NEKN02: Master Essay

The impact of BREXIT vote on stock returns

An event study on European bank industry

Authors:

Lachezar Bonchev, 920807T457 and Mariya Pencheva, 920412T264

Supervisor:

Frederik Lundtofte

Department of Economics

Lund University School of Economics and Management, 2017

Abstract

The study focuses on the impact of United Kingdom's vote for leaving the European Union on the banks stocks in Europe. The tool used for measuring this impact is event study. Putting the center of attention on the banking industry, we investigate 63 major banks in Europe. Abnormal returns are defined by using the well-known market model. As expected, the results show that banks experience significant negative abnormal returns. To find what could be the potential factors that have an effect on the returns, a linear regression is specified. Its results show that two factors that have a significant effect were the size of the bank and its domestic accounts, i.e. its orientation towards international markets.

Key words: Event study, Brexit, stock returns, bank industry, abnormal returns

Acknowledgments

We would like to express our sincere gratitude to our supervisor Frederik Lundtofte. His guidance and patience helped us in the whole process of creating this thesis. Without his support, we would probably still be searching for the perfect topic. Furthermore, we would like to appreciate the efforts that all of our lectors and teachers have put in their work. Last, but not least, we want to thank our families for the opportunity to study abroad, for their constant love and support and for always believing in us. – L.B. and M.P.

Table of Contents

List of tables and figures:

List of abbreviations:

AR – abnormal return

CAR – cumulative abnormal return

MM – market model

CAPM – capital asset pricing model

AAR – average abnormal return

UK – United Kingdom

BREXIT – term used to refer to Britain's withdrawal from the European Union

EU – European Union

EMH – Efficient Market Hypothesis

1. Introduction

It is a very rare case a certain event to be of deep interest to people from almost every country. Even if it is about elections or referendum, which usually are of national or regional importance. However, in the summer of 2016 the whole world was nervously following the news stream, the campaign and the odds for a single event in the United Kingdom. A referendum was held on 23rd of June asking whether the UK should remain or leave the EU. The unknown effects and unprecedented procedure of leaving the union that a potential negative outcome of the vote could lead to were the main reasons for the high anticipation of it. Some of the politicians in Europe have expressed their thoughts and concerns: “We keep all our fingers crossed for the Brits to decide to stay in the union,” Per Bolund, Sweden’s financial markets minister or Daniel Mulhall, Ireland’s UK ambassador, said: “It would be remiss of us not to draw to the attention of Irish people here in Britain the implications and the risks we see to British-Irish relations”. Furthermore, representatives from large companies admitted possible future issues if a negative vote occurs: “That’s not good for companies like ours that thrive by there being no barriers” – Ben van Beurden, Chief Executive of Shell.

On 24th of June the results from the referendum were announced showing that the citizens of the United Kingdom have voted for leaving the European Union. This decision caused a surprise and the reaction from the markets was disappointing. The pound dived to a 30-year low, while the FTSE 100 dropped by 9% at the beginning of the trading day.

The aim of this paper is to investigate the effect of the referendum vote on European banking sector and attempt to explain which factors cause higher reaction from banks. We choose a single industry, in order to provide an in-depth analysis and concrete inferences. They research the banking industry due to its importance to the national economy. Banks are usually subject to much more monitoring and restrictions than other companies. Furthermore, Ramiah, Pham and Moosa (2016) proved that banks were one of the most severely affected industries by UK referendum vote results with negative abnormal performance.

In order to investigate the abnormal performance of banks across Europe, we use event study methodology. Then we apply the CAR estimates as dependent variable in cross-sectional regressions, so as to test if the factors included in the regressions can explain the negative abnormal performance.

The contribution of this thesis is that it analyses a relatively new event, which is still not well researched. Despite the big number of issued papers on Brexit topic in the past year, most of them emphasize on the withdrawal procedure and how would Europe be affected after it. Only few investigate the event in particular. Moreover, in times of increasing Euroscepticism, countries should evaluate the consequence when considering their options. Therefore, this analysis could be an example in their research. On the other hand, the European authorities could learn from the topic in case if another country decides to leave.

Chapter 2 reveals the existing relevant literature and hypothesis development. In Chapter 3 the data selection and the core principles of the methodology used in this thesis are shown. Chapter 4 contains the actual results from the applied methods and their verbal meaning. Chapter 5 provides the reader with a brief overview of the paper and underlines the main inferences.

2. Literature review

2.1. Theoretical background

Stock prices reaction to news

There are a lot of previous studies that analyze the stock performance - whether it is predictable, whether it is related to news, etc. In the past, much research resulted in the common belief that all in all stock market prices are predictable. They seem to have reversal on daily and even on yearly basis, as well as monthly drift (Chan, 2001).

According to Fama (1970), the efficient market price 'fully reflects' the information that is known on the market. He argues that no empirical implications could actually turn this statement into untrue. Fama backed his research by stating the sufficient conditions to have capital market efficiency. First condition is the lack of transactional cost in trading securities. Second condition is that all market participants have all of the available information on the market without paying any cost. The last condition is that 'all agree on the implication of current information for the current price and distributions of future prices of each security'.

Of course, the conditions mentioned above exist in frictionless market that could not be found in the real world, but even with some deviations, the conditions are enough to ensure the reflection of the information on the security price.

Even though, the efficient market hypothesis could be used to support the research, we are well aware that it is only a hypothesis and could not use it as a real proof of impact that information has on prices. However, what Fama (1970) did was to investigate this issue by performing weak, semi-strong and strong tests of the Efficient Market Model. In the weak and semi-strong test cases, the evidence supports the hypothesis and in the strong test case, the evidence against the EHM is very limited.

Other authors that recently researched the news impact on stock prices are Heston and Sinha (2016). They used 900 000 public new stories and investigate their impact on the stock prices. The findings support previous literature and analyses by revealing that daily news predict stock prices for only 1-2 days. They also found that positive news has a positive effect on the stocks, whereas negative news has e negative effect.

For all we know, EHM is still a hypothesis, but the existing evidence in the form of different research papers, analyses and literature cannot be overlooked. One way or another news has high impact on stock prices. However, different news can hit the markets even before they are officially public or known. They can also induce positive or negative post-news reaction or they can result in not a single stock movement. With that in mind, we will see if the results in our case would support the past evidence.

Reaction of the market to major world events

One of the first authors to look over on the stock market reaction after big world events is Niederhoffer (1971). According to him, “The most unequivocal pattern of influence reported below is that large changes are substantially more likely following world events than on randomly selected days.” What is more, he also states that significant abnormal performance can be detected on the first and second day after a major world event. The author gathered approximately 20 headlines a year in the period of 1950-1966 and his study was based on constructing nineteen event categories which supported by theory and history may have a significant impact on stock price performance.

Furthermore, Merrill (1966) says “The market has some very bad moments immediately following the tragic news. Selling drives prices down to a surprising degree. However, when a day has passed, the market recovers from its panic, and sometimes works upward to a higher level.”

There are studies that analyze the effect of particularly economic events on the stock price changes. Example for such research is Dangol (2008), where the author centers their attention to the stock reaction due to unanticipated political events. He founded that negative announcement would likely result in negative abnormal performance, as well as good announcements would result in positive abnormal performance. The paper is based on eleven commercial banks, listed on Nepal Stock Exchange Ltd. covering the period between 2001 and 2006 with total of 81 observations. Another thing is the division of the events into two groups – bad news and good news, and investigating the effect each group has on the banks` stocks. The author adopts the market model for calculating the expected normal returns, since it was and still is considered as one of the most reliable ones when conducting event study with daily data. The study results showed that the abnormal performance in the pre-event window is usually significant and positive, while during the day t= -1 the abnormal performance is on average positive, but insignificant. Furthermore, immediately after the event the abnormal performance becomes strongly significant and negative and continued through the following four days. Later in the thesis, these findings would prove consistent with the results we got as well. In conclusion, the main finding that was the short-term abnormal performance after the event day and the fact that the sign of the effect is the same as the news, i.e. good news is „good“ for stocks, bad news are „bad“ for stocks.

Another related literature is the paper of Mahmood, Irfan, Iqbal, Kamran, 2014. The authors use the methodology of an event study to conduct an enquiry into whether major political events have impact on the KSE-100 index returns. They focus on 50 significant political events in the period between 1998 and 2013. Their findings reveal that some days before and after the event date, negative abnormal returns are observed.

2.2. Previous studies

Brexit is relatively new for the economic and finance history. That is why there are not many papers covering the impact of the event on stock prices. There are two main research papers that we used as foundation in developing the thesis.

First article is conducted by Burdekin, Hughson and Gu (2017) and focuses on Brexit impact on global equity markets. The authors use 64 stock exchanges in the period of 6th January 2016 and 30th June 2016. Their sample do not emphasize on particular industry, region or country. On the contrary, they focus on the equity markets as a whole and use data from around 41 countries from Europe, Asia, North and South America.

The authors chose to construct normal expected returns by using the market model (something that we chose as well and would become clear later in the thesis). According to their raw results, negative abnormal returns are noted on the 24th, 27th and 28th of June. Moreover, it is shown that although Brexit was considered as "bad news" for the world, not every country has experienced negative abnormal performance. The authors find it quite normal that the largest negative ARs are observed within EU. For example, the paper demonstrates that the most negatively affected by the news are the PIIGS countries with average of -6.64%. On the contrary, BRICS countries, Brazil and Russia, show positive abnormal returns of 5.5% and 5.3% respectively. As far as UK is concerned, the average AR is -4.2%.

Following in the research, the authors regress the abnormal returns on a constant, the country`s level of openness and indebtedness as they had suspicions that not only EU membership could effect on the stock's price changes. What they found was that more open countries suffer less than the others. All in all, the paper proves that Brexit had a big negative effect on stock market worldwide, especially on the ones in the Eurozone.

Another directly related study is the one performed by Ramiah, Pham and Moosa (2016). They investigate the referendum impact on different sectors in the British economy over the period June-July 2016. The method used is again event study and what they found is that Brexit has mixed effect depending on the particular sector.

As opposed to most of the prior literature, the authors chose to implement CAPM for expected normal returns calculation. For the sake of the analysis, the researches construct CAR over the following 10 days after the event. Zero ARs or CARs are assumed to be a result one of the following four: (i) Brexit has no impact on revenue or cost (ii) the industry is protected (iii) the industry can pass the cost to its customers or (iv) "the industry experiences a decline in revenue, which is offset by a decline in cost in the form of government subsidy (or vice versa)". The finding of the paper is that Brexit do have an impact on stock returns. The affected sectors showed on average significant negative results, meaning that the news was bad for UK economy in general.

One of the authors` hypotheses that is directly related with the thesis` topic is based on Financial Times discussion that "Banks have already begun to take action to shift operations out of the UK". That is why one of the theories Ramiah, Pham, Moosa are exploring and analyzing, is that Brexit is bad news for the banking sector, mainly because of the eventual loosing of passport rights, that are currently responsible for UK financial institutions to perform operations in EU without having a physical location. Average ARs for the sector is calculated to be -4.99%, with CAR2, CAR5 and CAR10, respectively, -7.81%, -11.90% and – 15.37%.

In conclusion, the article results showed that banking sector was one of the most severely affected by Brexit with negative abnormal performance, proving that predictions of Bank of England about changes in short-term systematic risk were right.

The main differences between the underlying thesis and the research papers above are:

(i) We focus on Brexit vote effect only on *Europe*.

(ii) We investigate the impact of the referendum in details on the *banking sector*.

In other words, the ongoing analysis is a combination of the two previous ones we found, providing more insights on the European banking industry and its reaction to the vote.

Hypotheses development

Based on the theory background and previous related literature we formulate three hypotheses.

H1*: Brexit's vote was bad news for the banking sector in Europe in short-term period*

The hypothesis can be translated as on average, we expect that that there would be significant negative abnormal returns in the banking sector. Not only, the prior literature shows that abnormal performance is expected, but we also take into account the words of modern economist experts. For example, Holger Schmieding, chief economist at Berenberg investment bank, wrote in a recent note the following: "A U.K. vote to leave the EU would not be a black swan event. Markets have discussed the risk since late 2015 and are unlikely to seize up, as they did in the Lehman crisis" (Oprita, A., (2016)).

***H2**: Brexit's vote effects worse on UK than other European countries.*

The intuition behind this hypothesis is that UK would suffer more consequences than the rest of the EU, resulting in lower negative abnormal returns. That is because the market conditions and arrangements changes that would happen, are going to be situated mainly in UK.

In order to find what could be the bank specific factors impacting on the stock performance, we construct a cross-sectional regression. We chose five independent variables:

(i) *Capadeq* – capital adequacy. The data about it was gathered from banks` annual reports. According to (Nzioki, 2011), capital adequacy is contributing positively to the profitability of commercial banks, which as economic theory implies is directly related with the stock price. Therefore, we expect that capital adequacy would have a significant effect on the price changes.

(ii) *Debt_TA* – debt to total assets ratio is calculated by dividing firm total liabilities by its total assets. This ratio is a sign of the financial risk the bank is carrying – the lower the ratio, the better off the bank. Since there is not much information in the prior literature whether debt ratio has an effect on the stock prices, we decide to include it in the cross-sectional regression and see if Nahoji, Abadi, Rafat (2014) are right in their results that significant relationship could be detected.

(iii) *Size* – the variable size is calculated by taking the natural logarithm of bank total assets. The information about this could be found in banks` financial reports. There is a lot of evidence that proves the existing and strong relationship between the firm size and its stock returns. For example, Van Dijk (2011) has gathered information about many of the previous literature supporting the hypothesis - Banz (1981), Reinganum (1981), Keim (1983), Lamoureux and Sanger (1989), etc. Each of the mentioned papers examines the relationship in different time periods, different duration and different markets. The common thing between them is they all prove that such correlation exists and cannot be ignored. What can be expected is that the relationship would be negative, since the bigger the banks is, the more affected could it be from the event. (the abnormal returns are expected to be negative in general)

(iv) *Domestic_Accounts* – this variable is calculated in percentage terms by dividing the domestic accounts to total accounts. The lower the percentage is, the more internationally oriented the bank is. The information is collected from the annual reports of the banks. According to Pynnönen (2005) the geographical position could interfere with stock prices. Since, the event took place in UK, but is affecting not only it, but other countries as well, we decided to check if that kind of relation exist. What we expect to find here is that the more domestically oriented a bank is, the smaller the abnormal performance there would be.

(v) ROA – return on assets. The information about the index is collected from Thomson Reuters Eikon website. In past literature, there is broad evidence that such relation could be found. For instance, Chen and Zhang (2010) examine new three-factor model for cross-sectional returns. The factors they analyze are the market excess return, the difference between the return on a portfolio of low-investment stocks and the return on a portfolio of high-investment stocks and ROA. All three of them showed significant, suggesting that the assumption was right. Furthermore, Warrad and Al Omari (2013) state that ROA has a significant positive effect on stocks.

Important thing to be mentioned here is that all of the extracted information was turned into thousands of GBP. Where the original currency was different from pound we used the closing exchange rate of 31st of December 2015, since the annual reports we used for data collection are to the same date as well.

***H3**: All included variables in the CARs regression have significant effect on CAR*

Judging by the explanations given about the independent variables above, we expect that all of the included variables would have significant effect on the stock returns.

3. Data and methodology

3.1. Sample selection

The study is based on 63 European banks. They are selected from the STOXX Europe TMI banks that originally consist of 73 components. Ten banks were removed due to various reasons, making them unsuitable for this analysis.

For example, all Swedish banks (total of 6) were excluded, because on 24th June Sweden is celebrating "Midsommarstång" and it is a national holiday resulting in no trade information on this day.

Removed are also KBC Ancora (due to lack of credible information, since their financial year starts in June), Banks of Cyprus Holdings, since it is traded in UK, but is a Cypriot bank originally. Same goes to BGEO Group, which is originally Georgian bank with headquarters in Georgia.

Intesa Sanpaolo is also excluded from the sample, since the bank group it is part of is already included. The last removed bank is Banque Nationale de Belgique, since it is a national bank and has different types of operations and regulations. In order for the results to be consistent, the sample used should include similar type of units with similar characteristics.

In the earlier event studies, most used type of data was monthly. However, with technology development, theory and knowledge base, it became natural to use daily stock returns (Sorokina, Booth, Thornton, 2013). This is the approach we use as well. The basic market index we chose is the EUROSTOXX 50 index. The information about it and banks` stock prices is collected through Thomson Reuters database. The gathered price data is in thousands of GBP.

The time period included is from 1st July 2015 till 30th June 2016. For some of the countries there were days that were not trading. We treated the missing values by using one of the four ways suggested by Bartholdy, Olson and Peare (2006). The lumped method they showed proved to have consistent results. The model itself uses the last available transaction price for the non-trading days. The event window return was calculated based on the index availability.

Another issue that was encountered was that some of the banks were publicly listed later than 1st July 2015. In other words, the number of calendars days is the same for each bank, but the number of observations varies, because of the non-trading days and lack of public data.

In order to make the analysis more efficient and easily understandable, the sample was divided into two groups – UK group, consisting of all UK banks from the sample and EX UK group, which includes the remaining ones. We also unite the two groups and name the whole sample as ALL group. This separation allows us to investigate the abnormal performance with and without taking UK into account, resulting in gaining more insights on the subject of matter.

3.2. Event study

3.2.1. Definition and event study structure

To conduct the research, event study method is adopted. It is a standard financial tool dated back in time used to investigate whether some particular event does or does not have an impact on stocks of a particular firm, industry, etc. (Campbell, Lo and MacKinlay, 1997) Its application is wide – from mergers and acquisitions and financial announcements to law field as well.

Event study can be conducted in different ways. The authors are following the structure given in Campbell and MacKinlay (1997).

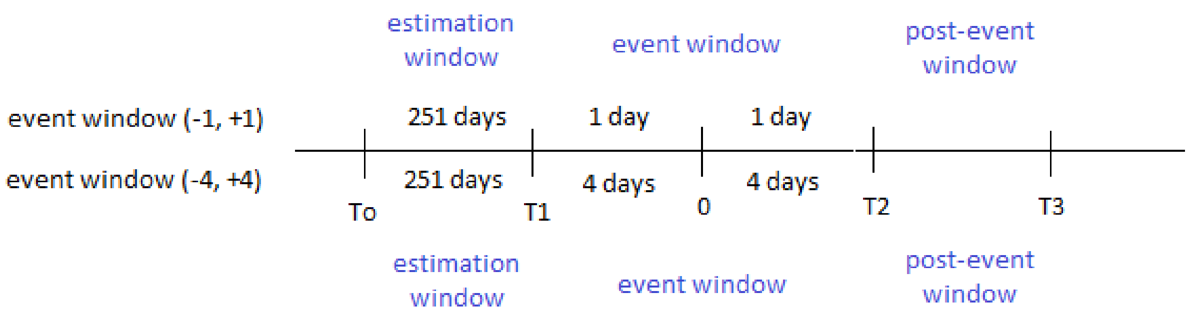
(i) Define the event of interest

First step is *defining the event* of interest. As it was already mentioned in the introduction, Brexit vote was chosen, since it is a unique event that does not have analogue in the modern economic history. The voting took place on 23rd June, but the results came in late on the same day, leading the markets to react on the next trading day. That is the reason why 24th June was selected to be event day ("day 0").

(ii) Identify the period of time

An example of the time structure of an event study is shown in the picture below:

Figure 1: *Even study time-line*



In figure 1 the period between days T_0 and T_1 is the estimation period, which as we explained before is $L_1 = T_1 - T_0 = 251$ days. The period between T_2 and T_1 is can be denoted with L_2, i.e. the event period. As we can see from the figure 1 L_2 is 3 days in the first model and 5 days in the second model.

In most of the related literature, the event window is defined in multiple days which include the event day and at least the previous and the following trading day. Examined are 2 event windows. First one, (-1, +1), is suggested by MacKinlay (1997). However, there can be any type of event windows. For example, Kansas (2005) uses (-3; +3) and Miyajima and Yafeh (2007) use (-5; +5). Longer periods are used for some special cases. For example, Cox and Peterson (1994) use (+4; +20). What is more, according to Dangol (2008): "The data present important evidence on the speed of adjustment of stock prices to new political information, i.e., in as many as 2 to 3 days from the announcement date". Taking into account all the prior literature mentioned above, for our second model, (-4, +4) window is used to capture the effect in longer period of time.

As for identifying the estimation window, the prior literature does not suggest unanimously a specific number of days. For example, Cox and Peterson (1994) use 100 days, Carow and Kane (2002) use 200 days, and Litvak (2007) uses 500 days. MacKinlay (1997) suggests 250 days. However, it is common that the estimation window is usually around 250 days (average trading year), but not less than 126 days (Benninga, 2008). Because of the all mentioned theory, we chose for our analysis estimation window of 251 days. Important note that should be made here is that the estimation window should not include the event itself. Taking that into account, it is preventing from interference in normal performance parameter estimates.

(iii) Selection criteria

The sample was based on the STOXX Europe TMI banks. As explained before used are 63 out of all 74 components of the index.

(iv) Define normal performance

Afterwards, *the normal returns are defined.* In general, normal return is the return that would be expected if the event did not happen. (Campbell, Lo, Mackinlay, 1997) A.C. For each bank, the following holds:

$$AR_{i,t} = R_{i,t} - E [R_{i,t} | X_t],$$

where $AR_{i,t}$ is the abnormal return, $R_{i,t}$ is the actual return and $E [R_{i,t} | X_t]$ is the expected normal return for bank *i* on day *t* of the event window. Expected normal returns can be estimated in different ways. For example, MacKinlay, (1997) suggest that the approaches can be grouped in two categories – statistical and economic model. The most commonly used statistical models are *constant-mean-return model* and *market model*. Statistical models have the following properties: (i) do not depend on economic conditions (ii) they assume that the asset returns are independently and identically distributed through time.

On the other hand, the economic models do depend on economic arguments, but they lack statistical assumptions by default. Most used models in this group are CAPM (Capital asset pricing model) model and APT model (Arbitrage pricing theory).

Previous literature offers different opinions on choosing best model or type of approach. For instance, Brown and Warner (1980, 1985) imply that simpler methods like constant mean model give better results than more sophisticated ones, where MacKinlay, (1997) suggests that economic models will give more precise normal measurement. He denotes that statistical models dominate, since they eliminate biases in economic models, and that the advantage of economic models over the statistical ones is not proven.

In the underlying study, market model is adopted. It is most commonly used approach for measuring normal performance. MM assumes stable linear relationship between the market prices and stock prices. Advantage of using MM will depend by R-squared of the regression used for calculating normal expected returns. There will be more variance reduction and more gain, when R-squared is higher. In this particular case, the average R-squared from all banks` regressions is 35.85%, which shows that the market model is a good fit for our data.

According to Strong, (1992), calculating the normal return is of crucial significance for the successful implementation of the model. That was one of the reason why we took seriously choosing the best model suiting the data and went thoroughly through prior literature in order to find it.

There are past studies investigating whether MM is a reliable model. Cable and Holland (1999) analyze in their study different models in order to provide more insights on choosing specification model. Their results show that regression-based models are better in general. They also study the dispute between CAPM and MM. The main difference between the given models is that in MM the risk-free rate is suppressed. Nonetheless, the market factors stay accounted for in both cases. MM is outperforming CAPM, proving valid in twenty-one cases, while CAPM is proven valid in only 12 cases, three of which it is preferred to MM. All in all, MM is clearly outperforming the other models.

Another author taking a stand for MM is Sorokina, Booth, and Thornton (2013) who states that despite some models perform similar as MM, it stays the most commonly used.

3.2.2. Measuring AR and CAR

In order to calculate the abnormal return, we use the following formula:

$$AR_{it} = R_{it} - (\alpha_i + \beta_i R_{it}),$$

Where AR_{it} is the abnormal return, R_{it} is the actual return in the event window and $(\alpha_i + \beta_i R_{it})$ is the return predicted by the market model.

Parameters α and β are calculated based on the estimation window data. After calculating the parameters, they are used to obtain the abnormal returns.

$$\widehat{\beta_\iota} = \frac{\sum_{\tau=T_0+1}^{T_1}(R_{i\tau} - \widehat{\mu_\iota})(R_{m\tau} - \widehat{\mu_m})}{\sum_{\tau=T_0+1}^{T_1}(R_{m\tau} - \mu_m)^2}$$

$$\widehat{\alpha_\iota} = \widehat{\mu_\iota} - \widehat{\beta_\iota}\widehat{\mu_m}$$

$$\hat{\sigma}^2_{\varepsilon_t} = \frac{1}{L_1 - 2} \sum_{\tau=T_0+1}^{T_1} (R_{it} - \widehat{\alpha_\iota} - \widehat{\beta_\iota} R_{mt})^2$$

where

$$\widehat{\mu_\iota} = \frac{1}{L_1} \sum\nolimits_{\tau=T_0+1}^{T_1} R_{i\tau} \qquad \text{and} \qquad \widehat{\mu_m} = \frac{1}{L_1} \sum\nolimits_{\tau=T_0+1}^{T_1} R_{m\tau}$$

In order to see the overall effect on the bank industry, the abnormal returns can be aggregated. Aggregating abnormal returns is widely used technique to get rid of some potential problems that may come up when using AR. According to Blume (1971) and Gonedes (1973) some of them are cross-sectional correlation in event time, different variances across firms, dependent across time for a given firm and greater variance during event time than in surrounding periods (Sorokina, Booth, Thornton, 2013).

Aggregation could be performed through two dimensions - through securities and through time. Following the example of McKinley, first they were aggregated through securities, then through time and lastly, through the two dimensions together.

Occasionally, some firms could show negative (positive) results when investigating abnormal performance, when the other has been expected (Brooks, 2014). Since, for the aim of this analysis we are interested not in an individual firm, but rather on the impact on the whole sample, implemented is aggregating through time. It is expressed by finding the average abnormal return (AAR) for each particular day of the event window, using the formula below:

$$\overline{AR_\tau} = \frac{1}{N} \sum_{i=1}^{N} \widehat{AR_{\iota\tau}}$$

For the first event window (-1, +1), there are three AARs, and for the (-4, +4) event window there are, respectively, nine average abnormal returns.

What is more, again according to Brooks, (2014) it is expected that returns can have quite a bit variation across the event window days, because of the natural rising and falling of prices. Having that in mind, it can be complicated and hard to find some unique patterns, etc. To remove this potential issue, aggregating through time is used.

By aggregating through time, cumulative abnormal returns are obtained. McKinley defines sample CAR from t1 to t2, where t1 and t2 are days in the event window.

$$\widehat{CAR}_{\iota}(\tau_1, \tau_2) = \sum_{\tau=\tau_1}^{\tau=2} \widehat{AR}_{\iota\tau}$$

Since there are two event windows, defined are different CARs for each of them. For three days window, calculated are CAR (-1, +1) and CAR (0, +1). For the nine days window, we calculate three cumulative abnormal returns – CAR (-4, +4), CAR (-2, +4) and CAR (-2, +2).

3.2.3. Testing AR and CAR

For the sake of the research, the obtained average abnormal returns and cumulative abnormal returns should be tested for significance. There are different ways that significance can be tested. In general, the testing models can be divided in two groups – parametric and non-parametric tests.

To find if AAR and CAR have significance performance standard t-test is used following Brooks.

Null hypotheses for AR significance and CAR significance – H0: AAR = 0 or "The event does not have an impact on the stock prices"

The formulas for the t_{AAR} and t_{CAR} are given below:

$$T_{AAR_t} = \sqrt{N}\frac{AAR_t}{S_{AAR_t}}$$

$$T_{CAAR} = \sqrt{N}\frac{CAAR}{S_{CAAR}}$$

Where S_{CAAR} and S_{AAR_t} are the standard deviations calculated in the event window using the whole sample.

3.2.4. Cross-sectional regression

Traditional event study approach is implementing cross-sectional regression. It is used in order to detect whether and which (usually firm specific) factors have an impact on the abnormal performance.

What we did is estimating two different OLS regressions:

$$CAR_i = \alpha + \beta_1 Capadeq + \beta_2 Debt\_TA + \beta_3 Domestic\_Accoutns + \beta_4 ROA + \beta_5 Size + \varepsilon$$

and

$$CAR_i = \alpha + \beta_1 Capadeq + \beta_2 Debt\_TA + \beta_3 Domestic\_Accoutns + \beta_4 Headquarters + \beta_5 ROA + \beta_6 Size + \varepsilon$$

The second regression has additional dummy variable Headquarters which takes the value of 1 if the bank is situated in UK and 0 otherwise. The aim of the second regression is to see the effect on the UK bank industry only.

4. Discussion of results

4.1. Event study results

The results of the event study are as follows:

Event window (-1, +1)

The abnormal returns for each of the tree dates are given in the table below.

Table 1. *The table shows the abnormal returns for ALL, UK and EX UK groups in (-1, +1) event window.*

Date	ALL	EX UK	UK
AR (+1)	-3.77% (-5.4938) ***	-2.71% (-4.8512) ***	-11.06% (-4.1539) ***
AR (0)	-3.72% (-5.6724) ***	-3.51% (-5.5642) ***	-5.18% (-1.8218) *
AR (-1)	0.70% (2.8253) ***	0.88% (3,2728) ***	-0.48% (-1.0028)

Where with *** is denoted significance at 1%, with ** - at 5% and with * - at 10%.

From the table, it can be seen that for the group ALL and group EX UK all AR are significant at 1% which shows that the impact of the news Britain leaving the UK was powerful enough. What is more, AR (0) and AR (+1) are negative showing that the news resulted in lower returns for the banks. As for group UK, the results show that all three abnormal returns are negative, but only one AR is significant – the one at 27 June. However, this may be a result from slow reacting markets in UK.

The average abnormal return for ALL banks is -2.26%. It is negative and significant as expected. In group EX UK, we have average negative abnormal return of -1.78%. Analyzing only UK banks it can be seen that the average AR is -5.58%. The largest ARs for EX UK group and ALL group are found on 24 June, which means the market reacted instantly. As for UK group, the largest AR can be observed on 27 June and takes the value of -11.06%.

For measuring the overall effect, CAR (-1, +1) and CAR (0, +1) are calculated. The table below shows the values for all three groups. The numbers in the brackets represent the t-test values.

Table 2. *The table shows the cumulative abnormal returns for ALL, UK and EX UK groups in (-1, +1) event window.*

Date	ALL	EX UK	UK
CAR (0, +1)	-7.67% (-6.697956) ***	-6.22% (-6.99888) ***	-17.63% (-3.05501) ***
CAR (-1, +1)	-6.88% (-6.429315) ***	-5.34% (-7.08686) ***	-17.43% (-3.10745) ***

Where with *** is denoted significance at 1%, with ** - at 5% and with * - at 10%.

From the table, it is observable that all CARs for all groups are significant at 1%. Moreover, all of them are negative as expected. Average CAR for group ALL is significant and takes the values of -7.27%. For group EX UK banks, we have average CAR of -5.78% and for the UK group average CAR is -17.53%. Largest CARs are observed in the UK group which leads to conclusion that the effect of Brexit is highest in UK banks.

Event window (-4, +4)

In the same way the results for event window (-4, +4) are analyzed.

The calculated ARs are presented in the table below with their t-test statistics, respectively.

Table 3. *The table shows the abnormal returns for ALL, UK and EX UK groups in (-4, +4) event window.*

AR	ALL	EX UK	UK
AR (+4)	-0.51% (-2.2500) **	-0.43% (-1.9641) **	-1.05% (-1.0639)
AR (+3)	-1.01% (-2.6652) ***	-1.42% (-3.6917) *	1.82% (1.9600) ***
AR (+2)	0.93% (2.4838) **	0.63% (1.7263) ***	2.97% (2.1098) **
AR (+1)	-3.78% (-5.5213) ***	-2.71% (-4.8348) *	-11.13% (-4.1584) ***
AR (0)	-3.91% (-5.6292) ***	-3.49% (-5.5483) *	-6.79% (-2.0203) **
AR (-1)	0.80% (3.2891) ***	0.87% (3.2676) *	-0.28% (-0.5361)
AR (-2)	0.46% (3.2662) ***	0.36% (2.5069) **	1.12% (2.5237) **
AR (-3)	-0.17% (-0.8194)	-0.13% (-0.5785)	-0.41% (-0.9704)
AR (-4)	0.33% (1.0567)	-0.06% (-0.1923)	3.00% (3.7390) ***

Where with *** is denoted significance at 1%, with ** - at 5% and with * - at 10%.

The table above is showing that for ALL group and EX UK group there are significant abnormal returns from day -2 to day +4. Almost all of the ARs in ALL group are significant at 1% level, while in the EX UK group the significance is not that strong – 10% on average. The average ARs for the event period for each of the groups are as follows: group ALL - -0.76%, group EX UK - -0.71% and UK group - -1.13%. Once again, it is obvious that the impact for UK banks is more powerful than for rest of the included European banks.

The largest ARs observed are for days 0 and +1.

When taking into account the overall effect of the event, we calculated three different cumulative abnormal returns – CAR (-4, +4), CAR (-2, +2) and CAR (-2. +4).

The results are given in the table below. They represent the particular CAR and its t-test statics given in parentheses.

Table 4. *The table shows the cumulative abnormal returns for ALL, UK and EX UK groups in (-4, +4) event window.*

CAR	ALL	EX UK	UK
CAR (-4. +4)	-6.86% (-7.13415) ***	-6.38% (-6.76949) *	-10.19% (-2.4562) **
CAR (-2, +2)	-5.51% (-5.94778) ***	-4.34% (-6.15477) *	-13.54% (-3.0257) ***
CAR (-2, +4)	-7.03% (-7.13195 ***	-6.19% (-7.13162) *	-12.78% (-2.5735) **

Where with *** is denoted significance at 1%, with ** - at 5% and with * - at 10%.

As it can be seen all of the CARs for each group are strongly negative and significant. Again, for group UK we have the most negative values. The average CAR for ALL group is -6.47%; for EX UK group, it is -5.64%; and for UK group it is -12.17%.

Another thing that could be seen is that abnormal returns in both cases are similar but do not match exactly. The reason behind this is that because of the different even windows, the estimation window changes as well. Because of that the regression conducted on the market model results in different OLS estimators – alpha and beta and that way lead to slightly different abnormal returns.

All in all, the results for both event windows show that the whole sample has on average negative abnormal returns and cumulative abnormal returns. This statement supports the first of our hypotheses, e.g. "On average, there are significant negative AR/CAR for all banks in Europe". Drawing the inferences for ALL group it is clearly visible that Brexit impacted in a bad way on the stock prices in the bank sector. For the

3-day event window we have abnormal performance of -2.26% for AR and -7.27% for CAR. Taking all this in to account, we can say that we cannot reject H1.

As it can be seen, no matter the size of the event window, the inferences remain the same for the three groups. In order to deal with the second hypothesis, we move the focus directly on the UK group. It has strongly significant and negative abnormal performance. They are the largest among the three groups, which supports the second of our hypotheses – "AR/CAR bigger for UK than for rest of Europe". Our conclusion, supports the conclusions made by Ramiah, Pham and Moosa (2016). Their result of abnormal performance of -15.37% in the banking sector is similar to the ones we calculated. The small difference both studies have may come from the different type of model used for calculating the expected normal returns, as well as, from the size of the samples used. In this study, we only chose 8 of the biggest UK banks, so the inferences made cannot be entirely the same.

4.2. Cross-sectional regression results

Based on the two event windows, we estimated 10 different regressions. The two models used were showed in the previous chapter – one of them including 5 independent variables and the other one with the additional dummy variable.

Event window (-1, +1)

For this event window, we estimated 4 regressions – two for each of the two main models. First model uses CAR (-1, +1) as dependent variable and the second one using CAR (0, -1). For each of them, we also run additional regression with dummy variable *Headquarter*. We decided to estimate both regressions, since for this particular event window, abnormal performance is visible on day 0 and after it. So, in order to catch the whole effect, as well as the strongest one, we chose to do two regressions.

$$CAR(-1,+1) = \alpha + \beta_1 Capadeq + \beta_2 Debt\_TA + \beta_3 Domestic\_Accoutns + \beta_4 ROA + \beta_5 Size + \varepsilon$$

$$CAR(0,+1) = \alpha + \beta_1 Capadeq + \beta_2 Debt_{ta} + \beta_3 Domestic\_Accoutns + \beta_5 ROA + \beta_6 Size + \varepsilon$$

$$CAR(-1,+1) = \alpha + \beta_1 Capadeq + \beta_2 Debt_{TA} + \beta_3 Domestic_{Accoutns} + \beta_4 ROA + \beta_5 Size + \beta_6 Headquarter + \varepsilon$$

$$CAR(0,+1) = \alpha + \beta_1 Capadeq + \beta_2 Debt\_TA + \beta_3 Domestic\_Accounts + \beta_4 ROA + \beta_5 Size + \beta_6 Headquarter + \varepsilon$$

Table 5. *The table shows the regression outputs for regression 1 and 2 with dependent variables respectively CAR (0; +1) and CAR (-1; +1)*

	Regression 1	**Regression 2**
Dependent variable	CAR (0; +1)	CAR (-1; +1)
Variable	Coefficient(t-stat)	Coefficient(t-stat)
C	0.175570(0.5845)	0.151152(0.6168)
CAPADEQ	-0.032209(0.9500)	-0.380095(0.4329)
DEBT/TA	-0.021513(0.9464)	0.028357(0.9250)
DOMESTIC ACCOUNTS	***-0.097393(0.0749)*** *	-0.079427(0.1214)
ROA	2.106254(0.2988)	2.365752(0.2158)
SIZE	-0.014388(0.1444)	-0.012678(0.1712)
R-squared	0.136531	0.124291
Adjusted R-squared	0.060788	0.047474
F-statistic	1.802552	1.618021
Prob(F-stat)	0.126911	0.169968

As it can be seen from the tables above, in the first regression there is only one significant independent variable – *DOMESTIC_ACCOUNTS*. At 10% significance. Unfortunately, in Regression 2, none of the independent variables are significant. These results could mean two things – first, the chosen independent variables are not actually impacting on the abnormal performance, or the window we chose for calculating the cumulative abnormal returns is not right. However, in the 3-day event window, we did find strong sings for abnormal performance. What is more, the CAR windows are the only one we can actually construct in this event window. So, we can assume that for this short-term event window the banks` specific factors that were chosen for independent variables, are not responsible for the movement of the stock returns.

On the other hand, we explore the specific effect on the UK banks by including in the lattes two regression the dummy variable *Headquarter*.

Table 6. *The table shows the regression outputs for regression 1 and 2 with dependent variables respectively CAR (0; +1) and CAR (-1; +1) with dummy variable Headquarters*

	Regression 1.1	**Regression 2.1**
Dependent variable	CAR (0; +1)	CAR (-1; +1)
Variable	Coefficient(t-stat)	Coefficient(t-stat)
C	0.255732(0.3956)	0.237090(0.3904)
CAPADEQ	0.216142(0.6566)	-0.113847(0.7983)
DEBT/TA	-0.124750(0.6780)	-0.082320(0.7650)
DOMESTIC ACCOUNTS	***-0.105103(0.0405) *****	***-0.087692(0.0614) ****
HEADQUARTER	***-0.105214(0.0031) ******	***-0.112796(0.0006) ******
ROA	-0.028835(0.9885)	0.076802(0.9667)
SIZE	-0.013348(0.1468)	-0.011564(0.1699)
R-squared	0.262517	0.290120
Adjusted R-squared	0.183501	0.214061
F-statistic	3.322328	3.814422
Prob(F-stat)	0.007200	0.002949

Here we find that for both regressions there are two significant independent variables – *DOMESTIC_ACCOUNTS* and *HEADQUARTER*, where *DOMESTIC_ACCOUNTS* is significant at 5% in Regression 1.1 and at 10% in Regression 2.1, and *HEADQUARTER* is significant at 1% significance level in both cases. What is more, in the regressions that include the dummy variable, R-squared is higher than in the ones that do now, showing the good fit of the data.

Event window (-4, +4)

For the other event window, we conduct 3 regressions for each of the two main models. First one uses CAR (-2, 2) as dependent variable, second one uses CAR (-4, 4) and last one uses CAR (-2, 4). The intuition behind these CARs is one to capture the effect for the whole event window (CAR (-4, 4)), one to capture the short-term effect close to day 0 (CAR (-2, 2)) and one to capture the effect mostly after the event date, since the days after it show abnormal performance (CAR (-2, 4)).

For each of the three regressions, we run additional one with including the dummy variable *Headquarter*.

$$CAR(-2,+2) = \alpha + \beta_1 Capadeq + \beta_2 Debt\_TA + \beta_3 Domestic\_Accoutns + \beta_4 ROA + \beta_5 Size + \varepsilon$$

$$CAR(-4,+4) = \alpha + \beta_1 Capadeq + \beta_2 Debt\_TA + \beta_3 Domestic\_Accoutnts + \beta_4 ROA + \beta_5 Size + \varepsilon$$

$$CAR(-2,+4) = \alpha + \beta_1 Capadeq + \beta_2 Debt\_TA + \beta_3 Domestic\_Accoutns + \beta_4 ROA + \beta_5 Size + \varepsilon$$

$$CAR(-2,+2) = \alpha + \beta_1 Capadeq + \beta_2 Debt\_TA + \beta_3 Domestic\_Accounts + \beta_4 ROA + \beta_5 Size + \beta_6 Headquarter + \varepsilon$$

$$CAR(-4,+4) = \alpha + \beta_1 Capadeq + \beta_2 Debt\_TA + \beta_3 Domestic\_Accounts + \\ +\beta_4 ROA + \beta_5 Size + \beta_6 Headquarter + \varepsilon$$

$$CAR(-2,+4) = \alpha + \beta_1 Capadeq + \beta_2 Debt\_TA + \beta_3 Domestic\_Accounts + \\ +\beta_4 ROA + \beta_5 Size + \beta_6 Headquarters + \varepsilon$$

Table 7. *The table shows the regression outputs for regression 1 and 2 with dependent variables respectively CAR (-4; +4), CAR (-2; +4) and CAR (-2; +2)*

	Regression 3	**Regression 4**	**Regression 5**
Dependent variable	CAR (-4; +4)	CAR (-2; +4)	CAR (-2; +2)
Variable	Coefficient(t-stat)	Coefficient(t-stat)	Coefficient(t-stat)
C	0.024352(0.9218)	-0.002877(0.9905)	0.089683(0.7287)
CAPADEQ	0.334655(0.4012)	0.037482(0.9232)	-0.250212(0.5463)
DEBT/TA	0.171759(0.4886)	0.259762(0.2857)	0.109395(0.6717)
DOMESTIC ACCOUNTS	***-0.109832(0.0105) *****	***-0.108172(0.100) ******	-0.063375(0.1484)
ROA	1.972118(0.2095)	***3.286339(0.0348) *****	1.834450(0.2619)
SIZE	***-0.019503(0.0121) *****	***-0.021485(0.0050) ******	***-0.014961(0.0613) ****
R-squared	0.268532	0.332794	0.142675
Adjusted R-squared	0.204368	0.274267	0.067471
F-statistic	4.185092	5.686184	1.897178
Prob(F-stat)	0.002619	0.000254	0.109059

From the results above, it can be seen that for Regression 3, there are two significant independent variables at 5% *DOMESTIC_ACCOUNTS* and *SIZE*. For Regression 4, there are 3 significant independent variables - *DOMESTIC_ACCOUNTS* at 1%, *ROA* at 5% and *SIZE* at 1% as well. For the last regression, 5, only *SIZE* is significant at 10% significance level. Results above lead us to assume that, *SIZE* is the independent variable that has the biggest effect on the abnormal performance, while the other two have smaller impact when the dependent variable changes.

To find the specific UK effect, we estimate three more regressions with dummy variable *Headquarter*.

Table 8. *The table shows the regression outputs for regression 1 and 2 with dependent variables respectively CAR (-4; +4), CAR (-2; +4) and CAR (-2; +2) with dummy variable Headquarters*

	Regression 3.1	**Regression 4.1**	**Regression 5.1**
Dependent variable	CAR (-4; +4)	CAR (-2; +4)	CAR (-2; +2)
Variable	Coefficient(t-stat)	Coefficient(t-stat)	Coefficient(t-stat)
C	0.034141(0.8917)	0.021766(0.9286)	0.150883(0.0.5370)
CAPADEQ	0.364982(0.3702)	0.113827(0.7721)	-0.060606(0.8780)
DEBT/TA	0.159153(0.5265)	0.228026(0.3496)	0.030577(0.9003)
DOMESTIC ACCOUNTS	***-0.110773(0.0106)*** **	***-0.110542(0.0085)*** ***	***-0.069261(0.0947)*** *
HEADQUARTERS	-0.012848(0.6530)	-0.032344(0.2448)	***-0.080327(0.0053)*** ***
ROA	1.711394(0.3092)	2.629994(0.1089)	0.204394(0.9002)
SIZE	***-0.019376(0.0133)*** **	***-0.021166(0.0056)*** ***	***-0.014167(0.0598)*** *
R-squared	0.271191	0.348861	0.254913
Adjusted R-squared	0.193104	0.279096	0.175083
F-statistic	3.472951	5.000529	3.193175
Prob(F-stat)	0.005471	0.000365	0.009117

Looking at the table above, we can see that *Size* and *Domesitc_Accounts* are significant in all three cases. What is more, *Headquarter* is significant in Regression 5.1 at 1% significance level.

In general, what these results mean is that *Capadeq*, *Debt_TA* and *ROA* were not significant in none of the 10 regressions. This directly rejects H3: "All included variables in the regression have significant effect on the CAR". The strongest impact of all, was the one of *Size*. What is more, the negative parameter it has in all cases show that the smaller the bank is, the smaller the magnitude of its stock reaction is when facing economic news, similar to Brexit. This is consistent with economic theory, because the bigger the bank is, the more transactions and services it performs, the higher the relation between stock and the market conditions is. The intuition behind this is that bigger banks could possibly have more influence on the whole banking industry, as well as having more foreign and international transactions, thus have higher stock price synchronicity with the market and so on.

Another independent variable that is significant in 8 out of 10 times is *Domestic_Accounts*. The sign of its parameter is always negative as well, showing the negative effect, it has on the abnormal performance. The economic intuition behind it is that the more domestic accounts a bank has, the more unresponsive to international news it is.

As far as the dummy variable are concerned, *Headquarter* is significant at 1% significance level in regressions 1.1, 2.1 and 5.1 The coefficients calculated are on average -0.1% which means that Car will decrease with 0.1% if everything else stays the same. As we can see, the R-squared of the regressions that have dummy variable are higher than the once that do not, which suggests that the model is correctly specified this way.

One thing that should be clarified is that the results from the regression depend on the event window. Possible intuition behind this is that in a longer event window, some firm-specific news could alter the results and impact the cumulative abnormal returns in a different way.

Comparing our results with Burdekin, Hughson, Gu (2017), we can see that overall the results are consistent with each other. The main difference is that what they found is that the most affected are PIIGS countries, which is not the case in our findings. The intuition behind the dissimilarity is that we did include only one Irish bank and no Greek banks in the sample. Working with limited sample size, it is normal that the results are quite different, because of the unaccounted information.

As far as the paper of Ramiah, Pham, Moosa (2016) is concerned, we find that our results are consistent with theirs. The difference is only in the value of the abnormal performance. This could be a results of different sample size, different approach in estimating the expected normal returns or different event window. All in all, the thesis is proven to be consistent to some extent with the previous two papers.

5. Conclusion

In conclusion, the thesis analyzes the effect of Brexit vote on the stock returns in the banking sector in Europe. Our findings show that as expected the event has on average negative significant impact on the banks` stock prices. For the sample 63 banks from the STOXX TMI Banks index were chosen for the sample. For the sake of the research, the sample was divided in two groups – UK group, consisting of 8 banks and EX UK group, including the rest of the 63. The analysis show that UK experienced more severe abnormal performance than the rest of the European countries used in the sample, which resulted in abnormal return of -17.53% in the 3-day event window and abnormal return of -12.17% in the 9-day event window.

However, while investigating the problem, we found out that not only United Kingdom, but the rest of Europe was affected as well. The impact was not as negative as with UK, but still significant, resulting in the following abnormal performance: -6.47% and -7.27% for ALL group in the different windows, respectively 3-day and 9-day.), -5.64% and – 5.78% for the EX UK group. These results show that the main driver for the whole banking sector was the UK banks. What is more, the findings lead to the inference that the impact was harsher during the first 1-2 days after the event, which supported the statement made in Dangol (2008). By constructing a cross-sectional regression with different cumulative abnormal returns, we found that two out of the five proposed factors were significant. Bank`s size and the percentage of domestic accounts were proven negative related to stock returns.

The contribution that our thesis has to prior literature is that it follows relatively new and unknown event in the economic history. It also builds on the previous studies we investigate, since it narrows the research down to one sector only, but at the same time considers not only the effect on UK, but rather on Europe as a whole. The paper could offer to the prior literature valuable insights and give an example what could be expected in future events similar to the referendum in United Kingdom.

One of the biggest limitation that the thesis has is the small number of banks in the UK Group. This is a result of the small number of independent listed UK banks, because of high consolidation. Bearing that in mind, the reader should be aware that even though the results show strong enough evidence for abnormal performance, we cannot guarantee high reliability. Furthermore, we chose not to include Greek banks, since the events happening in the country in the past few years could possibly bias the overall results.

References

1 Arnold, M, Noonan, L., (2016), Banks begin moving some operations out of Britain, *Financial Times*

2 Bartholdy, J., Olson, D., Peare, P. (2006). Conducting Event Studies on a small stock exchange, Finance Research Group, Aarhus School of Business, American University of Sharjah

3 Benninga, S. (2008). Financial Modeling, 3rd edition, *The MIT Press*, Cambridge, Massachusetts, London, England

4 Blume, M. E., (1971), On the assessment of risk, Journal of Finance 26, pp. 1-10

5 Brooks, C. (2014). Introductory Econometrics for Finance, 3rd edition, Cambridge: Cambridge University Press

6 Brown, S., Warner, J. (1985), Using daily stock returns: The Case of Event Studies, *Journal of Financial Economics,* vol.14

7 Burdekin, R.C.K., Hughson, E., Gu, J. (March 2017), A First Look at Brexit and Global Equity Markets, *Applied Economics Letters,* Claremont McKenna College

8 Cable, J., Holland, K. Modelling Normal Returns in Event Studies: A Model-Selection Approach and Pilot Study

9 Campbell, J.Y., Lo, A.W., MacKinlay, A.C., The Econometrics of Financial Markets, *Princeton University Press*, Princeton, New Jersey

10 Carow, K. A., Kane, E. J. (2002), Event-study evidence of the value of relaxing long-standing regulatory restraints on banks, 1970-2000, Quarterly Review of Economics and Finance 42, pp.439-463

11 Chan, W.S., (2001), Stock Price Reaction to News and No-News: Drift and Reversal After Headlines, M.I.T.

12 Chen, L., Zhang, L., (2010) A Better Three-Factor Model That Explains More Anomalies, *The Journal of finance*, vol. LXV, no. 2

13 Cox, D. R., Peterson, D. R. (1994), Stock returns following large one-day declines: evidence on short-term reversals and longer-term performance, Journal of Finance 49, pp. 255-267

14 Dangol, J., Unanticipated political events and stock returns: An event study, Tribhuvan University

15 Fama, F. E., (1970) Efficient Capital Markets: A Review of Theory and Empirical Work, Journal of Finance, Volume 25, Issue 2, pp 383-417

16 Gonedes, N. J., (1973), Evidence on the information content of accounting numbers: accounting-based and market-based estimates of systematic risk, Journal of Financial and Quantitative Analysis 8, pp. 407-443

17 Heston, Steven L. and Nitish R. Sinha (2016). "News versus Sentiment: Predicting Stock Returns from News Stories," Finance and Economics Discussion Series 2016-048. Washington: Board of Governors of the Federal Reserve System, http://dx.doi.org/10.17016/FEDS.2016.048

18 Kanas, A. (2005), Pure contagion effects in international banking: the case of BCCI's failure, Journal of Applied Economics 8, pp.101-123

19 Litvak, K. (2007), The effect of the Sarbanes-Oxley act on non-US companies cross-listed in the US, Journal of Corporate Finance 13, pp.195-228

20 MacKinley, A.S. (March 1997), Event Studies in Economics and Finance, *Journal of Economic Literature*, vol.35, pp. 13-39

21 Mahmood, S., Irfan M., Iqbal, S., Kamran, M., (2014), Ijaz, A., Impact of Political Events on Stock Market: Evidence from Pakistan, *Journal of Asian Business Strategy*

22 Malkiel, B.G., (2003) The Eficient Market Hypothesis and Its Critics, *Journal of Economic Perspectives*, vol.17, num 1, pp. 59 – 82

23 Merrill, A.A., (1966), Behavior of prices on Wall Street, Chappaqua, N.Y.: Analysis Press

24 Miyajima, H., Yafeh, Y. (2007), Japan's banking crisis: an event-study perspective, Journal of Banking & Finance 31, pp.2866-2885

25 Nahoji. S.J.M., Abadi, H.R.D., Rafat, B., (2014), The relationship between stock prices and debt ratio and Capital flows with assets, *Interdisciplinary journal of contemporary research in business*, vol.6, no 1

26 Niederhoffer, V., (1971), The analysis of world events and stock prices, *The Journal of Business*, Vol. 44, No. 2, pp. 193-219, The University of Chicago Press

27 NZIOKI, S. J., (2011), The impact of capital adequacy on the financial performance of commercial banks quoted at the Nairobi stock exchange, *A Research Project submitted in partial fulfillment of the requirements for the degree of Masters of Business Administration-School of Business, University of Nairobi*

28 Oprita, A., (2016), If Brexit Wins, It Is Unlikely to Be a Lehman-Like Event, Real Money, TheStreet

29 Pain, N., Young G., (2004), The macroeconomic impact of UK withdrawal from the EU, *Elsevier*

30 Pynnönen, S., (2005), On regression based event study

31 Ramiah, V., Pham H. N. A., Moosa I. (2016): The sectoral effects of Brexit on the British economy: early evidence from the reaction of the stock market, *Applied Economics*

32 Shiller, R.J., (2003), From eficient market theory to behavioral finance, *Cowles Foundation for research in economics at Yale University*

33 Sorokina, N., Booth, D.E., Thornton, J.H., (2013), Robust Methods in Event Studies: Empirical Evidence and Theoretical Implications, *Journal of Data Science* 11, pp. 575-606, Kent State University

34 Strong, N, (1992), Modelling Abnormal Returns; A Review Article, Journal of Business, Finance and Accounting

35 Tewels, R.J., Bradley, E.S., (1998), The Stock Market, John Wiley and Sons

36 Van Dijk, M.A., (2011), Is size dead? A review of the size effect in equity returns, *Journal of Banking & Finance* 35 (2011) 3263–3274

37 Warrad, L., Al Omari, R. (2013), Effect of Earning Per Shares (EPS) and Return On Assets (ROA) against Share Price on Coal Mining Company Listed in Indonesia Stock Exchange, *Journal of Resources Development and Management*, vol.7, 2015

Appendix A: List of banks included in the study

1. HSBC	33. SKANDIABANKEN
2. LLOYDS	34. SPAREBANKEN 1 NORD NORGE
3. BARCLAYS	35. SPAREBANKEN MORE
4. STANDARD CHARTERED	36. ING
5. ROYAL BANK OF SCOTLAND	37. ABN AMRO
6. CYBG	38. DANSKE
7. METRO BANK	39. JYSKE
8. VIRGIN MONEY HOLDINGS	40. SYDBANK
9. UNICREDIT	41. RINKJOBING
10. MEDIOBANCA	42. BNP PARIBAS
11. BANCO BPM	43. GRP SOCIETE GENERALE
12. UBI BCA	44. CREDIT AGRICOLE
13. FINECOBANK	45. NATIXIS
14. BPER BANCA	46. CICA
15. INTESA SANPAOLO RNC	47. DEUTSCHE BANK
16. BCA POPOLARE	48. COMMERZBANK
17. CREDITO EMILIANO	49. UBS
18. CREDITO VALTELLINESE	50. CREDIT SUISSE
19. BCO SANTANDER	51. JULIUS BAER
20. BCO BILBAO	52. CEMBRA MONEY
21. CAIXABANK	53. CANTONALE VAUDOISE
22. BCO SABADELL	54. VALIANT
23. BANKINTER	55. VONTOBEL
24. BANKIA	56. LUZERNER
25. BCO POPULAR	57. ST GALLER
26. BCO COMERCIAL	58. GRAUBUENDER
27. BCO BPI	59. ERSTE GROUP BANK
28. BANK OF IRELAND	60. RAIFFEISEN
29. DNB	61. KBC GROUP
30. SPAREBANK 1 SRBANK	62. KOMERCNI BANKA
31. NOR FINANS	63. MONETA MONEY BANK
32. SPAREBANKEN 1 SMN	

Appendix B: Cross-sectional regression estimation outputs

1. Regression 1 – CAR (-1, 1) in 3-day event window

Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 15:09
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.151152	0.300390	0.503186	0.6168
CAPADEQ	-0.380095	0.481282	-0.789755	0.4329
DEBT_TA	0.028357	0.299775	0.094596	0.9250
DOMESTIC_ACCOUNTS__	-0.079427	0.050509	-1.572520	0.1214
ROA	2.365752	1.890225	1.251572	0.2158
SIZE	-0.012678	0.009149	-1.385701	0.1712

R-squared	0.124291	Mean dependent var	-0.068762
Adjusted R-squared	0.047474	S.D. dependent var	0.084889
S.E. of regression	0.082850	Akaike info criterion	-2.053181
Sum squared resid	0.391253	Schwarz criterion	-1.849073
Log likelihood	70.67521	Hannan-Quinn criter.	-1.972905
F-statistic	1.618021	Durbin-Watson stat	1.715804
Prob(F-statistic)	0.169968		

Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 15:11
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.237090	0.273893	0.865631	0.3904
CAPADEQ	-0.113847	0.443330	-0.256801	0.7983
DEBT_TA	-0.082320	0.274016	-0.300419	0.7650
DOMESTIC_ACCOUNTS__	-0.087692	0.045937	-1.908949	0.0614
ROA	0.076802	1.829914	0.041970	0.9667
SIZE	-0.011564	0.008316	-1.390447	0.1699
HEADQUARTERS	-0.112796	0.031186	-3.616858	0.0006

R-squared	0.290120	Mean dependent var	-0.068762
Adjusted R-squared	0.214061	S.D. dependent var	0.084889
S.E. of regression	0.075257	Akaike info criterion	-2.231373
Sum squared resid	0.317164	Schwarz criterion	-1.993247
Log likelihood	77.28824	Hannan-Quinn criter.	-2.137717
F-statistic	3.814422	Durbin-Watson stat	1.845977
Prob(F-statistic)	0.002949		

2. Regression 2 – CAR (0, 1) in 3-day event window

Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 13:13
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.175570	0.319210	0.550014	0.5845
CAPADEQ	-0.032209	0.511436	-0.062977	0.9500
DEBT_TA	-0.021513	0.318557	-0.067532	0.9464
DOMESTIC_ACCOUNTS__	-0.097393	0.053674	-1.814542	0.0749
ROA	2.106254	2.008652	1.048591	0.2988
SIZE	-0.014388	0.009722	-1.479828	0.1444

R-squared	0.136531	Mean dependent var	-0.076661
Adjusted R-squared	0.060788	S.D. dependent var	0.090845
S.E. of regression	0.088041	Akaike info criterion	-1.931646
Sum squared resid	0.441815	Schwarz criterion	-1.727538
Log likelihood	66.84684	Hannan-Quinn criter.	-1.851369
F-statistic	1.802552	Durbin-Watson stat	1.740231
Prob(F-statistic)	0.126911		

Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 15:57
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.255732	0.298753	0.855997	0.3956
CAPADEQ	0.216142	0.483568	0.446973	0.6566
DEBT_TA	-0.124750	0.298887	-0.417381	0.6780
DOMESTIC_ACCOUNTS__	-0.105103	0.050107	-2.097579	0.0405
ROA	-0.028835	1.996006	-0.014446	0.9885
SIZE	-0.013348	0.009071	-1.471450	0.1468
HEADQUARTERS	-0.105214	0.034017	-3.093001	0.0031

R-squared	0.262517	Mean dependent var	-0.076661
Adjusted R-squared	0.183501	S.D. dependent var	0.090845
S.E. of regression	0.082088	Akaike info criterion	-2.057615
Sum squared resid	0.377351	Schwarz criterion	-1.819489
Log likelihood	71.81488	Hannan-Quinn criter.	-1.963959
F-statistic	3.322328	Durbin-Watson stat	1.808071
Prob(F-statistic)	0.007200		

3. Regression 3 – CAR (-2, 2) in 9-day event window

Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 13:34
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.089683	0.257278	0.348583	0.7287
CAPADEQ	-0.250212	0.412210	-0.607001	0.5463
DEBT_TA	0.109395	0.256752	0.426071	0.6717
DOMESTIC_ACCOUNTS__	-0.063375	0.043260	-1.464968	0.1484
ROA	1.834450	1.618944	1.133115	0.2619
SIZE	-0.014961	0.007836	-1.909240	0.0613

R-squared	0.142675	Mean dependent var	-0.055064
Adjusted R-squared	0.067471	S.D. dependent var	0.073482
S.E. of regression	0.070959	Akaike info criterion	-2.363025
Sum squared resid	0.287009	Schwarz criterion	-2.158917
Log likelihood	80.43527	Hannan-Quinn criter.	-2.282748
F-statistic	1.897178	Durbin-Watson stat	1.713717
Prob(F-statistic)	0.109059		

Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 13:48
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.150883	0.242895	0.621188	0.5370
CAPADEQ	-0.060606	0.393155	-0.154153	0.8780
DEBT_TA	0.030577	0.243004	0.125830	0.9003
DOMESTIC_ACCOUNTS__	-0.069261	0.040738	-1.700146	0.0947
ROA	0.204394	1.622808	0.125951	0.9002
SIZE	-0.014167	0.007375	-1.920947	0.0598
HEADQUARTERS	-0.080327	0.027657	-2.904430	0.0053

R-squared	0.254913	Mean dependent var	-0.055064
Adjusted R-squared	0.175083	S.D. dependent var	0.073482
S.E. of regression	0.066740	Akaike info criterion	-2.471595
Sum squared resid	0.249434	Schwarz criterion	-2.233469
Log likelihood	84.85524	Hannan-Quinn criter.	-2.377939
F-statistic	3.193175	Durbin-Watson stat	1.758190
Prob(F-statistic)	0.009117		

4. Regression 4 – CAR (-4, 4) in 9-day event window

Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 15:39
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.024352	0.246937	0.098615	0.9218
CAPADEQ	0.334655	0.395641	0.845855	0.4012
DEBT_TA	0.171759	0.246432	0.696986	0.4886
DOMESTIC_ACCOUNTS__	-0.109832	0.041521	-2.645188	0.0105
ROA	1.972118	1.553870	1.269165	0.2095
SIZE	-0.019503	0.007521	-2.593064	0.0121

R-squared	0.268532	Mean dependent var	-0.068629
Adjusted R-squared	0.204368	S.D. dependent var	0.076355
S.E. of regression	0.068107	Akaike info criterion	-2.445076
Sum squared resid	0.264399	Schwarz criterion	-2.240968
Log likelihood	83.01991	Hannan-Quinn criter.	-2.364800
F-statistic	4.185092	Durbin-Watson stat	1.926141
Prob(F-statistic)	0.002619		

Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 14:31
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.034141	0.249620	0.136771	0.8917
CAPADEQ	0.364982	0.404040	0.903330	0.3702
DEBT_TA	0.159153	0.249732	0.637294	0.5265
DOMESTIC_ACCOUNTS	-0.110773	0.041866	-2.645896	0.0106
ROA	1.711394	1.667740	1.026176	0.3092
SIZE	-0.019376	0.007579	-2.556385	0.0133
HEADQUARTERS	-0.012848	0.028422	-0.452042	0.6530

R-squared	0.271191	Mean dependent var	-0.068629
Adjusted R-squared	0.193104	S.D. dependent var	0.076355
S.E. of regression	0.068588	Akaike info criterion	-2.416973
Sum squared resid	0.263438	Schwarz criterion	-2.178847
Log likelihood	83.13464	Hannan-Quinn criter.	-2.323317
F-statistic	3.472951	Durbin-Watson stat	1.907344
Prob(F-statistic)	0.005471		

5. Regression 5 – CAR (-2, 4) in 9-day event window

Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 14:35
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002877	0.241542	-0.011909	0.9905
CAPADEQ	0.037482	0.386998	0.096852	0.9232
DEBT_TA	0.259762	0.241048	1.077635	0.2857
DOMESTIC_ACCOUNTS__	-0.108172	0.040614	-2.663392	0.0100
ROA	3.286339	1.519924	2.162173	0.0348
SIZE	-0.021485	0.007357	-2.920447	0.0050

R-squared	0.332794	Mean dependent var	-0.070267
Adjusted R-squared	0.274267	S.D. dependent var	0.078201
S.E. of regression	0.066619	Akaike info criterion	-2.489252
Sum squared resid	0.252974	Schwarz criterion	-2.285144
Log likelihood	84.41144	Hannan-Quinn criter.	-2.408975
F-statistic	5.686184	Durbin-Watson stat	1.998551
Prob(F-statistic)	0.000254		

Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 14:34
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.021766	0.241648	0.090073	0.9286
CAPADEQ	0.113827	0.391138	0.291015	0.7721
DEBT_TA	0.228026	0.241757	0.943202	0.3496
DOMESTIC_ACCOUNTS__	-0.110542	0.040529	-2.727464	0.0085
ROA	2.629994	1.614483	1.629001	0.1089
SIZE	-0.021166	0.007337	-2.884646	0.0056
HEADQUARTERS	-0.032344	0.027515	-1.175505	0.2448

R-squared	0.348861	Mean dependent var	-0.070267
Adjusted R-squared	0.279096	S.D. dependent var	0.078201
S.E. of regression	0.066397	Akaike info criterion	-2.481882
Sum squared resid	0.246882	Schwarz criterion	-2.243756
Log likelihood	85.17927	Hannan-Quinn criter.	-2.388226
F-statistic	5.000529	Durbin-Watson stat	1.970719
Prob(F-statistic)	0.000365		

Appendix C: Cross-sectional regression tests

White`s test of heteroscedasticity

1. Regression 1 – CAR (-1, 1) in 3-day event window

Heteroskedasticity Test: White

F-statistic	0.319665	Prob. F(5,57)	0.8991
Obs*R-squared	1.718387	Prob. Chi-Square(5)	0.8866
Scaled explained SS	3.971610	Prob. Chi-Square(5)	0.5535

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/02/17 Time: 15:09
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.021458	0.029969	-0.716020	0.4769
CAPADEQ^2	-0.019155	0.299470	-0.063964	0.9492
DEBT_TA^2	0.035419	0.031896	1.110458	0.2715
DOMESTIC_ACCOUNTS__^2	0.002544	0.008155	0.311977	0.7562
ROA^2	0.698055	11.11780	0.062787	0.9502
SIZE^2	-2.64E-05	7.57E-05	-0.349390	0.7281

R-squared	0.027276	Mean dependent var	0.006210
Adjusted R-squared	-0.058051	S.D. dependent var	0.014876
S.E. of regression	0.015302	Akaike info criterion	-5.431271
Sum squared resid	0.013347	Schwarz criterion	-5.227163
Log likelihood	177.0850	Hannan-Quinn criter.	-5.350994
F-statistic	0.319665	Durbin-Watson stat	1.771005
Prob(F-statistic)	0.899149		

2. Regression 2 – CAR (0, 1) in 3-day event window

Heteroskedasticity Test: White

F-statistic	0.235058	Prob. F(5,57)	0.9455
Obs*R-squared	1.272759	Prob. Chi-Square(5)	0.9377
Scaled explained SS	3.453805	Prob. Chi-Square(5)	0.6304

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/02/17 Time: 13:14
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.021347	0.036803	-0.580035	0.5642
CAPADEQ^2	0.005354	0.367758	0.014558	0.9884
DEBT_TA^2	0.037127	0.039169	0.947866	0.3472
DOMESTIC_ACCOUNTS__^2	0.001877	0.010014	0.187448	0.8520
ROA^2	-0.217809	13.65298	-0.015953	0.9873
SIZE^2	-3.17E-05	9.29E-05	-0.341459	0.7340

R-squared	0.020203	Mean dependent var	0.007013
Adjusted R-squared	-0.065745	S.D. dependent var	0.018202
S.E. of regression	0.018791	Akaike info criterion	-5.020450
Sum squared resid	0.020127	Schwarz criterion	-4.816342
Log likelihood	164.1442	Hannan-Quinn criter.	-4.940174
F-statistic	0.235058	Durbin-Watson stat	1.913108
Prob(F-statistic)	0.945491		

3. Regression 3 – CAR (-2, 2) in 9-day event window

Heteroskedasticity Test: White

F-statistic	0.328758	Prob. F(5,57)	0.8936
Obs*R-squared	1.765895	Prob. Chi-Square(5)	0.8805
Scaled explained SS	2.505318	Prob. Chi-Square(5)	0.7757

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/02/17 Time: 13:34
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.016694	0.017217	-0.969614	0.3363
CAPADEQ^2	0.042194	0.172047	0.245246	0.8071
DEBT_TA^2	0.019747	0.018324	1.077667	0.2857
DOMESTIC_ACCOUNTS__^2	0.001996	0.004685	0.426096	0.6716
ROA^2	2.404095	6.387241	0.376390	0.7080
SIZE^2	1.58E-05	4.35E-05	0.363885	0.7173

R-squared	0.028030	Mean dependent var	0.004556
Adjusted R-squared	-0.057230	S.D. dependent var	0.008550
S.E. of regression	0.008791	Akaike info criterion	-6.539761
Sum squared resid	0.004405	Schwarz criterion	-6.335653
Log likelihood	212.0025	Hannan-Quinn criter.	-6.459484
F-statistic	0.328758	Durbin-Watson stat	1.742608
Prob(F-statistic)	0.893571		

4. Regression 4 – CAR (-4, 4) in 9-day event window

Heteroskedasticity Test: White

F-statistic	1.027263	Prob. F(6,56)	0.4174
Obs*R-squared	6.246507	Prob. Chi-Square(6)	0.3962
Scaled explained SS	5.254453	Prob. Chi-Square(6)	0.5116

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/02/17 Time: 14:22
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002832	0.012098	0.234082	0.8158
CAPADEQ^2	-0.173693	0.120614	-1.440068	0.1554
DEBT_TA^2	0.005044	0.012806	0.393885	0.6952
DOMESTIC_ACCOUNTS__^2	0.001143	0.003291	0.347386	0.7296
ROA^2	3.584426	4.463679	0.803020	0.4254
SIZE^2	-8.12E-06	3.11E-05	-0.260968	0.7951
HEADQUARTERS^2	0.004808	0.002406	1.998159	0.0506

R-squared	0.099151	Mean dependent var	0.004182
Adjusted R-squared	0.002631	S.D. dependent var	0.006151
S.E. of regression	0.006143	Akaike info criterion	-7.242696
Sum squared resid	0.002113	Schwarz criterion	-7.004569
Log likelihood	235.1449	Hannan-Quinn criter.	-7.149039
F-statistic	1.027263	Durbin-Watson stat	1.994403
Prob(F-statistic)	0.417390		

5. Regression 5 – CAR (-2, 4) in 9-day event window

Heteroskedasticity Test: White

F-statistic	0.477432	Prob. F(5,57)	0.7916
Obs*R-squared	2.532383	Prob. Chi-Square(5)	0.7716
Scaled explained SS	1.974611	Prob. Chi-Square(5)	0.8526

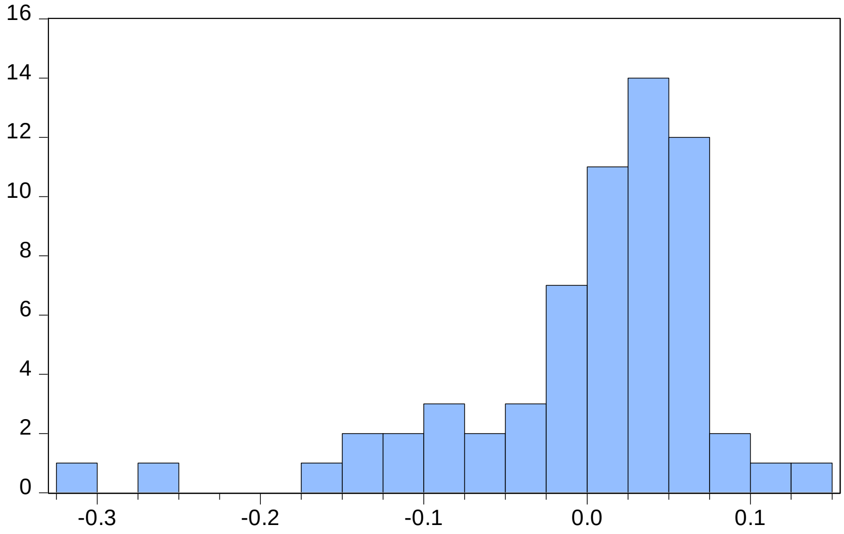
Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/02/17 Time: 14:35
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001678	0.011180	-0.150073	0.8812
CAPADEQ^2	-0.025074	0.111717	-0.224442	0.8232
DEBT_TA^2	0.001624	0.011899	0.136450	0.8919
DOMESTIC_ACCOUNTS__^2	0.000853	0.003042	0.280370	0.7802
ROA^2	1.521236	4.147490	0.366785	0.7151
SIZE^2	3.00E-05	2.82E-05	1.064226	0.2917

R-squared	0.040197	Mean dependent var	0.004015
Adjusted R-squared	-0.043997	S.D. dependent var	0.005587
S.E. of regression	0.005708	Akaike info criterion	-7.403359
Sum squared resid	0.001857	Schwarz criterion	-7.199251
Log likelihood	239.2058	Hannan-Quinn criter.	-7.323082
F-statistic	0.477432	Durbin-Watson stat	1.635638
Prob(F-statistic)	0.791587		

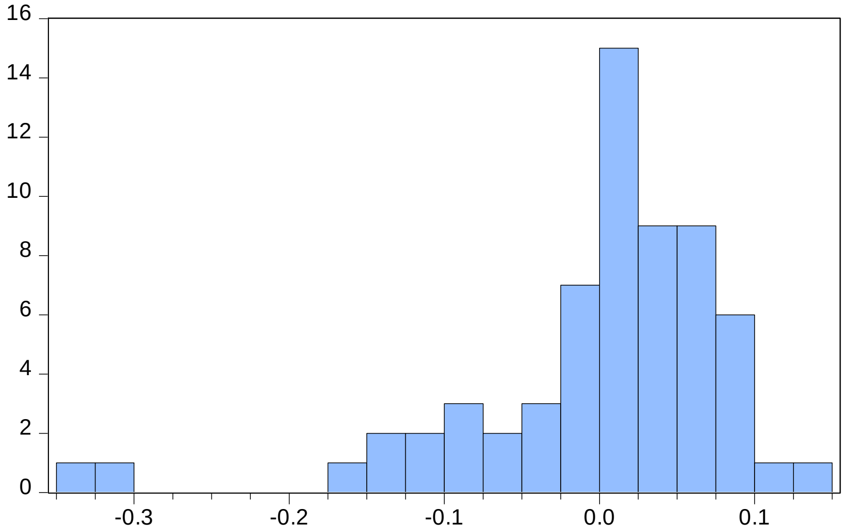
Jarque-Bera test for normality

1. Regression 1 – CAR (-1, 1) in 3-day event window



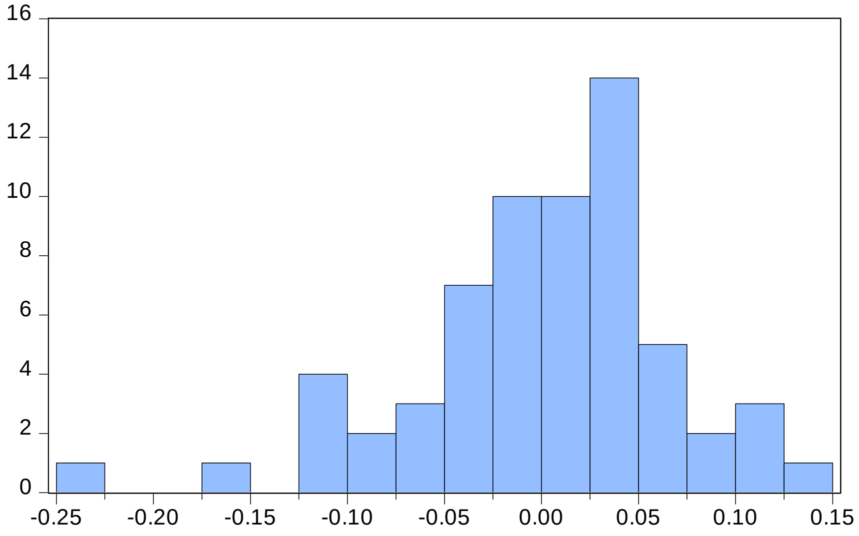
Series: Residuals	
Sample 1 63	
Observations 63	
Mean	3.48e-17
Median	0.019546
Maximum	0.134049
Minimum	-0.304153
Std. Dev.	0.079439
Skewness	-1.695185
Kurtosis	6.646861
Jarque-Bera	65.08481
Probability	0.000000

2. Regression 2 – CAR (0, 1) in 3-day event window



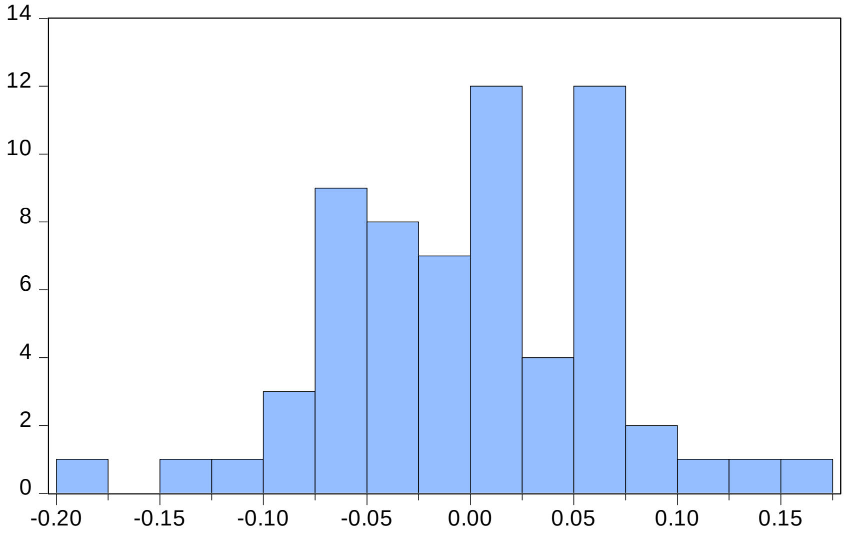
Series: Residuals	
Sample 1 63	
Observations 63	
Mean	3.00e-17
Median	0.016917
Maximum	0.139549
Minimum	-0.333241
Std. Dev.	0.084416
Skewness	-1.842271
Kurtosis	7.629992
Jarque-Bera	91.90830
Probability	0.000000

3. Regression 3 – CAR (-2, 2) in 9-day event window



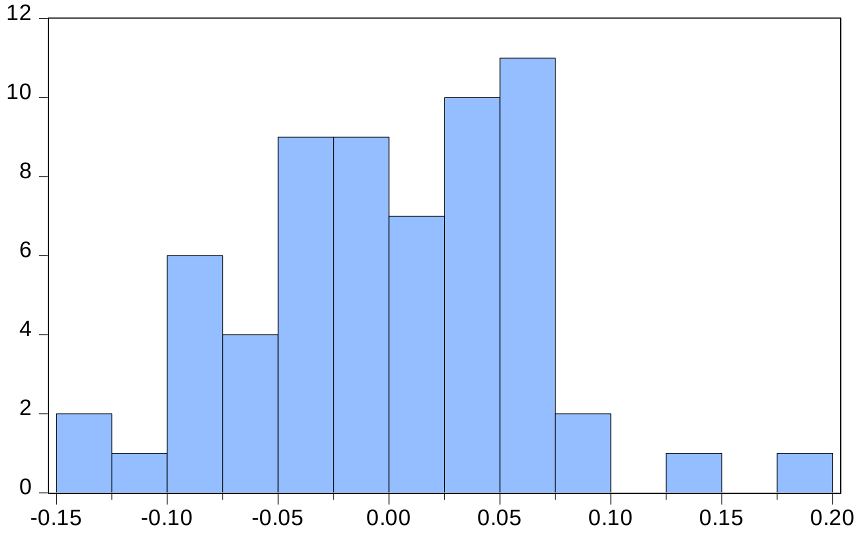
Series: Residuals	
Sample 1 63	
Observations 63	
Mean	8.81e-19
Median	0.009929
Maximum	0.137776
Minimum	-0.239919
Std. Dev.	0.068038
Skewness	-0.797509
Kurtosis	4.466246
Jarque-Bera	12.32165
Probability	0.002111

4. Regression 4 – CAR (-4, 4) in 9-day event window



Series: Residuals	
Sample 1 63	
Observations 63	
Mean	5.84e-18
Median	0.006678
Maximum	0.169049
Minimum	-0.176050
Std. Dev.	0.065184
Skewness	-0.062259
Kurtosis	3.129243
Jarque-Bera	0.084548
Probability	0.958607

5. Regression 5 – CAR (-2, 4) in 9-day event window



Series: Residuals
Sample 1 63
Observations 63

Mean	-2.95e-17
Median	0.009117
Maximum	0.175774
Minimum	-0.145857
Std. Dev.	0.063877
Skewness	-0.010289
Kurtosis	2.905082
Jarque-Bera	0.024761
Probability	0.987696

Ramsey RESET test for linearity

1. Regression 1 – CAR (-1, 1) in 3-day event window

Ramsey RESET Test
Equation: REGRESSION
Specification: CAR C CAPADEQ DEBT_TA DOMESTIC_ACCOUNTS__
ROA SIZE
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	2.432511	56	0.0182
F-statistic	5.917109	(1, 56)	0.0182
Likelihood ratio	6.328026	1	0.0119

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.037390	1	0.037390
Restricted SSR	0.391253	57	0.006864
Unrestricted SSR	0.353863	56	0.006319

LR test summary:

	Value	df
Restricted LogL	70.67521	57
Unrestricted LogL	73.83922	56

Unrestricted Test Equation:
Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 15:10
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.255414	0.333171	-0.766614	0.4465
CAPADEQ	0.276243	0.534827	0.516509	0.6075
DEBT_TA	0.055821	0.287847	0.193927	0.8469
DOMESTIC_ACCOUNTS__	0.068803	0.077858	0.883697	0.3806
ROA	-0.078634	2.073402	-0.037925	0.9699
SIZE	0.011346	0.013214	0.858650	0.3942
FITTED^2	-15.38048	6.322884	-2.432511	0.0182

R-squared	0.207978	Mean dependent var	-0.068762
Adjusted R-squared	0.123118	S.D. dependent var	0.084889
S.E. of regression	0.079492	Akaike info criterion	-2.121880
Sum squared resid	0.353863	Schwarz criterion	-1.883754
Log likelihood	73.83922	Hannan-Quinn criter.	-2.028224
F-statistic	2.450851	Durbin-Watson stat	1.764403
Prob(F-statistic)	0.035626		

2. Regression 2 – CAR (0, 1) in 3-day event window

Ramsey RESET Test
Equation: REGRESSION2
Specification: CAR C CAPADEQ DEBT_TA DOMESTIC_ACCOUNTS__ ROA SIZE
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	2.031399	56	0.0470
F-statistic	4.126583	(1, 56)	0.0470
Likelihood ratio	4.479323	1	0.0343

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.030322	1	0.030322
Restricted SSR	0.441815	57	0.007751
Unrestricted SSR	0.411492	56	0.007348

LR test summary:

	Value	df
Restricted LogL	66.84684	57
Unrestricted LogL	69.08650	56

Unrestricted Test Equation:
Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 13:14
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.228149	0.368909	-0.618444	0.5388
CAPADEQ	-0.080759	0.498534	-0.161993	0.8719
DEBT_TA	0.026228	0.311053	0.084319	0.9331
DOMESTIC_ACCOUNTS__	0.087406	0.104914	0.833123	0.4083
ROA	0.467730	2.115533	0.221093	0.8258
SIZE	0.014105	0.016922	0.833565	0.4081
FITTED^2	-13.43145	6.611921	-2.031399	0.0470

R-squared	0.195792	Mean dependent var	-0.076661
Adjusted R-squared	0.109627	S.D. dependent var	0.090845
S.E. of regression	0.085721	Akaike info criterion	-1.971000
Sum squared resid	0.411492	Schwarz criterion	-1.732874
Log likelihood	69.08650	Hannan-Quinn criter.	-1.877344
F-statistic	2.272286	Durbin-Watson stat	1.748386
Prob(F-statistic)	0.049391		

3. Regression 3 – CAR (-2, 2) in 9-day event window

Ramsey RESET Test
Equation: REGRESSION4
Specification: CAR C CAPADEQ DEBT_TA DOMESTIC_ACCOUNTS__ ROA SIZE
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	2.483348	56	0.0160
F-statistic	6.167016	(1, 56)	0.0160
Likelihood ratio	6.581791	1	0.0103

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.028471	1	0.028471
Restricted SSR	0.287009	57	0.005035
Unrestricted SSR	0.258537	56	0.004617

LR test summary:

	Value	df
Restricted LogL	80.43527	57
Unrestricted LogL	83.72617	56

Unrestricted Test Equation:
Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 13:47
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.144864	0.263839	-0.549062	0.5851
CAPADEQ	0.024167	0.409880	0.058960	0.9532
DEBT_TA	0.005303	0.249398	0.021264	0.9831
DOMESTIC_ACCOUNTS__	0.034430	0.057158	0.602367	0.5494
ROA	1.133028	1.575727	0.719051	0.4751
SIZE	0.009221	0.012293	0.750069	0.4564
FITTED^2	-15.32567	6.171373	-2.483348	0.0160

R-squared	0.227723	Mean dependent var	-0.055064
Adjusted R-squared	0.144979	S.D. dependent var	0.073482
S.E. of regression	0.067947	Akaike info criterion	-2.435751
Sum squared resid	0.258537	Schwarz criterion	-2.197625
Log likelihood	83.72617	Hannan-Quinn criter.	-2.342095
F-statistic	2.752133	Durbin-Watson stat	1.724254
Prob(F-statistic)	0.020485		

4. Regression 4 – CAR (-4, 4) in 9-day event window

Ramsey RESET Test
Equation: REGRESSION5
Specification: CAR C CAPADEQ DEBT_TA DOMESTIC_ACCOUNTS__ ROA SIZE HEADQUARTERS
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	2.382468	55	0.0207
F-statistic	5.676151	(1, 55)	0.0207
Likelihood ratio	6.187705	1	0.0129

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.024644	1	0.024644
Restricted SSR	0.263438	56	0.004704
Unrestricted SSR	0.238794	55	0.004342

LR test summary:

	Value	df
Restricted LogL	83.13464	56
Unrestricted LogL	86.22849	55

Unrestricted Test Equation:
Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 14:23
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.130430	0.249558	-0.522644	0.6033
CAPADEQ	-0.212332	0.457586	-0.464027	0.6445
DEBT_TA	0.023748	0.246556	0.096319	0.9236
DOMESTIC_ACCOUNTS__	0.036280	0.073671	0.492456	0.6244
ROA	2.279897	1.619859	1.407466	0.1649
SIZE	0.007506	0.013429	0.558950	0.5785
HEADQUARTERS	0.031504	0.033047	0.953310	0.3446
FITTED^2	-9.970123	4.184789	-2.382468	0.0207

R-squared	0.339370	Mean dependent var	-0.068629
Adjusted R-squared	0.255290	S.D. dependent var	0.076355
S.E. of regression	0.065892	Akaike info criterion	-2.483444
Sum squared resid	0.238794	Schwarz criterion	-2.211300
Log likelihood	86.22849	Hannan-Quinn criter.	-2.376409
F-statistic	4.036266	Durbin-Watson stat	1.746487
Prob(F-statistic)	0.001241		

5. Regression 5 – CAR (-2, 4) in 9-day event window

Ramsey RESET Test
Equation: REGRESSION6
Specification: CAR C CAPADEQ DEBT_TA DOMESTIC_ACCOUNTS__ ROA SIZE
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	2.273816	56	0.0268
F-statistic	5.170239	(1, 56)	0.0268
Likelihood ratio	5.563472	1	0.0183

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.021382	1	0.021382
Restricted SSR	0.252974	57	0.004438
Unrestricted SSR	0.231592	56	0.004136

LR test summary:

	Value	df
Restricted LogL	84.41144	57
Unrestricted LogL	87.19317	56

Unrestricted Test Equation:
Dependent Variable: CAR
Method: Least Squares
Date: 08/02/17 Time: 14:36
Sample: 1 63
Included observations: 63

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.068894	0.234964	-0.293209	0.7704
CAPADEQ	-0.082862	0.377304	-0.219615	0.8270
DEBT_TA	0.139296	0.238642	0.583703	0.5618
DOMESTIC_ACCOUNTS__	-0.035646	0.050541	-0.705289	0.4836
ROA	3.103923	1.469392	2.112386	0.0391
SIZE	-0.006300	0.009749	-0.646250	0.5208
FITTED^2	-5.232505	2.301200	-2.273816	0.0268

R-squared	0.389188	Mean dependent var	-0.070267
Adjusted R-squared	0.323744	S.D. dependent var	0.078201
S.E. of regression	0.064308	Akaike info criterion	-2.545815
Sum squared resid	0.231592	Schwarz criterion	-2.307689
Log likelihood	87.19317	Hannan-Quinn criter.	-2.452159
F-statistic	5.946871	Durbin-Watson stat	1.935662
Prob(F-statistic)	0.000074		

Appendix D: Descriptive statistics

	CAPADEQ	CAR_0_1	CAR_1_1	CAR_2_2	CAR_2_4	CAR_4_4	DEBT_TA	DOMESTIC...	ROA	SIZE
Mean	0.139387	-0.076661	-0.068762	-0.055064	-0.070267	-0.068629	0.918759	0.760127	0.005967	11.57335
Median	0.137000	-0.057527	-0.045344	-0.036752	-0.057491	-0.055266	0.926787	0.862200	0.004600	11.64769
Maximum	0.213900	0.063482	0.070105	0.070707	0.087790	0.072394	0.965463	0.999600	0.035000	14.60813
Minimum	0.098000	-0.423395	-0.394553	-0.302493	-0.274681	-0.275633	0.697182	0.060000	-0.010000	7.508312
Std. Dev.	0.025906	0.090845	0.084889	0.073482	0.078201	0.076355	0.043541	0.273309	0.007618	1.866234
Skewness	0.624114	-1.688520	-1.685497	-0.962980	-0.364715	-0.291859	-2.858946	-1.100586	1.856365	-0.149384
Kurtosis	2.816422	6.618680	6.347349	4.063134	2.471232	2.638237	13.33680	2.996985	8.207909	2.020880
Jarque-Bera	4.178409	64.31051	59.24191	12.70388	2.130615	1.237949	366.3024	12.71857	107.3800	2.750841
Probability	0.123786	0.000000	0.000000	0.001743	0.344622	0.538496	0.000000	0.001731	0.000000	0.252733
Sum	8.781400	-4.829625	-4.331998	-3.469002	-4.426809	-4.323629	57.88179	47.88800	0.375900	729.1208
Sum Sq. Dev.	0.041609	0.511674	0.446785	0.334772	0.379154	0.361464	0.117541	4.631259	0.003598	215.9354
Observations	63	63	63	63	63	63	63	63	63	63