The impact of Brexit on the Equity Market

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Abstract

This paper presents results from an empirical study based on evidence from the British stock market, that tests whether the Brexit caused FTSE100 firms to outperform a European and global benchmark. Through the extensive use of several different statistical tools, models, and a unique dataset of cross-sectional and panel data, the impact of Brexit on the British Equity Market will be captured. We find that change in the exchange rate is a driver of short-term abnormal returns, which is a subject with little academic coverage. Also, well-established theories on stock price determinants, such as growth and size, are confirmed by the results. It shows substantial abnormal returns in times of events, but re-integration in a long-run equilibrium.

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1. Introduction

On the 23rd of June 2016, a public vote was held on whether the United Kingdom (UK) were to leave the European Union (EU). Several arguments were presented, in favour of staying or against it. Not leaving, meant that the status quo would be maintained. Leaving would bring several opportunities and costs. A Brexit could mean, for instance: sovereignty, autonomy in security and immigration, and cost saving through the absence of an EU membership fee of approx. £8.5bn (The Week Staff, 2020). These subjects were mainly politically tinted, apart from an elimination of the upfront fee, and seemed rather beneficial for the UK. In contrary to these upsides, there was also a large and less tangible downside to a possible Brexit. Harder to determine, but rather influential, were the effects on free trade and inward investment. The EU functions as a single market where imports and exports are free of tariffs and barriers. A market where services, including financial, can be offered without restriction throughout the union. The pros and cons of leaving the EU are hard to measure upfront and affect macro- as well as micro-economy. Exchange rates, current account and interest rates might change, as well as firm-specific costs, demand, and profitability.

The outcome of the Brexit referendum held on the 23rd of June in 2016 showed immediate effects on stock prices and exchange rates. The latter expressed itself through a decrease in the exchange rate, which is also known as depreciation of the base currency, the Sterling in this case. Whether this was a just prediction for the long-term financial health of the UK is unknown, this speculation however did have direct impact on the prices. The effects of a potential Brexit showed significant negative short-term results (Breinlich *et al.*, 2018).

On the 29th of January 2020, the Brexit deal went through, and the UK left the EU. But what happened in the meantime on the national- and international stock markets? Was the investors sentiment substantiated or would the market return to the pre-Brexit equilibrium?

This paper revolves around the short-term and long-term effects the Brexit caused on the stock market, and more specifically the FTSE 100. Therefore, the research question reads:

What was the impact of the Brexit on the British equity market?

Events such as the Brexit tend to have a large impact on stock markets, for some industries for the better and for some, for the worse. The EU functioned as a single market, which fostered inter-European trade. Therefore, it is most likely that not only domestic stock markets were affected by the Brexit, but also European or even global markets. This effect has been captured

by Burdekin *et al.* (2017), who saw a nearly 5% overall decline in equity prices from the early news of the Brexit.

This research concentrates on the effects the Brexit had on the UK's equity market. To capture these, one needs the excess returns not compared to the British index itself, but also to a European and global index.

To determine the effect of the Brexit on the equity market, several event studies and regressions will be conducted. The determinants of price movements will be discussed; firm-specific variables as well as macro-economic variables, short-term relationships as well as long-term relationships. Furthermore, historic co-movers or proxies, that have little or no ties with the Brexit, will function as a benchmark for a state where no Brexit would occur. With the addition of interaction terms, structural breaks will be included in the model, to observe ante and post event movements. After controlling for intermarket variables such as currency and interest rates, deviations of British stocks from the benchmark will be defined as the impact of the Brexit on the equity market.

The research controls for industry effects, outliers, and other possible abnormalities, so the overall Brexit impact remains.

In the contrary to existing literature and popular belief, this research finds existence of outperformance of the FTSE100 over the benchmark indices, in times of Brexit events. Furthermore, evidence suggests that the exchange rate movement has significant explanatory value in stock price movements on the short run. However, the Brexit events do not seem to show significant impact on stock price movements in the long run.

2. Theoretical framework:

Since the introduction of the first publicly traded company, investors have been in pursuit of positive stock returns. Although the stock market is a widely researched phenomenon, it seems that no consensus has been reached on what the specific drivers of stock prices are. It is proven to be a complex vector of market sentiment, and micro- and macro-economic variables, which all seem to have direct and indirect impact on prices. The key question remains whether future stock prices can be predicted correctly.

2.1. Efficient market hypothesis:

Economic theory suggests that the price of a stock is the remaining value of the future cash flows, known as the intrinsic value (Fama, 1995). It is the value created by a firm for equity holders. The remaining cash flows are determined by firm-specific characteristics such as profitability, costs of capital and expenditures. These are internal factors that directly impact stock prices. A large part of these characteristics is heavily correlated with macro-economic variables. For instance, the cost of capital is heavily subjected to interest rates (Modigliani *et al.,* 1958), whereas changes in exchange rates have a large impact on current accounts. Therefore, macro-economic variables also tend to impact stock prices.

This all comes together in an influential modern economic theory, named the 'Efficient Market Hypothesis'. The theory states that share prices reflect all available information, publicly as well as privately. Not undervaluation nor overvaluation is possible because the market is extremely efficient in the incorporation of new information, on both company and market level. Stocks always trade at their fair value, which leaves fundamental analysis and technical analysis useless in asset pricing. Generating positive stock returns is not a matter of outperformance, but a 'risk-reward' function (Fama, 1970).

In the context of this research, some Brexit events might have zero to little impact on stock prices, because the market already priced in the available information. However, this is dependent on the nature of the event and the certainty of the outcomes. After all, different outcomes cannot be simultaneously be incorporated in prices.

Moreover, the theory used to be widely accepted, but it has also been a topic of debate more recently. The theory does not account for psychological or behavioural aspects in the pricing of assets. Furthermore, it assumes that the market is fully efficient in processing new information (Malkiel, 2003).

From this point of view, there is a possibility that stock prices deviate from their fundamental value, due to wrongfully processing of newly available information. This can be a long-term divergence because of persistent mis valuation, or a short-term divergence due to irrational investor behaviour that is caused by sentiment or wrongful future expectations.

2.2. Event-induced returns:

Research have shown that there is a connection between news and stock prices. A paper written by Fama *et al.* (1969) showed that the market reacts 'efficient' to stock-split announcements and that stock prices adjust very rapidly to new information. Evidence suggests that this is because stock splits are often associated with an increase in earnings (Fama *et al.*, 1969). Over the years, more correlation has been found throughout the literature between news/announcements and stock price movements.

Newly available information comes in different shapes on different levels. On corporate level, it can be in the shape of earnings announcements, annual reports, or a seasoned equity offering. On a national or global scale, this can be through a change in interest- or exchange rates, for instance. However, it does not necessarily have economic undertone. An event can be of political nature and still have economic consequences. This than translates to stock price movements. One can ask, what is the reaction of the stock market in case of a political, or macro-economic event?

Previous studies have shown a clear trend in the effect of news on stock prices. Where Fama *et al.* (1969) showed a rapid price adjustment to stock-split announcements on corporate level, several other academics showed the existence of a response of stock prices on macro-economic news. Waud (1970) found a negative correlation between discount rates changes and stock prices. Along with this, Roley *et al.* (1984) found evidence for the existence of the same relationship. In the short-term, changes in discount rate tend to have a significant impact on stock prices. An increase in rates, means a reduced short-term money supply, which leads to a fall in stock prices. This is in line with the findings of Pearce *et al.* (1983), that new information related directly to monetary policy significantly affects stock prices.

The overall effect that events have on stock prices, is captured by Niederhoffer (1971). This research looks at the relationship between world events and stock price movements from different perspectives, over the course of 3 years. The most influential findings are that the higher the relative amount of change an event causes, the larger the price movement. This change tends to be the biggest in the first two days following an event.

Furthermore, in contrary to popular belief, the category of the event does not hold more explanatory value for the price movement, ceteris paribus. For instance, election outcomes and the invention of a cure for disease have the same magnitude in movement, although they differ in nature (Niederhoffer, 1971). Consensus has been reached among academics that changes in (economic) environment through world events, cause stock prices to move. When it comes to good news, this is associated with positive event-induced returns, and negative returns are correlated to bad news.

But how can one specify the Brexit events? Public opinion is of conflicting nature on whether the Brexit is beneficial or costly, and academic literature lacks decisive evidence. This research looks at the short-term and long-term economic implications and their impact on stock prices in general.

2.3. Foreign exchange rates:

Firstly, the concept of exchange rate will be elaborated on, so it can be mentioned more efficiently throughout the rest of the paper, without causing any confusion. The exchange rate mentioned, is the rate of the base currency, the British Pound Sterling, over the quoted currency. This quoted currency is the Euro (*€)* in the models with the MSCI Europe as benchmark, and the United States (US) Dollar *($)* in the ones with the MSCI World as benchmark. Therefore, an increase in the exchange rate can be interpreted as an appreciation of the Sterling, and a decrease in rate as a depreciation.

After the referendum, Britain experienced a large depreciation in the domestic currency, the Sterling. It experienced a sharp decline in the Sterling to Euro rate and even a bigger drop in the Sterling to Dollar rate (Quaye, 2016). Although there seems to be a rather complex and indirect link between equity prices and exchange rates, one thing is certain: a weak Sterling boosts exports, which can boost profits and strengthen companies financially (Tsagkanos *et al.*, 2013). In case of the UK, which is predominantly exporting, this is a favourable outcome for the exporting sectors. (Phylaktis *et al.*, 2005). This effect was also found by Ma *et al.* (1990), which stated that an appreciation of the currency reduces competitiveness in international markets, which has a negative impact on stock prices. However, this same research showed conflicting outcomes, that a strong currency also is associated with positive stock price movements, because of the increasing attractiveness

Furthermore, evidence has been found for a two-way relationship between changes in exchange rates and stock prices. Sohrabian *et al.* (2006) showed the existence of a dual causal relationship

between stock prices, measured by the S&P index, and exchange rate. However, this effect is only existing in the short-term, and fades in the long-term. This means however, that the depreciation of the British currency might hold explanatory power for the stock price movements.

2.4. Interest rates:

Another macro-economic aspect that has a large influence on stock prices, is the interest rate. A rise in interest rates tends to lower stock prices due to higher interest payments, stagnating investments, default risk and higher costs of financial distress. It also impacts future real dividends and discount rates (Shiller *et al.*, 1988). The latter two are determinants of the intrinsic value of a stock, as explained before, and can therefore impact prices heavily.

While increasing interest rates can be beneficial for firms, due to an increasing value in tax-shields, it tends to have a negative impact on stock prices (Myers, 2001). In times when interest rates are low or decreasing, investors tend to move money from the debt market to the equity market. This is because the return on equity will be higher, relatively to the return on debt. If money flows to the equity market, firms have more financing options, which is ultimately beneficial for stock prices (Titman, 1988).

Alam *et al.* (2019) found the same negative relationship, existing in developed and developing countries. They dedicate this to a reduction of financing. This impact on the possibilities of financing is a widely accepted theory regarding the relationship between interest rates and stock prices.

Furthermore, for the European Union, banks can borrow money at the ECB rate. The same rates applied to all countries. With the UK leaving the EU, they gained autonomy on setting their own interest rates, with all its consequences. Being autonomous in exercising your monetary policy, can greatly shift investor believe in the future of the country and thus affect stock prices.

2.5. Previous research:

The empirical implications so far tend to be very similar in nature on the impact of the Brexit on the stock prices, but the underlying determinants remain absent.

An event study was conducted by Ramiah *et al.* (2016), who found significant differences in sector returns, with the worst returns in the banking sector. However, they abstain from giving

economic implications for their findings. They dedicate these negative movements to future predictions of the short-term systematic risk, made by the Bank of England.

Moreover, not only had the Brexit vote a negative impact on the British equity market, most of the European countries also experienced a sharp decline in stock prices. It seems that market participants not only expect Brexit to impact the UK, but also the rest of Europe. This is mainly due to the uncertainty surrounding the financial infrastructure of both the UK and EU (Raddant, 2016).

It seems that up until this point, the stock price movements are explained in the literature by uncertainty in the market. However, Oehler *et al.* (2017) found explanatory power in a firm-specific variable. Companies with a high level of domestic sales were subjected to a significantly larger negative return. While they do not give economic implications for the existence of this relationship, previous literature found that this might be caused by the decline in the Sterling, around the time of the event.

Moreover, Breinlich *et al.* (2018) found that the stock price movements of the 2016 referendum were mainly driven by the expectations of market participants of and economic downturn. Whether these expectations on the real economy are justified or not, they do not know. This is due to a lack of data, because of the event happening recently. The latter might be an explanation for the seemingly minimal amount of research conducted on the topic.

2.6. Hypothesis development:

The Brexit is a heavily debated topic among the British and even on a European and global level. As the results of the referendum showed, it seems that the group of proponents and opponents is relatively the same. Because of the substantial amount of political, cultural, and economic power, it seems that the outcome of the Brexit negotiations will have a considerable impact on the UK, Europe and even globally.

While most academic literature focusses on the potential downsides of the UK leaving the EU, this research values monetary autonomy very highly, especially for an exporting country. It is therefore, that the possible benefits of the Brexit might outweigh the costs. Hence, the first two hypotheses:

Hypothesis 1: The Brexit event-induced returns have a positive impact on the FTSE100 returns over the MSCI Europe.

Hypothesis 2: The Brexit event-induced returns have a positive impact on the FTSE100 returns over the MSCI World.

Furthermore, it is expected that the decline in the Pound Sterling has a large explanatory value in the abnormal returns of the event studies. It seems that this effect is strongly present in short-term price movements. Hence, the third and fourth hypothesis:

Hypothesis 3: There is a negative relationship between the changes in exchange rate of the Sterling/Euro and the abnormal returns of the FTSE100 over the MSCI Europe.

Hypothesis 4: There is a negative relationship between the changes in exchange rate of the Sterling/Dollar and the abnormal returns of the FTSE100 over the MSCI World.

Research have shown that stock prices are negatively related to the exchange rate as well as changes in interest rates (Kim, 2003). If the latter is true, the UK gained a powerful monetary instrument that can widely impact on equity prices. To account for this relationship, an appropriate measurement of interest rate is needed for each of the index of interest. Thus, a British rate that applies to FTSE100 companies, in such a fashion that the European equivalent applies to the MSCI Europe, and the American equivalent to the MSCI World. The choice fell on the Interbank overnight rates of the geographical areas concerned (for further specification we refer to the data section 3.2.1., on page 14).

This relationship is to be tested first, hence the fifth and sixth hypothesis:

Hypothesis 5: There is a negative relationship between the rate of British interest over the European interest, and the abnormal returns of the FTSE100 over the MSCI Europe.

Hypothesis 6: There is a negative relationship between the rate of British interest over the American interest, and the abnormal returns of the FTSE100 over the MSCI World.

Because this research concentrates on the relative performance between two benchmarks, in terms of abnormal returns, independent variables in relative degree might hold more explanatory value. What happens to the stock prices of the FTSE over the MSCI Europe, if the British rates increase relative to the European interest? With this approach, one can isolate the effect of the interest on the stock prices, and thus control for endogeneity.

3. Data & Methodology:

In this section a description of the data collection and transformation will be given, where after the applied methodology will be discussed.

3.1. Data:

Obtaining accurate data is an essential part of research. The first step in the analytical process is to determine which data fits best for answering the research question. This research looks at the impact of the Brexit on the equity market, on the long-run and the short-run. Due to the differing nature of the two, and different variables of interest, the data of both will be elucidated separately. Also, different tests are conducted for the short-run and long-run impact; further elaboration on these tests will be given in the methodology section.

3.1.1. Panel data sample:

To assess the short-term effects of the Brexit events, an event study is conducted. For this event study, one needs the returns an entity of interest, most commonly a company or index. The index of interest will be the FTSE100 index. The FTSE100 is an index that consists of the largest 100 UK qualifying companies, based on market capitalization. It accounts for 85% of market capitalization of British listed companies and is widely regarded as the most important gauge of the British equity market. Because of the latter, it qualifies for measuring the impact of the Brexit on the British equity market.

Secondly, a benchmark index is needed, to account for a group, country or economy that is less (or not) affected by the Brexit events. Ideally, the composition and exposure to risk will be similar to that of the entity of interest. To isolate the effects of the events on the UK, one makes a comparison between FTSE100 and benchmarks of interest. These are the MSCI Europe and the MSCI World. Just as the FTSE100, both contain around 85% of the market capitalization of the possible universe they represent, both contain only large-cap and mid-cap stocks, and both are historic co-movers with the FTSE100. They share risk-factor exposure, market wide movements, and react similar to market sentiment and (global) events. Therefore, they are goods peers and accurate benchmarks.

The variable of interest will be a stock-return measure, for FTSE100 as for the benchmark indices. A comparison between returns of an index of interest and a benchmark index is made, to account for the abnormal return impact of the Brexit. This will be done, throughout six different Brexit related events, to account for event independent effects and inconsistencies in stock market behaviour.

An event study is a comparison between stock returns to measure the impact of a certain event on stock prices. Because an index is rather large and very diverse, an event study only assesses the market in its entirety. Although this can capture the impact of the Brexit on the British equity market, it is not a very sophisticated measurement. After all, changes caused by the Brexit can have a very different impact on certain industries, and on certain firms specifically.

To account for firm and industry specific effects, a regression-analysis is conducted (hereinafter referred to as the '*Panel data model*'). The data will be a balanced panel data set on the individual level of FTSE100 constituents over the ten-day time windows of the six events (see Methodology). Regressing cross-sectional firm-specific variables on the abnormal returns may provide an insight in sign, magnitude and cause of the stock price movement. The firm-specific variables of interest are:

- Natural logarithm of the market value (SIZE) – In 1973, Fama & Macbeth (1973) found a diminishing relationship between size and stock returns. Although heavily researched in academic literature, consensus remained that for smaller firms a certain size premium exists. This premium might be caused by the increased price-volatility of small stocks. Political themed events like Brexit are characterized by high volatility and sentiment-driven trading. Therefore, it is most likely that the size premium tends to persist in this study.
- Price-to-Book (P/B) – Fama & French (2012) published an influential paper in 2012 on stock price determinants. Evidence shows the existence of a significant value premium, that is for firms with a low price/book ratio. The price is the market value of current shares outstanding and the book value is the net asset value. It is a widely accepted stock price determinant, which makes it suitable for the models.
- Earnings per share (EPS) – This is an earnings based multiple, the total net profit divided by the shares outstanding. It is a proxy for the profitability of the company and therefore for its financial health. Many investors see it as the leeway in the height of dividends payments and is therefore an important determinant of stock prices. Chang *et al.* (2008) found a positive significant relationship between stock prices and earnings per share.
- Price/Earnings (P/E) – Although another valuation multiple, the Price/Earnings is an indicator for future growth in earnings. This is the key difference with the P/B, which only functions as an indicator for returns on equity. Therefore, both variables differ in their contribution to asset pricing. (Penman, 1996).

- Leverage ratio (LEV) – The leverage ratio is the ratio of debt in percentage of total capital. This variable is an addition to the model, not because of a certain consensus in academic literature on its effect on stock prices, but because the cost of debt is largely subjected to interest rates. Without the restrictive interest rate guidelines of the ECB, the UK can set its own course. Therefore, the leverage variable can be seen a proxy for future interest rates.

Furthermore, there has been an immediate decline in the value of the Sterling Pound, the British national currency, from the moment the Brexit referendum was held. Research has shown that changes in exchange rates can severely affect stock prices. Therefore, in the abnormal returns model with the MSCI Europe as a benchmark, the '*Sterling/Euro*' (£/€) rate is embedded, and for the MSCI World model, the '*Sterling/Dollar*' rate (£/$).

The list of FTSE100 constituents and specific industry at the time of the events is obtained from a Bloomberg terminal. Index prices, company data and cross-sectional variables were recovered from Datastream. Because of a careful approach of selecting the FTSE100 constituents, the dataset is free from the survivorship bias. Thus, the regression and event study are based on relevant and accurate datasets. This means, on the other hand, that the study includes firms that might have delisted or bankrupted in the years that followed or were only admitted to the FTSE100 for a relatively short period beforehand.

3.1.2. Cross-sectional data sample:

To assess whether the Brexit events had an impact on equity prices in the long run, instead of just a temporary shock, another study is conducted. Once again, a regression-analysis is used (hereinafter referred to as the '*Cross-sectional data model*'). The dependent variable stays the same, but this time it will be the FTSE100 abnormal returns indexed as a whole. The reason for this, is because the indexed price of the FTSE100 contains all constituents at every different moment in time, value weighted for market cap. Therefore, it will never be a misrepresentation of the index, or subjected to the survivorship bias because of the frequent readjustment of the index. The data sets transform from panel data to cross-sectional data, because only the stock price movements of one entity are incorporated in the test.

The best way to compute the impact of the Brexit on equity prices, is to use a regression-analysis with breaks (see Methodology). Although the hypothesis states that the Brexit had a significant impact on equity prices, one still needs to control for macro-economic variables and firm specific variables that might have caused stock price movements.

To control for systematic exposure to certain risk-factors that can disentangle the explanatory power of the model, another model is embedded in the regression. This model is the '*Fama/French 3-factor model'* (FF3). It is a widely used and recognized asset pricing model, first published in an influential paper (Fama & French, 1992). It states that the risk-factors of the model can explain most of the observed stock returns. An international library, the Kenneth R. French – Data Library, provides data on these factors, based on geographical location. Therefore, it provides the risk-exposure of British firms to the Fama/French 3-Factor model. They are the following:

- Market premium (Mkt-rf) – portrays the Market-risk premium, the excess return over the risk-free rate.
- Small-minus-Big (SMB) – portrays the difference in Size as an explanatory factor for stock returns.
- High-minus-Low (HML) – portrays the difference in Book-to-Market value as an explanatory factor for stock returns.

After controlling for the firm-factors, one must control for macro-economic variables. These variables of interest are the ones most prominent in the established literature and are widely accepted as determinants of stock price movements. They are obtained from Datastream, and are as follows:

- Sterling/Euro Exchange rate (£/€) – This is the exchange rate of the British Pound Sterling over the Euro.
- Sterling/Dollar Exchange rate (£/$) – This is the exchange rate of the British Pound Sterling over the US Dollar.

As stated in the theoretical framework, interest rates are extremely important economic determinants. Rate changes tend to impact stock prices significantly.

- London InterBank Offer Rate (LIBOR) – This is the interbank interest rate for major global banks. It is widely accepted as a gauge for interest rates globally and as a proxy for the future interest rates.
- European OverNight Index Average (EONIA) – This is the interbank interest rate for banks within the Eurozone.
- Federal Fund Rate (FFR) – This is the interbank interest rate for banks within the United States.

The LIBOR rate is computed by a panel of banks based on the average the rate at which they are prepared to lend each other unsecured funds on the money market. It comes in five different currencies and seven maturities. For this research, the British Pound Sterling one-day LIBOR rate will be used. The European Union has their own rate, at which European banks could lend each other. This is called the EURIBOR. However, this does not come in one-day maturities. Therefore, the EONIA is used. This is the overnight rate of European banks denominated in Euro's. The FFR, the one-day rate in the US, which denotes in US Dollars, is set by a component of the Federal Reserve System (Federal Open Market Committee) and is the only rate that is not set by a panel of commercial banks. The reason these rates are denoted in their 'domestic currency' is because it gives an indication how the largest banks globally value the currency. As stated before, after the 5^{th} and 6^{th} hypothesis, the relative difference in rates might explain how capital reallocates to certain markets, for instance from the EU to the UK. This might hold explanatory power in the impact the Brexit has on the equity market.

The data used for the regression analysis is collected over a time ranging from January 2001 until June 2020. Since 2001, all the indices of interest have been co-movers and following the same trend. Because there is little divergence over this period, it is perfectly suited to tests whether the Brexit caused abnormalities in movements or persistent deviations in price.

3.2. Methodology:

To assess whether the Brexit affected the British equity market, the research will be divided in three separate studies. Firstly, an event study will be conducted. This will provide an insight in the short-term announcement effects of the Brexit and whether they had an impact on the equity prices in a short time interval.

Event studies are used if there is uncertainty about the outcome of an event or if the event itself is a surprise, with seasoned equity issuing for instance. Because the outcome is uncertain, the possibilities hold different implications for what stock prices might do. One cannot predict outcomes, and thus stock prices cannot incorporate this information (Boehmer *et al.*, 1991). Stock prices might move upon, in this case, outcome of the Brexit referendum and EU resolutions on Brexit. Where the first one is dependent on votes, and the second one on approval of the board. Hence, uncertainty surrounding the outcome.

Secondly, a regression-analysis is used on the results of the event studies, to assess which firm characteristics were determinants in the movement of the stock prices. Thirdly, another

regression-analysis is carried out, to assess whether the Brexit events had significant impact on the equity prices in the long run.

3.2.1. Event studies:

Event studies are widely used and very useful in financial research. They tend to capture the impact of an identifiable event on a variable, such as stock returns. In essence, event studies are an evaluation whether the efficient market theory is in effect; if so, only the announcement date will show significant market reaction, due to information being processed efficiently. The subsequent days will not display any further reactions. (Brooks, 2019).

In case of event studies, one asks himself if stock prices behave differently around an event in comparison to normal periods. Do the returns of the stocks around the announcement date differ from expected returns of in case of no event? This difference is labelled as the abnormal return and is the result of the event studies.

Every event differs in nature, and therefore, no united approach exists. To conduct a viable and adequate event study, some identifications a needed. De Jong (2007) uses three steps in conducting an event study, which is one the most used approaches:

1. Define the event of interest and the timing of the event.

Firstly, an event must be defined that may have had an impact on the stock prices. This is the event of interest. Over the course of a few years, there was some uncertainty on the Brexit deal going through and on the potential terms a departure. Because of this uncertainty, stock prices might have moved stochastically, due to differing market expectations. Therefore, we analyse the market reaction to six different events. Three of these events revolve around proceedings to a hard-Brexit; thus, high possibility of Britain's departure and equal investors' expectations. The events of interest are:

- The first referendum on whether the UK would leave the EU, on June 23, 2016. The outcome: a majority of 52% voted for leaving the EU. The first steps would be taken to realise this.
- The first deal struck on UK's Exit terms, on November 25, 2018. While later, this deal was not approved by the EU, but the UK was determined to leave on these terms.
- The day the UK's Exit terms were approved, on January 29, 2020. The Brexit became official and the UK would leave the EU two days later.

Next to this, a secondary approach has been used to identify possible influential events. Google trends data from the past few years show a few spikes in global interest in the Brexit. Although these dates do not occur around major Brexit events, it seems that public interest is somehow greatly increased. Because information is a large driver of stock prices, these events might have a significant impact on equity prices. The events of interest are:

- October 29, 2019
- March 29, 2019
- January 15, 2019

2. Specify a benchmark to proxy for normal stock returns.

To analyse the effects of the events on the stock prices, one needs the returns as well as the benchmark (normal) stock returns (behaviour of returns in case the event did not occur). Subtracting the normal returns (NR) from the observed returns (R) will define the abnormal returns; the returns driven by the event.

$$\mathrm{AR}it = \mathrm{R}it - \mathrm{NR}it \qquad (1)$$

In the literature, several methods can be found that proxy for accurate normal returns: the market-adjusted returns, market model residuals and the mean-adjusted returns. The first are considered to have an obvious advantage, because they capture market wide price movements. This paper uses the market-adjusted returns approach. In this case, the normal returns will be the return on a market index of choosing. This market index must be a well-chosen benchmark with similar composition, characteristics, and risk-exposure as the index of interest (the FTSE100 in this case), otherwise comparison would be meaningless.

The normal returns as a function of the market-adjusted returns, are defined as:

$$\mathrm{NR}it = \mathrm{R}mt \qquad (2)$$

Where R*mt* is the return of the benchmark indices at time t.

3. Calculate abnormal returns around the event date.

Thirdly and lastly, one calculates the abnormal returns around the event date, $\mathrm{AR}it$. These abnormal returns are the difference between the observed returns and the normal returns, the benchmark. The abnormal returns are calculated over a short window before the event (t=0) and after the event. This event window seems arbitrary, and no consensus has been reached on the length of the window. For instance, some studies assume information leakage early in time,

and persisting effects of the events. Therefore, they use a longer event window, such as (-20, +20). If one is only interested in public announcement effects and immediate effects, one uses an interval of (-1, +1). In this paper an event window of (0, +10) is used; two trading weeks after the event. Over the course of 10 days, the abnormal returns will be determined, that are induced by the Brexit-related events. If information leakage is a viable option, researchers tend to incorporate earlier days than t=0. However, since the Brexit events are publicly known and prices pre-event will be speculatively driven, this research focusses on the aftermath of the events.

It is most likely that these returns fluctuate during the event window, due to increased volatility. Because of this, identifying the concrete effects of the event might be harder. To account for these variations in stock price, one can compute the cumulative abnormal returns (CAR).

The CAR are defined as follows:

$$CARi = \sum_{t=t1}^{t2} ARit \qquad (3)$$

Where CAR*i* is a summation of the abnormal returns (AR*it*) over the event window (t1 till t2), that shows the combined value of a time-series. This might capture the overall impact of the event on the stock prices.

3.2.2. Testing abnormal performance:

To assess whether the results of the event studies are reliable, the analysis is supported by statistical tests. These tests are commonly applied to confirm if the abnormal returns differ from zero on a statistically significant level. This research uses a parametric t-test for the abnormal returns, as well as the cumulative abnormal returns, with null hypotheses respectively:

- H0: ARit = 0
- H0: CARit = 0

In essence, the t-test compares the returns in the estimation window with past realised returns, to see if these truly are ‘abnormal’ and do not just follow the trend in the historic returns.

The test statistics for the single abnormal returns of the index in time t is as follows:

$$t, \mathrm{AR}it = \frac{\mathrm{AR}it}{\mathrm{SAR}i} \qquad (4)$$

SAR*i* is the standard deviation of the abnormal returns in the estimation window.

This estimation window is the time between two certain instants: T1 and T2. T is the amount of measurements in the period and is defined as T = T2 – T1 + 1. The length of the estimation period is a widely debated topic. Armitage (1995) advocated the use of an estimation periods from 100 to 300 days for research that uses daily data. Overall, academics tend to use an estimation window of around 250 trading days, which is a year. This research will follow this commonly employed estimation window of 250 days.

To account for pre-event market movements based on expectations, outcome anticipation, speculations or information leakage, the estimation window is set to end 10 days before the event occurred (two weeks of trading). This means that the estimation window will be (-260, -10), respectively T1 and T2.

The same procedure applies to the cumulative abnormal returns, and therefore the test statistic is as follows:

$$t, CAR = \frac{CARi}{SCAR} \qquad (5)$$

The formulas differ slightly, because the standard deviations of the cumulative abnormal returns correct for the amount of days in the 'CAR-interval' whereas the AR standard deviation is calculated daily.

3.2.3. 'Panel-data model':

An event study shows whether the event of interest caused stock returns to differ significantly from zero. However, it lacks further explanation of why this happens. Since firms in the FTSE100 differ significantly in terms of exposure to certain risk factors, or industry risk, one needs to isolate the effect of those factors on stock price movements. To determine the sign and magnitude, a regression analysis is used. Firstly, the common risk factors as provided in the data section are regressed on the cumulative abnormal returns during the event window. Secondly, the Pound Sterling exchange rate is added, to control for currency driven stock price movements. This approach, provided that outcomes are significant, allows an insight and/or pattern in the way prices might behave.

The 'Panel data model' is:

$$CARt = \alpha i + \beta 1SIZE + \beta 2VALUE + \beta 3EPS + \beta 4PE + \beta 5LEV + \beta 6£/€ + \epsilon i \qquad (7)$$

The CAR is the cumulated excess return of the British index over the MSCI Europe at time t. β portrays the degree of which the returns are exposed to the factor that is linked to this beta.

The higher the beta the more it is exposed to the specific risk of this factor. As elaborated on in the data section, SIZE, VALUE, EPS, PE, and LEV are the explanatory factors for stock returns. £/€ will be the exchange rate of the Sterling Pound over the Euro at time t. ϵi denotes the error-term. (In the MSCI World model, EU values change to the US equivalent).

Usually, to test which factor exposure affected returns, a cross-sectional regression is used. This uses differences in firm variables to explain the difference in the returns. However, this approach does not control for changes over time, nor does it incorporate returns over time. Because of the assumption that the depreciation of the Sterling caused stock prices to rise, the model demands price changes over time. Therefore, regression approach is used based on panel data.

Along with the regression estimation technique, a '*fixed effect*' (FE) estimation will be employed. The FE controls for *'Omitted Variable Bias'* (OVB). This means that the model excludes a variable that is a determinant of the dependent variable and correlated with another independent variable. This OVB can decrease the coefficients estimation precision. Furthermore, The FE accounts for time-invariant and unobserved company characteristic. For instance, an industry fixed effect model will compare the stock return determinants intra-industry, instead of inter-industry. Thus, it controls for endogeneity problems and omitted variable bias. However, using a fixed-effects model has limitations. It cannot control for variables that change over time, like for instance, the exchange rate. Therefore, it functions mainly as a robustness check for the cross-sectional, firm-specific variables.

3.2.4. 'Cross-sectional data model':

Lastly, a regression is conducted to test whether the Brexit caused any lasting changes in the stock prices, or at least long-term price shifts. This regression differs from the 'Panel data model' in such a fashion that the dependent variable is the abnormal return of the FTSE100, rather than the cumulative abnormal returns of the individual FTSE100 constituents. To still account for firm-specific risk exposure, the 'FF3' factors are embedded to control for certain risk-factors, that tend to explain stock price movements. This approach severely reduces endogeneity issues if one considers asset pricing models to be accurate.

Furthermore, as illustrated in the data section, two macro-economic factors that are historic determinants of stock price fluctuations are incorporated in the model: 'the overnight interbank rate and the Pound Sterling exchange rate'.

In addition, dummy variables are added to account for the Brexit events that have significant cumulative abnormal returns, and therefore significantly caused stock prices to move. These dummies function as a structural break in the regression data and split up to regression in segments. For instance, a pre-referendum phase, as opposed to the post referendum phase. Therefore, if a dummy is proven to be significant, it imposes that the Brexit had a significant effect the FTSE100 price.

Addition of a dummy variable to a model tends to correct the model's intercepts, because of the introduction of intervals. However, the regression is still based on the data of the same independent variables, which does not account for possible changes in the slope. To improve the integrity of the test and account for the possible change in slope, interaction terms are added. These terms map the impact of the independent variable and its interaction with the dummy. Through addition these dummies, a breakpoint analysis is embedded in the regression. The dummy functions as the break, which will be the significant Brexit events. Because of introduction of interaction variables and thus a breakpoint, the model allows for a different impact of independent variables in different phases of the regression. This means that the regression allows for a change in slope and coefficients in the same output, because it distinguishes the different time intervals in the data (Pieterse-Bloem, 2016).

The 'Cross-sectional data model' is:

$$\mathrm{AR}t = \alpha i + \beta 1(Rm - Rf) + \beta 2SMB + \beta 3HML + \beta 4£/€ + \beta 5\mathrm{LIBOR/EONIA} + \delta n\mathrm{X}n + \epsilon \mathrm{i} \quad (8)$$

The AR is the excess return of the British index over the MSCI Europe at time t. Rf portrays the risk-free rate. This is the rate of return investors can earn without any risk of financial loss. Widely used for this is the 3-month US Treasury Bill (T-Bill). β portrays the degree of which the returns are exposed to the factor that is linked to this beta. The higher the beta the more it is exposed to the specific risk of this factor. $(Rm - Rf)$ portrays the Market-risk premium, the excess return over the risk-free rate. SMB portrays the difference in Size (Small minus Big) as an explanatory factor for stock returns. HML portrays the difference in Book-to-Market value (High minus Low) as an explanatory factor for stock returns. £/€ will be the exchange rate of the Sterling Pound over the Euro at time t. The LIBOR/EONIA is the British interest over the European interest at time t.

X*n* depends on the number of events with significant results, where *n* takes a maximum value of six. The interaction terms are not included in the formula, they are represented by the

multiplication of the dummy times the variable, for instance (Dummy1*SMB). ϵi denotes the error-term. (In the MSCI World model, EU values change to the US equivalent).

3.2.5. Benchmark indices:

In this study, two benchmark indices are used to analyse normal returns. Because of globalization and integration of (financial) markets, it is most likely that the Brexit also affected European- and global equity markets. The objective of the research is to map what the actual impact of the Brexit was, solely on the British equity market. One can argue that movements in stock prices of the benchmark during events in question, are likely to be induced by these Brexit relevant events. This will be larger for the MSCI Europe than for the MSCI world, because the latter will be less exposed to changes in Britain. After performing the same event studies and regressions with these two benchmark indices separately, outcomes will be compared. This will function as a robustness check and might map the exposure the Brexit has on, for instance, a European index, compared to a world index.

3.2.6. Co-integration test:

The MSCI World and MSCI Europe will consist of some FTSE100 stocks, which may cause correlation in the price movements. Furthermore, indices tend to move cyclical, which will also be a reason for some potential correlation. This will not harm the academic value of the research, and it might even hold some explanatory value. This is dependent on the co-integration level of the stocks. If the returns of the FTSE100, the MSCI Europe and the MSCI World are co-integrators, this means that they maintain a long-term equilibrium. These stocks can deviate from this equilibrium in the short-term, due to various reasons such as Brexit, but this will be corrected over time. However, the determinants of the stock price movements in the short-term, might hold little or no explanatory value in the long-term. Therefore, conducting this test can provide aid in understanding the difference between the 'Panel data model' and the 'Cross-sectional data model'.

Testing for co-integration will be done through performance of a Johansen test, which is a 'Vector error-correction model'. The basic VECM looks as follows:

$$\Delta Yt = \alpha\beta' Y(t-1) \sum_{t=1}^{p-1} \gamma i \Delta Y(t-i) + \varepsilon t \qquad (9)$$

Where α and β function as parameters, p is the number of lags, Yt will be the vector of variables and ϵi denotes the error-term, as stated in the paper by Johansen (1995), on simultaneous equations and cointegration. The null hypothesis of the test is that there are no more than

cointegrating variables. Test results on significant existence of co-integration are as follows (whole table can be found in *Appendix* B):

*Table 1 displays the results of the Johansen test. If the trace statistic exceeds the 5% critical value, the is a co-integrating relationship in the variables of interest. This significance at the 5% is denoted as **.*

Max. Rank	Trace stat.	5% Crit. value
0	7804,08**	29,68
1	4353,07**	15,41
2	1995,75**	3,76

From the results of the test above, the null hypothesis can be rejected. This means that there are one or more cointegrating relations (Johansen, 1995). The economic implications for these findings are as follows: The independent variables of interest can cause abnormal returns in the short run but are not likely to cause abnormal returns in the long run. This is because the FTSE100 and the benchmark seem to cointegrate in the long run, which means that the average abnormal return over time will be somewhere around zero. This does not mean that the variables of interest are not determinants for stock price movements, in the contrary. However, they will not hold explanatory power for the difference in stock price movements.

4. Results:

In this section, the test results will be disclosed. Because of the various types of tests on different datasets, only the most significant and relevant results will be included in the result section. The remainder of results will be added to *Appendix A.*

4.1. Event study results:

Firstly, the results of the event studies are discussed. To test the first hypothesis, the FTSE100 abnormal returns and cumulative abnormal returns in different estimation periods for each event were computed. The ARs were computed over the course of 10 trading days before and after the event, the CARs only 10 days after.

In the contrary to popular belief that political events cause significant changes in stock prices, five out of six events do not show clear significant abnormal returns, nor cumulative abnormal returns on the event study with the MSCI World nor with the MSCI Europe. For instance, the test results on the first deal struck on UK's Exit terms, on November 25, 2018:

*Table 2 displays the (cumulative) abnormal returns of the FTSE100 over the 'MSCI World' (WLD) and the 'MSCI Europe' (EU) on the event date of the 25th of November,2018, up to 2 trading weeks after.*** denotes significance at the 1%, ** at the 5% and * at the 10%. The t-stat column denotes t-statistics.*

Time	ARWLD	t-stat	CARWLD	t-stat	AREU	t-stat	CAREU	t-stat
(+10)	***2.39%	3.47	-1.68%	- 0.55	0.37%	0.71	-0.44%	- 0.19
(+9)	***-2.26%	- 3.28	-4.07%	- 1.36	-0.41%	- 0.79	-0.81%	- 0.36
(+8)	-1.03%	- 1.49	-1.81%	- 0.62	-0.14%	- 0.28	-0.40%	- 0.18
(+7)	***1.84%	2.67	-0.79%	- 0.28	0.16%	0.30	-0.25%	- 0.12
(+6)	-0.06%	- 0.09	-2.63%	- 0.95	-0.08%	- 0.16	-0.41%	- 0.20
(+5)	*-1.15%	- 1.67	-2.57%	- 0.96	-0.11%	- 0.21	-0.33%	- 0.16
(+4)	0.24%	0.35	-1.42%	- 0.55	-0.66%	- 1.26	-0.22%	- 0.11
(+3)	**-1.66%	- 2.41	-1.66%	- 0.67	-0.06%	- 0.11	0.44%	0.23
(+2)	-0.32%	- 0.46	0.00%	0.00	0.41%	0.79	0.49%	0.27
(+1)	-0.03%	- 0.04	0.32%	0.14	-0.03%	- 0.06	0.08%	0.05
(0)	0.34%	0.50	0.34%	0.16	0.11%	0.22	0.11%	0.07

Although some of the abnormal returns are significant, there is no clear pattern to detect, nor a similarity in abnormal returns between benchmarks. From the second column of the table, the FTSE100 returns on the 10^{th} day after the event closed 2.39% higher than the MSCI World, significant at 1%. The previous day it closed 2.26% lower, significant at 1%. However, the abnormal returns test is significant if the values are significantly different from zero, based on past performance. This does not mean that the AR is event induced, but rather a good (or bad) performance of the index on a specific day. Also, it is not likely that the market reacts two trading weeks after occurrence of an event.

Furthermore, as seen from the 4th and 8th column of the table, the CAR over both the MSCI Europe and MSCI World show a clear negative trend. However, because of the lack of significance, this will not be interpreted. Because of the seemingly random nature of the price movements, further testing on these events would not be of value for the research. The test results of the five inconclusive event studies can be found in *Appendix A*.

Although five out of six tests are uninterpretable, one event occurred with highly significant and interpretable test results. The event of interest is the first referendum on whether the UK would leave the EU, on June 23, 2016, with the following results:

*Table 3 displays the (cumulative) abnormal returns of the FTSE100 over the 'MSCI World' (WLD) and the 'MSCI Europe' (EU) on the event date of the 23th of June, 2016, up to 2 trading weeks after.*** denotes significance at the 1%, ** at the 5% and * at the 10%. The t-stat column denotes t-statistics.*

Time	ARWLD	t-stat	CARWLD	t-stat	AREU	t-stat	CAREU	t-stat
(+10)	0.89%	1.18	*5.73%	1.70	0.03%	0.06	***10.87%	4.33
(+9)	-0.96%	-1.27	4.84%	1.47	0.77%	1.37	***10.83%	4.43
(+8)	*1.28%	1.69	*5.80%	1.81	***2.19%	3.90	***10.06%	4.22
(+7)	-0.88%	-1.17	4.52%	1.45	-0.21%	-0.37	***7.87%	3.40
(+6)	0.70%	0.93	*5.40%	1.79	0.23%	0.41	***8.08%	3.60
(+5)	1.12%	1.48	4.70%	1.60	**1.15%	2.05	***7.85%	3.61
(+4)	*1.37%	1.81	3.58%	1.27	-0.05%	-0.08	***6.70%	3.19
(+3)	0.90%	1.19	2.21%	0.81	-0.55%	-0.99	***6.74%	3.33
(+2)	-0.25%	-0.33	1.31%	0.50	***2.54%	4.53	***7.30%	3.75
(+1)	**1.76%	2.32	1.56%	0.62	***5.62%	10.01	**4.75%	2.55
(0)	-0.20%	-0.27	-0.20%	-0.08	-0.87%	-1.55	-0.87%	-0.49

Firstly, as seen from the 8th column, the CAR of the FTSE100 over the MSCI Europe stands out in terms of significance of sign and magnitude of the movement. One can clearly see a pattern, a movement in the positive direction and reaching a height of 10.87% at 1% significance, as the days progress since the occurrence of the event. This consecutive significant positive movement persists from day (+1) until day (+10). These findings support the first hypothesis, that the event induced returns have a positive impact on the abnormal returns of the FTSE100 over the MSCI Europe.

A small deviation in results is the insignificance of the movement on the event date. However, there is an explanation for this. While the referendum was held on the 23rd of June 2016, the results were published that day after the stock market had closed. Therefore, it is highly presumable that the first opportunity to trade on the outcome and new information, was on day (+1), the 24th.

Because of the significance of the results, one can conclude that the referendum had a positive significant impact on FTSE100 returns, compared to European returns. Which companies and industries were more prone to stock price movements in terms of sign and magnitude, will be analysed in the *'Panel data model'*. Whether this was just a short term, sentiment driven movement, or a long-term prospect of a beneficial British economic situation, will be discussed in the '*Cross-sectional data model'*.

Secondly, looking at the CARWLD model in column 4, one can see positive significant cumulative abnormal returns for the days (+10), (+8) and (+6) at 5.73%, 5.80% and 5,40% respectively. The CAR show an ascending pattern, as the days after the event progress. This indicates a causality, event-induced stock price movements. Because of the similarity between the two CAR models, one can presume that the abnormal returns over the MSCI world were caused by the referendum outcome. Less distinctive and only significant at the 10% interval, nevertheless. Because of the lack of convincing evidence of causality, the abnormal returns over the MSCI World are dropped as variable of interest. Based on these outcomes, it seems that one cannot reject the second hypothesis, that the event induced returns have a positive impact on the abnormal returns of the FTSE100 over the MSCI World.

Furthermore, in the second and sixth column, several abnormal returns show positive significant effects. For instance, the abnormal returns over the MSCI Europe on the second and third day after the event are 5.62% and 2.54% respectively, at 1% significance. This can be seen as a foundation for the cumulative abnormal returns. After all, the CAR is build up out of the individual abnormal returns.

4.2. 'Panel data model' results:

In this section, the methodology is used to test how, and which firms were affected by the event-induced price movements. The dependent variable is the CAR over the MSCI Europe, and the independent variables are the firm specific variables discussed in the data section. Furthermore, the regression models will control for industry- and firm fixed effects and for the exchange rate of the Pound sterling. Because of the insignificant returns of the FTSE100 over the MSCI World, no useful regression can be conducted. After all, if there are no significant abnormal returns, there are no determinants. Therefore, the fourth and sixth hypothesis will not be tested. They state a negative relationship between British exchange- and interest rates over the US rates, respectively.

Regressing the independent variables on the FTSE100 CAR over the MSCI Europe gives the following results:

*Table 4 displays the coefficients of the dependent variables on the independent variable, the FTSE100 CAR over the 'MSCI Europe'. Ranging from t=(0) on the event date of the 23th of June, 2016, up to 2 trading weeks after, t=(+10).*** denotes significance at the 1%, ** at the 5% and * at the 10%.*

	Dependent variable: CAR*t*		
	(A)	(B)	(C)
Constant	***-5.004	***-5.228	***-7.481
	(-16.65)	(-14.2)	(-33.5)
SIZE	***0.489	***0.501	***0.725
	(13.35)	(13.46)	(35.18)
P/B	***0.003	***0.003	***0.002
	(5.7)	(5.62)	(5.28)
EPS	-0.000	-0.000	***-0.001
	(-0.27)	(-0.52)	(-10.54)
P/E	***0.002	***0.002	***0.001
	(4.49)	(4.16)	(11.3)
LEV	-0.294	-0.337	0.328
	(-1.41)	(-1.45)	(1.63)
£/€	***0.695	***0.699	***0.846
	(8.68)	(8.93)	(21.13)
# Observations	1012	1012	1012
R^2 within	0.811	0.814	0.839
R^2 overall	0.120	0.073	0.127
Industry dummies	NO	YES	YES
Time fixed effects	NO	NO	YES
Firm fixed effects	NO	NO	YES
Regression type	OLS	OLS	FE

To ensure robustness of the results, several different tests are conducted on the same data. For further specifications, see the methodology section.

From the table above, one can see consistent significant results for several variables, throughout the different models. SIZE stays significant at 1%, with a coefficient ranging from 0.489 in model A, 0.501 in model B and 0.725 in model C. This coefficient can be interpreted as follows: if the natural logarithm of the market capitalization increases with 1, the cumulative abnormal returns increase with 49 'basis points' (bp) over the MSCI Europe. Therefore, SIZE seems to have a rather large impact on the event-induced cumulative abnormal returns.

What can be the economic explanation for this? Firstly, the FTSE100 consists of the largest companies listed in the UK and therefore, even the smallest one might not be small enough to qualify for the size premium. An alternative explanation for the return reversal one sees here, in contrary to popular literature, is that larger firm have more market exposure. Due to

increased market exposure, they tend to be more prone to sentiment-driven trading. While over the course of ten days the FTSE100 was up a cumulative 10% over the MSCI Europe, this might have been due to event-induced momentum.

The P/B and P/E variable, both valuation multiples, show positive impact in all three models at 1% significance. If the P/B rate increases by 1 percent, the cumulative abnormal returns over the MSCI Europe increase with 0.3 bp (model A & B) and 0.2 bp (model C). The same goes for the P/E rate, with 0.2 bp and 0.1 bp, respectively. While the P/B and P/E differ in nature, they are both indicators of future growth. Due to this, the sign and magnitude of the movement are likely to correspond. The meaning of the coefficients is that the stock market believes that the companies are capable of significant future growth. This is in line with existing literature.

Lastly, the Pound/Euro exchange rate has a positive significant effect at 1% at the CAR. If the Pound/Euro rate increases with 1 percent, the CAR increase with 70bp in model A and B and 85bp in model C. This coefficient can be interpreted as follows: There is a positive relationship between the sign of the change in exchange rate and the stock prices. This means that if the exchange rate increases in the short term, the Sterling appreciates, and the abnormal returns will increase. This means that the third hypothesis, that states a negative relation between the change in Sterling/Euro exchange rate and abnormal returns over the MSCI Europe, cannot be accepted.

What is the economic implication of this finding? Analysis of the FTSE100 shows that the majority of the constituents generates their revenue outside of the national borders. This means that if the Pound Sterling depreciates, export increases and the received foreign currency appreciates. Therefore, the revenue increases in terms of Pound Sterling. However, this will only be the case if the exchange rate decreases over a longer time-interval, long enough to perceive an actual impact on the revenue generated overseas. Thus, this effect will not be captured in a regression analysis that only consists of ten consecutive days.

While the outcome of the Brexit referendum caused a sharp decline in Sterling in the months after, a different thing happened in the week after. Initially, upon receiving news of the outcome, the Sterling showed a very low through. The following two weeks, it increased slowly, whereafter it experienced another decline over the following months. This means that in this data set, the exchange rate sees an increase in value from t=0, up till t=10. During the event window, the exchange rate increased around 5.5%. Subsequently, the CAR of the index, as seen in the event study, reached a total of 10%. This means that 3.85% (5.5% * 70bp) of the

10% CAR of the FTSE100 over the MSCI Europe will be dedicated by the regression, to the increase in exchange rate alone. The positive relationship one can observe from this data, is in line with the theory, that stocks gain attractiveness when the currency appreciates.

Furthermore, the EPS and LEV show insignificant results, and will therefore not be interpreted. The impact of industry dummies on cumulative abnormal returns, as provided from model (B), is admitted to the appendix.

4.3. 'Cross-sectional data model' results:

In this section the determinants of the abnormal returns of the FTSE100 over the MSCI Europe are defined, and is tested if the Brexit referendum caused any persistent shifts or disruptions in the historic co-movement between both indices. Through the use of interaction terms, one assesses if some of the variables of interest only impacted the stock price after the Brexit referendum. This is all based on the assumption that the market perceives a non-EU UK very differently in terms of macro-economic environment as well as corporate environment.

The results of the regression are as follows:

*Table 5 displays the coefficients of the dependent variables on the independent variable, the FTSE100 AR over the 'MSCI Europe'. Ranging from 2013/02/01 to 2020/05/29). *** denotes significance at thee 1%, ** at the 5% and * at the 10%.*

	Dependent variable: AR*t*	
	(A)	(B)
Constant	0.000	-0.000
	(0.21)	(-0.4)
Mkt-rf	***-0.004	***-0.004
	(-42.79)	(-42.84)
SMB	***-0.004	***-0.004
	(-25.44)	(-25.51)
HML	***-0.001	***-0.001
	(-5.97)	(-6.01)
£/€	0.001	0.001
	(0.82)	(0.58)
LIB/EON	0.000	0.000
	(0.55)	(0.56)
DUMMY		0.009
		(0.69)
D * £/€		-0.006
		(-0.66)
D * LIB/EON		0.000
		(1.00)
# Observations	4903	4903
R^2	0.306	0.307
Regression type	OLS	OLS

The dependent variable is the AR over the MSCI Europe, and the independent variables are the firm specific variables and macro-economic variables discussed in the data section. The dummy variable takes a value of one, from the date of 23 June 2016 and onwards. The interaction terms display whether some variables had a different impact on the abnormal returns, after the occurrence of the event.

Several statements can be made based upon the test results of the models. Firstly, the Fama-French factors are significant at the 1% level with a negative sign, throughout both models. The interpretation for this is that a part of the dependent variable, the abnormal returns, are explained by the Fama-French factors. More specifically, this will be 31%, the value of the R^2. The R^2 measures how much of the variance of the dependent variable is explained by the independent variables. This leaves a large part of the return variance that is unexplained by the variables of interest. The same is the case in the second model. It seems that not the Brexit, nor the Brexit related interaction variables, have any significant impact on the FTSE100 abnormal returns over the MSCI Europe.

Concluding, the FF3 factors still hold significant explanatory power in predicting stock prices. Furthermore, the interest- and exchange rates included in the model do not seem to have any explanatory value. Which means that one cannot reject the fifth hypothesis. The dummy variables are not significant and thus have no impact on the long-term stock prices. This means that the event-induced returns can be seen as market-sentiment driven for a short amount of time.

Moreover, the model is in contrast with the results of the 'panel data regression', where the sign of changes in exchange rate tends to be positively related to the change in stock prices on the short run. However, the finding that it is not significant in the long run, is consistent with the theoretical background and the findings of the co-integration test.

4.4. Robustness checks & Multicollinearity:

Several robustness checks have been done for all the models. Winsorizing the firm-specific variables at 1% to account is a common way in financial research to correct for faulty data and/or extreme outliers. Furthermore, extension and reduction of the time-interval on the long-term regression, and exclusion of crisis years. The results of the tests and the parameters did not change on a significant level.

Furthermore, a statistical model can lose explanatory power, because of multicollinearity. Multicollinearity means that two or more independent variables are highly correlated. Regression analysis tests whether an independent variable has explanatory power in the movement of the dependent variable. This is an isolated relationship. If an independent variable has a strong correlation with another, the coefficients will be dependent on more than only one specific variable. This reduces the interpretation possibilities of the coefficients because it becomes harder to change a variable, without changing another. Because firm performance and balance sheet statements are related, the models were for multicollinearity. Computing multicollinearity diagnostics for all models, led to negative results, with no correlation exceeding the 80% benchmark, as stated in an influential paper by Grewal *et al.* (2004).

5. Conclusion:

As previous literature has shown, world events tend to cause stock prices to move. Due to the global financial integration of the United Kingdom, the Brexit is no exception in this. This paper tries to find evidence whether the Brexit created abnormal returns for the FTSE100 over benchmark indices and what drove these abnormal returns. Furthermore, it tries to analyse whether these events have a lasting impact, or short-term divergences. The results combined answer the research question, what the impact of the Brexit was on the British equity market.

The referendum on the 23rd of June was the kick-off of a long-lasting international debate, that ultimately ended on the UK leaving the EU on January 29th, 2020. Several decisive moments in the process spiked public debate, and increased uncertainty about the future. This research subjected six major events to an event study, to study the following impact. However, only one of these, the 23rd of June, caused the British stock prices to significantly diverge from the European ones. This meant that the abnormal returns of the FTSE100 over the MSCI Europe were significant and positive, cumulative over a course of ten days. This meant that, on that occasion, future expectations of the UK differed from those of Europe.

Further analysis through panel regression showed that high future growth prospects, had significant explanatory power. Another firm-specific variable that had a significant positive impact on the abnormal returns, is the firm size. This is in line with conventional academic literature. Moreover, the change in exchange rate of the Sterling over the Euro showed a significant positive relationship with the abnormal returns. The increase in value over the ten days after the event, explained a large part of the abnormal returns of the FTSE over the MSCI Europe.

On the long-term, the Brexit events did not have a significant impact on the abnormal returns of the FTSE100 over the benchmark indices. An economic implication for this is that event-induced returns were mainly sentiment-driven, due to future uncertainty. Macro-economic factors tend to converge back to their mean over a longer period, which eliminates uncertainty in the long run. This is expected and substantiated from the results of the co-integration tests, which also holds implication for a long-run equilibrium. Furthermore, the regression showed that only the FF3 factors have explanatory value in the movements of the stock market. That the factors yield high explanatory power was already established through intensely testing of the FF3 asset pricing model by academics. For the credibility and robustness of this research, it is useful that findings are aligned with widely acknowledged theories.

6. Discussion and further remarks:

Earlier research showed significant different outcomes in industries, throughout the referendum of the 23rd. While this researched accounts for industry effects, only two industries are significantly affected. This might be because there is a large correlation between industries that profit from a depreciation of the Sterling and their stock price movements. Since the UK is mostly exporting, the overall industry effects might be captured in the exchange rate beta. Therefore, the industry dummies will show no significant explanatory power in this research. Regarding this problem, addition of industries or a proxy for a firms 'current account', may clarify the relationship between the returns and the nations.

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Appendix A:

Event 3: Google trend event

Time	ARWLD	t-stat	CARWLD	t-stat	AREU	t-stat	CAREU	t-stat
(+10)	1.27%	1.61	-2.39%	- 0.68	0.66%	1.27	-2.45%	- 1.05
(+9)	-0.28%	- 0.35	-3.66%	- 1.07	-0.28%	- 0.53	-3.11%	- 1.37
(+8)	-1.08%	- 1.37	-3.38%	- 1.01	-1.14%	- 2.19	-2.83%	- 1.28
(+7)	-0.51%	- 0.64	-2.30%	- 0.71	-0.37%	- 0.71	-1.69%	- 0.79
(+6)	-0.91%	- 1.16	-1.79%	- 0.57	-0.97%	- 1.86	-1.32%	- 0.64
(+5)	0.10%	0.13	-0.88%	- 0.29	-0.49%	- 0.93	-0.36%	- 0.18
(+4)	0.03%	0.04	-0.98%	- 0.33	0.25%	0.48	0.13%	0.07
(+3)	0.68%	0.86	-1.01%	- 0.36	0.23%	0.43	-0.12%	- 0.06
(+2)	-0.87%	- 1.10	-1.69%	- 0.62	-0.30%	- 0.57	-0.35%	- 0.19
(+1)	-0.62%	- 0.78	-0.83%	- 0.32	-0.59%	- 1.14	-0.05%	- 0.03
(0)	-0.21%	- 0.27	-0.21%	- 0.08	0.54%	1.04	0.54%	0.33

Event 4: Google trend event

Time	ARWLD	t-stat	CARWLD	t-stat	AREU	t-stat	CAREU	t-stat
(+10)	-0.29%	- 0.39	-0.26%	- 0.08	-0.27%	- 0.51	-0.71%	- 0.31
(+9)	-0.04%	- 0.05	0.03%	0.01	-0.31%	- 0.60	-0.45%	- 0.20
(+8)	-0.27%	- 0.36	0.07%	0.02	-0.12%	- 0.23	-0.13%	- 0.06
(+7)	0.10%	0.13	0.34%	0.11	0.02%	0.04	-0.02%	- 0.01
(+6)	-0.07%	- 0.10	0.25%	0.08	-0.13%	- 0.26	-0.04%	- 0.02
(+5)	0.28%	0.37	0.32%	0.11	0.46%	0.87	0.10%	0.05
(+4)	-0.21%	- 0.28	0.04%	0.02	0.15%	0.29	-0.36%	- 0.18
(+3)	-0.16%	- 0.22	0.25%	0.09	-0.94%	- 1.79	-0.51%	- 0.27
(+2)	1.01%	1.34	0.42%	0.16	0.93%	1.78	0.42%	0.23
(+1)	-0.62%	- 0.82	-0.60%	- 0.24	-0.61%	- 1.17	-0.51%	- 0.29
(0)	0.02%	0.03	0.02%	0.01	0.11%	0.20	0.11%	0.06

Event 5: Google trend event

Time	ARWLD	t-stat	CARWLD	t-stat	AREU	t-stat	CAREU	t-stat
(+10)	0.34%	0.49	-1.24%	-0.4	0.32%	0.61	-0.71%	-0.3
(+9)	-0.31%	-0.45	-1.58%	-0.52	-0.52%	-0.98	-1.03%	-0.45
(+8)	-0.73%	-1.05	-1.27%	-0.43	-0.14%	-0.28	-0.51%	-0.23
(+7)	-0.10%	-0.15	-0.54%	-0.19	0.07%	0.14	-0.37%	-0.17
(+6)	0.02%	0.03	-0.44%	-0.16	-0.09%	-0.17	-0.44%	-0.21
(+5)	0.35%	0.5	-0.46%	-0.17	0.76%	1.45	-0.35%	-0.17
(+4)	0.50%	0.73	-0.81%	-0.31	0.05%	0.09	-1.11%	-0.57
(+3)	-0.08%	-0.12	-1.31%	-0.52	-0.07%	-0.13	-1.16%	-0.61
(+2)	-0.95%	-1.38	-1.23%	-0.51	-0.86%	-1.64	-1.09%	-0.6
(+1)	0.12%	0.17	-0.27%	-0.12	0.17%	0.32	-0.23%	-0.13
(0)	-0.39%	-0.56	-0.39%	-0.18	-0.39%	-0.75	-0.39%	-0.24

Event 6: UK Leaving the EU

Time	ARWLD	t-stat	CARWLD	t-stat	AREU	t-stat	CAREU	t-stat
(+10)	-0.10%	- 0.18	-1.87%	- 0.78	0.02%	0.03	-1.32%	- 0.58
(+9)	0.37%	0.68	-1.77%	- 0.75	-0.09%	- 0.18	-1.34%	- 0.60
(+8)	-0.61%	- 1.14	-2.14%	- 0.94	0.05%	0.09	-1.25%	- 0.57
(+7)	-0.02%	- 0.04	-1.53%	- 0.69	-0.12%	- 0.23	-1.29%	- 0.61
(+6)	-0.18%	- 0.34	-1.50%	- 0.70	0.07%	0.14	-1.17%	- 0.57
(+5)	-0.34%	- 0.62	-1.32%	- 0.63	-0.33%	- 0.64	-1.25%	- 0.63
(+4)	0.20%	0.36	-0.99%	- 0.49	0.11%	0.22	-0.92%	- 0.48
(+3)	0.17%	0.31	-1.18%	- 0.61	0.58%	1.13	-1.03%	- 0.56
(+2)	-0.05%	- 0.10	-1.35%	- 0.72	-0.59%	- 1.15	-1.61%	- 0.91
(+1)	-1.29%	- 2.40	-1.30%	- 0.73	-0.68%	- 1.33	-1.03%	- 0.60
(0)	0.00%	- 0.01	0.00%	- 0.00	-0.35%	- 0.67	-0.35%	- 0.21

Appendix B:

Johansen tests for cointegration

Trend: constant — Number of obs = 5325
Sample: 3 - 5327 — Lags = 2

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	12	51927.966	.	7804.0779	29.68
1	17	53653.469	0.47695	4353.0714	15.41
2	20	54832.631	0.35781	1994.7477	3.76
3	21	55830.005	0.31244		