security:

$$R_{i,T} = a_i + \beta_i R_{M,T} + \epsilon_{i,T}$$

Where $R_{i,T}$ are the period T returns on security i, $R_{M,T}$ are the period T returns on the market portfolio, $a_i\ en\ B_i$ are the parameters of the market model and $\epsilon_{i,T}$ is the zero mean disturbance term.

4.7 Calculate abnormal returns

The abnormal returns for the selected companies are calculated by subtracting the realised returns during the event period from the normal returns calculated using the market model (MacKinlay, 1997). These abnormal returns are the returns which are realised because of the event. This can be described using the following formula as defined by MacKinlay (1997):

$$AR_{i,T} = R_{i,T} - a_i - \beta_i R_{M,T}$$

Where $AR_{i,T}$ is the abnormal return for firm i in the event window.

To draw overall inferences for the event under investigation, the abnormal returns which are calculated have to be aggregated. These returns can both be aggregated to through time and through securities, but for this research, it is only necessary to aggregate through time. Hereafter the cumulative abnormal returns per company are calculated using the following formula as defined by MacKinlay (1997):

$$CAR_{i(T1-T2)} = \sum_{t=T1}^{T2} AR_{i,t}$$

Where $CAR_{i(T1-T2)}$ is the sample cumulative abnormal return (CAR) from $(T1\ to\ T2)$

4.8 Test the statistical significance of the AR and CAR

To test if the found cumulative abnormal returns are significantly different from zero a one sample t-test can be used. By using this test it is possible to calculate the possibility that the found CAR is significantly different from zero, and hence calculate the possibility that the event has an impact on the stock returns. For this test, a significant level of 1 per cent, 5 per cent and 10 per cent is used. The t-test is calculated using the following formula as defined by Rice (2006):

$$\mathrm{t} = \frac{\bar{X} - \mu}{s/\sqrt{n}}$$

Another test that needs to be performed is a test that checks if the mean CAR of a subsample is significantly different from the mean of the rest of the dataset. This can be done using an independent group t-test. The independent group t-test is calculated using the following formula as defined by Rice (2006):

$$t = \frac{\bar{X} - \bar{Y}}{S\sqrt{\frac{1}{n} + \frac{1}{m}}}$$

Where $\overline{X}$ and $\overline{Y}$ are the means of the different samples, n and m are the number of observations in the different samples and is S is the pooled variances of both samples. S is calculated using the following formula as defined by Rice (2006):

$$\mathrm{S} = \sqrt{\frac{(n-1)S_X^2 + (m-1)S_Y^2}{n+m-2}}$$

Where n and m are the number of observations in the different sample and S_X^2 and S_Y^2 are the unbiased estimators of the variances of the two samples.

The above mentioned independent group t-test can only be used if equal variances between the groups is assumed. Since this is assumed in this research, the alternative method needed when the variance is unequal will not be discussed further.

4.9 Variables used to explain the CAR

To find out which firm-specific characteristics or financial information causes the cumulative abnormal returns various t-test and regressions with one depended variable and multiple independent variables will be performed. For these test the following variables are defined:

Dependent variable

Cumulative abnormal returns (CAR): The cumulative abnormal returns realised by the firms during the event window around the Brexit Referendum on 24 June 2016. The CARs are calculated following the above-mentioned methodology. The data for this variable is gathered via Compustat Global.

Independent variables

Log Market capitalisation: The market capitalisation of the firm is a continuous variable and measure for size and reflects the opinion of investors about the market value of the company. The market capitalisation is calculated by multiplying the stock price on the publication date of the latest quarterly reporting by the number of shares outstanding on the same date. The market capitalisation variable is transformed to a log variable to make the relationship between the dependent and independent variable linear and therefore correct for exponential growth (Brooks, 2014). The data for this variable is gathered via Compustat Global.

Debt to equity ratio: The debt to equity ratio is a continuous variable and reflects the relative proportion of debt to shareholders equity and therefore explains how much leverage the company has. The ratio can be calculated by using the book or market value of the debt and equity (Koller et al., 2010). Since the market value of debt for most of the companies is not publicly available, the book value of both items is used in this paper. The data for this variable is gathered via Compustat Global from the quarterly reporting closest to the event date; in most cases 30 June 2016.

Number of subsidiaries: The number of subsidiaries a firm has is a continuous variable and is next to the market capitalisation of a firm a measure for size**.** The data for this variable is gathered via Orbis from the latest year available.

Subsidiaries outside the United Kingdom: This dummy variable shows if a company has subsidiaries or controlling stakes in other companies located outside the United Kingdom. The data for this variable is gathered via Orbis from the latest year available.

Income: Income is a continuous variable and measures the profitability of a firm. The income variable is defined as the quarterly income before tax of a firm. The data for this variable is gathered via Compustat Global from the quarterly reporting closest to the event date; in most cases 30 June 2016.

Earnings per share (EPS): The earnings per share is a continuous variable and measures the profitability of the company and tells us how much money the firm makes per share outstanding. The EPS are calculated by dividing the quarterly income before tax by the total number of shares outstanding on the reporting date (Koller et al., 2010). The data for this variable is gathered via Compustat Global from the quarterly reporting closest to the event date; in most cases 30 June 2016.

Book to market: The book to market is a continuous variable and explains the value of a company by dividing the book value of the assets of the company by the value of the company at the stock market. This ratio can be used to find over or undervalued companies and can, therefore, be seen as a measure of growth opportunities (Koller et al., 2010). The data for this variable is gathered via Compustat Global from the quarterly reporting closest to the event date; in most cases 30 June 2016.

Return on equity (ROE): The return on equity is a continuous variable and explains how profitable a firm is relative to its shareholder capital. The ROE can be calculated by dividing the quarterly income before taxes by the outstanding shareholder capital (Koller et al., 2010). The data for this variable is gathered via Compustat Global from the quarterly reporting closest to the event date; in most cases 30 June 2016.

Daily return factor: The daily return factor is a continuous variable and explains the daily returns generated by a stock over an extended period. The data for this variable is gathered via Compustat Global.

Subsidiaries in the EU, subsidiaries in the Eurozone, subsidiaries in North America, and subsidiaries in other continents: These four dummy variables describe the location of at least one subsidiary of a particular company in a region or continent. The first variable shows if at least one subsidiary is located in one of the 28 EU member states. The second variables shows if at least one subsidiary is located in in one of the nineteen countries in the Eurozone. The third variable if at least one subsidiary is located in North America (Canada, USA and Mexico). The fourth variables variable shows if at least one subsidiary is located in another continent than Europa or North America. The data for this variable is gathered via Orbis from the latest year available.

Category variables

Sector: This category variable shows the sector in which the firm is doing business according to the *North American Industry Classification System* (NAICS). The NAICS uses a five or six digit code to classify each business into a specific industry class. This coding system was initially developed for North American companies but the codes can be used for companies in other countries as well (United States Census Bureau, 2018). The data for this variable is gathered via Compustat Global. For this research, only the first two digits are used to split the sample into the following twenty sectors:

1. Agriculture, forestry, fishing and hunting (11)
2. Mining (21)
3. Utilities (22)
4. Construction (23)
5. Manufacturing (31-33)
6. Wholesale trade (42)
7. Retail trade (44-45)
8. Transportation and warehousing (48-49)
9. Information (51)
10. Finance and insurance (52)
11. Real estate rental and leasing (53)
12. Professional, scientific, and technical services (54)
13. Management of companies and enterprises (55)
14. Administrative,- support,- waste,- and remediation services (56)
15. Educational services (61)
16. Health care and social assistance (62)
17. Arts, entertainment, and recreation (71)
18. Accommodation and food services (72)
19. Other services (81)
20. Public administration (92)

Region: This category variable shows in which region the companies headquarter is located. These regions are defined using the Classification of Territorial Units for Statistics (NUTS) coding system, a geocode standard developed by the EU to divide subregions of countries for statistical purposes (EUR-lex, 2018). The NUTS categories Scotland, Wales, North Ireland and other regions outside the UK are aggregated into one category: Not in England. The data for this variable is gathered via Orbis. The following regions are defined:

1. London
2. North West England
3. North East England
4. Yorkshire and the Humber
5. South West England
6. South East England
7. East of England
8. West Midlands
9. East Midlands
10. NOT in England

Tradable: This category variable splits the sample into two parts: Tradable and non-tradable. Tradable companies are defined using the methodology used by Mian and Stufi (2014). They classified a company as tradable if their NAICS code started with the following numbers: 11, 21, 31, 32, 33 and 51. Data for this variable is gathered via Compustat Global.

Externally finance dependent (EFD) and externally equity finance dependent (EEFD): These category variables split the sample into two parts: Externally (equity) finance dependent and not externally (equity) finance dependent. EFD and EEFD is introduced by Rajan and Zingales (1998) as a proxy for the amount of external financing in different industries since data on this topic is regularly not public available. They define the level of external finance dependency of a particular company as follows: capital expenditures minus cash flow from operations plus decreases in inventories, decreases in receivables, and increases in payables divided by capital expenditures. External equity finance dependency is defined by Rajan and Zingales (1998) as the ratio of the net amount of equity issues (sale – purchase of common stock) to capital expenditures. Firms with a positive sign for the EF ratio are defined as in need of external financing and for the EEFD firms with a ratio higher than 1 are defined as in need of external equity financing. Since data on these items, and capital expenditures in particular, is not available for 420 companies in our dataset these companies are excluded from the dataset in the tests concerning this variable. 364 of these companies report their financial statements in financial services style. The data for this variable is gathered via Compustat Global from the quarterly reporting closest to the event date; in most cases 30 June 2016.

4.10 Regression used to explain the CAR

After identifying which category variables have significantly different mean CARs the various reasons that cause these CARs to be significant need to be researched. This is done by using multiple regressions with the above-described variables as input. All variables are split into the following four categories and regressed independently:

1. Firm characteristics
2. Financial multiplies
3. Regions

The first two categories are used to identify, for companies active in either the significant sectors, regions or firm characteristics, which firm-specific aspects causes the CARs to be different from the rest of the sample. Therefore it is possible to identify what kind of companies are affected the most by the Referendum. These two regressions can be defined as follows:

$$(1)\ CAR = c + LogMarketcap\ X_1 + DEratioX_2 + NumberofSubsX_3 + OutsideUKSubsX_4$$

$$(2)\ CAR = c + IncomeX_1 + EPSX_2 + BooktoMarketX_3 + ROEX_4 + DRfX_5$$

The last category is used as a cross-check to examine first of all if the sectors identified as significant stay significant if the sample is narrowed down to significant regions. Secondly, these regressions can be used to identify which sectors are affected the most, positively or negatively, in respectively the sector. The results of this regression are controlled for firm specific characteristics using variable X_{11}, X_{12}, X_{13}, X_{14}, X_{15} and X_{16}.

$$(4)\ CAR = c + LondonX_1 + NorthWest\ X_2 + NorthEastX_3 + YorkshireX_4 + SouthWestX_5 + SouthEastX_6 + EastofEnglandX_7 + WestMidlandsX_8 + EastMidlandsX_9 + NOTinUKX_{10} + LogMarketcap\ X_{11} + DEratioX_{12} + IncomeX_7 + EPSX_{13} + BooktoMarketX_{14} + ROEX_{15} + DRfX_{16}$$

Next to the three categories, another regression is done to test the effect of the location of a subsidiary of a company, while controlling for the firm specific characteristic variables. This regression is performed on all companies in the sample. The results of this regression are controlled for firm specific characteristics using variableX_5, X_6, X_7, X_8, X_9, X_{10} and X_{11}. This regression can be defined as follows:

$$(5)\ CAR = c + SubsinEUX_1 + SubsinEUROX_2 + SubsinNAX_3 + SubsinOtherX_4 + LogMarketcap\ X_5 + DEratioX_6 + IncomeX_7 + EPSX_8 + BooktoMarketX_9 + ROEX_{10} + DRfX_{11}$$

For all five regressions, a significant level of 1 per cent, 5 per cent and 10 per cent is used

4.11 Descriptive statistics

In table 1 the descriptive statistics for the variables used are shown.

Table 1 Descriptive statistics of the variables used

	Mean	Standard deviation	Min	Max
Market capitalisation	1.53e^9	7.00e^9	314078	9.23e^10
Debt to equity ratio	0.414	1.277	0	15.611
Number of subsidiaries	90.806	288.851	0	4364
Subsidiaries outside UK	0.599	0.490	0	1
Income before tax	19.627	162.576	-1888.831	3475.502
Earnings per share	0.079	0.389	-2.160	10.173
Book to market ratio	0.948	1.176	-10.313	12.315
Return on equity	-0.005	0.508	-10.000	7.448
Daily return factor	2.081	5.384	1	156.950
Subsidiaries in the EU	0.425	0.494	0	1
Subsidiaries in the Eurozone	0.399	0.490	0	1
Subsidiaries in North America	0.393	0.489	0	1
Subsidiaries in other continents	0.524	0.500	0	1
Agriculture, Forestry, Fishing and Hunting	0.005	0.072	0	1
Mining	0.099	0.298	0	1
Utilities	0.005	0.072	0	1
Construction	0.031	0.173	0	1
Manufacturing	0.225	0.418	0	1
Wholesale Trade	0.018	0.133	0	1
Retail Trade	0.045	0.207	0	1
Transportation and Warehousing	0.017	0.130	0	1
Information	0.097	0.296	0	1
Finance and Insurance	0.261	0.439	0	1
Real Estate Rental and Leasing	0.055	0.228	0	1
Professional, Scientific, and Technical Services	0.076	0.264	0	1
Management of Companies and Enterprises	-	-	0	1
ASWMR- Services	0.021	0.145	0	1
Educational Services	0.003	0.059	0	1
Health Care and Social Assistance	0.002	0.041	0	1
Arts, Entertainment, and Recreation	0.009	0.092	0	1
Accommodation and Food Services	0.021	0.142	0	1
Other Services	0.005	0.072	0	1
Public Administration	-	-	0	1
Located in London	0.452	0.498	0	1
Located in North West England	0.049	0.216	0	1
Located in North East England	0.020	0.139	0	1
Located in Yorkshire and the Humber	0.057	0.231	0	1
Located in South West England	0.049	0.216	0	1
Located in South East England	0.138	0.345	0	1

Located in East of England	0.070	0.256	0	1
Located in the West Midlands	0.039	0.193	0	1
Located in the East Midlands	0.023	0.151	0	1
NOT located in England	0.104	0.305	0	1
Tradable	0.342	0.474	0	1
Dependent on external finance	0.422	0.494	0	1
Dependent on external equity finance	0.631	0.483	0	1

4. Results

5.1 Significance tests on the CAR

First of all the cumulative abnormal returns for all firms are jointly tested to find out if the CARs are significantly different from zero for all stocks during the Brexit Referendum. The test showed that the CARs for all firms is -0.069 with a corresponding p-value of 0.000. This indicates that the event of 24 June 2016 caused a significant decrease in the overall stock price of almost 7 per cent. The t-tests on a firm-specific level showed that 103 of the 1,165 firms had significant abnormal returns around the Referendum in the previously defined event window. A full list of these companies and their CARs and t-values can be found in the appendix in table 1.

Hence, the first hypothesis which states that t*he outcome of the Brexit Referendum negatively influenced the stock market in the United Kingdom* cannot be rejected.

To further analyse the impact of the Referendum on the various CARs the total sample is tested using the independent group t-test and a set of categorical variables. The output of these tests can be found in table 2, 3 and 4.

In the table below it is shown that companies active in the constructions sector, retail trade sector, finance sector, real estate sector and other services sector showed significantly different CARs. The finance sector is, with a mean CAR of -5.5 per cent, the only significant sector with a lower than average CAR. The other sectors have a mean CAR ranging from -9.5 per cent to -17.7 per cent. The five significant sectors accounted for 39.6 per cent of the total dataset. The other fifteen sectors had no significantly different mean CARs from the rest of the sample.

Table 2 CARs broken down by sector

	Observations	**Mean**	**p-value**
Agriculture, Forestry, Fishing and Hunting	6	-0.011	0.165
Mining	115	-0.066	0.644
Utilities	6	-0.069	0.974
Construction	36	-0.118	0.005 ***
Manufacturing	262	-0.065	0.361
Wholesale Trade	21	-0.103	0.135
Retail Trade	52	-0.098	0.044 **
Transportation and Warehousing	20	-0.083	0.581
Information	113	-0.073	0.775
Finance and Insurance	304	-0.055	0.004 ***
Real Estate Rental and Leasing	64	-0.095	0.044 **
Professional, Scientific, and Technical Services	88	-0.079	0.393
Management of Companies and Enterprises	0	-	-

Administrative,- Support,- Waste Management,- and Remediation Services	25	-0.063	0.723
Educational Services	4	-0.038	0.535
Health Care and Social Assistance	2	-0.015	0.451
Arts, Entertainment, and Recreation	10	-0.043	0.414
Accommodation and Food Services	24	-0.073	0.887
Other Services	6	-0.177	0.012 **
Public Administration	0	-	-

**** Significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent*

Hence, the second hypothesis which states that *the impact of the outcome of the Brexit Referendum on the cumulative abnormal returns is different per sector* has to be rejected.

In the table below it is shown that London and the North East of England have significantly different mean CARs from the rest of the sample. The mean CARs of firms located in London is -6.4 per cent, which is lower than the rest of the sample. The mean CARs of firms located in the North East of England is -10.8, and higher than average. These two significant regions accounted for 47.1 per cent of the total dataset. The other eight regions had no significantly different mean CARs from the rest of the sample.

Hence, the third hypothesis which states *that the impact of the outcome of the Brexit Referendum on the cumulative abnormal returns is different per region* has to be rejected.

Table 3 CARs broken down by region

	Observations	**Mean**	**p-value**
Located in London	526	-0.064	0.077 *
Located in North West England	57	-0.072	0.899
Located in North East England	23	-0.108	0.078 *
Located in Yorkshire and the Humber	66	-0.089	0.134
Located in South West England	57	-0.066	0.764
Located in South East England	161	-0.070	0.969
Located in East of England	82	-0.068	0.870
Located in the West Midlands	45	-0.079	0.542
Located in the East Midlands	27	-0.099	0.143
NOT located in England	121	-0.071	0.887

**** Significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent*

In table 4 the results of the t-test on the other three category variables are shown. The results indicate that companies which are dependent on external equity finance had a significantly more adverse price reaction after the Referendum compared to firms which are not dependent on external equity financing. Firms which are dependent on external finance had, on average, a lower price reaction to the outcome of the Brexit Referendum compared to firms which are not dependent on external financing. However, this difference is not significant. The results also indicates that firms which are doing business in a tradable sector had a less adverse price reaction after the Referendum than firms which are not operating in a tradable sector. However, this difference is also not significant. These results show that firms which are in need of external equity finance were hit harder by the outcome of the Referendum than firms which do not match this criterion. However, it is necessary to make a strong footnote on the results from the EF and EEFD regression. Since 440 firms are excluded from the data set for this test and most of them are financial service companies, which showed a lower than average and significant CAR in table 2, the results found are not representative for the rest of the sample.

Hence, the fourth hypothesis which states that *the impact of the outcome of the Brexit Referendum on the cumulative abnormal returns is different for firms in the tradable sector* has to be rejected.

Furthermore, the fifth hypothesis which states *the impact of the outcome of the Brexit Referendum on the cumulative abnormal returns is different for firms which are externally (equity) finance dependent* has to be rejected as well.

Table 4 CARs broken down per industry-specific characteristics

		Observations	Mean	p-value
Tradable sector		398	-0.063	0.122
Non-tradable sector		767	-0.073	0.122
	Total	**1,165**		
Externally financed depended		315	-0.068	0.241
Non-externally financed depended		430	-0.077	0.241
	Total	**745**		
Externally equity financed depended		275	-0.062	0.027 **
Non-externally equity financed depended		470	-0.080	0.027 **
	Total	**745**		

**** Significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent*

5.2 Variables influencing the significant CARs

Since the different sectors, regions and other industry-specific characteristics that causes the cumulative abnormal returns to be significant are determined, it is possible to dive deeper into the firm-specific characteristics that cause these mean CARs to be different. The results are split into eight tables whom all show a different dimension on what causes the cumulative abnormal return to be different. In table 5, 6 and 7 the results of the regression with CAR as the dependent variable and firm characteristics variables as independent variables are given. Since heteroscedasticity was found in the second model, robust standard errors are used for this regression. The regression output for the significant sectors indicates that the market capitalisation, the debt to equity ratio and whether the firms have subsidiaries outside the United Kingdom all have a negative coefficient and are significant. The sign for the number of subsidiaries variable is negative as well, but not significant.

For the significant regions, the results are more or less the same. The number of subsidiaries and whether or not they are outside the United Kingdom negatively and significantly influences the CAR. The sign of market capitalisation changed, and the coefficient is now no longer significant. The sign of the debt to equity ratio did not change, but the coefficient is no longer significant. The third regression indicated that the market capitalisation and number of subsidiaries abroad had a positive relationship with the CAR, but this variable is together with all other coefficients not significant. Therefore it is possible to conclude for the first two categories that firms with subsidiaries outside the United Kingdom had a more adverse price reaction to the Brexit Referendum compared to firms which do not match this criterion. Furthermore, firms which were larger and highly leveraged and active in significant sectors had a more adverse price reaction during the Referendum than firms which do not match this criterion. It is also possible to conclude that firms with many subsidiaries and active in the significant regions had a more adverse price reaction to the Brexit Referendum compared to firms which do not match this criterion.

Hence, the third hypothesis which states that t*he significant abnormal returns realised around the Brexit are caused by firm characteristics* has to be rejected.

When the regression was done on the whole sample, all signs were negative, and the debt to equity ratio variable and subsidiaries outside UK variable were the only significant coefficients with a p-value of respectively 0.004 and 0.016.

Table 5 CARs for significant sectors broken down by firm characteristics

	Coefficient	Standard error	P-value
Log Market capitalisation	-0.009	0.002	0.000 ***
Debt to equity ratio	-0.007	0.003	0.019 **
Number of subsidiaries	-3.11e^-07	0.000	0.977
Subsidiaries outside UK	-0.031	0.009	0.000***
Constant	0.115	0.004	0.003 ***
R-squared	0.135		

*** Significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent*

Table 6 CARs for significant regions broken down by firm characteristics

	Coefficient	Robust Standard error	P-value
Log Market capitalisation	0.001	0.003	0.607
Debt to equity ratio	-0.003	0.003	0.359
Number of subsidiaries	-0.000	9.8e^-06	0.042 **
Subsidiaries outside UK	-0.022	0.010	0.024 **
Constant	-0.074	0.049	0.130
R-squared	0.019		

*** Significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent*

Table 7 CARs for significant industry-specific characteristics broken down by firm characteristics

	Coefficient	Standard error	P-value
Log Market capitalisation	0.000	0.003	0.870
Debt to equity ratio	-0.007	0.005	0.160
Number of subsidiaries	-0.000	0.000	0.618
Subsidiaries outside UK	0.015	0.014	0.284
Constant	-0.097	0.050	0.054 *
R-squared	0.007		

*** Significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent*

Since the subsidiaries outside UK variable was significant in both the sectors and regions regression, it would be interesting to further study the relationship between the CAR and the location of the subsidiaries.

This is done in table 8 where the results of the regression with CAR as dependent variable, the location of the subsidiaries dummy variables as independent variables and the firm specific characteristics variables as control variables. The regression output shows a negative and significant sign for the subsidiaries in the Eurozone variable. The results also indicate a positive and significant for the subsidiaries coefficient in other continents variable. The subsidiaries in the EU and subsidiaries in North America variables indicate respectively a negative and positive sign as well but they are not significant. The debt to equity ratio and EPS variable are the only control variables with a significant coefficient and have respectively a negative and positive sign. Hence, we can conclude that, while controlling for firm-specific characteristics, firms with subsidiaries in the EU had a more adverse price reaction after the Referendum compared to firms which do not match this criterion. On the other hand, firms which have subsidiaries in other continents have suffered less from the negative price shock caused by the Brexit Referendum.

Table 8 CARs broken down by the location of subsidiaries

	Coefficient	**Robust Standard error**	**P-value**
Subsidiaries in the EU	-0.014	0.009	0.128
Subsidiaries in the Eurozone	-0.021	0.008	0.010 **
Subsidiaries in North America	0.006	0.008	0.487
Subsidiaries in other continents	0.013	0.007	0.048 **
Log Market capitalisation	0.001	0.002	0.755
Debt to equity ratio	-0.007	0.003	0.014 **
Income before tax	8.49e^07	0.000	0.948
Earnings per share	0.007	0.003	0.007 ***
Book to market ratio	-0.000	0.003	0.908
Return on equity	-0.000	0.003	0.996
Daily return factor	-0.000	0.006	0.535
Constant	-0.074	0.038	0.056 *
R-squared	0.026		

**** Significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent*

In table 9, 10 and 11 the results of the regressions with CAR as the dependent variable and financial multiplier variables as independent variables are given. Since heteroscedasticity was found in the first two models, robust standard errors are used for these regressions. The regression output for the significant sectors shows that the EPS, book to market and daily return variables have a positive sign, but only the EPS and book to market coefficient are significant. The other two variables have a negative sign and are not significant. Hence, firms which have a higher EPS or book to market ratio have suffered less from an adverse price reaction after the Referendum. The regression output for the significant regions and significant industry-specific characteristics showed no significant results.

Hence, the fourth hypothesis which states that *the significant abnormal returns realised around the Brexit are caused by financial multipliers* has to be rejected.

When the regression was done on the whole sample all signs, except for the EPS variable, were negative. However, the EPS coefficient was, with a p-value of 0.003, the only significant coefficient.

Table 9 CARs for significant sectors broken down by financial multipliers

	Coefficient	Robust Standard error	P-value
Income before tax	-0.000	0.000	0.248
Earnings per share	0.007	0.003	0.007 ***
Book to market ratio	0.018	0.007	0.019 **
Return on equity	-0.030	0.050	0.555
Daily return factor	0.002	0.004	0.663
Constant	-0.093	0.012	0.000 ***
R-squared	0.024		

*** Significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent*

Table 10 CARs for significant regions broken down by financial multipliers

	Coefficient	Robust Standard error	P-value
Income before tax	-0.000	0.000	0.404
Earnings per share	0.008	0.008	0.353
Book to market ratio	0.001	0.003	0.755
Return on equity	-0.001	0.008	0.860
Daily return factor	-0.001	0.001	0.569
Constant	-0.066	0.007	0.000 ***
R-squared	0.002		

*** Significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent*

Table 11 for significant industry-specific characteristics broken down by firm characteristics

	Coefficient	Standard error	P-value
Income before tax	0.000	0.000	0.665
Earnings per share	-0.066	0.052	0.206
Book to market ratio	-0.005	0.006	0.428
Return on equity	0.002	0.010	0.829
Daily return factor	-0.000	0.001	0.473
Constant	-0.073	0.007	0.000 ***
R-squared	0.006		

*** Significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent*

In table 12 the results of the regression with CAR as the dependent variable, the different region dummy variables as independent variables and the firm specific characteristics variables as control variables are given. The regression output shows that all region variables, except North East of England, have a positive sign. However, only the following regions are significant: London, East of England, West Midlands and NOT in England. The market capitalisation, debt to equity ratio and EPS variables are the only control variables with a significant coefficient and respectively a negative, negative and positive sign. Hence, it can be concluded, while controlling for firm-specific characteristics, that companies which are active in either the construction sector, retail trade sector, finance sector, real estate sector, or other services sector located in the significant regions mentioned above have suffered less from the negative consequences caused by the Referendum. These results partly match the findings made in sector 5.1.

Table 12 CARs for significant sectors broken down per region

	Observations	**Coefficient**	**Standard error**	**P-value**
Located in London	244	0.064	0.023	0.005 ***
Located in North West England	15	0.021	0.030	0.490
Located in North East England	11	-0.007	0.032	0.834
Located in Yorkshire and the Humber	20	0.053	0.028	0.057 *
Located in South West England	20	0.037	0.028	0.188
Located in South East England	42	0.041	0.025	0.106
Located in East of England	20	0.059	0.028	0.037 **
Located in the West Midlands	13	0.060	0.031	0.052 *
Located in the East Midlands	15	Omitted	-	-
NOT located in England	62	0.051	0.024	0.037 **
Log Market capitalisation	1,165	-0.013	0.002	0.000 ***
Debt to equity ratio	1,165	-0.010	0.003	0.000 ***
Income before tax	1,165	0.000	0.000	0.129
Earnings per share	1,165	0.012	0.006	0.061 *
Book to market ratio	1,165	0.009	0.006	0.113
Return on equity	1,165	0.015	0.047	0.747
Daily return factor	1,165	0.004	0.003	0.124
Constant	1,165	0.113	0.043	0.010 **
R-squared	0.179			

**** Significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent*

5. Conclusion and limitations

6.1 Conclusion

Since all information and results needed to answer the research question are collected and found it is possible to answer the research question. An overview of the test results on the previously defined hypotheses is given in table 13 to help explain the conclusions made in the following paragraphs.

Table 13 Test results on the defined hypotheses

Hypotheses	**Not rejected/Rejected**
H1: The outcome of the Brexit Referendum negatively influenced the stock market in the United Kingdom.	Could not be rejected
H2: The impact of the outcome of the Brexit Referendum on the cumulative abnormal returns is different per sector.	Rejected
H3: The impact of the outcome of the Brexit Referendum on the cumulative abnormal returns is different per region.	Rejected
H4: The impact of the outcome of the Brexit Referendum on the cumulative abnormal returns is different for firms in the tradable sector.	Rejected
H5: The impact of the outcome of the Brexit Referendum on the cumulative abnormal returns is different for firms which are externally (equity) finance dependent.	Rejected
H6: The significant abnormal returns realised around the Brexit are caused by firm characteristics.	Rejected
H7: The significant abnormal returns realised around the Brexit are caused by financial multipliers.	Rejected

With this information it is possible to answer the following research question:

What is the effect of the outcome of the Brexit Referendum on stock prices in the United Kingdom and what causes these effects?

There was an adverse and significant effect on the stock prices for all listed companies in the United Kingdom after the Brexit Referendum when they were tested jointly. However, these effects disappeared for most of the sectors, regions or other industry-specific characteristics when the mean differences per group were compared. It was also not possible to identify significant relations when the sectorial effects were studied in the significant sectors. However, there appeared to be a relation between the share prices and owning at least one subsidiary in the EU, Eurozone or other continents. The results also indicated that there is no relationship between the fact that a company is doing business in a tradable sector or externally (equity) finance dependent.

In the second part of chapter 5, the last two hypotheses, which represent the last part of the research question, were tested and had to be rejected as well. It was possible to identify some of the factors that had a significant effect on both samples (e.g. number of subsidiaries and whether the subsidiaries are located in the UK or not), but it was for both sets of variables not possible to draw any overall conclusions.

6.2 Limitations and recommendations for further research

The scope of this research is not infinite and all-encompassing which results in certain limitations and recommendations for further research. In this section, an overview of these limitations and recommendations will be discussed.

The conclusions about the consequences of the UK leaving the EU on the various sectors and regions of this paper are only limited to the fact that they are only based the price reaction on the stock market after the referendum. For further research, it could be possible to enhance this overview of the consequences of the Brexit by looking at for example economic growth rates, export and import data; or socioeconomic development data. Furthermore, the results of this paper could only be used to get a better understanding of the Brexit on the British stock market since the external validity of this paper is low. This limitation could be resolved by studying the stock market reaction in different countries in the EU on the days after the Referendum. The results found on the EFD and EEFDD category variable are limited to the fact that only 740 of the 1165 firms in the total dataset are examined because of missing data for the other companies.

For further research, it might be relevant to investigate the effects of the Brexit Referendum on firms located in the UK but listed outside the UK. It could be interesting to study the differences and similarities in results between this paper and the suggested paper to get a better understanding of the impact of the Brexit. Next to this, it might also be interesting to repeat this research after the outcome of the negotiations is made public. These results could be interesting since many of the uncertainties mentioned in this paper are resolved then, and the real consequences of the UK leaving the bloc are priced into the share price of all firms.

6. Bibliography

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7. Appendix

Table 1 Significant companies and their descriptives

Compay name	CAR	Std. dev.	t-value
RIO TINTO GROUP (GBR)	-0.192	0.019	-3.155
ASTRAZENECA PLC	0.062	0.009	2.102
CARR'S GROUP PLC	-0.193	0.031	-1.999
WEIR GROUP PLC	-0.207	0.023	-2.795
KINGFISHER PLC	-0.194	0.030	-2.023
VOLEX PLC	-0.239	0.030	-2.485
BOOT (HENRY) PLC	-0.154	0.016	-2.975
PENDRAGON PLC	-0.356	0.056	-2.024
ICG ENTERPRISE TRUST PLC	-0.078	0.012	-1.988
HORNBY GROUP	0.096	0.013	2.295
INVESTMENT CO PLC	-0.062	0.007	-2.771
NTH ATLANTIC SMLLR IT	-0.054	0.008	-2.262
SLINGSBY(HC)	0.023	0.000	20.223
AVINGTRANS PLC	-0.157	0.016	-3.165
HIGHWAY CAPITAL PLC	-0.567	0.086	-2.093
BILLINGTON HOLDINGS PLC	-0.089	0.013	-2.161
STERLING ENERGY PLC	-0.178	0.024	-2.301
CALEDONIAN TRUST	0.053	0.006	2.614
TOMCO ENERGY PLC	0.430	0.062	2.187
SCOTTISH INVESTMENT TR PLC	-0.066	0.010	-2.196
SANDERSON GROUP PLC	-0.222	0.026	-2.717
CLARKE(T) PLC	-0.163	0.017	-3.047
STEWART & WIGHT	-0.006	0.000	-9.090
CORERO NETWORK SECURITY PLC	-0.159	0.022	-2.271
NWF GROUP PLC	-0.141	0.021	-2.140
SOPHEON PLC	-0.121	0.013	-3.038
HEATH(SAMUEL)&SONS	-0.013	0.001	-7.381
TRIAD GROUP PLC	-0.256	0.034	-2.359
GRESHAM HOUSE	-0.042	0.006	-2.297
SHEPHERD NEAME LTD	-0.069	0.010	-2.181
ENERGISER INVESTMENTS PLC	0.010	0.001	2.083
WYG PLC	-0.183	0.024	-2.409
KCOM GROUP PLC	-0.084	0.012	-2.173
JOHN LEWIS OF HUNGERFORD PLC	0.142	0.020	2.275
PEEL HOTELS PLC	-0.085	0.011	-2.355
SCISYS PLC	-0.119	0.018	-2.070
TRANSENSE TECHNOLOGIES PLC	-0.215	0.032	-2.105
ZOO DIGITAL GROUP PLC	-0.195	0.031	-1.984
TIGER RESOURCE FINANCE PLC	0.016	0.001	8.884
MINOAN GROUP	-0.237	0.036	-2.065
WMC RETAIL PARTNERS PLC	0.015	0.001	3.962

INDEPENDENT INVESTMENT TRUST	-0.102	0.014	-2.251
MAVEN INCOME & GROWTH VCT 5	-0.008	0.001	-2.710
REACH4ENTERTAINMENT ENTPR	-0.339	0.037	-2.901
MBL GROUP PLC	-0.122	0.017	-2.289
ACCESSO TECHNOLOGY GROUP PLC	-0.037	0.005	-2.116
UNICORN AIM VCT PLC	-0.027	0.003	-2.534
SURFACE TRANSFORM PLC	-0.259	0.034	-2.410
FUTURA MEDICAL	-0.285	0.038	-2.377
TRANS-SIBERIAN GOLD LTD	-0.157	0.021	-2.306
ROBINSON PLC	-0.195	0.027	-2.245
ADMIRAL GROUP PLC	-0.119	0.016	-2.403
AUGEAN PLC	-0.138	0.022	-1.973
SAREUM HOLDINGS PLC	-0.274	0.031	-2.798
CHINA NONFERROUS GOLD LTD	-0.305	0.036	-2.702
M&C SAATCHI PLC	0.163	0.017	3.010
REDSTONECONNECT PLC	-0.395	0.051	-2.430
REAL GOOD FOOD CO PLC	-0.093	0.014	-2.060
GETECH GROUP	-0.119	0.015	-2.506
CARETECH HOLDINGS	-0.078	0.012	-1.984
DRIVER GROUP	-0.253	0.031	-2.613
ELDERSTREET DRAPER ESPRIT VC	0.004	0.000	5.079
VAST RESOURCES PLC	-0.453	0.045	-3.161
ACCESS INTELLIGENCE PLC	-0.013	0.000	-37.943
ARDEN PARTNERS PLC	-0.052	0.008	-2.091
CONNECT GROUP PLC	-0.107	0.017	-1.977
MEDICX FUND LTD	-0.093	0.013	-2.283
IMAGINATIK PLC	-0.481	0.074	-2.043
CONYGAR INVESTMENT CO	-0.068	0.011	-1.970
POLAR CAPITAL HLDGS PLC	-0.076	0.010	-2.386
AVANTI COMM GROUP PLC	-0.251	0.025	-3.228
CASPIAN SUNRISE PLC	-0.208	0.029	-2.301
1PM PLC	-0.115	0.018	-2.071
GREATLAND GOLD PLC	-0.586	0.081	-2.291
CRANEWARE PLC	-0.074	0.009	-2.619
PLASTICS CAPITAL PLC	-0.175	0.025	-2.214
MOUNTFIELD GROUP PLC	-0.149	0.018	-2.674
NEWRIVER REIT PLC	-0.134	0.020	-2.066
FULCRUM UTILITY SERVICES LTD	-0.067	0.004	-4.785
DP POLAND PLC	-0.220	0.019	-3.621
INSTEM PLC	-0.038	0.006	-2.126
HUMMINGBIRD RESOURCES PLC	-0.249	0.035	-2.248
MAVEN INCOME & GROWTH VCT 3	-0.017	0.002	-3.005
MOBEUS INCOME & GROWTH VCT	-0.008	0.001	-3.151
IDEAGEN PLC	-0.110	0.017	-2.093
BELVOIR LETTINGS PLC	-0.027	0.003	-2.999
QUIXANT PLC	-0.121	0.018	-2.109

NEW CENTURY AIM V2	-0.036	0.005	-2.093
CROWN PLACE VCT PLC	0.004	0.000	3.597
MAVEN INCOME & GROWTH VCT 4	-0.005	0.000	-152.999
WHEELSURE HOLDINGS PLC	0.026	0.004	2.017
NETSCIENTIFIC PLC	-0.116	0.018	-2.019
TUNGSTEN CORP PLC	-0.312	0.045	-2.204
EU SUPPLY PLC	-0.089	0.013	-2.110
ACTUAL EXPERIENCE PLC	-0.034	0.004	-2.492
ROSSLYN DATA TECHNOLOGIES	-0.088	0.013	-2.159
SHOE ZONE PLC	-0.163	0.022	-2.383
AGGREGATED MICRO POWER HLDGS	-0.283	0.044	-2.051
STRAT AERO PLC	-0.205	0.031	-2.072
HSS HIRE GROUP PLC	-0.149	0.023	-2.033
GATELEY HOLDINGS PLC	-0.078	0.008	-3.145
PEMBROKE VCT PLC	0.010	0.000	8.726
AQUILA SERVICES GROUP PLC	-0.103	0.015	-2.232