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# EFFECTS OF PRESCHEDULED POLITICAL EVENTS ON STOCK MARKETS: THE CASE OF BREXIT

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# Effects of Prescheduled Political Events on Stock Markets: the Case of Brexit

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***Abstract***

This paper analyses the relationship between prescheduled political events and stock markets. The advantage of such events is that one can study the effects of political uncertainty on stock markets before the actual event as well as abnormal returns that are caused by the actual event. To expand the existing body of literature, which mainly focuses on national presidential or parliamentary elections, it was decided a recent political event – the referendum in the United Kingdom on the question of whether it should remain part of the European Union. Volatility analysis using opinion polls as well as internet searches as measures of the threat of the Leave campaign's victory was conducted for the part analyzing the uncertainties that predate the event. As for the announcement date of referendum results, event study's methodology was used to estimate abnormal returns based on companies' selling orientation and industry classification. The obtained results suggest that political uncertainty is indeed associated with higher market volatility and that it increases as the referendum date approaches. Event studies point out that abnormal returns differ across industries and that international selling orientation has a positive relationship with abnormal returns. A more detailed analysis of industry characteristics that affect the size of those abnormal returns.

*Contents*

## *1. Introduction*

In efficient markets, stock prices are said to incorporate all available information and can thus be interpreted as present values of all future cash flows to the investor. However, it is widely accepted that company specific financial, as well as macroeconomic variables, are not sufficient to explain all the variations in the stock markets. For this reason, a significant amount of research has been directed to examining another potential source that can affect movements in stock prices, which are unexplained by financial and real variables – politics. While it is rather intuitive that unexpected political events such as, for instance, wars, which have dire economic and financial consequences, induce volatility in stock markets, prescheduled political events such as national presidential or parliamentary elections, referendums, assemblies, etc. require more thorough analysis. Pre-announced political events affect stock markets as usually they are expected to bring about policy changes, which can subsequently benefit or harm individual companies or even the whole industries. Trade policies, in such cases, are amongst the most important ones as they are directly aimed at either helping companies operate domestically by limiting imports or companies that are exporting – by establishing better trade agreements with other countries. The most important characteristic of prescheduled political events that makes them worth studying is that one can study both variations in the market that predate the event as well as the effect that the event itself has on stock markets. Conveniently, for the pre-event analysis opinion polls can be used to measure the uncertainty in the market as well as the possibility of a specific outcome, while the event effect at the scheduled date can be analyzed by generating abnormal returns around the announcement day.

One of the most recent political events that is worthy of a thorough analysis is the United Kingdom's (UK) referendum on a question whether the country should remain a part of the European Union (EU). As a distinguished Irish writer, Oscar Wilde, states in one of his most famous works, *The Importance of Being Earnest*, "The very essence of every romance is uncertainty." Ever since the beginning of the European Union (EU) its *relationship* with one of its most important members, namely the United Kingdom (UK), has been rather ambiguous as there have always been some discussions in the background about the country leaving the union. However, the threat of the actual break up had remained rather low until Eurosceptic politicians reserved their seats in the parliament and pressed for the referendum. Eventually, the events took a turn in favor of the Eurosceptics, and the date for the EU referendum was set to be June 23, 2016. A lot of uncertainty surrounded the potential outcome in case the UK was to leave the EU. What would be the impact on UK's economy? What type of trade agreement would be negotiated? How

would stock markets react? Hence, this event serves for an analysis of the linkages between prescheduled political events and stock markets as it believed to have affected all industries in the country. Numerous newspaper articles were written on the topic, yet there still is a lot of room for academic research.

This research paper focuses on the effects that the political uncertainty imposed by Brexit has on stock market volatility and company values. Hence, the research questions addressed in this paper are the following:

1) How did the increases in the threat of Brexit affect the volatility in the Great Britain's stock market before the referendum results?
2) How were company returns affected in the short run by the decision to leave the EU based on their selling orientation and the industries that they operate in?

We believe that this paper will contribute to the existing literature about the linkages between important political events and stock markets by exploring an unprecedented event, which allows going beyond the effect of typical political elections. Even though, one could argue that Brexit is a one-time event that will never occur again, making the results of the research not applicable in a broader context, current political turmoil in Europe, where nationalistic and Euroskeptic parties are gaining ground in other EU member states such as the Netherlands and France, suggests that it is worthy to examine what effects leaving the union has on stock markets. Also, the paper provides larger scale analysis of industry and selling orientation specific effects based on more controlled approaches, which to the best of our knowledge has not been conducted to the event of Brexit. Lastly, an innovative approach of internet searches (Google Trends) is used alongside the conventional one of opinion polls to measure the possibility of a political event, in this case – Brexit.

The paper is divided as follows: section (2) discusses the existing literature on the relationship of political uncertainty and stock market volatility as well as the effects that trade protectionism might have on company value; section (3) defines the evolution of the events leading to the referendum; section (4) explains the methodology utilized to determine the effects that political uncertainty has on stock market volatility and how stock values were affected by the event of Brexit based on company's selling orientation and industry; section (5) specifies the data used for the research; sections (6) and (7) cover and discuss the results and their relation to the previous research; and section (8) concludes.

## *2. Literature Review*

### 2.1 Uncertainty and Stock Market Volatility

Uncertainty and volatility are so unquestionably closely related that the two concepts are rather often mistakenly used as synonyms. However, as it is accurately pointed out by Nicholas Bloom (2014) the difference between the two concepts is that uncertainty is something that cannot be meticulously measured as according to the definition it is fluctuations in possible future values, such as stock prices, while volatility is a statistical concept that measures past variability. The way in which the two are interconnected when it comes to stock markets is that, generally speaking, increases in volatility of stock prices signal that investors' expectations about future earnings are diverse and sensitive or, in other words, uncertain, meaning that there is a chance of some "bad news" (Bittlingmayer, 1998). Hence, stock market volatility is usually used as a measure of financial uncertainty.

Numerous economic research papers have been written over the years discussing significant negative effects of increases in uncertainty in the economy on valuations of stocks and their volatility in various markets around the world (e.g. Dixit and Pindyck 1994; Daniel, Hirshleifer and Subrahmanyam, 1998; Arnold and Vrugt 2006). However, other scholars, such as Fama (1990) and Cutler, Poterba and Summers (1991) show that unexpected variations in present and/or future real (macroeconomic) and financial variables explain at best from one fifth to half of variation in stock returns. Hence, considerable part of the research on the topic has been devoted to one particular source from which the possibility of bad news stems, namely political uncertainty.

For instance, Bittlingmayer (1998) suggests that political uncertainty might be an exogenous factor causing both higher volatility in stock markets and business cycle downturns. He thus hypothesizes the probability of United States becoming socialist (uncertainty about further economic policy) to be one of the causes of high volatility in US stock market in 1930s as well a reason for business slump due to subsequently deterred investment. By studying Germany over the years 1880-1990 he finds significant empirical evidence that politically important historical events of the first twenty years of the 20th century, such as World War I, the Armistice as well as the subsequent political turmoil damaged German stock market and heightened its volatility, while later political stabilization made the market more stable.

Similar results are obtained by Chau, Deesomsak and Wang (2014), who study the effects of political uncertainty induced by the Arab Spring on stock market volatility in Middle East and North African countries. The authors use GARCH models in order to create abnormal erratic

returns of both indices from MENA countries as well as more traditional ones from around the world. Their results suggest that political uncertainty that was prompted by the "Arab Spring" indeed had a significant effect on stock markets of MENA countries (especially, the ones of Islamic countries) by increasing the volatility. However, the effect on more conventional indices was negligent. Hence, the authors conclude that stock markets are affected by political turmoil which is reflected by an increase in stock price volatility.

Even though majority of aforementioned research has been concentrated on examining the effects of unexpected events or announcements a growing number of research papers examine the field of prescheduled ones. For instance, Ederington and Lee (1996) hypothesize in their research that the difference between the two types is that in case an announcement or an event is unexpected, implied standard deviation (ISD), which is used as a proxy for market uncertainty, should increase post-announcement, while a prescheduled news release should calm down the markets that were experiencing ex-ante increased levels of ISD. Having conducted a study of the effects that the two types of announcements have on the ISD, which is derived from options prices of T-bonds, Eurodollars and Deutchemarks, the authors find their hypothesis to hold. This is an important finding to keep in mind when studying political events that are prescheduled, such as national elections as well as referendums.

The same logics is used by Gordon Gemmill (1992) one of the first researchers to explore the effects of a prescheduled political event, which holds a lot of uncertainty about future - national elections. The author suggests that unlike other events that affect stock markets, the source of uncertainty that stems from national elections is their outcome but not the date. In the paper he specifically examines stock market returns and their variability during the 1987 national election in United Kingdom. By transforming data obtained from opinion polls to probability of Conservative party winning the election, the author first of all finds significant relationship between polling results and FTSE 100 stock index, which is used as market proxy. In addition, even though Gemmill (1992) finds an increase of implied volatility of some option prices over two weeks preceding the election, suggesting a possibility of Conservatives losing the election, which is inconsistent with the fact that opinion polls showed increased probability of Conservative victory. The author explains it as an effect of ill-informed investors who did not realize that the probability was already reflected in the Index.

Li and Born (2006) also use opinion polls to understand how uncertainty about future president and hence the future economic policy during the election cycle is reflected in the stock markets. They argue that despite the fact that opinion polls may be affected by a sampling error,

they can still be employed as a likelihood measure of a switch from one party to the other. Specifically, they explore US presidential elections that took place in 1996 and 2000 to find that there is a positive relationship between the uncertainty of the winning party and stock market volatility.

Bialkowski, Gottschalk and Wisniewski (2008) test the relationship between national elections and stock market volatility by conducting a cross-country event study that includes 134 parliamentary and presidential elections that happened in 27 OECD countries over the time frame of 1982-2004. The authors conclude that despite all the predictions of the election outcomes, surprise factor is nonetheless present as they find that the country-specific part of volatility of index returns can increase as much as two-fold as the election date approaches. They also find that the extent of volatility increase is more pronounced in countries with relatively young stock markets (Bialkowski et al., 2008).

Goodell and Vahamaa (2013) raise two opposing hypotheses when studying US presidential elections effect on stock market: election uncertainty hypothesis (EUH), which states that volatility should be higher when polling results move closer to 50/50, and political uncertainty hypothesis (PUH), which assumes that stock market volatility should increase in line with the possibility of the eventual winner. The former one, as stated by the authors, is consistent with Li and Born's (2006) work, while the latter one, which uses the logic that an unforeseen increase in the probability of the eventual winner increases uncertainty about the future economic policies, especially as the election date approaches, is in line with Gemmil (1992) and Bialkowski et al. (2008). Having examined 5 national elections that took place in the US over the years 1992- 2008, the authors find evidence for the UH to hold, yet not for EUH. This suggests that new polling results can be seen as a novel information which in turn leads to higher market volatility.

Some of the researchers go even further trying to determine specific features regarding elections as well as stocks themselves that increase the impact of political uncertainty on stock volatility. For example, Biakowski et al. (2008) are the first ones to point out, the results being close-cut and reversal in the government's ideology being among the most important ones. By employing similar methodology to that of Goodell and Vahamaa (2013) Smales (2014) shows that the same is true in the context of Australian elections: volatility both in stock and bond markets is enhanced by the level of political uncertainty and it is positively related to the margin by which one party is leading against the other in the opinion polls (the smaller the margin, the greater political uncertainty). In his later paper, Smales (2015) also suggests that markets "prefer the devil they

know" as they are more stable in case the probability of an incumbent winning is substantial as in such case uncertainty about future economic policy is smaller.

Furthermore, Boutchkova, Doshi, Durnev, and Molchanov (2011) suggest that the extent to which political uncertainty affects stock volatility might depend on industry-specific factors. The authors study both the effects of local political events as well as the foreign ones. They hypothesize that companies that operate in highly trade-dependent industries have higher exposure to political risk in domestic as well as foreign countries, with which they have important trade partnerships. Additionally, they test whether the effect that the political uncertainty has on companies depending on whether they operate in more labor dependent industries as it is one of the main interests of voters (who are the suppliers of labor) and therefore the main concern of politicians. After conducting extensive cross-country analysis, they find that the exposure to international trade is one of industry-level dimensions that increases the sensitivity of firm's returns to national and international political events. The same way relationship is detected for labor intensity: the higher labor intensity in the industry, the more pronounced effect political uncertainty has on volatility of stock returns of firms within that industry (Boutchkova et al., 2011).

Given what has already been written regarding the relationship between political uncertainty and financial uncertainty reflected by stock market volatility one can speculate about the effects that increases in the threat of Brexit should have on volatility in UK stock market. First of all, as paramount political uncertainty, which subsequently leads to economic uncertainty, lies behind the occurrence of Brexit it seems that the relationship should be significant and positive, strengthening as the day of the final vote approaches. This is also in line with Bialkowski et al. (2008) and Smales (2015) proposition that volatility is stronger when the probability of change in political orientation of the government is high as it was then and it is now obvious that in case of Brexit happening substantial changes in economic and international policy of UK are to take place. Hence, volatility should be lower on the days when the threat of Brexit is lower and vice versa. Lastly, as changes in international policy were expected, the impact on stock volatility should be the most profound in the industries that have higher export-exposure while more domestically oriented industries should experience lower effect. However, it is highly important to understand that while in case of national elections the uncertainty is more or less resolved when the results are announced it is not the case for the EU referendum. In this case, uncertainty is not expected to be higher when the polling results are close-cut, which is the case in national election, but instead it should increase when the spread between Leave and Remain campaigns increases in favor of the former. This is because in

this referendum uncertainty lies not in the voting outcome but specifically in one of the outcomes, which is the decision to leave the EU.

Hence, the hypothesis arises:

1. *The Implied Volatility Index should increase when the threat of Brexit increases.*

### 2.2 Trade Protectionism Effects on Company Variables

Jean-Claude Juncker, the president of the European Commission, said that it would not be possible for the United Kingdom to access the single market of the European Union without accepting the free movement of labour, one of the indicated pillars of a single market ("Brexit talks", 2016). Based on the motivations behind Brexit it seems rather unlikely that the United Kingdom would accept the free movement of people, as one of the main incentives behind Brexit was to have individual migration laws. Hence, the United Kingdom's access to the single market will be restricted. Bearing this in mind, additional barriers to trade with the EU member countries should arise as well as the country will need to renegotiate current trade agreements with non-EU countries which could result in more restricted trade. This, in turn, should lead to changes in company variables (such as productivity, international sales, profitability, etc.) based on their industry specific factors and sales orientation. Consequently, increasing trade barriers should affect company stock prices due to changes in company specific variables.

In order to understand and analyse the possible effects of such changes and their dependencies on industry and sales orientation past research paper and articles related to trade protectionism and liberalization (assuming that it should have an opposite effect as compared to that of trade protectionism) are used.

One of the earlier studies on the topic is carried out by Lenway, Rehbein and Starks (1990) who conduct an event study to analyse the effects that various forms of trade protectionism have on domestic steel producing firms in the United States. They find than independent on whether price or quantity restrictions are implemented on the US steel imports, domestic firms' register positive abnormal returns following the announcement. They explain such trend by stating that restrictive imports regulations increase the competitiveness of domestic firms relatively to foreign ones, subsequently increasing their future earnings, which is immediately reflected in the stock prices. Additionally, Lenway et al. (1990) find that stocks of smaller less integrated firms registered higher abnormal returns than those of integrated giants. As potential explanations for this they point to companies' lifecycle stage as well as the fact that bigger companies are more likely to export their products than the smaller ones.

Yu, Ye and Qu (2013) research trade liberalization effects on Chinese firms' and analyse the differences of magnitudes of these effects based on whether firms are exporting their production or importing. They find that trade liberalization has an overall significantly positive effect on the productivity of labour force yet it is only caused by firms producing complex goods as companies which were making simple goods face a slight setback in productivity. The authors suggest that one of the possible reasons for such differences in effects might be that due to specialization capital moves from simple goods industries to complex goods industries. Even though both exporting and non-exporting firms are subject to positive effects from trade liberalization, the effect on non-exporting companies is surprisingly higher. According to the authors, exporting companies before liberalization were more productive than non-exporting ones, hence, faced lower marginal effect.

In his paper on Mexican trade liberalization, Luong (2011) analyses different effects based on a firm's industry and its production nature and suggests that, generally, in intermediate product markets, only companies with not differentiated inputs experience an increase in productivity due to liberalization. On contrary, in final products markets, only companies with differentiated inputs register productivity growth. Thus, on the opposite side, one can hypothesize trade protectionism to have the most significant negative effects on companies that use rather unique resources for their final production and companies that use homogeneous resources for products that will be further used as inputs for other final goods. However, same impact was not closely studied and proven in case of the United Kingdom.

Another form of trade protectionism, which cannot always be directly observed and has not yet been intensively researched, is disguised protectionism. Kim (2015) is one of the few researchers to analyse the topic in his paper on World Trade Organization (WTO) trade disputes. Disguised protectionism according to the authors include regulations a country imposes on a specific industry which are not tariffs, subsidies or quotas yet through meeting some requirements such as health standards these specific regulations (usually promoting domestic producers) create additional barriers for foreign firms to export their production to the country. The author suggest that as barriers to trade arise, some industries become isolated due to country specific regulations. Therefore, after the United Kingdom leaves the European Union their domestic markets will potentially not need to follow the same regulations as in the European Union which would suggest that industries of the United Kingdom that are subject to stricter regulations would face less significant consequences of Brexit than less regulated ones due to higher market protection. This disguised protectionism, as argued by the authors, should most significantly affect healthcare industry and some product groups of consumer goods.

Regarding recent global developments of trade protectionism, Kee, Neagu, and Nicita (2013) in their paper on national trade policies over the period of 2008 – 2009, research 135 countries and determine that trade protectionism has increased in this period yet the increase was not very drastic globally. They note that only countries such as Russia, Argentina, Turkey and China implemented quite aggressive trade protectionism measures while others were more passive over the period of investigation. Additionally, they find that protectionism measures explain only around 2% of the drop in the global trade size. Similarly, Georgiadis and Grab (2016) in their research on growth, real exchange rates and trade protectionism on a global scale after the financial crisis, discuss the protectionism measures undertaken by the United Kingdom in the global context. Despite noting that trade protectionism has not been prevalent up to present, there is a threat that due to global economic slowdown national governments will be much more likely to impose additional trade barriers in pursuit of protecting their local industries. The authors outline the United Kingdom as one of few countries in the European Union which is still able to use their exchange rate as a measure to affect their competitiveness and indirectly create trade barriers to other countries (Georgiadis, Grab, 2016).

Despite the threats, the European Union coherently tries to reduce trade barriers for its member countries even under pressure by internal and external factors as it is discussed in G. Siles-Brugge (2011) article on EU – South Korea Free Trade Agreement. A rather srong stand of the European Commission on the necessity of trade liberalization implies that even more such trade agreements (most important of which are with Japan, Canada and the USA) might be signed in the future as indicated in this research paper. Regarding the United Kingdom, they would not be a part of these future agreements and it might even further increase trade protectionism in the country relatively to the EU. Bollen, De Ville and Orbie (2016) in their article on EU trade policy as well indicate that the EU did not change their general direction towards liberalization of trade yet there has been some contentious protectionism asserted in such cases as procrastinations voting procedures, country level laws. Additionally, Bollen et al. (2016) point out that United Kingdom is one of the countries within the EU, where conflicts related to regulatory issues, sovereignty and safety often arise during negotiations of trade agreements with non-EU countries. This suggests that the UK is relatively inclined to be against free trade with non-EU countries, meaning that they would be only more likely to impose trade barriers to these countries after exiting the EU.

Hence, the hypotheses that follow:

2. *Companies with international selling orientation should be affected more negatively than those that sell their goods and services domestically.*

3. *Industries, where companies use rather unique resources for their final production and homogeneous resources for products that will be further used as inputs for other final goods should be more negatively affected.*
4. *Industries that face stricter internal regulation should be less negatively affected by the decision to leave the EU. One such industry could be Health Care.*
5. *More labor intensive industries should face more negative impact than less labor intensive ones.*

## 3. Timeline Leading to the Referendum

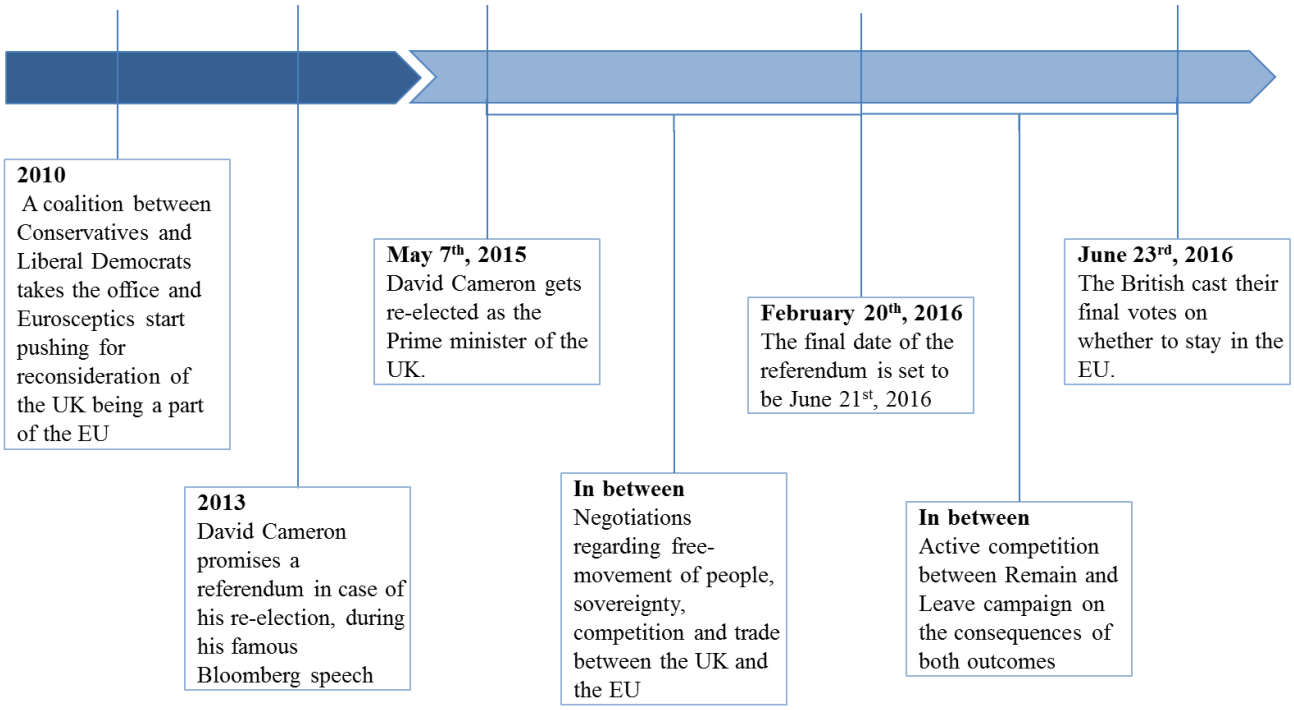


*Figure 1. Timeline leading to the referendum*

Talks about the United Kingdom (UK) leaving the European Union (EU) are almost as old as the union itself. However, the possibility of it actually happening remained negligible until 2010 (Figure 1), when a coalition between Conservatives and Liberal Democrats took the office and the, so called, Eurosceptics started pushing for reconsideration of UK being a part of the EU. Even then the referendum taking place was rather unlikely as Liberal Democrats, who supported the EU, were reluctant to make any commitments regarding the issue. As a compromise, aimed at calming the Conservative Euroskeptics down, the European Union Act 2011, which stated that in case of broadening of the EU powers in the UK a positive referendum would have to agree on that, was enacted. This allowed David Cameron, the Prime Minister (PM), to delay further commitments

until 2013, when during his famous Bloomberg speech, he promised a referendum, which was to be held in case of re-election.

The two main reasons of deviating from PM's previous position as pointed out by Paul Craig (2016) was an increased pressure from Conservative Eurosceptics as well as the need to cope with the problem of UK Independence Party's (UKIP) growing popularity. It is important to note that the PM did not really expect to be reelected and even then only agreed to offer British people the chance to decide the whether they want to stay in the EU after he negotiated new conditions for UK in the union.

When David Cameron won the 2015 elections the negotiations took off. There were four main issues to be considered: insurance of non-Eurozone countries from discrimination in trade and additional expenditures; role and importance of competitiveness in the EU; sovereignty from any further development of a closer union; and tighter regulation of the free-movement of people (Craig, 2016). The negotiation took place in February 2016 and majority of UK's requests were fulfilled. Consequently, the referendum date was finally set to be June 23 2016, more than three years after David Cameron promised it for the first time.

The debate on the issue accelerated immensely as the supporters of the Leave campaign were quoting exaggerated numbers of UK's contribution to the EU together with disadvantages of uncontrollable immigration. On the other side of the camp, the members of the Remain Campaign tried to predict the size of economic hit that would be caused by leaving the union. According to the Organization for Economic Co-operation and development (OECD, 2016), in case of Brexit GDP would be 3% lower by 2020 compared to what it would be in case of UK remaining in the EU. In the long-term pessimistic scenario, it could be by as much as 7.7% lower as a result of loss of trade, foreign direct investment (FDI), skills and immigration. In the report published the Treasury three alternatives were pointed out and different estimates assigned to each of them. In the most optimistic scenario, UK would, like Norway, stay a member of European Economic Area (EEA) with GDP contracting by 3.8% percent. Otherwise it could negotiate bilateral agreement, similar to for example that between the EU and Canada, or simply remain a member in the World Trade Organization, which would have -6.2% and 7.5% impact on GDP respectively (Great Britain Treasury, 2016). Yet the most pessimistic forecast was that of researchers from the Centre for Economic Performance of the London School of Economics and Political science, who taking into account the impact that a curtailment of trade would have on productivity set the pessimistic long-term effect at -9.5% (Dhingra, Ottaviano, Sampson & Van Reenen, 2016). They also forecasted that stock markets would reach positively to an outcome of UK remaining in the EU and negatively in

case of decision to leave. At the same time Gerlach and Giamberardino (2016) predicted the value of the Sterling to depreciate by as much as 5-15% conditional on the surprise factor of the referendum outcome.

Hence, even though there was a lot of uncertainty involved regarding the subsequent policies and trade agreements to be negotiated in case of Brexit, it can be seen that majority of institutional as well as individual economists agreed that it would have dire economic as well as financial consequences for the UK. Whenever the Leave campaign would try to answer such reports, they would claim that the organizations conspired with the EU Commission or use exaggerated numbers of the cost the UK had to pay for its membership in the EU (£350 million per week) (Craig, 2016). Nonetheless, they had an important card that always proved to be in their favor: the dissatisfaction among UK citizens about extensive immigration and the costs of all the welfare benefits that immigrants were subject to. Despite all the threats of Brexit's effects on real economy and finance that were relentlessly being put forward when the day of final vote, June 23, came UK citizens made their decision and it was to leave the EU with the lead of 4%.

## *4. Methodology*

### 4.1 Measures of Threat

Research papers that use opinion polls to construct a variable that would measure political uncertainty employ different methods to do so. While, for instance, Goodell and Vahamaa (2012) use deviations from 50/50 as a measure of political uncertainty in case of US elections, Gemmil (1992) uses three distinct methods to measure the probability of Conservative party winning the 1987 national election in the UK. In case of the EU referendum, Goodell and Vahamaa's (2012) method does not seem to be the appropriate one as unlike in national elections, uncertainty comes not from the polling results being close-cut but rather from the increases in probability of Brexit actually happening. Therefore the three methods employed in Gemmil's (1992) research were considered. The first one is calculated as a point forecast by taking the simple lead of the Conservative party in three latest opinion polls (or all the polls in case they happened on the same day) and calculating the mean and its standard error. The problem with this method is that by construction it makes the probability of one party wining linearly related to the lead. However, it seems rather trivial that an increase in the lead from an already high point is going to have a much lower impact than an increase from a 0% or a negative lead. Hence, as a second approach he employs a method first applied to studying elections by Manning (1989), who pointed out the importance of the fact that even if one party has a lead over another it does not necessarily imply the probability of the latter to win the election to be zero. Consequently, the risk is said to be non-linearly related to the party's lead. This measure was employed in this paper after being calculated by using this equation:

$$Threat_t = \frac{1}{1+exp(\beta * lead_t)} \quad (1)$$

Where $Threat_t$ is the estimated threat of the referendum vote turning out to be in favor of the UK leaving the EU, $lead_t$ is the average lead of those in favor of the Brexit on a given day and the $\beta$ coefficient was estimated by conducting a grid search. In particular, the $\beta$ coefficient was estimation was based on Gemmil (1992) by trial and error approach testing plugging in $\beta$ coefficient values from 0.1 to 1.0 (with a step of 0.1) and investigating which $\beta$ coefficient provides the highest explanatory power measured as adjusted $R^2$. In this research $\beta$ coefficient providing the highest explanatory power was determined to be 0.3 which is quite close to 0.4 $\beta$ coefficient which was used in Gemmil's (1992) work.

However, this measure ignores the fact that the time left until the referendum might have an impact on the accuracy of the polling results. To tackle this issue Gemmil (1992) introduces another method which allows for probability to be dependent on the time remaining until the final vote day. His logics regarding the UK national election can be easily applied to the case of the EU referendum. It is rather intuitive that a small lead of those in favor of UK leaving the EU on March 6 could have easily reversed by the time of referendum while that on June 19 when only a couple of days were remaining until the vote reflected a much higher probability of Brexit actually happening. Gemmil (1992) constructs his estimate by firstly making an assumption of the lead following a normal distribution, which has a constant daily variance $s^2$. Subsequently, an assumption of random walk imposes that the variance when there are n days until the referendum is the daily variance multiplied by n. This implies that the distribution curve is flatter when there are more days left until the final vote as compared to only a few days remaining. However, Gemmil (1992) in his work follows predictions of changes in stock values after the vote in order to be able to determine probabilities of particular parties winning based on the spread of predicted changes, thus, this method cannot be directly applied due to nonexistence of persistent and reliable predictions of changes in stock values due to Brexit. Nonetheless, in further regressions of implied volatility the authors employed variable of days left until the referendum to at least partly control for this effect.

Another chosen proxy for the threat of Brexit is based on Google Trends data. This is a rather novel tool to be used, however its effectiveness of measuring the economic uncertainty and its effects on stock markets has been proven by Dzielinski (2012). The intuition behind using such measure, as explained by psychologists (e.g. Liemieux and Peterson, 2011), is that in case of an increase in uncertainty, individuals tend to look for information with a view to resolving it. Based on this logic it seems than when the possibility of Brexit rises subsequently increasing the uncertainty, the number of internet searches should also increase. Two main advantages of such measure are high frequency and spontaneity of the gathered data. The latter one is said to limit the endogeneity problem as the number of Internet searches is not directly affected by the financial markets. On the other hand, it can be argued that such measure only takes into account individual and not institutional investors that are believed to be more financially sophisticated. Dzielinski (2012) addresses this concern by explaining that in times of substantial stock market volatility it is usually the former group of investors that has the greatest impact. When using Google Trends data, it is of paramount importance to choose the right keyword in order to be able to extract only the relevant content. In case of the EU referendum, the most appropriate one seems to be “brexit”, which was first used in June 2012 to define back then still a hypothetical event of the UK leaving

the EU (MaxMillan Dictionary, 2016). The main advantage of this keyword is that it should not contain any noise as it is not used to describe any other event or concept (for example, using "leaving the EU" could also refer to Grexit).

### 4.2 Analysing the Effect of the Threat of Brexit on Implied Volatility

In order to determine whether the threat of Brexit affects implied volatility of the UK market and the direction of this effect, it was chosen to use methodology conceptually based on the one of Smales (2016). In his paper, the author regresses implied volatility of the UK and Germany markets on a political uncertainty measure, the day when the referendum date was set, and a vector of macro-economic variables (which were jointly insignificant in his regressions). However, the political uncertainty measure used by the author, which is the percentage of Leave campaign supporters divided by the percentage of Remain campaign supporters, is rather simplified. Hence, in this paper it was decided to employ the methodology of Manning (1989) as it captures the effects of substantial changes in polls lead on the political uncertainty better. Moreover, based on the reasoning of Gemmil (1991) it was decided to add $tLeft_t$ to better account for time related effects due to the closeness of the referendum. Consequently, the equation used for the analysis is:

$$VIXUK_t = \alpha + \beta_0 Threat_t + \beta_1 tLeft_t + \beta_2 Set_t + \varepsilon_t \quad (2)$$

Where $VIXUK_t$ is the FTSE 100 implied volatility index, $Threat_t$ is political uncertainty measure based on earlier discussed Manning (1989) methodology (choosing beta inside the $\text{Threat}_t$ variable based on the goodness of fit), $tLeft_t$ is number of days left until June 24, 2016, $Set_t$ is a dummy variable which is equal to zero until February 20, 2016, the day when the date of referendum was set, and to one from February 20, $\alpha$ is base implied volatility, $\beta_0$, $\beta_1$, $\beta_2$ are coefficients estimated by the regression and $\varepsilon_t$ is an error term. Similarly, the same regression was run for data from Google Trends:

$$VIXUK_t = \alpha + \beta_0 LogGoogleTrends_t + \beta_1 tLeft_t + \beta_2 Set_t + \varepsilon_t \quad (3)$$

Where $LogGoogleTrends_t$ is a log of index value of Google Trends for word "Brexit" and other variables coincide with previously described ones.

To estimate betas time series regressions with daily data were used with Newey-West standard errors and lag operator of 5. In order to determine maximum lags allowed in Newey-West regressions, truncation parameter (m) was approximated by formula $m = 0.75*T^{1/3}$ (Benkovskis, 2015) where T is number of periods, and after calculation m is rounded downwards to the closest integer number. For instance, a typical regression in this research containing more than 1 year daily

data (approximately 400 observations) would have truncation error of approximately 5. Time window was chosen to be from May 7, 2015 (David Cameron gets re-elected) to June 23, 2016 (one day before the announcement of the referendum results. The missing values of VIXUK and lead (only afterwards the Threat variable is calculated) were linearly interpolated. Afterwards, Jarque-Berra test for normality, Dickey-Fuller test for stationarity and Durbin-Watson statistic for autocorrelation were used in order to further analyse the credibility of these regression results.

### 4.3 Analysing the Effect of Brexit on Companies Based on Industries and Selling Orientation

To determine the direction and relative magnitude of the effects of Brexit on firms based on their industry and selling orientation event studies analysis was used on company level data. Oehler, Horna, Wendt (2017) also conduct event studies analysis of the Brexit referendum results announcement date (June 24, 2016) and event time window around it. However, they only focus on intraday stock value movements (taking 5 minute candles) and do not analyze industry specific variables results as the sample size of their research paper is rather small, consisting of 51 company. Due to small sample size Oehler et al. (2017) obtained insignificant industry dummy variables, suggesting that different industries did not have significantly different effects on abnormal returns, which prevented them from conducting further industry specific analysis. The methodological approach employed in this paper, which aims to determine industry and selling orientation specific effects, was mainly derived from their methodology with some substantial modifications. As it is further discussed in the data overview, each company's selling orientation was determined by dividing its international sales by total sales. Further on, expected market returns were calculated for those companies using modified Sharpe (1964) and Lintner (1965) Capital Asset Pricing Model for regional and global factors. Modification for these factors was based on the methodology of a paper by Bekaert, Hodrick, Zhang (2008) who analyze international stock return co-movements. Hence, for the expected stock returns calculation we included two factors: $r_m$ – return on global market proxy with excluded local market stocks and $LMF$ – local market factor:

$$(r_{i,t} - r_{f,t}) = \beta_i(r_{m,t} - r_{f,t}) + \beta_j LMF_t + \varepsilon_t \quad (4)$$

Where $r_f$ is risk free rate chosen as LIBOR 6M adjusted for USD and recalculated from yearly return to daily, $r_m$ return on market proxy, for this particular situation chosen as MSCI All World ex UK index denominated in USD, $\beta_i$ – stock exposure to this market return proxy, coinciding with a measure of international exposure, $LMF_t$ – orthogonalized FTSE All Share index

denominated in GBP returns with respect to MSCI All World ex UK index returns, $\beta_j$ – exposure to this factor, $r_{i,t}$ – realized returns of firm i on day t and $\varepsilon_t$ – residuals at day t.

Returns of the FTSE All Share index were regressed on returns of the MSCI All World ex UK (minus risk free) using simple OLS regression to obtain residuals which are the $LMF$ factor as seen in the Equation 5. By construction this factor is not correlated with MSCI All World ex UK index returns. Further, it adds significant explanatory power to the regression by capturing domestic market specific return movements which were deliberately denominated in GBP to better reflect the movements within the local market at least to some extend isolating GBP fluctuation effects.

$$\left(\mathrm{r_{m,t}} - \mathrm{r_{f,t}}\right) = \left(\mathrm{r_{FTSE,t}} - \mathrm{r_{f,t}}\right) - \mathrm{LMF_t} \tag{5}$$

The reasoning behind the particular variables was that we tried to capture the expected UK stock returns in a relation to the global equity market while maintaining high explanatory power of the model. Furthermore, this focus to the global equity market and the choice of variables and returns calculation were mainly stimulated by the sharp drop and fluctuations in GBP after the announcement of Brexit. As the effects on UK listed companies in the global context is of interest rather than only relative domestic effects, for that purpose FTSE All Share index cannot just be taken as a market proxy because it would not reflect effects on companies on a global scale. Further, using an index which excludes the UK stock market as a proxy to calculate abnormal returns is more reasonable as using it better shows the effects of Brexit on individual firms (in relation to their exposure to international market rather than domestic). Nevertheless, such major event as Brexit has probably affected all other stock markets as well and the effects of it will still be traceable even in such index. Yet, arguably, it is much better controlled for this outcome than an index without exclusion would be. Additionally, it is worth noting that this not mean that the return estimation was completely cleared of the effects of Brexit.

The chosen estimation period for these regressions was from November 1, 2015 to June 1, 2016. Once the expected return were calculated, abnormal returns were determined by using the following formula:

$$AR_{i,t} = r_{i,t} - E\left(r_{i,t}\right) \tag{6}$$

Where $r_{i,t}$ are actual returns of firm i on day t denominated in USD.

Moreover, compounded abnormal returns (CAR) were calculated by summing abnormal returns for a specific period. In this research, we analyzed two event windows: June 24, 2016 (the announcement of the referendum results); June 23, 2016 - June 30, 2016 (in order to see whether

the values did not revert after some time had passed). AR and CAR returns were stored and then used in cross-company regression:

$$AR_i(or\ CAR_i) = \beta_0 + \beta_1 * IS_i + \beta_2 * S_i + \varepsilon_i \quad (7)$$

This regression uses cross-sectional data, where $IS_i$ is international sales percentage of a company, $\varepsilon_t$ – residuals of a company i, $\mathrm{AR_i}$ – calculated abnormal returns of a company on a given day (in this research regressions used as June 24), $C\mathrm{AR_i}$ – compounded one week abnormal returns of a company for a given week (in this research used as June 23 – 30). $S_i$ is a vector of 9 industrial dummy variables based on ICB classification, where Oil & Gas industry was taken as the base industry. Hence, obtained results of industry specific dummies were adjustments on top of Oil & Gas ARs or CARs. The regression was used to estimate selling orientation and industry effects for both equally weighted portfolio (all companies had same weights) and value weighted portfolio (companies were weighted based on their market capitalization).

## *5. Data*

As a starting date of the study it was decided to use May 7th 2015, the day when David Cameron was re-elected to be the Prime Minister of the United Kingdom. As explained in the Timeline Leading to the Referendum section a promise had been made by David Cameron to hold a referendum in case he got re-elected. Hence, it was back then, when the possibility of the EU referendum actually taking place became plausible. This gives a time frame of 413 days (more than 58 weeks). However, it may vary depending on a different measure of threat used in regressions.

### 5.1 Polls

All data on individual polls was attained from Financial Times Brexit Poll Tracker site, where the results of all individual pollsters are listed (Brexit Poll Tracker, 2016). Overall, 272 ballots had been executed by 15 distinct polling agencies since September 9 2010 until the final vote day, June 23 2016 (170 when only taking into account those that fall into the time frame used for this study). The average (median) sample size of those polls is 1,946 (1,762) with the largest one amounting to 20,058 and the smallest – 500.

Once the raw polling data was obtained the subsequent step was to transform it so that it could be used as a measure of the threat of Brexit. Firstly, a simple lead was calculated by subtracting the percentage of pollsters voting to remain in the EU from the percentage of those voting to leave. The average simple lead is -1.9 p.p. with a standard deviation of 8.6. As for some days, especially for those right before the referendum, more than one opinion-poll result was available, the measure of Brexit probability had different confidence levels depending on a date. For instance, on June 13$^{th}$ 2016 there were 5 opinions polls carried out, which produced an average lead of Leave of 4.6% with a minimum of -1% and maximum of 7% leading to a high standard deviation of 3.29%. On the contrary, there was only one poll on June 16$^{th}$ with a negative lead of -1%, which could not be considered as a credible evidence of the previous day's amendment. Therefore, as suggested by Gemmil (1992) it was decided to make point estimates for each day (explanation provided in Methodology section), which would have their individual standard errors. Eventually, there were 104 such point forecasts generated that fall into the time frame used for this study with average (median) value of -3.59pp (3pp) and standard deviation of 4.59.

The main flaw of opinion polls is that they do not happen daily or even at a regular time intervals meaning that in order to make a time series regression, missing points have to be interpolated. Another way of solving this issue is using a poll tracker calculated by Matt Sigh and

provided by Number Cruncher Politics (Kennedy, Hutton, 2016), which gives moving daily averages adjusted for different agency characteristics, methodologies, historical performance as well as weights are assigned depending on how recent are the polls. The average (median) lead given by this polling average is -5.79pp (-5.40) and it has a standard deviation of 3.35. The only disadvantage of this tracker is that it only provides values starting from September 1st 2015.

### 5.2 Internet Searches

The most convenient tool to measure the intensity of internet searches of some specific topic is unquestionably Google Trends as according to Dzielinski (2012) more than 70% of global searches have been consolidated to this platform. As it has been already discussed in the Methodology the keyword employed in this research is "Brexit". Additionally, as the study measures the impact of the threat of the UK leaving the EU on stocks listed on London's Exchange, a geographical filter for searches is applied to only count the ones that were generated in the United Kingdom. Another aspect of Google Trends that is important to keep in mind is that the numbers provided are not levels of searches but instead concentration: number of searches that include the chosen keyword divided by the total number of searches. These numbers are further standardized by assigning the value of 100 to the day when the concentration of searches was the highest and adjusting all other values accordingly. This is of great concern as Google Trends are only providing daily observations in case a time period of less than six months which does not cover the whole time frame of this study. Hence, several periods had to be obtained each having at least one date that overlaps with the previous period so as to construct an index that would cover the whole time frame of the research. Such index has a value of 100 on May 8th 2015, a day after the re-election of David Cameron, and the highest value of 30,421.63 on the day of the final vote. The mean (median) value of the index is 1,108.94 (59.29) with a standard deviation of 2,879.44. Such a high divergence between mean and median values can be explained by exponential increases of searches as the referendum date approached. For this reason, for the regression that included Google Trends it was decided to use log values of this index in order to better capture effects of this index on the implied volatility for the whole selected period (for comparison of raw score and log value development refer to Appendix A). Consequently, the peaks of the variable were smoothed and the mean (median) value dropped to 4.96 (4.08) with a standard deviation of 2.04.

### 5.3 Indices and Rates

As a United Kingdom market proxy it was decided to use FTSE All Share index (daily frequency) as it has the widest coverage that for now has 635 constituent companies and intends to cover at least 98% of total market capitalization of companies listed on London Stock Exchange. This index was used for the generation of local market factor in event studies analysis in order to capture exposure to country specific effects.

MSCI World ex UK Index (daily values) denominated in USD was chosen as a proxy for global market portfolio used to determine exposure to global rather than local market. The index covers approximately 85% of medium and large companies in terms of market capitalization in 22 out of 23 Developed Markets. Conveniently, the UK is excluded from the index which diminishes the effect of Brexit on its performance. However, the effect is not fully eliminated as other markets outside of the UK were also affected by the event. The largest weight of more than 64% in the index is unquestionably attributed to the United States followed by Japan with a 10% contribution. In terms of sectors, financials, information technology and consumer discretionary are the largest ones each with 18%, 16% and 13% share, respectively (MSCI, 2017).

FTSE 100 Implied Volatility Index (daily frequency) was used to measure market volatility in the United Kingdom. The main advantage of using this index that instead of simply quantifying historical volatility it represents the future volatility expectations that are prevalent in the market by calculating it from options prices (FTSE Russel, 2016). Over the period under investigation the index ranged from 10.74 to 32.48 with an average value of 18.72 (median 16.95) and a standard deviation of 4.89 (for the index's development over time refer to Appendix A).

LIBOR 6M interest rate (daily frequency) denominated in USD was used as a proxy for risk free rate. This rate is commonly used in short to medium term estimation for UK based companies. The average (median) LIBOR rate over the period of 275 days was 0.74 (0.71) with a standard deviation of 0.18.

GBP to USD rate (daily frequency) was used to convert daily stock values of companies from denomination in GBP to USD. Mean (median) exchange rate over the period under investigation amounted to 0.67 (0.67) GBP per USD and had a low standard deviation of 0.03.

### 5.4 Company Variables

All company variables of 635 firms included in the FTSE All-Share index were obtained from DataStream database. The main variables that were collected consist of stock prices (daily

frequency), ICB classification, net sales or revenues (yearly frequency), and international sales (yearly frequency). The obtained sample had to be narrowed down because not all of the data was available for all the companies. Particularly, 59 companies were eliminated because either sales or international sales data was not available for them on the DataStream. 5 more companies were dropped because they did not have return stock data in the study period (were established or merged with other companies recently). Additional 58 companies were eliminated as international sales data was not available for the year 2015, which was used for international sales ratio calculation. Also, 6 more companies were excluded from the sample deliberately because their international sales ratios were not in the boundaries of 0 and 1 (five positive ratios ranging from 1.01 to 1.64 and one negative ratio of -0.06) which we believe can be attributed to the reporting time mismatch of small companies on the DataStream. Consequently, we were left with a sample of 507 for our equally weighted portfolio analysis. Nevertheless, for value weighted portfolio analysis 504 companies were used as market capitalization data was not available for three companies on June 23, 2016.

Furthermore, international sales values were divided by total sales in order to calculate the ratio of company orientation, meaning that values close to 0 are selling mostly domestically in the UK, while values close to 1 are mostly exporting to international markets. Values from the year 2015 were used to calculate the ratio with a view to having the highest number of observations as not all companies have disclosed such information for 2016. However, this should not significantly alter the results as the ratio should remain more or less constant over the years. The ratio had a mean (median) value of 0.34 (0.13) and a high standard deviation of 0.38.

Furthermore, to group the companies into industries it was decided to use ICB classification. In their analysis of industries, which uses portfolio based on FTSE100 index, Coelho, Hutzler, Repetowitz, and Richmond (2006) compare ICB classification to other classifications. The authors employ minimal spanning tree (MST) analysis to investigate time series of correlation of stocks to detect clustering of different stocks that belong to the same industry. They conclude that even though ICB classification does not perfectly coincide with MST clustering, it still provides a much better result than other classifications that predate it (Coelho et al., 2006). This implies that ICB industry division is the most suited for industry level analysis as companies within distinct industries exhibit the highest co-movements. The classification divides companies into ten industries: Oil & Gas, Basic Materials, Industrials, Consumer Goods, Healthcare, Consumer Services, Utilities, Telecommunications, Financials, Technology.

Lastly, to be able to form value weighted portfolios market capitalizations of all companies were also retrieved from DataStream. It was decided to use values on 23 June for them not to be

affected by the announcement. The mean (median) market capitalization of companies listed on London Stock Exchange was £3.74 billion (£0.83billion) with a standard deviation of £10.29 billion.

| Variable | Time Period | Observations | Units | Mean | Median | Standard Deviation | Minimum | Maximum | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|---|
| Point estimates of leads from all opinion polls | 5/11/2015 - 6/22/2016 | 104 | Percentage | -3.59 | -3.00 | 4.59 | -19.33 | 6.33 | -1.15 | 5.15 |
| Lead from Number Cruncher Politics | 9/1/2015 - 6/22/2016 | 296 | Percentage | -5.79 | -5.40 | 3.35 | -39.00 | 3.80 | -3.10 | 34.74 |
| Google Trends score | 5/7/2015 - 6/22/2016 | 413 | Index | 1108.94 | 59.29 | 2879.44 | 8.78 | 30421.63 | 5.23 | 39.31 |
| Log of Google Trends | 5/7/2015 - 6/22/2016 | 413 | Index | 4.96 | 4.08 | 2.04 | 2.17 | 10.32 | 0.64 | 2.12 |
| Implied Volatility Index | 5/7/2015 - 6/22/2016 | 295 | Index | 18.72 | 16.95 | 4.89 | 10.74 | 32.48 | 0.81 | 2.77 |
| LIBOR 6m | 6/1/2015 - 6/30/2016 | 275 | Percentage | 0.71 | 0.74 | 0.19 | 0.42 | 0.99 | -0.09 | 1.28 |
| USD per GBP | 6/1/2015 - 6/30/2016 | 284 | $/£ | 0.67 | 0.67 | 0.03 | 0.63 | 0.76 | 0.39 | 2.39 |
| MSCI All World ex UK | 6/1/2015 - 6/30/2016 | 284 | Index | 412.15 | 412.73 | 18.68 | 364.89 | 448.90 | -0.23 | 2.70 |
| FTSE All Share Index | 6/1/2015 - 6/30/2016 | 284 | Index | 3435.38 | 3421.61 | 140.24 | 3046.53 | 3786.84 | 0.31 | 2.98 |
| International sales ratio | 2015 | 512 | Ratio | 0.34 | 0.13 | 0.38 | 0.00 | 1.00 | 0.53 | 1.62 |
| Market capitalization | 6/23/2016 | 562 | Million £ | 3737.98 | 832.32 | 10287.07 | 23.65 | 90038.56 | 5.34 | 34.75 |

*Table 1. Descriptive statistics.*

## *6. Results and Discussion of Threat of Brexit on Implied Volatility*

### 6.1 Results of Threat of Brexit on Implied Volatility

Results obtained from all regressions on the impact of risk of Brexit on implied market volatility are presented in Table 2. Overall, they suggest that probability of Brexit as proxied by simple leads in opinion polls, Gemmil's (1992) measure of the threat, as well as Google Trends score, has a positive relationship with Implied Volatility Index.

The first two columns in Table 2 present the results obtained from regressions that used the moving averages of results of all polls to calculate the simple lead of Leave campaign and a measure of threat by using Gemmil's (1992) methodology of implying non-linearity to the lead. When using the simple lead, even though the coefficient before it is positive it is completely statistically insignificant, while the coefficient before the measure of threat is approaching significance with a p-value close to the universally accepted one of 0.05. As for time left until the referendum, it has a significant negative effect on market volatility and the results are significant at all standard significance levels, meaning that when there is one less day left until the referendum, implied volatility increases by approximately 0.03 points in both regressions. Contrary to our expectations, the date when the referendum day was set has a negative and statistically significant effect on volatility. All variables, are jointly significant and together explain 26.6% of variations in implied market volatility when the simple lead is used and 27.1% when the non-linearity is imposed on it. It is important to note that this study does not try to identify the determinants of market volatility but instead examines the effect of an event, which bears a high level of political uncertainty, on the implied volatility. Hence, even though $R^2$ might seem relatively low it is enough to confirm the relationship between the variables. Furthermore, after applying Dickey-Fuller test for stationarity it can be said that the residuals are integrated at level 0, which only strengthens the validity of the results. Even though, a test for normality suggests that residuals are non-normally distributed it can be explained by the fact that the FTSE 100 Implied Volatility Index cannot be negative and that it only varies between values of 10.74 and 32.48.

When the same regressions were run with the moving daily polling averages calculated by Matt Sigh, the results turned out to be slightly different (3rd and 4th columns of Table 2). Firstly, the regression that used simple lead of the Leave campaign performed the worst among all five regressions as the coefficients are only jointly significant at 5% significance level, variables explain only 12.9% of variations in market volatility and coefficient before the lead is insignificant. On the

other hand, regression which used the measure of threat calculated by imposing non-linearity to Number Cruncher Politics' polling average performed the best out of the five regressions: all coefficients are jointly significant at all standard significance levels and variables included in the regression explain a third of variations in market volatility. As for the coefficient before the measure of threat, it was estimated to be 23.22 and significant at all standard significance levels, meaning that a 1pp increase in the calculated threat of Brexit could be associated with a 23.22 point increase in the Implied Volatility Index. One of the explanations for such high effect could be a very low standard deviation of Brexit threat calculated by imposing non-linearity to daily averages calculated by Matt Sigh as compared to that of averages calculated from individual pollsters' results. In terms of time left until the referendum, the coefficient remains negative, yet completely loses its statistical significance. Nonetheless, the main disadvantage of using this measure is that it does not cover the whole study period.

The results of regression where internet searches (Google Trends) were used as a proxy for an increase in political uncertainty coming from the threat of Brexit are provided in the last column of Table 2. It can be seen that, in line with expectations and results obtained when using opinion-polls, the coefficient before the log value of Google Trends index is positive (1.1269) and has a distinct trend towards significance with the p-value of 0.07. Even though, results would be slightly better when using absolute values of Google Trends score, it is important to use logarithmic values as they smooth peaks (in this case the peak around the referendum date was substantial), as it was explained in the Methodology section. The coefficient before the time left until the referendum almost perfectly coincides with that obtained in the first regression and is statistically significant at all standard significance levels. Overall, the variables explain 28.6% of variations in implied volatility, which is a rather impressive result from all three regressions.

It is worth mentioning that in accordance to Smales (2015) methodology control factors such as changes in real GDP, changes in CPI, unemployment rate, consumer confidence index, trade-weighted index, returns on 10Y zero coupon government bond were tried to be used together with political uncertainty measures yet due to only monthly data availability (except for 10Y government bond returns) were jointly insignificant. Those variables were retrieved from DataStream and all except previously mentioned one had only 14 observations in the study period.

| | All polls simple lead | All polls, estimated threat | Number Cruncher Politics, simple lead | Number Cruncher Politics, estimated threat | Google trends |
|---|---|---|---|---|---|
| Lead1 | 0.18976<br>(0.115) | | | | |
| Threat1 | | 5.45173<br>(0.056) | | | |
| Lead2 | | | 0.33589<br>(0.223) | | |
| Threat2 | | | | 23.21781***<br>(0.000) | |
| LogGoogleTrends | | | | | 1.1269<br>(0.073) |
| tLeft | -0.02725***<br>(0.000) | -0.02721***<br>(0.000) | -0.0174<br>(0.289) | -0.00317<br>(0.818) | -0.02541***<br>(0.000) |
| Set | -6.47841***<br>(0.000) | -6.6366***<br>(0.000) | -5.88543**<br>(0.007) | -6.05774**<br>(0.003) | -9.68336***<br>(0.000) |
| α | 27.25563***<br>(0.000) | 24.96572***<br>(0.000) | 27.0072***<br>(0.000) | 18.84721***<br>(0.000) | 21.30875***<br>(0.000) |
| N | 409 | 409 | 296 | 296 | 413 |
| R2 adjusted | 26.600% | 27.100% | 12.900% | 30.100% | 28.643% |
| F | 17.06 | 16.39 | 3.24 | 23.35 | 17.40 |
| Prob > F | (0.000) | (0.000) | (0.0224) | (0.000) | (0.000) |
| AIC | 2333.0 | 2330.2 | 1713.8 | 1648.7 | 2346.3 |
| BIC | 2349.1 | 2346.3 | 1728.6 | 1663.5 | 2362.4 |
| Durbin-Watson | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Jarque-Bera | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Dickey-Fuller | (0.0229) | (0.0224) | (0.0025) | (0.0001) | (0.0029) |

p-values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

*Table 2. Regression results on relationship between the threat of Brexit and implied volatility index*

### 6.2 Discussion of Results of Threat of Brexit on Implied Volatility

Brexit is a unique opportunity to test the proposition that political uncertainty has an effect on stock markets. Most importantly it allows the research of prescheduled political events to go beyond national elections, which are discussed in numerous previous research papers (e.g. Gemmil 1992, Goodell and Vahaama 2012). Results obtained from the first three regressions, which measure how the threat of Brexit, proxied by the lead of Leave in opinion-polls, affects the market volatility, are in line with all the previous literature.

As it was expected, based on Gemmil (1992), an increase in the threat of Brexit measured by opinion polls results in a higher volatility in stock market. According to the political uncertainty hypothesis, which was established in the work of Goodell and Vahaama (2012), this is because the event of Brexit incorporates a substantial amount of uncertainty about future policies, most importantly trade related ones. As it was explained in the Timeline Leading to the Referendum part, there was no clear consensus on what trade agreements the United Kingdom would be able to negotiate and how big of an impact it could have on the country's economy. Hence, an increase in the possibility of it happening made investors uncertain about the future earnings of the companies whose stocks they hold. Consequently, the stock prices, which represent the present values of expected future cash flows to investors, became more volatile. This is also in line with the proposition of Biakowski et al. (2008) and Smales (2015) stating that markets "prefer the devil they know", yet in this case "the devil" that is known to the markets is not the political party which is to be re-elected, but instead remaining a part of the EU and maintaining all trade agreements that had been negotiated.

The obtained negative relationship between the number of days left until the referendum and the implied volatility index coincides with expectations that were based on Gemmil (1992). It is nonetheless important to note that while Ederington and Lee (1996) state that the uncertainty and hence volatility which surrounds prescheduled announcements is normally resolved once the announcement is made, it is not the same in the case of Brexit. The actual event of Brexit is the main source of uncertainty, while the threat of it, which was measured by opinion polls, is mainly a possibility that there will be a lot of future uncertainty. Hence, while the results are consistent the part of Ederington and Lee's (1996) claim, which states that volatility increases before prescheduled announcements, it is not with the one, which says that it decreases once the news is publicly announced. One the other hand, the latter proposition most probably would have held in case the referendum's outcome had been for the UK to remain part of the EU as it would have resolved uncertainty in the market.

The most important contribution to the existing body of knowledge of this part of the research, however, is that the data of internet searches is also proven to be a possible measure of threat of an important political event taking place as well as a measure of uncertainty prevalent in the market. The regression that uses the logarithmic value of Google Trends index performs not worse than those that use opinion polling data and explains slightly more of variation in volatility index than three out of four other regressions. Hence, the findings strengthen the hypothesis of Dzielinski (2012) which states that rational individuals use information sources to decipher any

uncertainties that might arise. Even though one could argue that the positive relationship between the measure of the threat variable based on Google Trends data and the stock market volatility could suffer from reverse causality, we strongly believe that it should not be of great concern. The main reason for this is that the number of searches which comes from investors trying to find explanations for increases in market volatility as compared to those that come from individuals who are not involved in investing but instead simply try to resolve their uncertainties coming from an increase in the threat of Brexit should be negligent. In this regard, we believe that Google Trends serves as a much better proxy than, for instance, the number of articles written on the topic, which could arguably be more reversely affected as the number of sophisticated financial articles that are trying to explain increases in volatility would account for a more substantial part and could suffer from a lag of publishing.

## *7. Results and Discussion of Brexit Effects on Companies Based on Industries and Selling Orientation*

### 7.1 Results of Brexit Effects on Companies Based on Industries and Selling Orientation

Results obtained from the event studies regressions are displayed in Table 3. Overall, as suggested by F values of all four regressions, the all coefficients are jointly significant at all significance levels. When looking at adjusted $R^2$ variables of regressions with equally weighted (value weighted) portfolios explain 16.7% (49.0%) of variations in CAR when looking at the event window of June 24 and 20.3% (46.8%) when looking at the eight-day event window of June 23-30. Here, again it is important to note that such $R^2$ are satisfactory for our research as we do not try to determine the overall determinants of cumulative abnormal returns but simply analyze whether they depend on companies' selling orientation and industries in which they operate.

Regarding selling orientation, the results show that, contrary to our expectations, international sales ratio has a positive relationship with abnormal returns registered on the two event windows chosen for the regressions. In case of equally weighted (value weighted) portfolios, the coefficients before international sales ratio are 0.0388 (0.0908) and 0.0831 (0.134) for the event windows of June 24 and June 23–30, respectively. Both coefficients are highly significant at all standard significance levels. Hence, a 1pp increase in international sales ratio can be associated with a 0.04pp (0.09pp) increase in abnormal returns, when using one-day event window, and 0.08pp (0.13pp) increase in case the broader event window is used.

When looking at the coefficients before industry dummies it is important to first look at the basis industry, which in our case is Oil & Gas, as all other coefficients are showing effects on top of it. Hence, in case some industry dummies have insignificant coefficients, it does not mean that they did not register cumulative abnormal returns but instead that the cumulative abnormal returns are not different from those of Oil & Gas industry. The coefficients before Oil & Gas industry when equally weighted (value weighted) portfolio is used are -0.0628 (-0.0744) and -0.104 (-0.0867) for event windows of the referendum results announcement date and June 23–30, respectively. All of the coefficients are statistically significantly different from 0 on all standard significance levels. As all coefficients before Basic Materials dummy are statistically insignificant, it suggests that cumulative abnormal returns that there registered in this industry are not statistically significantly different from those of Oil & Gas. Similarly, when looking at Utilities industry, cumulative abnormal returns can only be said to be different from those of Oil & Gas when taking employing an equally weighted portfolio over the broader event window. In this regard, a company that belongs to Utilities industry and does not have international sales can be associated with negative cumulative abnormal returns of 4.3%. On the other hand, companies operating in Industrials and Consumer Services industries registered CARs that are statistically significantly more negative than those of Oil & Gas industry at all significance levels. For instance, when looking at value weighted portfolio CARs for the event window of June 23-30, they were more negative in Industrials and Consumer Services than those in Oil & Gas by 11.0pp and 13.4pp, respectively. Similarly, Technology sector also registered statistically significantly more negative CAR than those of Oil & Gas in three out four regressions, except when using equally weighted portfolio for the event window of June 23-30. In the regression with value weighted portfolio for the wider event window, companies within the Technology sector that do not have international sales were estimated to have CAR of -17.4%. As for Financials industry, CAR were statistically significantly different from those of Oil & Gas when using value weighted portfolio but not when using equally weighted portfolio. In the former case, for the event window of the announcement day (June 23-30) CAR of companies operating in Financials industry with no international sales were -12.9% (-21.8%). The opposite was true for Consumer Goods industry, where the coefficients were statistically significantly different from the base case when using equally weighted but not value weighted portfolio: for one-day event window, they were more negative by 5.8pp and for the broader one – by 10.7pp. Lastly, results for Telecommunications and Health Care industries showed coefficients not to differ significantly when using equally weighted portfolio and significantly differ on all significance levels only when using either one-day or eight-days event windows. For

Telecommunications, it was the latter case (more negative CAR by 8.0pp) and for Health Care – the former (more negative CAR by -2.6pp).

Our results are superior to those obtained by Oehler et al. (2017) as, firstly, variables in our regressions explain more of variations in CAR and coefficients are jointly more significant. Moreover, we found coefficients before the international sales ratio to be significant at all standard significance levels, while in their regressions those coefficients are only significant at 5% significance level. Most importantly, as we used a ten times bigger sample of companies, we found the relationship between the base case and CAR to be statistically significant at all significance levels and also statistically different from five out of ten industries.

| | Equally weighted June 24 | Equally weighted June 23-30 | Value weighted June 24 | Value weighted June 23-30 |
|---|---|---|---|---|
| International sales ratio | 0.0388*** | 0.0831*** | 0.0908*** | 0.134*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Basic Materials | 0.00185 | 0.00399 | -0.00744 | -0.0369 |
| | (-0.899) | (-0.896) | (-0.605) | (-0.273) |
| Industrials | -0.0481*** | -0.0925*** | -0.0592*** | -0.110*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Consumer Goods | -0.0583*** | -0.107*** | -0.0246* | -0.0381 |
| | (0.000) | (0.000) | (-0.010) | (-0.099) |
| Health Care | -0.0241 | 0.00475 | -0.0261*** | -0.0246* |
| | (-0.064) | (-0.833) | (0.000) | (-0.012) |
| Consumer Services | -0.0544*** | -0.109*** | -0.0567*** | -0.134*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Telecommunications | -0.03 | -0.00911 | -0.0523** | -0.0803*** |
| | (-0.089) | (-0.680) | (-0.007) | (0.000) |
| Utilities | -0.00483 | 0.0609** | -0.0143 | 0.0213 |
| | (-0.698) | (-0.007) | (-0.114) | (-0.125) |
| Financials | -0.0238* | -0.0357 | -0.0543*** | -0.131*** |
| | (-0.025) | (-0.094) | (0.000) | (0.000) |
| Technology | -0.0412*** | -0.0766 | -0.0605*** | -0.0869*** |
| | (0.000) | (-0.059) | (0.000) | (0.000) |
| Base case (Oil & Gas) | -0.0628*** | -0.104*** | -0.0744*** | -0.0867*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| N | 507 | 507 | 504 | 504 |
| R2 adjusted | 16.686% | 20.331% | 49.000% | 46.751% |
| F | 13.76 | 26.64 | 36.04 | 66.90 |
| Prob > F | (0.000) | (0.000) | (0.000) | (0.000) |
| AIC | -1637.9 | -930 | -1757.1 | -1047.6 |
| BIC | -1591.4 | -883.5 | -1710.7 | -1001.1 |

p-values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

*Table 3. Results of event studies regressions*

Moreover, for the further analysis of industry-specific effects on company returns in the short run we have decided to cluster the industries into groups based on their abnormal return levels. In order to do that we tested whether each industry dummy beta is equal to each of other

industry dummy betas (except for Oil & Gas industry for which these differences can be observed from the regression). These tests were based on F statistic with the null hypothesis that two betas are equal. The most suitable industry grouping was determined to be for the value-weighted CAR (June 23 – 30) portfolio at a 1% significance level (meaning that the abnormal return levels are said to be different if p-value of the F test is below 1%). Further, we have filled a 10x10 matrix as shown in Figure 2, where "***" indicate that industries have different abnormal return levels at a 0.1% significance level, "**" – at 1% significance level and "*" – at 5% significance level. By using this matrix we distinguished three different abnormal returns groups:

1) Industries which had not had significantly different abnormal return from Utilities (D7) industry. Industries that were included in this group: Oil & Gas (D0), Basic Materials (D1), Consumer Goods (D3), Healthcare (D4) and Utilities itself.
2) Industries which had not had significantly different abnormal return from Consumer Services (D5) industry. Industries that were included in this group: Industrials (D2), Financials (D8), Technology (D9), and Consumer Services itself.
3) An industry that had statistically significantly different effect from both: Utilities and Consumer Services. This group includes Telecommunications.

The distinguished grouping is well suited for the industries as the groups are mutually exclusive and collectively exhausting. Also, the abnormal return variation in the groups was relatively small for the period of June 23 – June 30 value weighted portfolio: within the first group CAR (adjusted for the base case) varied from -6.54% (Utilities) to -12.9% (Consumer Goods), within the second group CAR varied from -17.37% to -22.04%, while the third group CAR was -16.7% (Telecommunications). Hence, group 1 performed relatively better in terms of abnormal returns, group 2 performed relatively worse, and group 3 performance was mediocre.

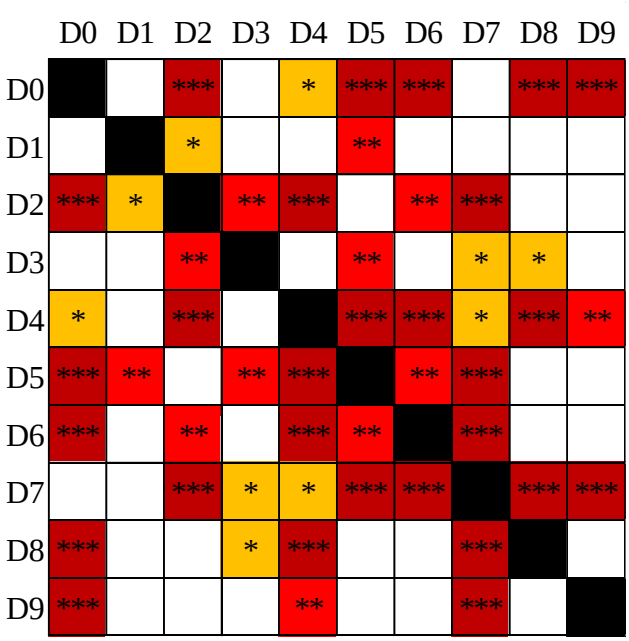


*Figure 2. Plotted F Test p-value significance levels based on the pairs of industries. D0 – Base case (Oil & Gas), D1 – Basic Materials, D2 – Industrials, D3 – Consumer Goods, D4 – Healthcare, D5 – Consumer Services, D6 – Telecommunications, D7 – Utilities, D8 – Financials, D9 – Technology. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

### 7.2 Discussion of Results of Brexit on Companies Based on Industries and Selling Orientation

As it has already been explained in the Results section, the results obtained from our regression show the opposite relationship of what we were expecting based on previous research: higher international selling orientation is associated with less negative abnormal returns. The main explanation behind such results could potentially be the fact that we only study short term effects. As it can be seen in Figure 2 the exchange rate of USD per GBP experienced a significant drop, which in the short-term made companies that export their goods benefit from an increase in competitiveness. However, we strongly believe that a thorough examination of the long-run effects of Brexit would have the relationship, which was expected based on the previous literature, as over the long run the effect of the pound depreciation would diminish and the one from the impact of trade policies could be isolated. Then, in line with Lenway et al. (1990) companies that mainly operate domestically would benefit from potential barriers to trade, which are expected to arise during upcoming negotiations, and that would be reflected in the stock prices. For the moment, it is understandable that a sharp depreciation of the British pound had a stronger effect than potential trade limitations.

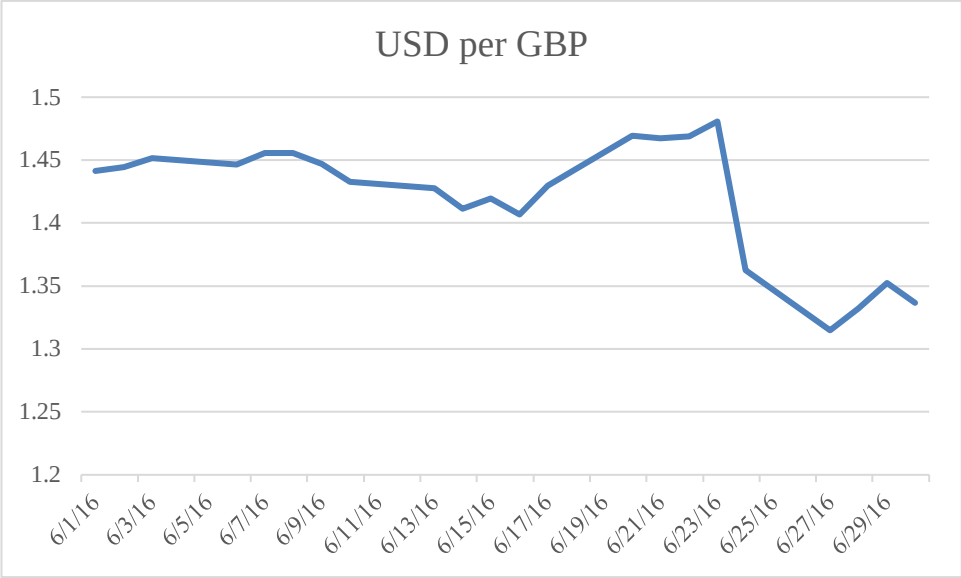


*Figure 2. Development of USD per GBP exchange rate over June 2016.*

As industries are very broad categories and some of them have very distinctive sectors that can be affected in the opposite direction by different as well as the same factors it is sometimes very tough to determine which of those factors play the key role when determining its cumulative abnormal returns. Thus, for an industry such as Consumer Goods, which has a very broad specter of sectors it is almost impossible to point to a specific characteristic that could be responsible for its reaction to referendum results. For instance, when thinking about the reasoning based on Luong (2011) the industry should be more affected if it uses unique as compared to homogenous resources. This is difficult to apply for Consumer Goods industry as one of its sectors – Automobiles & Parts – falls under the former characteristic, while for example Food & Beverages – under the latter (for the division of industries into sectors consult Appendix B). Similarly, if we try to explain the results by using the logics of regulation introduced by Kim (2015), Tobacco – one of the sectors within Consumer Goods industry – should be the least affected as it is very strictly regulated. On the contrary, for instance, Personal Goods, which are mainly apparel and footwear face very little regulation and thus should be more affected by the event of the UK leaving the EU.

However, for other industries, it is easier to apply theoretical frameworks discussed in literature review section. As Boutchkova et al. (2012) argue, more labor intensive industries usually experience a greater impact of political events in terms of abnormal returns. When looking at ICB classification, Consumer Services, which registered the most negative cumulative abnormal returns, is arguably one of the most labor-intensive industries as it includes sectors such as Travel & Leisure as well as Retail. In addition, according to the Migration Observatory at the University of Oxford (2016, May 6) , these two sectors also have the highest proportions of EU-immigrants over the total

workforce, which is the group of people to be affected the most by limitations to free movement of people – the key promise of the Leave campaign.

Additionally, as argued by Kim (2015), disguised protectionism, which through some industry or sector specific regulations can create additional barriers to trade and isolate local industry from foreign competition, will arguably be much more prevalent in the UK after it leaves the EU and will have more freedom in implementing domestic laws. As discussed by the author, one of the most affected industries by disguised protectionism is healthcare industry which has to follow the extensive amount of regulation and for which the process of legislation is often outweighed by minimum quality requirements rather than free trade arguments. Hence, an argument could be made that one of the factors why Healthcare industry in the UK performed relatively better than other industries is that the probability the UK imposing laws favorable for domestic Healthcare companies increased.

Luong (2011) conclusions regarding that companies which use homogenous intermediate products are positively affected by trade liberalization can be applicable for the UK Industrials industry. The UK leave from the EU followed by the increase in trade protectionism should have reverse effects on companies which rely on homogenous intermediate products. Consequently, as Industrials from ICB classified industries uses the most homogeneous intermediate imports for their final production (especially such sectors as Construction & Materials and General Industrials), the possibility of additional barriers to trade should have negatively affected their returns. This reasoning is consistent with the results we obtain from the event study regressions as Industrials did face one of the most significant negative abnormal returns.

Moreover, according to the same paper by Luong (2011) regarding final product markets, industries that produce unique final products should be subject to marginally higher increase in productivity (which in efficient markets should be reflected in prices) than companies selling rather homogenous final products. Again, when a country such as the UK shifts more towards trade protectionism, mentioned effects should be reversed, meaning that due to additional barriers to trade producers of unique final products should face more substantial decrease than those oriented in the production of homogeneous final products. These effects are reflected in our value weighted CAR of June 23 – 30 regression results, as the industries that can be distinguished by their close to homogeneous outputs: Utilities, Basic Materials, and Oil & Gas experienced relatively higher returns (all of them were clustered into group 1) than those industries producing unique, sometimes to client-tailored services: Consumer Services and Technology (both in group 2). Consequently, the

dimension of homogeneity of final products is arguably one of the most extensively reflected in our regression results.

Also, one of the factors that can be taken into consideration is the dependence of an industry on market integration. The most noticeable confrontation of this factor is Utilities and Financials industries. Utilities industry is only weakly dependent on market integration as companies conduct most of the operations domestically and do not constantly need access to foreign markets while Financials industry is greatly dependent on the integrated both financial market to access capital and labor market to access an international pool of talents (Wosoba, 2017). Consequently, the risk of the decrease in market integration between the UK and the EU has arguably affected Financials industry (group 2) much more negatively than Utilities industry (group 1).

Even though one could question the external validity of our research by saying that Brexit is one of a kind event and that the results cannot be indicative for other prescheduled political events, the paper can serve as some ground for speculations of the impact that the decision to leave the EU has on country's stock markets. First and foremost, the observed negative abnormal returns on the results' announcement day, are indicative that overall negative sentiment prevails in the market about the decision: investors believe that the future cash flows of companies listed on the country's stock exchange will be lower due to the decision. As for the selling orientation of companies it is difficult to speculate what would be the effect in other countries as in most of other EU members, where the idea of a referendum taking place is being considered, there is no national currency. This is a very important factor as national currency's depreciation positively affects the competitiveness of the exporting companies. It is possible that there would be opposite result as leaving the monetary union as well as the EU itself could harm and complicate trade relations with member states even more than in the UK's case. When looking at specific industries, one of the results that is strongly in line with the previous studies is that the most internally regulated industries, such as Healthcare industry, should be among the least affected ones. As for the labor intensive industries the effect will depend on whether there is a large number of EU immigrants working in that industry and whether the country's officials are quoting extensive immigration of EU citizen as one of the reasons of the referendum taking place.

## *8. Conclusions*

This research analyses the effect that prescheduled political event – Brexit – has on stock markets in the short term. It divides the effects into two parts: volatility induced by the threat of the event actually happening that predates the event and abnormal returns caused by the announcement of referendum results based on companies' selling orientation and industry classification.

As financial and macroeconomic variables are proven to be able to explain at best half of the variability in stock markets (Fama, 1990), it is important to find another sources of uncertainty that make markets unrest. In line with previous research, we find that one of the potential sources can be said to be political events. Our study of the UK's EU referendum, which is a perfect example of a prescheduled political event, strengthens the existing results from previous research that suggest that due to uncertainties about the eventual outcome of prescheduled political events, such as national elections, and the subsequent economic policies that affect companies' future earnings, implied volatility in the stock markets increases. Furthermore, as part of the uncertainty is resolved once the results are out, one can look at the abnormal returns. While previous research that uses multiple events find that the abnormal returns depend on the party that wins the election, we contribute by showing that the result is not homogenous across different industries. Based on different industry characteristics, such as labor intensity, regulations, and uniqueness of products we are able to explain some of the differences in abnormal returns across industries.

The results are believed to be of importance to investors as they suggest that portfolio risk increases before important prescheduled political events, yet the subsequent abnormal returns are not equal among different industries, based on their different characteristics. As our work only examines short-term effects of the EU referendum's results as a direction for future research we would suggest examining long-term effects that the referendum outcome has on companies listed in London Stock Exchange. Particularly it would be interesting to explore, which industry specific outcomes are reversed after more time has passed and whether the direction of selling orientation's effect changes as more information about future trade agreements becomes available for investors. Also, a thorough examination of negotiations that are soon to take place and the effects of different decision announcements could move the literature of the relationship between political events and stock markets even further. Lastly, it would be interesting to apply Boutchkova's et al. (2012) methodology to study how stock markets of UK's main trading partners reacted to the referendum results.

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## *10. Appendices*

### Appendix A. Development of variables over time

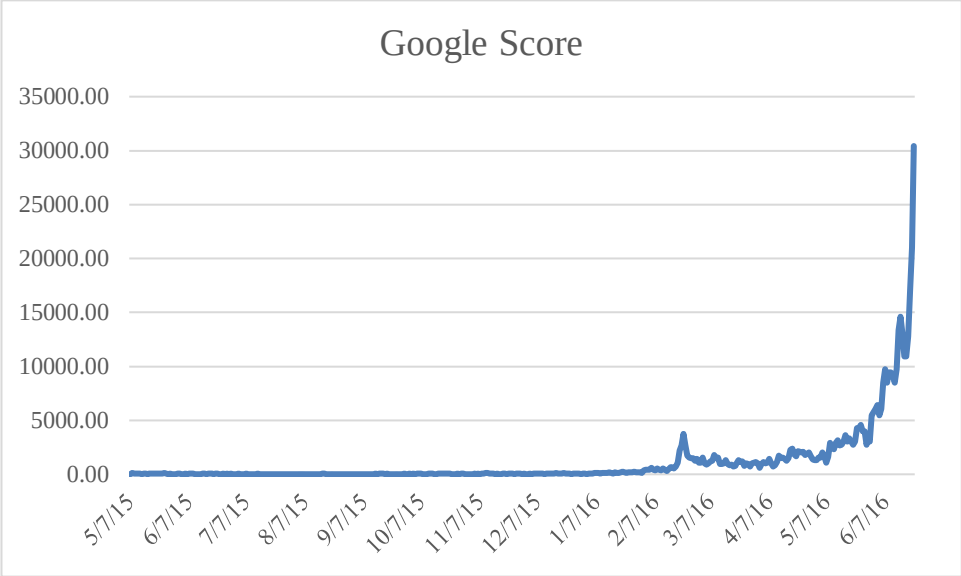


*Figure A2. Development of Google Trends Score*

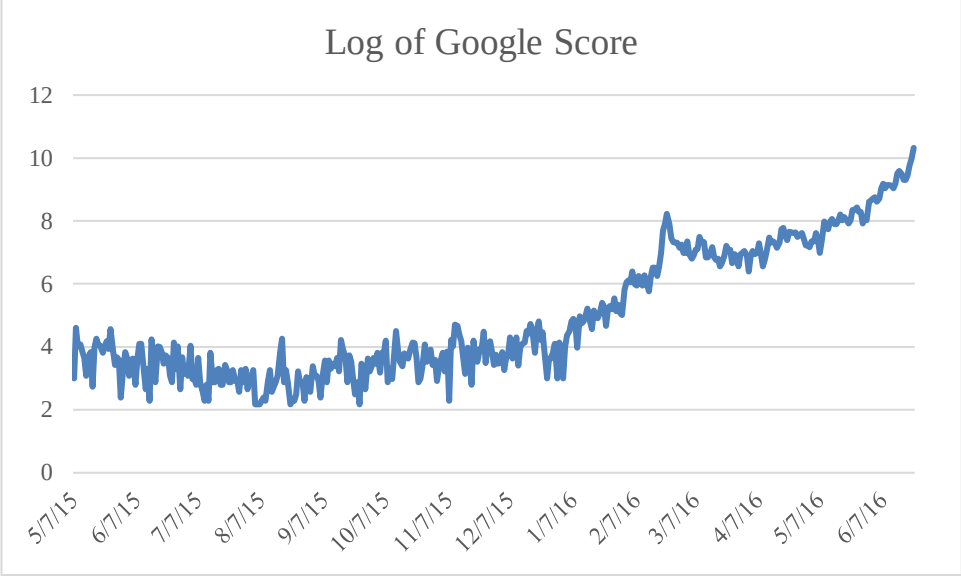


*Figure A2. Development of log values of Google Trends Score*

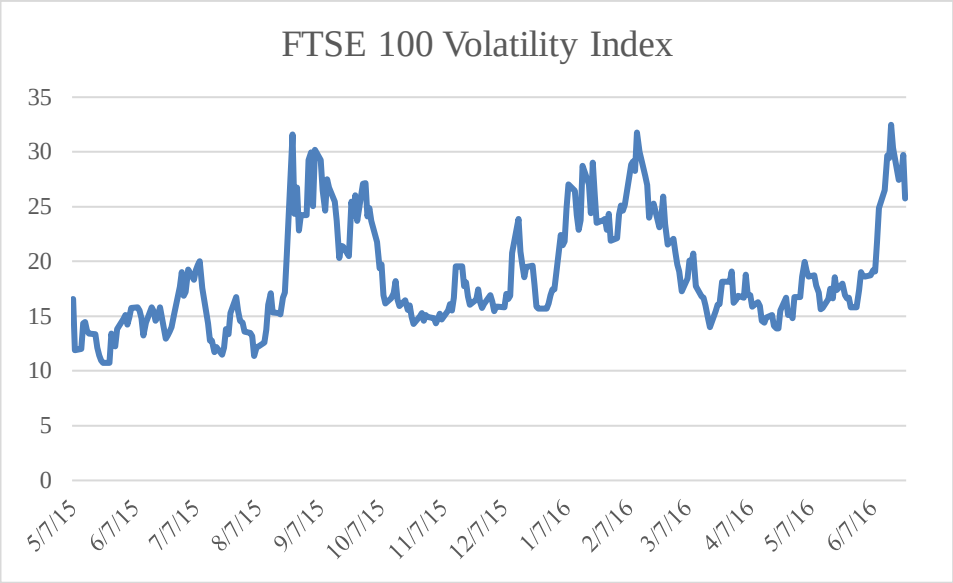


*Figure A3. Development of FTSE 100 Volatility Index*

**Appendix B. ICB industry classification division into sectors**

| Industry | Supersector | Sector |
|---|---|---|
| 0001 Oil & Gas | 0500 Oil & Gas | 0530 Oil & Gas Producers |
| | | 0570 Oil Equipment, Services & Distribution |
| | | 0580 Alternative Energy |
| 1000 Basic Materials | 1300 Chemicals | 1350 Chemicals |
| | 1700 Basic Resources | 1730 Forestry & Paper |
| | | 1750 Industrial Metals & Mining |
| | | 1770 Mining |
| 2000 Industrials | 2300 Construction & Materials | 2350 Construction & Materials |
| | 2700 Industrial Goods & Services | 2710 Aerospace & Defense |
| | | 2720 General Industrials |
| | | 2730 Electronic & Electrical Equipment |
| | | 2750 Industrial Engineering |
| | | 2770 Industrial Transportation |
| | | 2790 Support Services |
| 3000 Consumer Goods | 3300 Automobiles & Parts | 3350 Automobiles & Parts |
| | 3500 Food & Beverage | 3530 Beverages |
| | | 3570 Food Producers |
| | 3700 Personal & Household Goods | 3720 Household Goods & Home Construction |
| | | 3740 Leisure Goods |
| | | 3760 Personal Goods |
| | | 3780 Tobacco |

| | | |
|---|---|---|
| 4000 Health Care | 4500 Health Care | 4530 Health Care Equipment & Services |
| | | 4570 Pharmaceuticals & Biotechnology |
| 5000 Consumer Services | 5300 Retail | 5330 Food & Drug Retailers |
| | | 5370 General Retailers |
| | 5500 Media | 5550 Media |
| | 5700 Travel & Leisure | 5750 Travel & Leisure |
| 6000 Telecommunications | 6500 Telecommunications | 6530 Fixed Line Telecommunications |
| | | 6570 Mobile Telecommunications |
| 7000 Utilities | 7500 Utilities | 7530 Electricity |
| | | 7570 Gas, Water & Multiutilities |
| 8000 Financials | 8300 Banks | 8350 Banks |
| | 8500 Insurance | 8530 Nonlife Insurance |
| | | 8570 Life Insurance |
| | 8600 Real Estate | 8630 Real Estate Investment & Services |
| | | 8670 Real Estate Investment Trusts |
| | 8700 Financial Services | 8770 Financial Services |
| | | 8980 Equity Investment Instruments |
| | | 8990 Nonequity Investment Instruments |
| 9000 Technology | 9500 Technology | 9530 Software & Computer Services |
| | | 9570 Technology Hardware & Equipment |

*Figure B1: ICB classification by industry, subsector and sector. Source: Industry Classification Benchmark, retrieved from: http://www.icbenchmark.com/structure*