UNIVERSITY OF VAASA

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THE IMPACT OF TERRORIST ATTACKS ON EUROPEAN STOCK MARKETS

Master's thesis in
Accounting and Finance

Master's Degree Programme in Finance

VAASA 2020

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Master's Programme: Master's Degree Programme in Finance
Year of Entering the University: 2013
Year of Completing the Thesis: 2020 **Pages**: 62

ABSTRACT

Terrorism is increasingly present and creates fear among the people in today's world. Terrorism can take many different forms, but massive and organized terrorist attacks can be seen as the most destructive and fearful form of terrorism. After the most destructive terrorist attack in the 2000s, 11th of September 2001 in New York, studying the impact of the terrorist attacks on the economy and stocks markets has started to raise its popularity. Earlier studies have investigated the stock market reactions and changes in investors' sentiment after the terrorist attacks with different terrorist attack samples and time periods. These studies have shown that terrorism can indeed cause negative reactions to stock markets and that these reactions can vary depending on the time and nature of the attack.

The purpose of this thesis was to study the stock market reactions of European countries to terrorist attacks occurred after the year 2000 and to see whether the terrorist attacks have been remarkable enough to cause negative reactions. The attack-day abnormal reactions of stock indices in countries where the terrorist attacks took place were in particular under the investigation. The sample of terrorist attacks included in this thesis consist of the most remarkable and a lot of media attention attracted attacks occurred mainly in Europe. The event study methodology is used to investigate the abnormal returns of stock indices after the terrorist attacks. Furthermore, the causes of abnormal returns were analyzed using regression analysis, by taking into account the specific features of different attacks, such as the number of fatalities and injured people.

The results of this study show that abnormal returns of European stock indices have been, on average, negative after the terrorist attacks in the 2000s. The stock index reactions have been stronger at the beginning of the 2000s and have decreased when moving closer to the year 2017. However, the stock index reactions after the most recent terrorist attacks in 2017 have also been negative for the major European stock indices. With the regression results, it can be concluded that the negative abnormal stock returns are mostly related to the changes in volatility.

KEYWORDS: Terrorism, Stock markets, Abnormal return, Event study

VAASAN YLIOPISTO
Laskentatoimen ja rahoituksen yksikkö
Tekijä: Tommi Heinonen
Tutkielman nimi: The impact of terrorist attacks on European stock markets
Työn ohjaaja: Klaus Grobys
Tutkinto: Kauppatieteiden maisteri
Oppiaine: Master's Degree Programme in Finance
Aloitusvuosi: 2013
Valmistumisvuosi: 2020 **Sivumäärä:** 62

TIIVISTELMÄ

Nykypäivänä terrorismi on yhä enenevissä määrin läsnä ja aiheuttaa pelkoa ihmisten keskuudessa. Terrorismia voi ilmentyä monissa eri muodoissa, mutta massiiviset ja järjestäytyneet terrori-iskut voidaan nähdä terrorismin tuhoisimpana ja pelokkaimpana muotona. New Yorkissa 11 syyskuuta 2001 tapahtunutta terrori-iskua voidaan pitää 2000-luvun tuhoisimpana iskuna. New Yorkissa tapahtuneen terrori-iskun jälkeen terrorismin vaikutuksia taloudelle ja osakemarkkinoille on aloitettu tutkimaan enemmän. Aikaisemmissa tutkimuksissa on tutkittu osakemarkkinoiden reaktioita ja muutoksia sijoittajien käyttäytymisessä terrori-iskujen jälkeen, hyödyntäen erilaisia ja eri aikoina tapahtuneita iskuja. Aikaisemmat tutkimukset ovat osoittaneet, että terrorismi voi aiheuttaa negatiivisia reaktioita osakemarkkinoilla. Osakemarkkinoiden reaktiot voivat vaihdella riippuen terrori-iskun luonteesta ja koosta, sekä siitä milloin isku on tapahtunut.

Tämän tutkielman tarkoituksena oli tutkia Euroopan maiden osakemarkkinoiden reaktioita vuoden 2000 jälkeen tapahtuneisiin terrori-iskuihin, ja selvittää ovatko terrori-iskut olleet riittävän merkittäviä aiheuttamaan negatiivisia reaktioita osakemarkkinoilla. Tutkielmassa keskityttiin erityisesti osakeindeksien epänormaaleihin tuottoihin isku päivinä. Tutkielman keskiössä oli aina sen maan osakeindeksi, joka oli iskun kohteena. Tutkielmaan valikoidut terrori-iskut ovat olleet merkittävimpiä ja eniten media huomiota herättäneitä iskuja, jotka ovat pääosin tapahtuneet Euroopassa. Osakeindeksien epänormaalien tuottojen tutkimiseen käytettiin tapahtumatutkimus menetelmää. Löydettyjen epänormaalien tuottojen syitä analysoitiin lisäksi regressioanalyysillä, ottamalla huomioon iskujen erityispiirteitä kuten kuolonuhrien ja loukkaantuneiden määrä.

Tämän tutkielman tulokset osoittavat, että Euroopan osakeindeksien epänormaali tuotto on ollut keskimäärin negatiivinen 2000-luvulla tapahtuneiden terrori-iskujen jälkeen. 2000-luvun alussa osakeindeksien reaktiot ovat olleet voimakkaampia ja reaktiot ovat laantuneet siirryttäessä lähemmäksi vuotta 2017. Tutkielmassa mukana olevat viimeaikaisimmat terrori-iskut vuonna 2017 ovat kuitenkin aiheuttaneet taas negatiivisia epänormaaleja tuottoja Euroopan tärkeimmille osakeindekseille. Regressioanalyysin tulosten perusteella voidaan todeta, että negatiiviset epänormaalit osaketuotot selittyvät enimmäkseen volatiliteetin muutoksilla.

AVAINSANAT: Terrorismi, Osakemarkkinat, Epänormaali tuotto, Tapahtumatutkimus

1. INTRODUCTION

Stock markets have a fundamental role in modern economies. They provide the platform for both companies to raise funds in order to grow and for individuals to invest in companies. When stock markets are discussed, reference is typically made to one or more stock indices. In general, stock markets go hand in hand with the economic situation: great performance of the stock market is typically a signal of a growing economy. When the economic conditions are strong and growing, the spending power of the citizens is greater, and they are able to buy goods and services. As a conclusion, stock markets can provide a helpful view on understanding the country's economic performance. However, in increasingly globalized world also a variety of factors that go beyond economic features and country borders can come to play and impact to the stock markets.

The stock markets fluctuate on the basis of how individuals perceive the economic conditions because the price of individual stocks reflects investors' current confidence and their hopes and fears about the future. This reality, combined with the highly liquid feature of the stock markets makes an intriguing research sites for investigation of how major unexpected, shocking events may produce turbulence and uncertainty to the stock markets. Shocking events, such as terrorists' attacks, nature catastrophes, political volatility, and major acts of violence, can trigger panic in the stock markets, which can manifest as abnormal behaviour in how people decide to buy or sell stocks.

This thesis examines the impact of shocking events on the stock markets through the specific lens of terroristic attacks. Since the 11 of September 2001 World Trade Center attacks in New York, terrorism has taken a stronger footing in people's everyday lives, concretely, and in terms of increased awareness. As terroristic attacks have the potential to cause a significant societal uncertainty, there is a need to gain a deeper understanding of their impact on stock markets and subsequently to economies. The need for this understanding is increasing, when considering the nature of the modern world, which is more global than perhaps ever, and where the news and information spread rapidly across countries through the media. As a result, information is widely and easily reachable, thus providing informed people more means to be aware of ongoing incidents and enabling them to act in the stock markets on the basis of this information.

Given these circumstances, this thesis not only investigates the consequences that a single terrorist attack may have to the stock markets of the respective country but also how the occurred attacks can spread to impact to the stock markets between different countries.

1.1. Purpose of the study

The purpose of this thesis is to study the effects of the terrorist attacks to the stock markets and investigate further the underlying features causing those possible effects. More precisely, it is explored whether terrorist attacks are remarkable enough to cause significant negative abnormal returns in stock indices, and what are the main explanatory factors of terrorist attacks that explain the stock index reactions. Furthermore, possible differences in stock reactions between different terrorist attacks, occurring in different time periods, are took into consideration.

The empirical part of the thesis focuses on European stock markets. To study the effects of different terrorist attacks to European stock indicess, the data comprise the most remarkable terrorist attacks that took place between the years 2001–2017. To get a better understanding of the possible *spillover effect* of the terrorist attacks, some of the attacks outside the European area are as well taken into account in the analysis.

In order to investigate the effects detailed above in the present thesis, *event study* methodology is utilized. The event study methodology is a popular and effective tool to examine the consequences of specific and unexpected events (e.g. terrorist attacks). By using the event study methodology, it is possible to define statistical significance of the potential abnormal reactions of the stock indices. The event study methodology is grounded on the assumptions of *the Efficient Markets Hypothesis* (EMH). According to this hypothesis, markets, where stock prices reflect completely available information, are called efficient markets. (Fama 1970.)

Research hypotheses of this thesis are formed in order to investigate detailed research questions above. Totally, the effects of terrorist attack on stock markets are investigated using four specific hypotheses. These hypotheses are: "*H1: Terrorist attacks are significant enough to cause negative abnormal returns in stock*

indices", "H2: The effects of terrorist attacks spread beyond the target country", "H3: Stock indices have become more immune to terrorist attacks" and *"H4: Specific characteristics of terrorist attacks are able to explain stock index reactions".*

1.2 Structure of the thesis

This thesis is divided into six chapters. The first chapter introduces the topic and the purpose of the thesis. The second chapter focuses on theories and issues relevant to the present study. In the third chapter, prior researches on the effects of terrorism on the economy and stock markets are reviewed. Chapter four presents the research hypotheses of the thesis and describes the data and methodologies used to answer the hypotheses. Then, the empirical findings of the study are presented in chapter five. Finally, in chapter six, conclusions are discussed based on the empirical findings.

2. THEORETICAL BACKGROUND

Theoretically, this study is structured around the hypothesis of efficient markets introduced by Eugene Fama (1970). According to this theory, in conditions where markets are efficient, they should react to all available information. In the modern financial world, stock markets are more and more integrated. Information and news spread around the world rapidly, having the ability to cause global changes in stock markets. With the given assumptions of the efficient market hypothesis, it is interesting to examine if the information raised by occurred terrorist attacks can cause significant fluctuations in the stock markets.

Next, the theory of efficient market hypothesis, its underlying assumptions, and deeper historical roots are described in more detail.

2.1 The efficient capital markets

The hypothesis of an efficient market can be considered as a red thread of the modern financial theory. The basic assumptions of the efficient market hypothesis can be summarized as follows (see Fama 1970):

- Financial markets are informatively efficient.
- Efficient markets reflect all available information.
- Information should be available for every market participant at all times.
- All market participant should react in the same way to the information; nobody can earn an abnormal return.
- There are no transaction or trading costs.
- New information is never anticipated; stock prices are changing unpredictably.

Although the concept of efficient capital markets is best known from Eugene Famas' seminal research in the year 1965 and 1970, the most early connected research can be traced all the way to the beginning of 20s century. Louis Bachelier's work (1900), applying the Brownian motion to pricing options and futures, is widely considered as the foundation of the modern efficient market hypothesis. The Brownian motion is a stochastic process consisting of

independent and identical normally distributed increments. According to Bachelier, the market follows Brownian motion and, therefore, the stock markets are not predictable, the prices are normally distributed (Mandelbrot & Hudson 2008: 44–54). Or as Bachelier himself put it: "The market, unwittingly, obeys a law which governs it, the law of probability" (as cited in, Mandelbrot & Hudson 2008: 54.)

Also, the research of Alfred Cowles 3rd can be seen as having a major influence on the later developments of the efficient market hypothesis. By studying the performance of investment professionals between the years 1928–1932, he found that investment professionals were not able to find stocks more profitable than the average market return (Cowles 1933). More precisely, it was found that best-achieved records of individual investment professionals did not significantly depend on their skills. Instead, the results highlighted the significance of chance in explaining the returns. In light of these findings, it can be concluded that abnormal returns are almost impossible to earn in the stock markets.

Maurice Kendal (1953), in turn, investigated the movement of stock prices through indices. By using a time series of 22 different indices of industrial share prices, Kendal found that stock prices fluctuate randomly and were not predictable. Based on these findings, Kendal concluded that there are no patterns in the prices of stocks and commodities. As a result, *random walk* theory, eventually influencing to developments of efficient market hypothesis, took its first steps.

The fundamental purpose of the random walk theory is to explain the price fluctuations of stock market prices. The random walk theory really came to the awareness of the financial world when Burton Malkiel published 1973 his research about the performance of passive and holding investment strategies. Malkiel claimed that passive and holding strategies would be outstanding compared to actively and professionally handled funds, since price changes and deviations from previous prices are random, and the rate of return obtained by market prices are equal to return achieved by professional. (Malkiel 2003.)

The notions about the randomness of the financial markets formed the basis for the modern financial theory. In 1965, the concept of efficiency really made its way into the mainstream financial market research with Paul Samuelson's seminal

study (1965). In that study, he was able to prove mathematically that correctly predicted prices fluctuate randomly, by connecting complete information and randomness together.

As mentioned earlier, these earlier studies described above can be seen having a great influence on the developments of the efficient market hypothesis. In his 1965 seminal paper, Fama harnessed the concept of efficient market to describe the financial markets, and to estimate empirically the random walk model of stock price behavior.

Fama developed the efficient market hypothesis further in his subsequent study in 1970. The basic underlying assumption of the efficient market hypothesis is that the financial markets are informatively efficient so that stock prices completely reflect the information that is available. This means that when the stock markets are efficient, the stock prices will adapt quickly to the new information. Thus, the stock prices can change rapidly as new information enters the market. In order for the market to be efficient, however, information must be available for every market participant at all times. The efficient market hypothesis also assumes that all market participants should react in the same way when the new information appears. Furthermore, when the current stock prices reflect the all available information, it becomes impossible to earn profits based on the utilization of the information and price variations of the past. On the other hand, in efficient markets, new information is unpredictable, and the price changes of the stocks follow the random walk. Therefore, it's tomorrow's "news" that determine tomorrow's price change. Importantly, Fama has also pointed out that in the long run, it is not possible to get a return from the financial markets without risk, meaning that there are no arbitrage opportunities. Arbitrage opportunity disappears when the efficient markets price the stocks to match their level of risk. (Fama 1970; Malkiel 2003.)

The figure 1 below illustrates the market reaction to the new, positively surprising information. In the figure, the black line reflects the reaction in an efficient market and the blue line the reaction when the market is not efficient. The figure shows that in an efficient market, the market reacts immediately and correctly to positive information and that the effects of the information are reflected in the stock price. In comparison, the reaction in an inefficient market is

slow, and it takes time before the new positive information reflects to the stock prices.

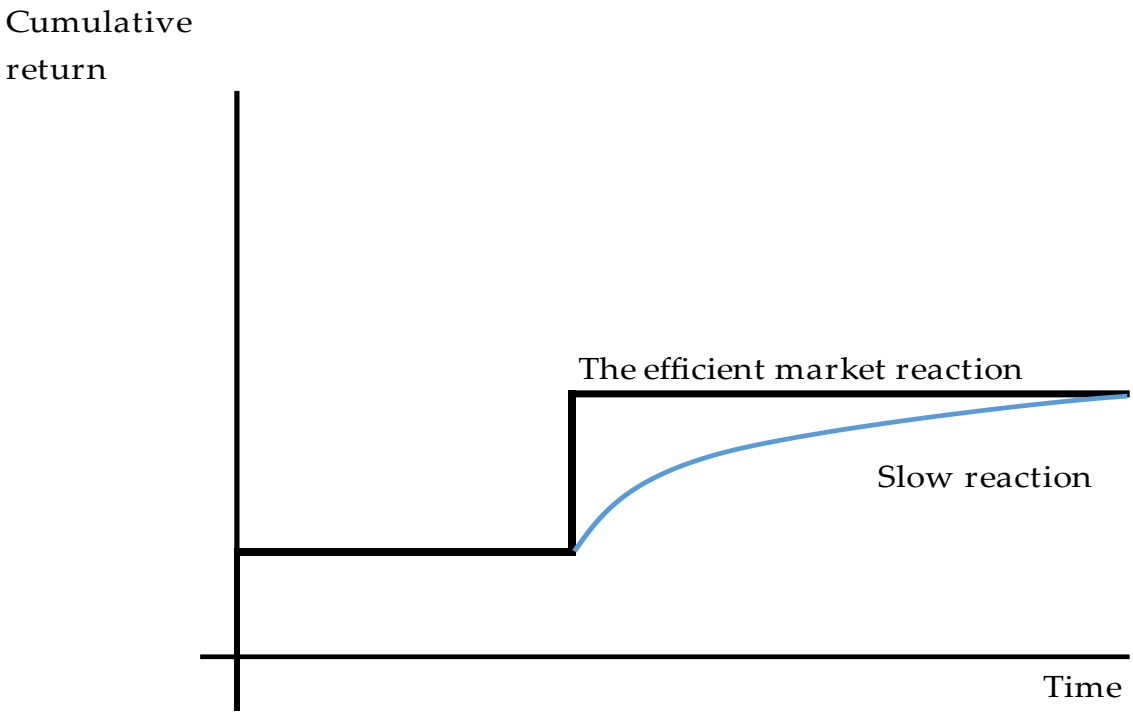

Figure 1. The reaction to new positive information in efficient vs. inefficient markets. (Knüpfer & Puttonen 2012: 162.)

Efficient markets can be divided into three forms based on their informative efficiency, capturing how efficiently information transmits to the market price (Fama 1970). These three forms of efficiency proposed by Fama are *weak-form*, *semi-strong-form* and *strong-form*. These different forms of market efficiency are also reliant on each other. For instance, when the market fills the requirements of the strong-form efficiency, the markets will also be efficient regarding the other forms of efficiency.

In the weak-form efficient market, the current stock prices should include all historical information about the stock prices, and price changes should follow the random walk. Therefore, abnormal returns should not be gained by looking at

past stock prices. To illustrate this more concretely, the formula of stock price in the weak-form efficient markets is provided below:

$$P_t = P_{t-1} + E(r_t) + \alpha_t \quad (1)$$

Where P_t defines the price of stock at time t, P_{t-1} stock price at time t-1, $E(r_t)$ the expected return, and α_t the random component. The random component term defines the effect of new information appearing on the market. Stock prices follow the random walk when the equation above holds. (Ross, Westerfield & Jaffe 2009: 483.)

In the semi-strong-form efficient markets, stock prices are expected to contain all information that is publicly available, such as annual reports or announcements made by companies. When all publicly available information is included in current stock prices, abnormal returns are not possible to achieve by using public information. When the new information is instantly incorporated into the stock prices, the markets can be seen as semi-strongly efficient. (Ross et al. 2009: 484.)

The most efficient form of market efficiency is the strong-form efficiency. The strong-form efficient markets are characterized by markets where current stock prices contain all publicly available information, as well as more private information such as those possessed by insiders. Consequently, it is not possible to earn any abnormal returns by means of information in strong-form efficient markets. (Knüpfer & Puttonen 2012: 165.)

Although the efficient market theory is widely acknowledged and celebrated theory, it and its underlying assumptions have also attracted criticism from early on. Even Eugene Fama himself noted that the efficient market hypothesis is mostly theoretical, and do not always apply in the "actual" markets (Fama 1970). In the twenty-first century, the efficient markets hypothesis began at the latest to lose its universal dominance. This is partly because psychological and behavioral elements of stock-price determination started to increase interest among the economist and statisticians. Contrary to the assumptions of efficient market theory, it was increasingly acknowledged that past stock price patterns and certain valuation metrics are capable of predicting future stock prices. As a result,

economists started to believe that investors are able to achieve abnormal risk-adjusted rates of return with predictable stock patterns. (Malkiel 2003.)

Criticism has also stemmed from an observation that all market participants do not always act rationally. This means that unpredictable patterns, as well as irregularities in stock prices, can be found from the market, unfolding over longer or shorter time periods. In addition, various anomalies have been recognized in the market, which can be exploited to earn abnormal returns. Given these factors, it can be claimed that there is no real opportunity for the market to be perfectly efficient. (Malkiel 2003; Knupfer & Puttonen 2012: 165–168.) It should also be noted that criticism toward the efficient market hypothesis has typically heightened when the markets have collapsed. For instance, Paul Volcker (2012) has stated that too confident belief in rational expectations, market efficiency, and the modern finance techniques are part of the causes for the financial crisis.

The *actual market approach* can be understood to address many of the shortfalls detailed above. According to this approach, markets are efficient when:

- Participants have low-cost access to all information
- transaction costs are low
- the market is liquid
- investors are rational

As presented above, low transaction costs are one of the many factors that are in play when considering different efficient market situations. For instance, when the transaction costs in the market goes lower, the markets become more efficient. In an efficient market, supply and demand of securities quickly adjust to the new equilibrium level. Transaction costs are a remarkable factor than can have an impact on how quickly the new equilibrium level is reached. In efficient markets, there are no transaction costs. Another factor to affect efficiency level of market is liquidity. When the liquidity of market increases, securities are traded more often, and the new information can be integrated to the prices of stocks. The Rationality of investors can also be seen as a factor to have impact of market efficiency. Good and unexpected information should make investors buy rather than sell. (Vernimmen, Quiry, Fur, Dallocchio & Salvi 2014: 257.)

2.2 Stock market and indices

To put it simply, stock market means a trading venue where securities are traded. The securities that are commonly traded are holdings in public companies, commonly known as stocks. The formation of the price of individual stocks is a result of supply and demand. The supply of a certain stock is simply determined by the number of shares issued to the stock market, meaning that it is fixed. In turn, the demand of the stock is created by the people who are interested in buying the issued stocks from their current owner. The price of a stock increases when there are more people who want to buy at the current price than there are people who want to sell - or vice versa, the price of the stock decreases when there are relatively more people selling their stocks. (Finanssivalvonta 2018; Euronext 2019.)

Stocks that are selected according to a certain criteria form stock index. Stock indices can be understood as a kind of portfolios, which are used as metrics to track price fluctuations of stocks. Indeed, the changes in the stock market are often described by the changes in the value of stock indices. By following the changes in the value of stock indices, it is possible to have a good view whether the stock market is going up or down, and in this way, it can provide valuable indicators about economic trends. (Corporate finance institute 2020; Finanssivalvonta 2018.)

Further, particular stock indices may contain a different amount of stocks or even all the stocks from a certain stock market; for example, a stock index may only contain stocks from a specific industry. In most cases, the stock indices are formed based on weighted market values, which means that the largest companies included in the index receive a relatively larger weight than the smaller companies. (Knüpfer & Puttonen 2012: 57.)

In this study, stock indices that reflect the economic situation of the desired countries are under consideration and included in the empirical analyses.

2.3. Integration in stock markets

As mentioned already in the introduction, stock markets in the modern financial world are increasingly integrated. As a result, for instance, stock market movements in one stock market has the potential to drive stocks movements in other markets, too. The globalization of financial markets, together with macroeconomic factors such as inflation and interest rates, can be seen as one of the major explanatory factors for increased market integration. (Dickinson 2000.)

When the markets are financially integrated, domestic and foreign investment options are available to investors. Open domestic and foreign investment options mean that investments with the same level of risk have equal return expectations. Integrated financial markets gives the capital opportunity to flow in those markets where return generation will be the highest. The common features of integrated stock markets are high correlation between countries stock returns, better liquidity, and increased market size compared to the time before integration. It is important to note that even though the integration of financial markets makes it easier to achieve foreign capital, they are also more exposed to different crises around the world, which in turn can cause uncertainty to the stock markets. (Bekaert, Harvey & Lumsdaine 2002; Büttner & Hayo 2011.)

The concept of *volatility* is commonly used to describe the level of uncertainty in the stock market in a given time. Ederington and Lee (1993) posited that information has a direct impact on stock markets and that it is one of the main factors which explain changes in the stock prices. Hence, information can be seen as one of the main sources of volatility in stock markets. New information often causes the stock market to fluctuate, creating volatility in the market as investors respond and act based on the new information. Therefore, in highly integrated financial markets, where information spread rapidly around the world, the circumstances in one stock market have the potential to cause changes to the stock prices in other markets, too.

Based on these features of integrated financial markets and the effectiveness of the information, it is topical and interesting to investigate whether the terrorist attacks are impressive enough to cause changes in the stock markets, and whether the possible changes spill over to the other markets also.

2.4. What is terrorism?

Today, terrorism, in its various forms, increasingly shakes our lives and societies. Terrorism is brutal, often transient and irrational activity that aims to intimidate societies and spread fear among people. This section delves deeper into the meaning of terrorisms and into the complex and debated question of "what is terrorism".

Globally, the first terrorist acts can be understood occurring in the early years of the 1900s – although some forms of terrorisms most likely existed already before that. Nevertheless, onwards from the 20th century, clear signs of terrorism began to show in all continents. Global terrorism index shows that terrorism has evolved and changed in how it has manifested. Terrorist attacks in the 21st century have mainly been targeted to civilians, compared to earlier years when military troops were the common targets. Terrorism is also nowadays a threat to almost every country in the world, and its effects spread globally. (Institute for Economics & Peace 2019.)

At the beginning of the 21st century, 51 countries faced at least one death caused by terrorism. And in the year 2016, there were 79 countries faced at least one casualty from terrorism. Total deaths caused by terrorism has fallen during the recent years, but the number of countries affected to terrorism and recorded at least one death has remained high. The most recent data shows that terrorist attacks in the EU area decreased in the year 2019 in comparison to the year 2018, but still EU member states reported a total of 119 terrorist attacks. In this time span, the greatest number of terrorist attacks were reported occurring in South Asia. (Institute for Economics & Peace 2019; Europol 2020.)

Despite the long history of terrorism, deeper and more systematic analysis of forms and impact of terrorism has relatively short roots. Unsurprisingly, the World Trade Center terrorist attack in the United States at 11th of September 2001 acted as a driving force for more comprehensive and widespread research on the topic. However, still today "terrorism" and "terrorist" are acknowledged as a multifaceted and controversial concepts that are hard to precisely define. (Gupta 2005: 16; Jensen 2013: 16.)

One of the main challenges of defining the concept of terrorism relate to the fact that terrorism covers such a wide range of events and actions, raising questions such as whether terrorism should only be seen as attacks on civilians, or should attacks on military bases outside war zones be seen as a terrorist acts as well? The definition can depend also whether terrorism is interpreted from individual, social, state, or global perspective (Taylor 2010). However, many experts have come to a conclusion that terrorism is largely a constantly changing concept because it gets constantly re-conceptualized socially by the people who are actually affected by it, which makes it difficult to form an unambiguous and static conceptualization of terrorism. (Ganor 2002.)

Nevertheless, terrorism can always be said to be a concern of security. The feeling of insecurity related to terrorism can be caused by violence, aggressive or challenging behavior that touches people's everyday life's or becomes meaningful politically. Widely agreed is also that terrorism involves violent, illegal activities that pose a threat to private citizens. Moreover, terrorism can cause fear also among those who are not *directly* affected by the attack. Indeed, causing anxiety and insecurity among people, as well as communities and societies can be seen as the one main purpose of terrorism. (Bjorgo 2005, 1–3.)

In this thesis, terrorism is understood, in line with operationalization's of Federal Bureau Investigation (FBI) and the Institute for Economics and Peace, broadly as act or threat of violence that aims to advance political, social, religious, or economic objectives through violence and hostile attacks (Procasky & Nacasius 2016; Taylor 2010).

2.4.1 Classification of terrorism

Terrorist attacks can be further classified into different categories according to their nature. For instance, FBI divides terrorism into two clear categories: *international* terrorism and *domestic* terrorism. This categorization classifies terrorism based on territory. The difference between these categories is mainly the area of the activity of the terrorist organization. Therefore, this classification can be made by answering the question "does it work in or outside of the destination country?" (FBI 2020).

Europol, in turn, has classified terrorism in five different categories based on the nature and characteristics of terrorism in its recent annual TE-SAT report (Terrorism situation and trend report) (Europol 2020):

1. *Jihadist terrorism*: terrorist acts are inspired by the traditional Islamic religion. Terrorism is done by individuals, groups, networks and organizations.

2. *Ethno-nationalist and separatist terrorism*: Nationalism, ethnicity and religion are the guidelines for ethno-nationalist and separatist terrorist groups. The attempt to unite the scattered nation into one state or carve out a state for themselves from a larger country.

3. *Left-wing and anarchist terrorism*: At the heart of the action is the promotion of communist and socialism structures via violent acts as a goal of establish communist and a classless society.

4. *Right-wing terrorism*: Strongly based on ideologies. Belief in one's own superiority as a race, nation or culture is typical. Right-wing terrorism purpose is to cause changes in the entire political, social and economic system.

5. *Single-issue terrorism*. Terrorism that focuses in individual disadvantages and issues. Animal rights and environmental protection are common terrorist targets.

Almost half (i.e., 57) out of the total reported terrorist attacks (i.e., 119) in EU area in the year 2019 were implemented by ethno-nationalist and separatist terrorist. In turn, both jihadist and left-wing terrorists can be counted as responsible of over twenty terrorist attacks. When comparing the caused deaths and injuries in year 2019, the jihadist terrorism stands out; almost all terrorism casualties (ten deaths and 27 injured) were caused by jihadists 2019. (Europol 2020.)

Although terrorist attacks, as describes above, can be distinguished into different categories based on their nature and manifestation, in this thesis, separate classifications were avoided when the empirical analysis were carried out.

3. PREVIOUS LITERATURE

Given the increased presence of terrorism in the modern world, it unsurprising that the academic research focusing on the effects of terrorism has been building up in the recent years. This section focuses on reviewing the prior research findings on the impacts of terrorist attacks to the world economy, and particularly on the stock markets.

3.1 The effects of terrorism on the economy

Terrorist attacks can cause both *direct* and *indirect* costs to the economy. In prior research, it has been further acknowledged that the duration of these costs can vary from short to medium and to long-term.

Direct costs can be considered the most immediate costs of terrorist attacks. These costs include, for instance, the destruction of production facilities, equipment, housing and structures, means of transport and other economic resources, including workers in the capacity of human victims**.** Direct costs also cover immediate investments allocated into public safety and helping of people**.** Direct costs are typically short-lived, but, for instance, rebuilding of destroyed infrastructure and aiding people with their needs are seen as a medium- and long-term direct costs of terrorist attacks. (Buesa, Valino, Heijs, Baumert & Gomez 2007.)

Terrorist attacks can also cause costs to the economy that are less explicit, i.e. indirect costs. It has been suggested that indirect costs bear even more significant costs to the economy than direct costs. Most of the medium and long-term costs of terrorism are indirect; for instance, the decrease of consumption, a general decrease of direct investments, increased security costs, economic growth slowdown and the cost of counterterrorism. Indirect costs can also manifest in a shorter time span, like losses in tourism, decreased use of restaurants and entertainment, and this has been linked to people's fear of possible new terrorist attacks. (Buesa et al. 2007.)

Abadie and Gardeazabal (2008) focused on estimating the potential effects of the increased terrorist threat in an integrated world economy. Their findings propose

that terrorism can cause major capital movements across countries since the risk of terrorism depresses net foreign investment positions.

In another study, Blomberg, Hess and Orphanides (2004) investigated the macroeconomic consequences of terrorism and collective violence. The study showed that terrorist acts could have a significant relation to negative economic growth. However, the authors pointed out that the effects of terrorist acts to economic growth are considerably smaller and less continuous in comparison to external wars or internal conflicts. A second key finding of the paper is that terrorism incidents tends to relocate spending towards government expenditures instead of investments, but that these consequences differ across geographic areas and political governances.

In turn, Greenbaum, Dugan and LaFree (2007) examined the indirect impacts of terrorism on the stability of Italy's economy by focusing on employment and business outcomes between the years 1985–1997. Their findings suggested that terrorist attacks can reduce the number of companies, and in turn increase unemployment due to the reduction in business formations and expansions.

In their study, Blomberg, Hess and Tan (2011) used terrorism as a component which decreases trust in an economy among people, when they investigate the effect of terrorism on income. According to their findings, terrorism can have negative impacts on income, and the impact of trust is positive and significant to explain results.

Figure 2 at below illustrates the global economic impact of terrorism in billions of US$. The estimates of global economic impacts are slightly conservative according to Institute for Economics & Peace, because the overall impact of terrorism is difficult to measure. For example, the cost of reduced tourism and business activity is hard to exactly estimate for longer periods. Like visible in the figure, the trendline from the year 2000 to 2018 was upwards, with the highest single global economic cost in 2014 (i.e., staggering 111 billion US$). However, after the year 2014, the cost of terrorism has started to decline. In the year 2017, the global economic cost of terrorism was only half compared to the year 2014, but still 54 billion US$.

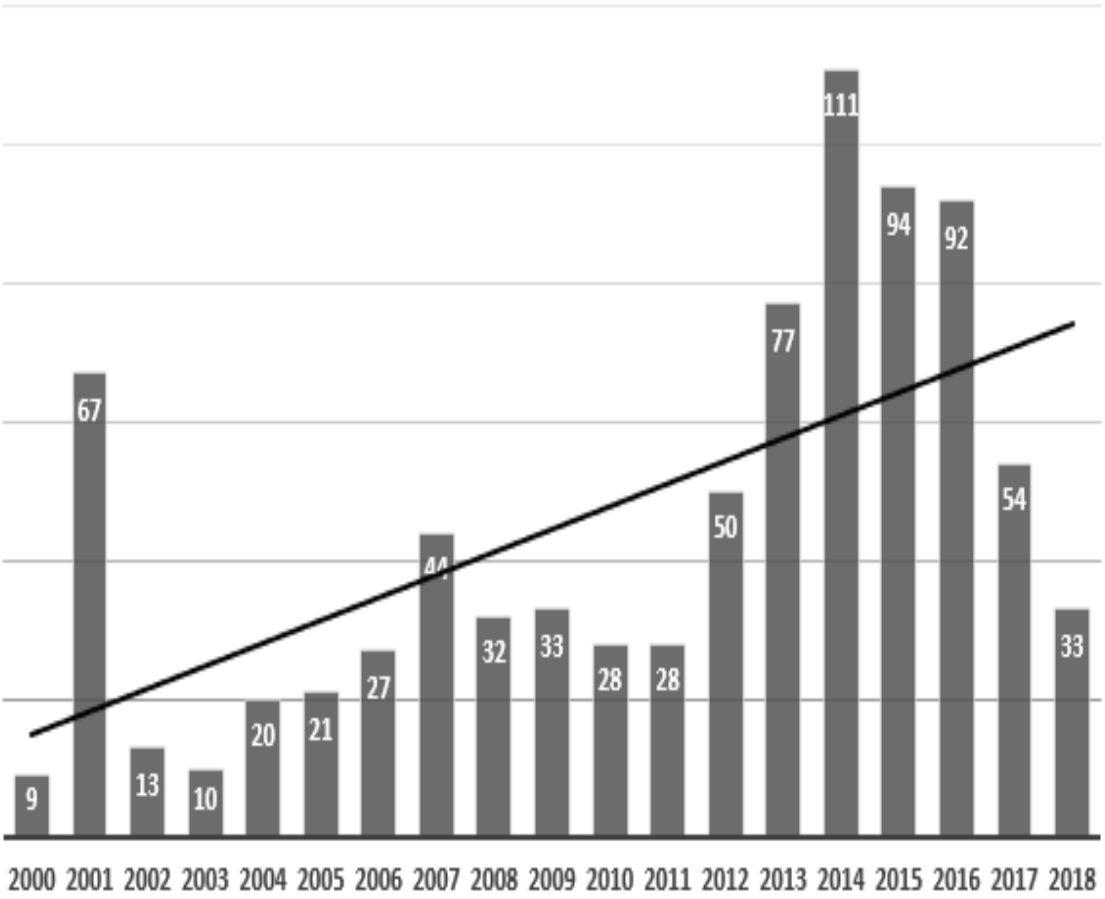

Figure 2. The global economic impact of terrorism in billions of US$. (Institute for Economics & Peace 2019.)

3.2 The effects of terrorism on stock markets

Literature and research about the impacts of terrorism on the stock market have constantly increased during the past decades. Chen and Siems (2004) says that the interest to investigate the effects of terrorism to stock markets relates largely to the features and nature of individual stocks. That is, investors' have hopes and fears about the future, and these expectations are reflected in the prices of individual stocks. In addition, liquidity of stock markets enables rapid response to new information. Investors can easily decide to buy or sell individual stocks, and price movements are able to create a wave of activity. For these reasons, research on the impacts of terrorist attacks to stock markets is crucially needed.

In their study, Chen and Siems (2004) investigated the effects of terrorism on global capital markets. They used event study methodology, the same method that is used in this thesis, to examine the response of US and the global stock market to 14 terrorist and military attacks occurring between the years 1915–2001. Specifically, they aimed to explore if the initial panic caused by catastrophic events could drive investors to seek safer investment options and sell in panic, which could cause further "chaos" in the stock markets. Findings of the study suggested that terrorism and military invasions do have great potential to effect on capital markets around the world, but the effects are typically short-termed. Additionally, Chen and Siems noticed that US capital markets have become more resilient to terrorist attacks over time and that the recovery is faster than in other global capital markets.

Johnston and Nedelescu (2006) found similar results than Chen and Siems (2004). They investigated the effectiveness of stock markets in countering the effects of terrorist attacks. Their findings suggest that diversified, liquid and stable stock markets are efficient in absorbing the negative effects of terrorist attacks when the crisis management responses are well organized.

Chesney, Reshetar and Karaman (2011) studied empirically the behaviour of stocks, bond and commodity markets during different terrorist attacks. In total, they investigated the effects of 77 different terrorist attacks in 25 different countries using event studies and also other methods. In their study, global, American and European stocks and industrial markets were included in the analysis. Results showed that, overall, impacts of terrorist attacks were significantly negative to stock markets, with the reactions being the highest in the Swiss markets and the lowest in the US markets.

In their study, Nikkinen and Vähämaa (2010) examined the effects of terrorism on stock market sentiment. They used the behaviour of expected probability functions of the FTSE 100 index to define the effects of three different terrorist attacks. Findings of the study pointed out that terrorism has a strong adverse effect on stock market sentiment, which suggests that investors revise their future expectations of profits or risk premiums. All examined terrorist attacks were associated with a descending move in the expected value of the FTSE100 index, and a significant increase was found in the spreading of expectations.

Many studies that have focused on the effects to stock markets, has examined the effects of the WTC terrorist attack in New York 2001. For instance, Charles and Darne (2006) investigated 10 daily stock market indices using an outlier detection methodology, with findings that terrorist attack and its aftermath in New York caused massive shocks on international stock markets.

Nikkinen, Omran, Sahlström and Äijö (2008) received similar results than Charles and Darne (2006), when they investigated the short-term impact of the terrorist attacks in New York on global markets return and volatility. They found that volatility and stock returns reacted significantly to the terrorist attack, so that volatility increased in every studied region and in time period. Negative reactions in stock markets were found to be impressive, but stock markets seemed to recover quickly, suggesting that impacts of terrorist attacks can be short-termed and vary across regions. They found that less integrated regions did not face the effects of terrorism as large than in internationally integrated regions.

In the study of Brounrn and Derwall (2010), all significant terrorist attacks to major economies from 1990 to 2005 were included when they examined the effects of terrorist attacks on stock markets. Using event study methodology, they found that terrorist attacks produced slightly negative impacts on stock markets, and that the impacts were temporary and strongest in that country where the attack took place. However, they also found that negative impacts of terrorist attacks were more pronounced than the impacts of other unanticipated events, such as earthquakes.

Terrorist attacks do not have a specific classification or expression. Karolyi and Martell (2010) noticed in their study, which focused on investigating such terrorist attacks where publicly traded firms around the world were targets between 1995–2003, that those terrorist attacks that particularly caused losses on human capital created more significant negative stock reactions than attacks that caused losses on physical assets. The results showed that the abnormal decline in stock prices was -0,83%, on average. Negative stock price reactions were greater when terrorist attacks were targeted to wealthier and more democratic countries.

The study of Kollias, Papadamou and Stagiannis (2011) concentrated on investigating the effects of terrorist attacks in Spain 2004 and in the UK in 2005.

Empirical findings of their event study showed that attack day stock market reactions in Spain and in UK were similar, but it took more days for Spanish stock market to rebound back to the same levels than before the terrorist attack. Kollias et al. argued that a possible explanation for these longer-term impacts in Spanish stock markets was the particular nature of the Spanish attack, i.e., a bomb attack. In the UK, in turn, the attackers were suicide bombers contrary to the attack in Spain. Kollias et al. suggested that the potential threat of terrorism continued longer in Spain after the attack because the terrorists were not neutralized immediately.

In addition, Eldor and Melnick (2004) found in their study that the effects of occurring terrorist attacks in Israel depended on the characteristics of the attacks. They investigated different types of terrorist attacks between 1993 and 2003. According to the findings, the effects of suicide attacks were permanent for the markets and, on the other hand, other type of terrorist attacks had no effects. They also noticed that the number of victims was the main characteristic that caused permanent effects to the markets.

Arin, Ciferri and Spagnolo (2008) investigated the effects of terrorism in six different financial markets between the years 2002–2006, including emerging and developed markets. They found that there was a significant causality reaction on both the stock markets and the stock market's volatility at the time of terrorist activity. Interestingly, the impact of terrorism was found to be larger in emerging markets in comparison to developed markets. They concluded that investors in developed countries seem to be more resilient to unexpected events, which has been noted also in some other earlier studies.

Aslam and Kang (2015) focused to study the effects of terrorism on Pakistan stock market. In their study they used daily time series data from year 2000 to 2011. Pakistan had suffered multiple terrorist attacks during that estimation period of their study. Their findings showed that terrorist attacks had affected negatively on the KSE–100 index which also indicates that Pakistan has faced massive economic costs. However, the stock market in Pakistan recovered rapidly (only in one day) after the terrorist attacks, and the negative reactions were short lived.

Hasso, Pelster and Breitmayer (2020) studied the behaviour of individual investors after terrorist activities. Their main focus was to investigate how the

individual investors reacted after the terrorist attacks in Europe 2015–2017. Findings of their study showed that trading activity of individual investors decreased, and that the use of leverage was smaller. Hasso et al. also noticed that the reactions of individual investors are similar around the world, but the investors that are located in the country where the specific terrorist attack occurs, are impacted the most significantly and strongly.

4. DATA & METHODOLOGY

This chapter presents the research hypotheses of this thesis and describes the used data and methodology. These are presented in four subsections: research hypotheses of the thesis are presented first, then the data included in the study are described, and finally the applied research methods are presented.

4.1 Research hypotheses

As mentioned, the main purpose of the thesis is to investigate the impact of terrorist attacks to the European stock markets. More precisely, the purpose is to examine if terrorist attacks are significant enough to cause negative abnormal returns in stock indices and whether these possible negative reactions are characterized by certain factors like the nature of the attack or the destination where the attack occurs. In order to investigate these research questions further, the following four specific hypotheses were formed.

Previous research studying the effects of terrorism to stock markets has found that stock index reactions to terrorist attacks have varied during the years, and that there have been differences between the attacks and indices. Given these earlier findings, the first hypothesis is:

H1: Terrorist attacks are significant enough to cause negative abnormal returns in stock indices.

With the second hypothesis, the possible spill over effect is tested. This means that the second hypothesis tests whether the possible stock markets reaction after the terrorist attack spreads also to other countries than to the one in which the actual attack took place. Therefore, the second hypothesis is formed as:

H2: The effects of terrorist attacks spread beyond the target country.

The third hypothesis aims to answer to the question whether the stock markets have become more immune to terrorist attacks over the years. This hypothesis is tested by comparing the stock market reactions at different times. Given that terrorism has become more and more common threat in people's lives after the

WTC attacks in the USA in 2001, it is important to see whether the reactions to terrorism have subsided over time. The third hypothesis is as follows:

H3: Stock indices have become more immune to terrorist attacks.

Finally, the fourth hypothesis focuses to different factors that might have had impact to the stock market reactions after the terrorist attacks. With this hypothesis, it is tested whether specific characteristics of the different terrorist attacks are able to explain the stock markets reactions. The fourth hypothesis is as follows:

H4: Specific characteristics of terrorist attacks are able to explain stock index reactions.

4.2 Data

The used data in this thesis consist of daily returns of total return stock indices. Total return indices are used because it, contrary to the price return index, takes capital gains and dividend components into account. However, if total return index was not available, the price return index was alternatively used. The data of daily returns of total return stock indices were collected from the databases of the University of Vaasa, and the original source of data is Thomas Reuters. The stock indices used in the thesis are mostly European stock indices. Further, the focus was on the most remarkable terrorist attacks that occurred mainly in Europe in the 2000s. Year 2000 was a natural starting point for the collected daily stock index data since the first remarkable terrorist attack of the 21st century took place in year 2001 (i.e., WTC attack in New York). By estimating stock index reactions to terrorist attacks during the time period from January 2000 to December 2017, it will be investigated how time and the constant development of the world affected to the phenomena under examination.

Table 1 describes the terrorist attacks included in the examinations in this thesis. The original idea and aim was to analyze multiple terrorist attacks occurred around the Europe, but the final sample of terrorist attacks in the analysis include only the most remarkable and a lot of media attention attracted terrorist attacks that had occurred in the European countries. Also, the most remarkable attacks

outside of Europe were decided to be included in the study as visible in table 1. The final sample, therefore, include 22 different terrorist attacks, with 17 of these attacks occurred in Europe and five of them outside of Europe.

Table 1. The characteristics of terrorist attacks. (Global Terrorism Database).

Event date	Country of attack	Continent	Number of fatalities	Number of injured
11/09/01	United States *	North America	2 977	16 000
23/10/02	Russia	Europe	170	700
15/11/03	Turkey	Europe	58	over 700
11/03/04	Spain*	Europe	192	1 800
03/09/04	Russia	Europe	344	727
07/07/05	United Kingdom*	Europe	56	784
26/11/08	India	Asia	183	252
22/07/11	Norway	Europe	69	60
16/12/14	Pakistan	Asia	158	121
07/01/15	France*	Europe	20	22
13/11/15	France*	Europe	149	439
22/03/16	Belgium	Europe	35	370
12/06/16	United States	North America	50	53
28/06/16	Turkey	Europe	48	235
14/07/16	France*	Europe	87	433
19/12/16	Germany*	Europe	12	48
01/01/17	Turkey	Europe	39	69
07/04/17	Sweden	Europe	5	14
22/05/17	United Kingdom*	Europe	23	119
03/06/17	United Kingdom*	Europe	11	48
17/08/17	Spain*	Europe	21	110
01/10/17	United States	North America	59	851

Note: * = Attacks included in the estimations of possible spillover effect and the impact of time on the effects of terrorist attacks. (see table 6.)

The five selected terrorist attacks from outside Europe were included in the analysis to enable better understanding whether the impact of the terrorist attacks can spread globally (i.e., spill over effect). As visible in Table 1, seven of all the investigated terrorist attacks took place before 2010 and fifteen of them between the years 2011–2017. The time span of the different attacks (see Table 1) enabled to investigate whether stock market reactions to attacks have changed over time. The selected terrorist attacks also vary in terms of their nature and size (number of fatalities and injuries), which enables a fruitful view into their potential impacts.

Data about the characteristics of the terrorist attacks (see Table 1) have been collected from the Global Terrorism Database. Global Terrorism Database includes many types of terrorist activities from all over the world. In total, the database contains information of over 180 000 terrorist events, making it the most comprehensive source of terrorism data. Global Terrorism database was used in this study to source information because the aim was to get as reliable data as possible on the victims, locations and attack times of terrorist attacks.

The terrorist attacks included in the study had naturally consequences for the selection of indices as well, given that one of the aims of the thesis is to investigate the relationship of stock index and terrorist attack in the particular country where the attack took place. Thus, the stock indices of the target countries of each selected terrorist attacks were included. In addition to the stock indices of the countries targeted by the terrorist attacks, the index sample is supplemented by the stock indices of the biggest economies in Europe in order to examine the overall effects of different terrorist attacks on the major European stock indices. The most economically significant stock indices of the countries, which are also comparable, are selected as the stock indices for this thesis.

Table 2 presents the selected stock indices. Index name, the country of which stock market index it is, and a short description of the index are provided .It should be noted that stock indices of Italy and Switzerland were included even though in those countries no attacks occurred (see Table 1) because both of these countries are top ten largest economies in Europe when measured by nominal GDB.

Table 2. List of stock indices.

Country	Index	Description
Germany	DAX 30	Consists of Germany's 30 largest and most actively traded shares on the Frankfurt Stock Exchange.
United Kingdom	FTSE 100	Stock index including 100 highest market capitalisation companies listed in London stock exchange.
France	CAC 40	Reflects the development of the shares of France's 40 largest companies, which are most actively traded and are listed on the Euronext stock exchange in Paris.
Italy	FTSE MIB	Market value weighted stock index which includes the 40 most traded shares in Italy.
Russia	RUSSIA RTS	One of the most important stock exchanges in Russia and important leading indicator for the whole Russian market.
Spain	IBEX35	The index consisting of the 35 largest companies in Spain according to market value
Switzerland	SMI	Includes the 20 largest and most liquid stocks from the Swiss Performance Index.
Norway	OSEB	The most actively traded stocks on Oslo exchange.
Sweden	OMXS 30	Consisting of the 30 most shared stock on the Stockholm exchange.
Belgium	BEL 20	Represents a maximum of 20 the largest and the most actively traded stocks on the Brussels Stock Exchange.
Turkey	BIST 100	Turkey's main stock exchange. Capitalization weighted index containing national market companies without investment trusts.
United States	S&P 500	The 500 highest market-capitalization-weighted and publicly traded companies in USA.
Pakistan	KSE 100	Benchmark index which contains 100 representative and highest capitalization of the companies on the Pakistan exchange.
India	BSE100	The index measures the development of the 100 largest and most liquid Indian companies.

Impacts of the terrorist attacks on stock market indices were examined based on the returns of the indices for each specific event days; in other words, the days when the attacks occurred. The closing prices of every indices were used. If the

terrorist attack occurred while the stock market was closed (including weekends), the next trading day was taken into account in the calculations.

Table 3 shows the descriptive statistics for every index that were presented earlier. Descriptive statistics for indices were calculated for the entire period from January 2000 to December 2017. All the indices, excluding the FTSE MIB index, had slightly positive daily mean returns over estimation period as visible in the table. The mean returns of European indices and S&P 500 index were very similar, which provides support for stock market integration.

Table 3. Descriptive statistics for daily returns of stock indices.

	DAX 30	FTSE 100	CAC 40	FTSE MIB	RUSSIA RTS	IBEX 35	SMI	OSEB	OMXS 30	BEL 20	BIST100	S&P 500	KSE 100	S&P BSE 100
Mean	0,01 %	0,01 %	0,01 %	-0,001 %	0,04 %	0,01 %	0,01 %	0,03 %	0,01 %	0,004 %	0,04 %	0,02 %	0,07 %	0,04 %
Median	0,05 %	0,02 %	0,02 %	0,02 %	0,04 %	0,03 %	0,02 %	0,06 %	0,001 %	0,01 %	0,01 %	0,03 %	0,04 %	0,05 %
Maximum	10,80 %	9,38 %	10,59 %	10,88 %	20,20 %	13,48 %	10,79 %	10,14 %	9,87 %	9,33 %	17,77 %	10,96 %	8,51 %	15,49 %
Minimum	-8,87 %	-9,27 %	-9,47 %	-13,33 %	-21,20 %	-13,19 %	-9,07 %	-10,48 %	-8,80 %	-8,32 %	-19,98 %	-9,46 %	-8,66 %	-11,94 %
Std. Dev.	0,0148	0,0117	0,0144	0,0152	0,0214	0,0148	0,0116	0,0143	0,0148	0,0124	0,0210	0,0119	0,0133	0,0149
Skewness	-0,05	-0,16	-0,03	-0,20	-0,40	-0,07	-0,18	-0,597	0,011	-0,02	-0,03	-0,20	-0,31	-0,37
Kurtosis	7,62	9,57	8,14	8,35	11,91	9,08	10,32	6,95	3,92	9,29	11,22	12,04	4,62	7,70
Observations	4 678	4 678	4 678	4 678	4 678	4 678	4 678	4 678	4 678	4 678	4 678	4 678	4 678	4 678

4.3. Event Study methodology

Most of the previous studies examining the effects of terrorist attacks to stock markets and stock indices have used event study methodology. The event study methodology is a powerful and widely used method to examine the effects around a specific event. The method enables to identify abnormal changes of stock indexes under unpredicted event. Abnormal return describes the return of stock index, which deviate from its expected return. (Kollias et all. 2011; Chen & Siems 2004.). Therefore, event study methodology was considered well-suited to investigate the research questions of this thesis.

The study by Fama, Fisher, Jensen & Roll (1969) has been seen the first to present the event study methodology. They used the method to identify the impacts of stock splits on stock prices. The logic behind the usefulness of the event study methodology is based on the efficient market hypothesis, which posits that the impacts of specific events will be immediately included on the prices of securities. (Chen & Siems 2004.)

Terrorist attacks are a meaningful topic to study with event study methodology because terrorist attacks include a surprise effect. In other words, investors are not calculating beforehand the effect of terrorist attack for the period prior to the attack. Thus, it is not usual that event study results, when investigating terrorist attacks, are not biased by beforehand actions of investors. (Karolyi & Martell 2010.)

According to Chen & Siems (2004), the favorable reactions of investors to an unpredicted event should produce positive abnormal return around the event date. On the other hand, if the reactions of investors are unfavorable, the abnormal returns around the unpredicted event should be negative. Terrorism, of course, is seen in a very negative light and its impacts are often unfavorable. Therefore, in this thesis abnormal returns of stock indices around different terrorist attacks are expected to be negative.

When using the event study analysis, the return of stock indices on every event day has to be calculated. Returns of stock indices are necessary to calculate abnormal returns (AR). Returns of stock indices can be calculated by using either absolute or logarithmic values. In this study, returns are calculated by using logarithmic values using the following formula:

(2) $$R_{it} = ln\left(\frac{P_{it}}{P_{i,t-1}}\right)$$

Where:

R_{it} = return for stock index *i* at time *t*
P_{it} = stock index *i* price at time *t*
$P_{i,t-1}$= price of stock index *i* at time *t* – 1.

Excess return approach by Brown and Warner (1985) is used to estimate abnormal return of stock index *i* on event day *t*. Excess return approach uses the average return of stock index to estimate how much the return on event day differs from its past average return. Average return of stock index is calculated over the estimation window. Following Chen and Siems (2004), in this thesis the estimation window starts 30 days prior the event day and lasts the following 20 days. In other words, the expected return of index is the average of the return over the period -30 to -11 days prior the event. Figure 3 shows the visual presentation of event study layout used in this study. Abnormal return of stock index is calculated by using the following formula (Brown and Warner 1985):

(3) $$AR_{i,t} = R_{i,t} - \bar{R}_i \quad ,$$

(4) $$\bar{R}_i = \frac{1}{\mathrm{N}} \sum_{-30}^{-11} R_{i,t}$$

Where:

$AR_{i,t}$ = abnormal return of the stock index *i* at time *t*
$R_{i,t}$ = return of the stock index *i* at time *t*
$\bar{R}_i$ = average return of stock index in the estimation period (-30, -11)
N = the number of days in estimation window

The main event window in this thesis is the attack day (t=0). For cumulative abnormal returns (CAR) two other event windows is used: five days following the attack (t+5) and ten days following the attack (t+10). Cumulative abnormal returns of stock indices are calculated to see the total impact of terrorist attacks to stock markets and whether the reaction of stock indices occurs with a delay. The attack day abnormal return was included in CAR results to determine the overall effects of each attack. The CAR calculations follow the equation below:

(5) $$CAR_{i(t_1,t_2)} = \sum_{t_1}^{t_2} AR_{i,t}$$

Where:

$CAR_{i(t1,t2)}$ = Cumulative abnormal return for stock index i for the period t_1 to t_2

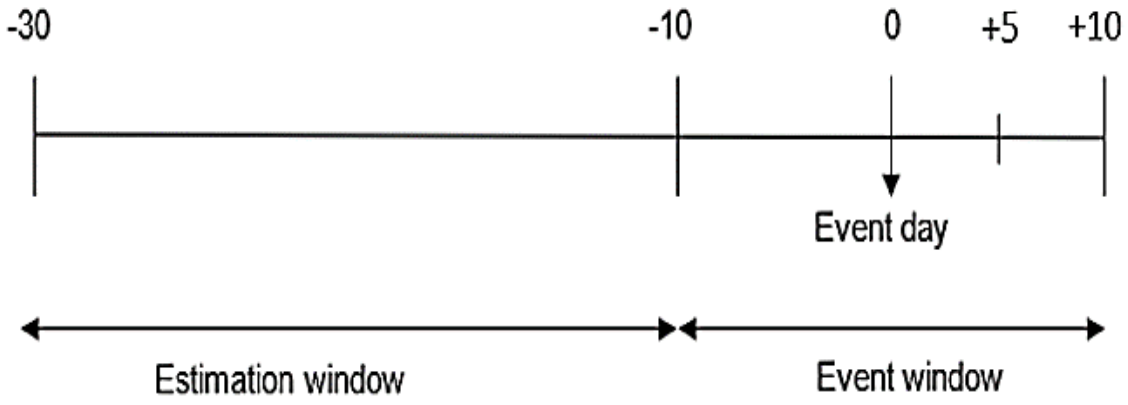

Figure 3. Event window layout.

To see whether different events are able to cause significant reactions on stock index returns, statistical significance of abnormal returns and cumulative abnormal returns were tested. Statistically significant results prove that the certain event caused a reaction of stock index return that deviate significantly from the average return of the index.

Hypotheses for testing statistical significance are:

H0: Stock index abnormal returns are not affected by the event

H1: Stock index abnormal returns are affected by the event

Statistical significance of obtained abnormal return at the event day is tested using test statistics by Brown & Warner (1985). Test statistics gives the t-value for estimated abnormal return. T-value shows the significance level of the estimated return. For example, if the t-value of estimated abnormal return is lower than -1.96 or higher than 1.96 the null hypothesis can be rejected by the 5% significance level, which would show that the stock index returns are affected by the event. Critical t-values noticed above are valid when the estimated sample is normally distributed. Student-t distribution was used to define critical values when the critical values of normal distribution were not usable.

Test statistics is the ratio of event day abnormal return to its estimated standard deviation. Estimated standard deviation is the standard deviation of the abnormal returns in the estimation window. The test statistics for every stock index *i* at time *t* is calculated by following formula:

(6) $$t_{AR_{i,t}} = \frac{AR_{i,t}}{S(AR_i)}$$

Where:

$t_{ARi,t}$ = t-statistic for stock index *i* abnormal return at time t
$S(AR_i)$ = estimated standard deviation for AR_i

The statistical significance and the null hypothesis that *Stock index returns are not affected by the event* is tested for cumulative abnormal returns as follows:

(7) $$t_{CAR_{i,(t1,t2)}} = \frac{\overline{CAR}_{i,(t1,t2)}}{S(\overline{CAR}_{i,(t1,t2)})} \sim N(0,1)$$

Where:

$\overline{CAR}_{i,(t1,t2)}$ = Average cumulative return for stock index *i* over the period *t1* to *t2*
$S(\overline{CAR}_{i,(t1,t2)})$ = Standard deviation of $\overline{CAR}_{i,(t1,t2)}$

4.4. Regression model

The final part of the empirical investigation consists of the analysis of explanatory factors for possible negative abnormal reactions of stock indices that occurred during the terrorist attacks. In other words, the aim is to define the determinants of abnormal returns. Cross sectional regression is used to test the relationship between the independent variables and dependent variable. In this study, the dependent variable is the attack day abnormal return of that index where the terrorist attack occurred. Thus, the regression analyses in this thesis is used only to the target country's stock reactions. The regression analysis included all the 22 terrorist attacks that were presented earlier (see Table 1).

Main purpose of the regression analysis is to test whether the size of the attack is significant enough to explain different reactions of stock indices. Size of the attacks are operationalized as numbers of fatalities and injuries caused by the attacks. Other variables included in the regression analysis are the time and volatility variables. The time variable describes the time that has elapsed from previous attack in the tested sample. The time variable seeks to determine whether the interval between the terrorist attacks is an explanatory factor to the stock index reaction. The volatility variables are included to see whether the abnormal returns of stock indices only depend on the level of volatility or volatility changes.

With the test measures described above the regression equation is formed as follows:

$$(8)\ AR_{i,t}(t=0) = \beta_0 + \beta_1 FATALITIES + \beta_2\, INJURED + \beta_3 TFPA + \beta_4 VOLLEVEL + \beta_5 \Delta VOL + \in$$

Where $AR_{i,t}$(t=0) is the abnormal return for target country's stock index in attack day, β_0 is the constant of the regression, $\beta_1 FATALITIES$ is a variable for the number of fatalities caused by the attack, $\beta_2\ INJURED$ is a variable for the number of injured people caused by the attack, $\beta_3 TFPA$ variable defines the days lasted from previous attack. $\beta_4 VOLLEVEL$ is a variable for the volatility level in attack day, $\beta_5 \Delta VOL$ is a variable for the change of the volatility in attack day, and $\in$ is the error term.

The explanatory power of the number of fatalities, injured people and time from previous attack (TFPA) are all tested in separate models. Therefore, four different models are tested. Model 1 includes independent variables: $\beta_1 FATALITIES$, $\beta_4 VOLLEVEL$ and $\beta_5 \Delta VOL$. Model 2: $\beta_2\, INJURED$, $\beta_4 VOLLEVEL$ and $\beta_5 \Delta VOL$. Model 3: $\beta_3 TFPA$, $\beta_4 VOLLEVEL$ and $\beta_5 \Delta VOL$. Model 4 is as in equation 8.

All four regression models are tested with *two* different terrorist attack sample. First sample includes all the 22-terrorist attack presented earlier (see Table 1). The other sample includes only the attacks occurred in Europe, given that Europe was in the main focus of the thesis. The Europe sample consist of 17 terrorist attacks. The purpose of dividing the regression analysis according to these two samples is to enable studying further the stock market reactions only in Europe, and to see whether the independent variables are able to explain stock market reactions in the target countries in Europe.

5. EMPIRICAL FINDINGS

The empirical findings from the earlier defined examinations are presented and discussed within this chapter. Results from the event studies with the different samples and estimation perspectives are presented and discussed first. After the results from the event studies, the results of the regression analysis are presented.

5.1. Abnormal returns of stock indices

Table 4 and 5 presents the average abnormal returns (AAR) during the 21–day event window period (t= -10 to t=+10). These tables also present the percentage of indices that declined and shows how large was the change of volatility. Table 4 describes the effects of terrorism to European stock markets, examined with event study methodology and including only the eleven European stock indices that were presented earlier in this study. Event study results are further separated in two different panels: Panel A includes all the examined terrorist attacks (22 attacks), while in Panel B, the terrorist attack in World Trade Center 11th of September 2001 is excluded. There was a need for these two separate analyses because, like Charles and Darne (2006) and others have showed, it is undeniable that the WTC attack had a major impact on the stock markets around the world.

The event study findings in Panel A indicates that average abnormal stock index reaction of the attack day (t=0) is slightly negative (-0,65%) and statistically significant at 1% level. The percentage of declined stock indices is 60,23%, thus indicating that terrorist attacks had negative impact on the majority of stock indices on the day of the attack. The attack day findings in Panel A also point out major increase in the change of volatility compared to days around the terrorist attacks. In light of the findings after the attack day, the average negative effects of terrorist attacks on stock index returns seems to be short termed, with average abnormal returns varying from negative to positive during the days after the attack. The findings show no persistent negative average abnormal returns in the days following the terrorist attacks.

In Panel B (i.e., without WTC attack), the negative average abnormal return on the day of the attack (-0,43%) is smaller compared to the findings in Panel A.

However, the attack day reaction remains still statistically significant at 1% level in Panel B. In all, excluding the 11th of September 2001 attack in the sample means that the percentage of the negatively affected stock indices (59,13%) is modestly smaller and that the change of volatility (1,3%) decreases.

Table 4. Average abnormal returns for the European stock indices.

Table shows average abnormal returns (AAR), the percentage of indices that declined (%-) and the change of volatility around the terrorist attacks. Statistical significance at 10% level is defined by *, 5% level by ** and 1% level by ***. Panel A includes all terrorist attacks and panel B eliminates the effect of terrorist attack in World Trade Center.

	Panel A				Panel B			
	All terrorist attacks				Without 11/09/01 attack			
t	AAR	t-Stat	%-	Δvol	AAR	t-Stat	%-	Δvol
-10	-0,23 %	-2,40**	55,68 %	-0,80 %	-0,20 %	-2,00**	53,97 %	-1,08 %
-9	0,25 %	2,91***	43,94 %	-0,32 %	0,29 %	3,29***	43,25 %	-0,54 %
-8	-0,02 %	-0,15	60,23 %	0,67 %	0,06 %	0,59	58,73 %	0,33 %
-7	0,08 %	0,96	42,05 %	-1,83 %	0,08 %	0,91	41,67 %	-1,56 %
-6	0,17 %	1,55	53,41 %	1,09 %	0,23 %	1,98**	51,59 %	0,81 %
-5	-0,29 %	-3,43***	55,30 %	2,16 %	-0,35 %	-3,96***	56,75 %	2,55 %
-4	-0,13 %	-1,31	55,68 %	0,98 %	-0,07 %	-0,70	55,16 %	0,85 %
-3	0,02 %	0,19	52,65 %	0,17 %	0,09 %	1,10	51,19 %	-0,26 %
-2	-0,08 %	-0,44	56,06 %	0,76 %	0,01 %	0,05	53,97 %	0,66 %
-1	-0,25 %	-2,36**	48,86 %	0,26 %	-0,21 %	-1,9*	46,83 %	0,04 %
0	**-0,65 %**	**-5,02*** **	**60,23 %**	**2,73 %**	**-0,43 %**	**-3,95*** **	**59,13 %**	**1,30 %**
+1	0,49 %	3,94***	45,45 %	-0,44 %	0,49 %	3,96***	46,03 %	-0,35 %
+2	-0,01 %	-0,12	53,79 %	-0,48 %	-0,01 %	-0,08	54,76 %	-0,10 %
+3	-0,52 %	-4,50***	61,74 %	1,28 %	-0,32 %	-3,16***	59,92 %	0,34 %
+4	0,22 %	2,61***	48,48 %	-1,52 %	0,18 %	2,17**	48,81 %	-1,39 %
+5	-0,01 %	-0,08	56,06 %	-0,80 %	0,03 %	0,38	54,37 %	-0,50 %
+6	0,03 %	0,33	49,24 %	0,27 %	0,09 %	1,08	47,62 %	-0,18 %
+7	-0,71 %	-6,91***	71,97 %	3,00 %	-0,55 %	-5,80***	70,63 %	2,64 %
+8	0,35 %	2,37**	50,00 %	-0,64 %	0,54 %	3,85***	47,62 %	-0,96 %
+9	0,10 %	0,66	38,26 %	-0,97 %	-0,13 %	-0,94	39,68 %	-0,25 %
+10	-0,12 %	-1,14	52,27 %	0,22 %	-0,18 %	-1,66*	53,57 %	0,03 %

The results detailed above and shown in table 4 are in line with earlies studies. For instance, Brounrn and Derwall (2010) found similar results as they identified that terrorist attacks produced slightly negative impacts to stock markets. The impacts they identified were statistically significant but only temporal. The identified increase in the change of volatility in the present study is also consistent with previous studies such as Nikkinen et.al (2008). Their findings suggest that volatility under terrorist attacks can change significantly, with global increase in volatility around the stock markets

Table 5 shows some additional analyses to table 4. That is, event study findings in table 5 are results from the examinations with the whole sample of stock indices (14). Event study analysis including all the terrorist attacks and stock indices, which were under investigation in this thesis, were done to see whether the reactions of stock indices outside the Europe could have significant impact to the results in comparison to the earlier findings in table 4. Like in table 4, findings are separated into Panel A and Panel B. The findings in table 5 show that the attacks day results of the negative abnormal return and increase in the change of volatility are modestly smaller in both panels compared to those results detailed in table 4. These results are not surprise given the strong stock market integration in Europe, as discussed earlier.

The results showed in table 5 gives support for the findings of Nikkinen et al. (2008). They showed that less integrated stock markets (e.g. those in Asia) are not exposed to the effects of terrorist attacks as much as integrated stock markets. However, event study results in table 5 includes only two indices, KSE 100 and BSE 100, which are not European stock indices and could be called as less integrated stock markets. Therefore, the findings in table 5 do not provide very large and significant evidence for this matter.

As a conclusion, findings detailed in table 4 and 5 suggest that European stock indices are negatively exposed to terrorist attacks, and that the expose is larger than in less integrated stock markets; however, the impact is modest and temporary. Further, the impact of the WTC terrorist attack in 11th of September 2001 to average abnormal return is clear and significant. Based on these findings, hypothesis one, expecting that terrorist attacks are significant enough to cause negative abnormal returns in stock indices, can be accepted.

Table 5. Average abnormal returns for the whole sample.

Table shows average abnormal returns (AAR), the percentage of indices that declined (%-) and the change of volatility around the terrorist attacks. Statistical significance at 10% level is defined by *, 5% level by ** and 1% level by ***. Panel A includes all terrorist attacks and panel B eliminates the effect of terrorist attack in World Trade Center.

	Panel A				Panel B			
	All terrorist attacks & all indices				Without 11/09/01 attack			
t	AAR	T-Stat	%-	Δvol	AAR	T-Stat	%-	Δvol
-10	-0,21 %	-2,65***	57,14 %	-0,85 %	-0,18 %	-2,17**	55,44 %	-0,21 %
-9	0,24 %	3,13***	44,48 %	-0,41 %	0,28 %	3,55***	43,54 %	-0,54 %
-8	-0,02 %	-0,28	59,09 %	0,61 %	0,04 %	0,47	57,48 %	0,25 %
-7	0,06 %	0,81	42,21 %	-1,63 %	0,06 %	0,84	41,84 %	-1,50 %
-6	0,13 %	1,43	53,57 %	0,98 %	0,18 %	1,91*	52,04 %	0,74 %
-5	-0,30 %	-4,20***	57,79 %	2,35 %	-0,34 %	-4,67***	59,52 %	2,47 %
-4	-0,12 %	-1,44	54,22 %	1,07 %	-0,07 %	-0,88	53,74 %	0,76 %
-3	0,06 %	0,85	50,97 %	0,05 %	0,13 %	1,81*	49,32 %	-0,31 %
-2	-0,12 %	-0,82	56,49 %	0,88 %	-0,05 %	-0,31	54,76 %	0,57 %
-1	-0,23 %	-2,69***	50,32 %	0,21 %	-0,20 %	-2,29**	48,64 %	0,00 %
0	**-0,51 %**	**-4,75*** **	**60,06 %**	**2,63 %**	**-0,34 %**	**-3,64*** **	**59,18 %**	**1,05 %**
+1	0,38 %	3,72***	45,45 %	-0,65 %	0,41 %	4,06***	45,92 %	-0,33 %
+2	-0,01 %	-0,07	52,27 %	-0,50 %	0,01 %	0,09	53,06 %	-0,10 %
+3	-0,50 %	-5,04***	61,36 %	1,13 %	-0,31 %	-3,59***	59,86 %	0,13 %
+4	0,16 %	2,11**	49,35 %	-1,41 %	0,17 %	2,41**	49,32 %	-1,29 %
+5	-0,01 %	-0,17	57,47 %	-0,77 %	0,01 %	0,12	56,12 %	-0,52 %
+6	0,05 %	0,72	47,73 %	0,06 %	0,11 %	1,50	46,26 %	-0,23 %
+7	-0,60 %	-7,01***	70,45 %	2,84 %	-0,47 %	-5,81***	69,05 %	2,37 %
+8	0,24 %	1,98**	50,00 %	-0,75 %	0,41 %	3,56***	47,62 %	-1,06 %
+9	0,09 %	0,75	38,31 %	-0,66 %	-0,10 %	-0,87	39,80 %	-0,06 %
+10	-0,04 %	-0,47	49,68 %	0,17 %	-0,08 %	-0,90	50,68 %	0,06 %

Table 6 present the event study findings of specific terrorist attacks. Terrorist attacks presented in the table 6 were chosen for the analysis because they have been the most prominent and attention-grabbing terrorist attacks in the

investigation period considered in this thesis. All the included attacks have also occurred in the most influential countries in Europe, except the 11th of September 2001 attack in the USA. The attack in the USA is included because its large impacts to European stock markets (as seen in table 4), and to see how the stock indices have reacted to terrorist attacks after that. The findings in the table 6 show the effects of selected terrorist attacks on five different stock indices. These stock indices are FTSE 100, DAX 30, CAC 40, IBEX 35 and S&P 500.

The event study was conducted with the above stock indices, as the purpose was to include all the indices of those countries that were the target of the terrorist attack at the time. The results shown in the table therefore consist of the effects of the most prominent terrorist attacks on Europe's most influential stock indices, plus the S&P 500 index. With these factors it was therefore possible to investigate the spillover effects to other countries in Europe and how the terrorist attack targeted to Europe affected to stock markets in USA, and vice versa. Furthermore, as mentioned already earlier, the selected terrorist attacks occurred in different times. Thus, the comparison of different stock market reactions in different decades and whether the time from previous terrorist attack was long or short could be also investigated, as also shown in table 6.

Consistent with previous studies (e.g. Chen & Siems 2004), the attack-day abnormal return from the 11/09/01 attack was largely negative and statistically significant for all the indices, as shown in table 6. The reaction of European stock indices in the attack day was found from -4,73% (IBEX 35) to -8,53 % (DAX 30), with all attack day abnormal returns highly statistically significant at 1% level. The findings indicate (see Table 6) that terrorist attack in the USA affected stock markets in Europe even longer event windows after the attack, with cumulative abnormal returns (CAR5 and CAR10) being significantly negative for all European indices. Further, it seems that S&P 500 index recovered more quickly, since the CAR 10 results were not significant anymore, though still -3,89%. The stock index reactions for the other two terrorist attacks (11/03/04 & 07/07/05) in the beginning of the 2000s were found partly similar than the reactions for the 11/09/01 attack. Attack-day abnormal returns of European stock indices were found negative and statistically significant after the attacks in Spain 11/03/04 and UK 07/07/05. Negative stock market reaction was larger after the attack in Spain (from -2,24% to -3,33%) than after the attack in the UK (from -1,51% to -2,13%). Interestingly, the stock index reaction was not the most negative in that particular

country where the particular terrorist attack occurred. The effects of terrorist attack in Spain 2004 also lasted longer, and cumulative abnormal returns for five and ten days were negative and highly significant for all four European indices. In comparison, after the attack in UK 2005, cumulative abnormal returns (for 5– and 10–day event window) were not statistically significant in any of the European indices, with the FTSE 100 index the only to record negative effects for both CAR 5 and CAR 10. When considering the abnormal returns of the S&P 500 index after the terrorist attacks in Spain 11/03/04 and UK 07/07/05, we can see that the reaction was significantly negative only after the attack in Spain. Cumulative abnormal returns for five and ten-days were significant at 10% level and negative after the attack in Spain, when in comparison, after the terrorist attack in UK, negative reactions were not visible in the returns of the S&P 500 index.

When we move forward in time, we can see that the reaction of European stock indices to terrorist attacks in 2015 and beyond has been very different from those of early 2000s. None of these more recent terrorist attacks have caused statistically significant negative results for attack-day abnormal returns of European indices, albeit terrorist attacks in France 13/11/15, in the UK 03/06/17 and in Spain 17/08/17 attack-day abnormal returns were slightly negative for all four European indices. Terrorist attacks in the UK 03/06/17 and Spain 17/08/17 caused also statistically significant negative cumulative abnormal returns at least 5% level. After the 03/06/17 attack, negative and statistically significant CAR 5 results can be seen for indices FTSE 100 (-1,95%), DAX 30 (-2,47%), CAC 40 (-3,55%) and IBEX35 (-1,88%). Negative and statistically significant CAR 10 results were for the indices FTSE 100 (-3,12%), DAX 30 (-2,12%) and CAC 40 (-3,78%). Cumulative abnormal returns after the attack in Spain 17/08/17 are highly significant and negative especially in Spain (IBEX 35): -1,82% (CAR 5) and -2,41% (CAR 10). Findings show that statistically significant negative return reactions occurred also in CAR 5 (-0,38%) and CAR 10 (-0,21%) results for FTSE 100 index and in CAR 5 (-0,81%) and CAR 10 (-1,00%) results for CAC 40 index.

Stock market reactions for the terrorist attacks between the years 2015–2017 in USA correlate with the results pointed out in the context of European stock markets. Attack-day abnormal returns have been negative and even statistically significant after the attacks in France 13/11/15 (-1,54%) and in Spain 17/08/17 (-1,65%). Findings also shows that after the terrorist attack in Spain 17/08/17, five-

day and ten-day cumulative abnormal returns were statistically significant and negative (CAR 5: -1,75%, CAR 10: -0,84%).

The findings in table 6 also shows interesting stock market reactions, when taking closer look for such terrorist attacks that occurred close to each other time wise, and even in the same country. First, when comparing the stock market reactions after the terrorist attacks in France 07/01/15, 13/11/15 and 14/07/16, differences can be seen. The AR, CAR 5 and CAR 10 results are all positive, after the attack in 07/01/15, and cumulative abnormal returns are statistically significant for the FTSE 100, DAX 30 and CAC 40 indices. The cumulative returns are the most positive for the CAC 40 index, thus the stock index of the country where the attack occurred reacted the most positively.

The findings concerning the effects after the attack in 13/11/15 are opposite to the previous attack. Attack-day abnormal returns are negative for all indices, but statistically significant only for S&P 500 index. Cumulative abnormal returns for five and ten days are all negative, except FTSE 100 index. Findings for these longer event periods are insignificant, except CAC 40, but it can be said that reactions in stock markets were negative and opposite to reactions after the attack in France circa ten months earlier. However, when comparing these two terrorist attacks, it must be noted that the attack in 13/11/15 was much more destructive, causing more fatalities and injured people (see table 1).

Terrorist attack 14/07/06 in France gives better comparison to 13/11/15 terrorist attack, because the consequences of these two attacks were more similar. FTSE 100 is the only index where the reactions after the attack in France 14/07/16 is negative for all the estimated event periods. However, the results of the FTSE 100 index are not statistically significant. All the other indices reacted positively in all estimated event periods and cumulative abnormal return results are statistically significant at least at 5% level. In sum, the terrorist attacks that occurred closely together in France provoked varying reactions in stock markets. And according to these findings, it seems that stock market reactions to terrorist attacks occurring closely to each other are more likely less negative, or even positive to the latter terrorist attacks.

Terrorist attack in The UK 22/05/17 and 03/06/17 gives more information of the stock market reactions in a situation where the terrorist attacks occurs closely to

each other within the same country. In this case the time between the attacks is only few days so the findings are not totally comparable to the findings concerning the aforementioned attacks in France. Following the latter attack in the UK, stock index reactions were negative and significant for the longer event periods, when after the attack few days earlier the reactions were less negative and mostly insignificant.

Table 6. Event study results for specific terrorist attacks.

Table reports attack-day abnormal returns (AR), five-day cumulative abnormal returns (CAR 5) and ten-day cumulative abnormal return (CAR 10) for the stock. Statistical significance is shown in parentheses. ***, ** and * describes the significance at 1%, 5% and 10% level.

	11/09/01 USA	11/03/04 Spain	07/07/05 UK	07/01/15 France	13/11/15 France	14/07/16 Fance	19/12/16 Germany	22/05/17 UK	03/06/17 UK	17/08/17 Spain
FTSE 100										
AR	-5,93 %	-2,29 %	-1,51 %	0,93 %	-1,25 %	-0,39 %	0,03 %	0,37 %	-0,56 %	-0,51 %
	(-6,77)* **	**(-3,48)*** **	**(-3,45)*** **	(0,74)	(-1,42)	(-0,22)	(0,04)	(0,46)	(-0,93)	(-0,89)
CAR(5)	-4,01 %	-3,34 %	-0,26 %	0,93 %	0,98 %	-0,45 %	0,51 %	1,20 %	-1,95 %	-0,38 %
	(-2,66)* **	**(-4,48)*** **	(-1,19)	**(2,28)** **	(0,17)	(-1,08)	**(2,03)** **	**(2,02)** **	**(-2,48)** **	**(-2,00)** **
CAR(10)	-8,08 %	-4,14 %	-1,68 %	6,65 %	0,32 %	-0,84 %	1,35 %	1,11 %	-3,12 %	-0,21 %
	(-1,97) **	**(-2,75)*** **	(-1,60)	**(2,03)** **	(0,26)	(-1,31)	(1,60)	**(2,56)** **	**(-2,17)** **	(-1,84)*
DAX 30										
AR	-8,53 %	-3,33 %	-2,12 %	0,48 %	-1,33 %	1,67 %	0,08 %	-0,35 %	-0,24 %	-0,38 %
	(-6,74)* **	**(-3,73)*** **	**(-3,35)*** **	(0,33)	(-1,20)	(0,75)	(0,11)	(-0,43)	(-0,28)	(-0,54)
CAR(5)	-8,67 %	-4,38 %	0,27 %	3,42 %	-0,74 %	4,04 %	-0,33 %	-1,26 %	-2,47 %	-0,02 %
	(-4,28)* **	**(-3,91)*** **	(-0,50)	**(2,09)** **	(-1,59)	**(2,71)*** **	(-0,01)	**(-1,85)***	**(-2,22)** **	(-0,81)
CAR(10)	-11,47 %	-3,84 %	1,73 %	8,06 %	-2,37 %	6,70 %	0,34 %	-0,72 %	-2,12 %	-0,50 %
	(-2,78)* **	**(-3,50)*** **	(0,16)	**(1,98)** **	(-1,60)	**(2,15)** **	(-0,43)	**(-1,88)***	**(-2,56)** **	(-0,96)
CAC 40										
AR	-7,55 %	-3,01 %	-1,60 %	0,78 %	-1,51 %	1,44 %	-0,37 %	-0,32 %	-0,86 %	-0,51 %
	(-6,79)* **	**(-4,02)*** **	**(-2,76)*** **	(0,50)	(-1,23)	(0,57)	(-0,49)	(-0,29)	(-0,79)	(-0,692)
CAR(5)	-9,14 %	-6,11 %	0,86 %	3,75 %	-1,84 %	2,68 %	-0,76 %	-1,51 %	-3,55 %	-0,81 %
	(-4,61)* **	**(-3,78)*** **	(0,02)	**(2,37)** **	**(-1,70)***	**(2,87)*** **	**(-1,78)***	(-1,56)	**(-2,76)*** **	**(-2,63)*** **
CAR(10)	-10,20 %	-5,09 %	1,08 %	10,08 %	-3,94 %	5,13 %	-0,75 %	-2,96 %	-3,78 %	-1,00 %
	(-3,10)* **	**(-3,51)*** **	(0,55)	**(2,02)** **	**(-1,68)***	**(1,98)** **	**(-1,94)***	(-1,62)	**(-2,64)*** **	**(-2,35)** **
IBEX 35										
AR	-4,73 %	-2,24 %	-2,13 %	0,29 %	-0,75 %	1,37 %	-0,63 %	-0,69 %	-0,43 %	-0,96 %
	(-4,25)* **	**(-2,97)*** **	**(-3,82)*** **	(0,17)	(-0,62)	(0,40)	(-0,83)	(-0,69)	(-0,37)	(-1,5)
CAR(5)	-9,02 %	-6,11 %	0,28 %	0,72 %	-0,81 %	3,98 %	0,18 %	-1,36 %	-1,88 %	-1,82 %
	(-2,89)* **	**(-2,72)*** **	(-0,55)	(0,46)	(-0,44)	**(2,42)** **	(-0,27)	(-1,12)	**(-1,67)***	**(-4,48)*** **
CAR(10)	-9,95 %	-5,09 %	-0,13 %	5,99 %	-2,76 %	5,23 %	1,22 %	-2,85 %	-2,79 %	-2,41 %
	(-2,54) **	**(-3,41)*** **	(-0,38)	(0,99)	(-1,03)	**(2,15)** **	(0,35)	(-1,38)	(-1,51)	**(-2,99)*** **
S&P 500										
AR	-4,91 %	-1,58 %	0,15 %	1,14 %	-1,54 %	0,59 %	-0,06 %	0,42 %	-0,20 %	-1,65 %
	(-5,54)* **	**(-2,81)*** **	(0,38)	(1,19)	**(-1,97)** **	(0,50)	(-0,10)	(0,97)	(-0,37)	**(-4,81)*** **
CAR(5)	-7,87 %	-0,55 %	2,00 %	0,21 %	-0,36 %	0,98 %	-1,27 %	0,88 %	-0,84 %	-1,75 %
	(-3,21)* **	**(-1,66)***	**(2,28)** **	(1,60)	(-1,06)	**(3,43)*** **	(-1,23)	**(3,25)*** **	**(-2,76)*** **	**(-5,12)*** **
CAR(10)	-3,89 %	-2,10 %	1,52 %	1,04 %	-2,37 %	1,53 %	-3,66 %	1,28 %	-0,20 %	-0,84 %
	(1,15)	**(-1,67)***	**(2,93)*** **	(-1,02)	(-1,41)	**(3,26)*** **	(-1,26)	**(2,64)*** **	**(-2,37)** **	**(-4,59)*** **

In light of the findings detailed in table 6, it is noticeable that terrorist attacks at the beginning of the 2000s caused more negative and significant reactions in stock markets than the attacks in 2010s. The effects of terrorist attacks spread to other countries and the stock market reaction can be even more significant outside of the country where the attack occurs. These results converge with Chen and Siems 2004 and Johnston and Nedelescu 2006, who have concluded in their studies that the stock markets have become more immune to terrorism over the years. However, the findings in table 6 point out that the recent terrorist attacks in 2017 have still caused significant and negative cumulative abnormal returns for stock indices.

In addition, Kollias et.al 2011 have suggested that the reactions of stock indices after different terrorist attacks are partly influenced by the nature and manner of the attacks. Event study results described in table 6 focuses only on the stock index reactions after the terrorist attacks, thus deeper and different type of analyses are needed to explain the possible reasons for these varying reactions to different terrorist attacks. Altogether, based on the findings presented in table 6, hypotheses two and three can be accepted.

5.2. Regression results

Final part of the empirical analyses focuses to the results of the multivariate regressions. The goal of the regression analyses was to investigate whether the stock index reaction, of that country where the terrorist attack occurs, can be explained by the number of fatalities or injured people, and whether the time form previous attack is significant enough to explain stock index reactions. Selected factors explaining the stock index reactions are studied by including array of explanatory variables (see Table 7 and 8). Dependent variable in all models in table 7 and 8 is the attack-day abnormal return of that stock index where the terrorist attacks took place. Independent variables consist of factors that define the size of the attacks, the time lasted from previous attack, and volatility. As mentioned earlier, the size of the terrorist attacks was determined by the number of fatalities and injured people.

Table 7. Regression results for the whole sample.

Table present the results of equation (8). The dependent variable in all regression models is attack-day abnormal return of stock indices. Fatalities is a variable for the number of fatalities caused by the attack. Injured is a variable for the number of injured people caused by the attack. TFPA is a variable to define the time from previous terrorist attack. Vol level is a variable for the level of volatility in attack day. ΔVol defines the change of volatility in the attack day. T-statistics are in parentheses. ***, ** and * describe statistical significance at 1%, 5% and 10% level by using student-t distribution.

	Event day abnormal returns			
	Model 1	Model 2	Model 3	Model 4
Dependent variable:	Abnormal return			
c	-0,014 **(-2,36)****	-0,013 **(-2,23)****	-0,009 (-1,22)	-0,018 **(-3,06)*****
FATALITIES	-1,5E-05 **(-2,89)****			2,1E-06 (-0,17)
INJURED		-7,79E-06 **(-3,20)*****		-1,27E-05 **(-1,97)***
TFPA			1,44E-06 (-0,13)	-2,33E-05 **(-2,39)****
VOL LEVEL	0,001 **(2,40)****	0,001 **(2,54)****	0,000 (-0,75)	0,001 **(3,64)*****
ΔVOL	-0,072 **(-3,74)*****	-0,064 **(-3,29)*****	-0,095 **(-4,42)*****	-0,047 **(-2,43)****
Number of observations	22	22	22	22
R-Squared	0,67	0,70	0,52	0,78

Table 7 presents the regression results including all the 22 terrorist attacks. Independent variables: *Fatalities, Injured* and *TFPA* are all separated to own models, and one model takes all the independent variables into account. This means that altogether four models are estimated. The constant is negative to all estimated models, and statistically significant in models one, two and four. In model 1, the coefficient for the variable *Fatalities* is negative and statistically significant at 5% level, indicating that the number of fatalities explains the negative abnormal returns of stock indices. However, the explanatory power is

very modest, though the coefficient for variable *ΔVOL* in model 1 is -0,072, and it is statistically significant at 1% level, indicating that the negative abnormal return reaction of stock indices is explained by the increased change of volatility more than by the number of fatalities. Regression results in model 2 are similar to model 1. Independ variable *Injured* is statistically significant at 1% level and the coefficient is negative, but still very minor. The number of injured people was found to have modest impact to the negative abnormal returns of stock indices. The coefficient of *ΔVOL* decreases slightly but remains negative and highly significant.

As visible in Table 7, the coefficient of the variable *TFPA* were positive and insignificant in model 3. Thus, in model 3, the time from previous attacks cannot explain the negative abnormal returns of stock indices. In model 3, the R-Squared was also the lowest of all models (0,52). Model 4 combines all five aforementioned independent variables. The R-Square of the model 4 is the highest (0,78) out of all models. This means that, model 4 is the best to explain the negative attack-day abnormal returns of stock indices. All the other independent variables are statistically significant except *Fatalities*. Compared to model 1, the coefficient of a variable *Fatalities* is positive and insignificant in Model 4. Moreover, coefficient of variables *Injured* and *TFPA* turned out statistically significant and negative in model 4, but because the coefficients are minor, neither of these variables can explain substantially the negative abnormal stock index returns on the day of the attacks. To summarize the results shown in table 7, it can be stated that volatility variables explain significantly the negative abnormal attack-day returns for stock indices, and that the explanatory power of the number of fatalities and injured people, and the time from previous attack are very modest (but still not zero).

Table 8 present the regression results based on the same regression than shown in table 7, but with different estimation sample. That is, the results in table 8 includes only the stock index reactions on the days when the terrorist attack occurred in Europe. Therefore, the terrorist attack sample consist of 17 terrorist attacks and, of course, 17 stock index reactions. The results shown in table 8 are smaller compared to those earlier shown in table 7. In table 8, constant is still negative for all models, but it is not statistically significant in any model. Coefficients of variable *Fatalities* in model 1 and variable *Injured* in model 2 stays negative but are both insignificant -- in the results shown in table 7, both of these

variables were statistically significant. Interestingly, and on the contrary to table 7, variable *TFPA* in model 3 is now statistically significant and negative. The coefficient is very small, but when estimating terrorist sample consisting only terrorist attacks in Europe, the time lasted from previous terrorist attack turns to be statistically significant in explaining at least small part of the negative stock index reactions. The coefficient of *ΔVOL* stays negative and significant in all models, except in the model 4. The value of R-Squared decreases in models 1, 2 and 4 when compared to the results in table 7. The model 3 manages to explain better the attack-day abnormal return in table 8 (R-Square 0,65) than in table 7 (R-Square 0,52), due to the significant results of *TFPA* variable.

Table 8. Regression results for the European attacks.

Table present the results of equation (8). The dependent variable in all regression models is attack-day abnormal return of stock indices. Fatalities is a variable for the number of fatalities caused by the attack. Injured is a variable for the number of injured people caused by the attack. TFP is a variable to define the days from previous terrorist attack. Vol level is a variable for the level of volatility in attack day. ΔVol defines the change of volatility in the attack day. T-statistics are in parentheses. ***, ** and * describe statistical significance at 1%, 5% and 10% level by using student-t distribution.

Event day abnormal returns (attacks in Europe)				
	Model 1	Model 2	Model 3	Model 4
Dependent variable:	Abnormal return			
c	-0,004 (-0,37)	-0,005 (-0,57)	-0,009 (-1,17)	-0,011 (-1,55)
FATALITIES	-5.48E-06 (-0,17)			2.30E-05 (-0,82)
INJURED		-8.96E-06 (-1,45)		-1.17E-05 (-2,04)*
TFPA			-5.97E-05 (-2,90)**	-5.95E-05 (-3,13)***
VOL LEVEL	2.66E-05 (-0,05)	0,0003 (-0,57)	0,001 (-1,54)	0,001 (-2,18)*
ΔVOL	-0,064 (-3,05)***	-0,051 (-2,37)**	-0,046 (-2,62)**	-0,030 (-1,67)
Number of observations	17	17	17	17
R-Squared	0,42	0,50	0,65	0,75

To sum up, stock index reactions in the country targeted to terrorist attacks are not explained by the number of fatalities or injured people when estimating these factors separately with volatility factors. Among these independent variables, the increased change of volatility (ΔVOL) is the main factor that explains stock index reactions in the attack day and *H4* cannot be accepted.

6. CONCLUSIONS

Terrorism has taken increasingly stronger presence around the word in the recent years, with the threat of terrorism increasing among our everyday lives. The terrorist attack in the United States 11th of September 2001 was perhaps the first remarkable terrorist attack that had also major global impact, and after that the effects of terrorism to economy and stock markets started to gather interest. In this thesis, the main purpose was to investigate the effects of the major terrorist attacks, occurred in Europe in the 2000s, to stock markets. Especially, the effects to European stock markets were under analytical lens.

The effects of terrorist attacks to European Stock markets were examined in a few different ways, and the more specific reasons causing these reactions were also under investigation. The reactions of stock markets on that particular day when the terrorist attack occurred was the main focus of the investigations. The stock market reactions were examined by using event study methodology, and with stock indices of countries where the terrorist attacks occurred. To determine the causes of the stock index reactions, regression analyse was used.

The findings of this thesis show that European stock indices reacted, on average, negatively on the day of particular terrorist attack. Brounrn and Derwall (2010) have stated that stock market reactions are the most significant for local markets. The findings of this thesis show that the negative reactions of stock indices are also reflected in stock indices of those countries that are closely related to the particular country where the terrorist attack first took place. In line with earlier findings by Nikkinen et.al (2008), the change of volatility was also found to increase significantly on the day of the terrorist attacks. These findings mentioned above were statistically significant. Based on those terrorist attacks and stock indices that were included in this thesis, it can be therefore concluded that terrorist attacks have negative impact to European stock markets. Albeit the found negative reactions were temporary and having decreased over time, various terrorist attacks can cause statistically significant negative stock market reactions even today.

The regression analyses regarding possible explanatory factors did not manage to explain comprehensively the negative attack-day abnormal returns of the stock indices. The impact of number of fatalities and injured people were modest

across all the regressed models, even though the coefficient of these variables were negative and statistically significant in model 1 and model 2 when the whole sample of the terrorist attacks were included in examinations. Therefore, future research should take a closer look on the factors that could explain the different reactions of stock indices to terrorist attacks. Moreover, the stock market reactions in this study differed in regard of time, with finding that attacks that occurred even closely each other caused different reactions in stock indices. Therefore, it would be interesting to explore further, for example, why the cumulative stock market reactions have been negative and significant after the most recent terrorist attacks in the UK 03/06/17 and in Spain 17/08/17, given that the reactions of stock indices were mostly positive and insignificant after the other terrorist attacks that took place in 2010s.

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