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From Madrid to Brussels: The impact of four terror attacks on European stock markets

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1 Introduction

On the morning of March 22nd 2016, two bombs exploded in the departure hall of Brussels international airport, Zaventem. One hour later, an explosion occurred in a subway train in the station of Maelbeek, situated in the European district of the Belgian capital. These attacks, for which the terror group Islamic State of Iraq and the Levant (ISIL) later claimed responsibility, left 32 people dead and several hundreds injured. This was the second attack Europe suffered in a short time: merely four months earlier, the same terror group executed a series of organised attacks in different Parisian neighbourhoods, resulting in a death toll of 130. Hundreds more were wounded.

As if the human toll of these attacks is not already sufficient sorrow for a country to deal with, and by extension, the world, there are also other consequences of terror attacks, consequences that often provoke significant additional damage: the impact on the economy. While it may seem heartless to think in such a way while innocent people have lost their lives or got injured because of these acts of brutal violence, it is a phenomenon that does exist and to which attention needs to be paid. What is more, when perpetrators of terror acts do what they do, creating economic damage is one of their main goals. Let's not forget Al Qaeda's primary purpose of the 9/11 attacks was to derail the American economy (CNN, 2004). Another example is the mass shooting that occurred in a tourist resort in Tunisia in June 2015: well aware of the importance of tourism for the Tunisian economy, ISIL, the terrorist group responsible for this attack, aimed to strike a blow to this country's economy (Sengupta, 2015). More recently, terrorists deployed the same strategy when they attacked the Istanbul's international Atatürk Airport in Turkey on 28th June 2016 (Letsch & Woolf, 2016).

Since a couple of years already, researchers have been investigating the effects of terror on the economy, and the literature has also seen studies emerge that have looked at the impact on stock markets. The results of these studies are mixed, indicating that stock market reactions to terror attacks can differ substantially depending on place, time, target, or other characteristics of the attack. Now that there is resurgence of terrorism in Europe, we can wonder as to how these recent attacks have impacted European stock

markets, we can try to explain why, and we can compare them to previous large-scale terror acts Europe has known.

The aim of this thesis is as follows. We want to complete the existing literature by examining the stock market effects of two recent terror attacks: the one in Paris and the one in Brussels. Our goal is to put these events next to the earlier attacks in Madrid and London, and as such arrive at a picture of what these four attacks have signified for European stock markets, on different levels of analysis. To the best of our knowledge, this comparison is not yet available in the literature. With this study we want to provide information about terrorism in Europe in the last 15 years and its relation to the stock market. As such, this thesis is a descriptive one. We do not aspire to predict how terror attacks on European soil in the future will affect the European stock markets. To do that, the data set is too limited.

To achieve our goal, we use the event study methodology. This is a popular tool to examine if a certain event provoked a stock reaction or not, based on statistical significance. It is based on the Efficient Markets Hypothesis (EMH), an influential theory in finance that states that in efficient markets, prices on a stock market fully reflect all available information (Fama, 1970; 1991). We will conduct these event studies on relevant indices of European, country and sectorial stock markets.

This thesis addresses eight research questions. We want to find out how the four terror attacks impacted (1) the *general European* stock markets, (2) the general stock markets of the *country under attack,* (3) the European stocks of the *individual industries*, and (4) the European stocks of *those specific industries that are expected to feel more impact from terrorism*. For each of these levels we will examine if (a) an effect is found that is abnormal to the index' previous returns average, and (b) if there is an effect that is abnormal to the market. That is why we will look, for each of the four levels mentioned, through two different methodological lenses: for a given index we will compare its returns after a terror attack first to its historical returns, and then to its expected returns as based on its usual relationship with a market index. We will thus look at the problem in two different ways.

The thesis is structured as follows. First, in Chapter 2, we take a look at the existing literature that has focused on the effects of terrorism on the economy. We look at the

effects of terrorism on the economy in general, before doing a close-up and reviewing the existing literature with regard to the effect of terror attacks on the financial markets, and especially the stock market. We distinguish between studies that have examined the topic from a more general and international point of view, and papers that have taken a closer look at specific countries or specific industries. Other studies have done research into attacks on firms or on the effects on other financial products than stocks, which we concisely review as well. We proceed, in Chapter 3, by describing the different key concepts around which our study is based. Next, in Chapter 4, we briefly outline the goal of this thesis and the research questions it will seek an answer to. Chapter 5 describes the methodology that is used: the tools we use are described in detail. We explain what an event study is and in which forms our study puts this methodology to use. In Chapter 6 we take a look at the empirical results we found. We conclude, in Chapter 7, by discussing these results and by trying to find plausible explanations for our findings.

2 Literature review

2.1 Terrorism and its impact on the economy

The literature about the effects of terrorism on the economy is vast. Many studies exist that have looked at the impact of terror attacks on the (macro-)economy, economic parameters, or business. Not surprisingly, most of the research has focused on the 9/11 attacks.

First, let us mention some works that cover a broad spectrum of consequences of terrorism on the economy. Alexander and Alexander (2002) treat all kinds of impacts on government, business, labor, economy, financial markets, among other subjects, and do so in depth. Sandler and Enders (2008) give an overview of noteworthy works in different subdomains of terrorism and economy. A chapter of the 2001 IMF's World Economic Outlook (2001) lists and discusses the different effects of the 9/11 terror attacks on the global economy.

Terrorism does not only come with direct costs such as property damage and casualties. It is reported by Enders and Olson (2012) that the indirect costs of terrorism are much larger than these direct costs. The authors draw attention to this discrepancy and name the transportation and tourism sectors, the financial markets, and the amount of foreign direct investment in a country as particularly sensible to terrorist attacks. In the same way, some studies have looked at the costs of the 9/11 attacks and found that these go beyond direct costs (Navarro and Spencer, 2001; Rose and Blomberg, 2010).

2.1.1 Macroeconomic consequences

Evidence that is found for indirect consequences of terrorism often comes in the form of macroeconomic changes. For instance, in a sufficiently open world economy, where international investors are able to diversify country risks other than terrorism, terrorism may cause large movements of capital across countries (Abadie & Gardeazabal, 2008). Gaibulloev and Sandler (2008) report consequences of terrorism on growth, but show that western economies are quite robust and that a large number of

incidents are needed in order to have a large impact on growth. In their article on the macroeconomic consequences of terrorism, Blomberg, Hess, and Orphanides (2004) obtain three main results. First, although they find negative effects on growth resulting from terrorism, they find the effects of (civil) wars to be larger and more persistent when compared to the former. Second, they see a shift from investment spending to government spending. Third, they see a lot of differences depending on the country of the attack. Greenbaum, Dugan, and LaFree (2007) find that terrorism reduced the number of firms and employment in Italy, by reducing business formations and expansions. In an article by Nitsch and Schumacher (2004) analysing bilateral trade flows between more than 200 countries, terrorism is found to reduce the volume of trade. Llussá and Tavares (2010) looked at rates of growth of output, private consumption, investment, and public consumption and their dependence on a number of terror indicators, such as the number of attacks, the number of casualties, targeted at civilians or not, among others. Their results revealed that private consumption and private investment were significantly and negatively impacted by all terror indicators in the study. Private consumption was, moreover, most severely impacted by the number of victims and private investment by the number of attacks. Meanwhile, output growth and public consumption growth were little affected by the indicators. The conclusion of a study by Crain and Crain (2006) measuring the macroeconomic costs of terrorism and the potential gains of terrorism reduction summarises in that a country's economy would benefit greatly from a reduction in terrorism. These benefits are dependent, nevertheless, on the country's population, base level of output, and investment. The authors also calculated the world cost of terrorism for the year of 2002 and found that the world GDP lost $3.6 trillion in that year due to terrorism. In their macroeconomic paper, Eckstein and Tsiddon (2004) discuss that a high rate of terror makes output, consumption, investment and exports decline significantly. They find significant declining effects of output per capita following terrorism in Israel. Enders, Sachsida, and Sandler (2006) find no lasting negative influence of 9/11 on U.S. foreign direct investment (FDI) flows, but do find a small significant impact of attacks committed abroad against U.S. interests on the stock of U.S. FDI in the OECD countries. For non-OECD countries there was no such effect. Remaining with the subject of FDI, it was found that terrorism had a significant and persistent negative impact on the net foreign direct investment of Spain and Greece (Enders & Sandler, 1996). Terrorism's impact on a

country's cost of debt, then again, is the research angle of a recent paper by Procasky and Ujah (2016). They examined the effect on the sovereign risk of 102 countries, after which they conclude that terrorism results in a higher cost of debt for countries and companies. The effect found was larger in the more developing markets.

2.1.2 Effects on industries

A particular domain that has received a large amount of scientific attention is the effect of terrorism on tourism. Baker (2014) is one of the authors who did research into this topic, and he writes about the disastrous economic consequences terrorism can have on international tourism and, moreover, observes that terrorism can have an effect on the flow of foreign exchange into a country because of this negative impact. He also finds that travel anxiety for destinations that suffered a terror attack is common. Also, terrorist groups target tourists and tourist destinations more and more, he says, and they attract global media attention doing so. Goodrich (2002) focuses in detail on the travel and tourism sector in the US, and the effects they incurred after 9/11. The author names the heightened state of security across the US as the most visible effect of the tragedy. He lists an extensive number of changes that have occurred to the aforementioned industries in that respect, but he also addresses costs. Pizam and Smith (2000) conducted a broad study where they collected terrorist attacks at tourist destinations, which, they report, are numerous. They confirm that tourists are often targets chosen by terrorists. Most of the attacks had a significant effect on tourism, with half of the cases showing evidence of recovery after a couple of months. They found different negative impacts on tourism according to certain characteristics of the attacks. An important finding, one that is based on data for Israel, is the one by Pizam and Fleischer (2002), who discovered that the frequency of terrorist acts had a larger impact on tourism than their level of severity. The authors conclude that avoiding sequences of attacks is the most important thing a country can do. Another study looked at the consequences of the 9/11 attacks for the Mediterranean and Canary Islands' tourism demand (Araña & León, 2008). Tourists' utility was affected, and a change in the image and attractiveness of destinations was reported. Some destinations, on the contrary, became more popular as a consequence of terrorism, which suggests movement of tourists between destinations. More particularly, results indicated a more severe impact

on the market share of resort destinations with a high proportion of Islamic population than on that of their competitors with a lower proportion. The shift of market share between touristic countries is something that is reported by Drakos and Kutan (2003) as well. Spillover effects are also detected by these authors. A moderate but significant negative influence on tourist flows was found by Llorca-Vivero (2008), both for domestic and international terrorism. Secondly, he found that the impact of terrorism is more severe in developing countries as the cost of terrorist actions in terms of tourist arrivals is noticeably higher there. Sönmez and Graefe (1998) did a study into the tourism decision-making process: they found that there were three parameters that had a direct influence on international vacation destination choice - international attitude, risk perception level and income -, while touristic experience and education were indirect influences on the decision process. Large losses for the tourism industry were found in a study focusing on Greece, Italy, and Austria and terrorism acts that occurred in these countries during the '70s and '80s (Enders, Sandler, & Parise, 1992). Short-term effects of terrorism on incoming tourism to the US were found by Sloboda (2003). Terrorist events had a significant negative impact on the number of tourists visiting Spain, according to Enders & Sandler (1991). Enz, Kosova, and Lomanno (2012) studied the 9/11 impact on hotels and compared it to the effects of the 2008 financial crisis. Their results show a more immediate negative reaction from the former incident, as opposed to a slower impact of the latter, worsening over time. Among their other findings are that high-end hotels suffer most but recover quicker. Evidence also suggests that hotels that are used by foreign visitors are most sensitive to terror attacks, as a study by Greenbaum and Hultquist (2006) on the Italian hotel industry states.

Research has been conducted regarding the consequences for air travel as well. Ito and Lee (2005) discovered two effects on airline demand following the 9/11 attacks in the US. A large, temporary demand shock occurred immediately, but also an ongoing, more structural demand shift was set off by the attacks. Other authors found that the 9/11 attacks have appeared to have had only a short-term impact on air transport passenger demand (Lee, Oh, & O'Leary, 2005). Domestic air travel in the US after 9/11 was also studied by Blunk, Clark, and McGibany (2006), who tried to answer the question if it managed to return to the levels that would have existed in the absence of the attack, i.e. to the trend that existed before the attack. Their results suggest it did not. Perhaps the best-known consequences of the 9/11 attacks are the heightened security measures,

especially in the airline sector (Clark, McGibany, & Myers, 2009). These security precautions are now part of our everyday life. Finally, UK air travel was found to recover quickly from the impacts suffered as a result of three terror-related events in the late eighties and early nineties (Coshall, 2003).

The insurance industry too is known to be sensitive to terrorism. In order to have an idea of the impact terrorism can have on the insurance industry, it suffices to look at the 9/11 attacks in New York. These resulted to be a source of gigantic life and non-life insurance losses for American insurance companies. Alarmed by the magnitude of the costs terror attacks can create, the insurance industry believed that there was an absolute necessity for a federal backstop for terrorism insurance, and the American government met these demands by creating The Terrorism Risk Insurance Act, a federal law that provides for this kind of protection. The act should allow insurers to continue to cover terrorism risk, and avoid the entire insurance industry to collapse due to large-scale terror attacks (Hartwig, 2002; Allyn, 2003). Ericson & Doyle (2004), looking back on 9/11, say that, all things considered, American insurance companies succeeded fairly well in loss compensation of the damages and victims in the aftermath of the 9/11 attacks. They state that for the future however potential problems may arise for protection against terrorism, as this type of insurance is not available for everyone, which may provide for inequality. Baranoff (2009) reports that other catastrophes have taken place after 9/11, greatly impacting the insurance industry as well, but that there is a strong capacity of this industry to endure major setbacks and to recover.

2.1.3 Other research

Several other topics have been the subject of research on terrorism and economy. In their economic research on terrorism in Northern Ireland, Frey, Luechinger, and Stutzer (2007) show that, apart from such economic consequences as FDI, investment, or growth, terrorism can lead to a strong reduction in people's life satisfaction, because of large utility losses that are incurred. Another article decided to look at technological innovations and R&D and how they are affected by terror, and find that the effects are differential. The author talks about new technologies in the war on terrorism, competition for R&D talents and resources between counterterrorism and commercial

domains, and government funding of venture capital as consequences of terrorism (Koh, 2007). Levy and Galili (2006) did research into the stock investment decisions of individual households upon the occurrence of terrorist acts in Israel. Increases in terror activity resulted in unusually low levels of financial trade. The business literature too has addressed terrorism and more specifically its implications for international business (Czinkota, Knight, Liesch, & Steen, 2010).

We conclude this section with a recent study that labels the impact of the Paris and Brussels terrorist attacks as potentially damaging to the economies of the respective countries now and in the coming months (Ruiz Estrada & Koutronas, 2016). The Brussels attacks are expected to have a short-term negative impact on the Belgian economy and a long-term impact on markets and cross-border commerce. The lapse of the recovery period and the ability of restoring public confidence are cited as important parameters for the economic consequences of Paris.

2.2 Terrorism and its impact on the stock market

Research into the effects of terrorism on the stock market is a growing part of the terrorism and economy literature. In the following section we discuss the existing research in this domain. Terrorism is generally expected to have negative consequences for stocks, as investors often flee the market to look for safer financial instruments; “Panic selling” can occur (Karolyi, 2006). Stock returns, but also volatility, are the aspects that are most often the dependent variables of the research papers in this domain.

Rather than providing us with a yes or no answer to the question if terrorism has an effect on stock markets, these studies will often show that effects differ depending on certain characteristics of the attack, among which for example the location, the moment in time, or the target, among several others.

2.2.1 Effects on general and international stock markets

A number of studies exist that have looked into the effects of terrorism on stock markets in several countries and/or on the global stock market, and also examined how these impacts can differ based on differences in time or space, or based on other criteria.

For instance, in a study on the effects of terrorism on financial markets in six countries, a negative and significant causality effect of terrorism on stock returns was found (Peren Arin, Ciferri, & Spagnolo, 2008). There was also evidence for an effect on the volatility of returns. The magnitude of these effects was larger in the emerging markets than in the European markets used in the sample.

Lower returns are reported on the day of a terror attack, as suggested by evidence from 22 countries (Drakos, 2010). This author also shows a link with investor sentiment: the amplitude of the negative impact on stock returns is related to the degree of psychosocial impact of the event.

Using event study methodology, Chen and Siems (2004) investigated the consequences of terrorist and military attacks for the U.S. stock market and for the global stock market. They generally found negative effects. Their main conclusion is that U.S. stock markets, in comparison with global markets and in comparison with the past, recover faster. As for an explanation for this resilience, the authors point to the liquidity of the banking and financial sector in the US, which promotes market stability.

Chesney, Reshetar, and Karaman (2011) investigate the effect resulting from 77 terror attacks, using several methodologies including event studies, and find overall significant negative reactions on global, European, American and Swiss stock markets.

Large shocks, some permanent, some temporary, were found on international stock markets following and in the aftermath of September 11, 2001 (Charles & Darné, 2006).

In a paper by Baumert, Buesa, and Lynch (2013), the impact of the Boston Bombing on global market indices is compared to the impact of previous terror attacks on these indices. Findings indicate that there were abnormal (negative) market reactions after the Boston attack for all indices. However, the impact of terrorism on these indices has been diminishing over time, when looking at the period of 9/11 up to Boston. Also, the

markets' reactions have become more homogeneous: the spread between their reactions is more reduced in recent times than for earlier attacks.

Several papers treated the consequences of the 9/11 attacks for stock markets in countries outside of the US. In one study researchers looked at integration of economies of different countries, and the return and volatility impact they felt in the aftermath of the 9/11 attacks. The developed and European countries felt a negative impact following these attacks. The negative effects, when found, were nevertheless short-lived. The regions that were less impacted by the attacks were the Middle East, North Africa and Latin America. These findings suggest that the more a region is integrated with the international economy, the more it is vulnerable to an impact of lower returns and increased volatility following a terror attack in another country (Nikkinen, Omran, Sahlström, & Äijö, 2008). In the same respect, Hon, Strauss, and Yong (2004) tested if there was any contagion of the 9/11 attacks to the other world equity markets. They found that international stock markets, particularly in Europe, responded more closely to U.S. stock market shocks in the three to six months after the attacks than before. According to a study by Mun (2005), who did research on contagion effects as well, volatility contagion occurred from the U.S. markets to those of the UK and Germany after 9/11, while it was return contagion that hit Japanese markets. The same author finds volatility contagion from the events of 9/11 in the US to emerging markets (Mun, 2009). Kumar and Liu (2013) did research into the effects caused on countries' national stock indices when terror stroke their trading partners. They did so in part by using event study methodology. They found negative spillovers. Evidence suggested that this is especially the case for smaller countries, as compared to bigger ones: terrorist attacks propagate from a bigger trading partner to a smaller trading partner; but not in the other direction.

Looking at several attacks, Johnston and Nedelescu (2005) report that well-functioning financial markets have been generally efficient in absorbing shocks coming from terrorist attacks, not in the least thanks to quick and flexible responses of the authorities, such as measures taken by central banks, and cross-border cooperation among central banks as well as among national regulators and the industry.

Brounen and Derwall (2010) found several interesting results in their research on the consequences of terror attacks on stock markets. They employed event study analysis to

do so. First and foremost, mildly negative stock reactions were discovered. Another research question involved the comparison with earthquakes. When compared to the effect of terror attacks, the former seem to have less impact, results suggest. Further, it is indicated that most of the attacks had short-lasting effects on the stock markets. The authors also found that price reactions can differ across countries and across industries, but these differences seem to reflect the cross-sectional variation in the systematic risk of the industries. An exception to this were the 9/11 attacks; these showed a change in the systematic risk: a rise in beta for several industries was reported. Riskiness was examined by another academic as well: Choudhry (2005) sought to find out if U.S. firms became more risky after the attacks of 9/11 and examined if these affected their time-varying beta (systematic risk). Most of the betas increased, and the volatility of the betas saw an increase as well.

Finally, Nikkinen and Vähämaa (2010) did research on investor sentiment, and found a strong adverse impact on stock market sentiment, with in particular altered expectations of stock market price levels, and diminished stock market uncertainty.

2.2.2 Effects on general country stock indices

There are a number of studies that have examined the effects of terrorism on specific stock markets. Abadie and Gardeazabal (2003) show how in 1998-1999 the Basque region saw stocks of local firms outperform non-Basque company stocks when a truce between terrorist group ETA and Spain became credible, and an opposite effect when the cease-fire ended. Barros and Gil-Alana (2008) also find negative effects on Basque stock returns as a result of ETA terrorist acts.

Nguyen and Enomoto (2009) focused on a stock market in Pakistan (Karachi) and in Iran (Tehran). They found significant, but different, stock index return shifts and changes in volatility in the two markets. Alam (2013) finds a negative impact of terrorism on the stock markets in Pakistan in the long run but not in the short run.

In her research on the subject of terrorism and financial markets in the US, Cam (2007) finds that firms residing in the WTC buildings experienced heavy negative abnormal returns compared to other firms, after the 9/11 terror attacks in New York.

Kollias, Stephanos, and Stagiannis (2011) did research into the impact of the Madrid and London bombings on the stock markets of those same cities. In both cases the reaction was negative, however, in London the impact was more limited, and the stock market recovered more quickly. Nevertheless, in both cities the effects were transitory.

Israel's stock and foreign exchange markets have been the subject of a study by Eldor and Melnick (2004). Using a dataset of 639 attacks that have occurred over a time span of 14 years, the authors discovered an impact on the stock market, depending on the characteristics of the attack. They distinguish the attacks and their effects according to type of attack, type of target, location of the target, number of fatalities, number of attacks per day, among others. Suicide attacks, as well as the numbers of victims, had a permanent effect on both the stock and foreign exchange market. Location of a terror attack had no effect on either market. No evidence was found that markets became desensitized to terror attacks over time. The authors conclude by stating that the financial markets continued to function in a normal way and that the process of market liberalization contributed to the economy's coping with the terror.

In still a different study, when looking at the Athens and London stock exchange for a number of 36 terrorist incidents spread out over 25 years, it was found that stock market volatility was affected by the number of victims of an attack. Volatility models also showed that the Athens stock exchange was more affected by terrorism than its London counterpart. This suggested robustness of the London Stock Exchange (LSE) is in line with other studies. Furthermore, Athens' small capitalisation market, as compared to London's large market, is shown to be more sensitive to attacks that victimise important businessmen. One other research outcome was the absence of any pattern of change of stock reactions over time, in both of the markets (Kollias, Manou, Papadamou, & Stagiannis, 2011).

Two studies were carried out with data from the Turkish stock market. A first study examines the impact of three big terror events on Istanbul's stock exchange. Results show that some impact is significant, but is short-lived (Christofis, Kollias, Papadamou, & Stagiannis, 2013). In a second paper, evidence suggests a non-linear relationship between terrorism and stock market returns (Eruygur & Omay, 2014). When the intensity of terrorist events passes a certain threshold level, results of the Turkish market indicates, then terrorism has a statistically significant negative effect on the

stock market. For terrorist activities below this threshold level, the negative effect continues but becomes statistically insignificant. This means that an increase in terrorism is not always related to negative effects on the stock market.

The Australian stock market was seen to be impacted in particular by the 9/11 attacks, to a lesser extent by the Madrid and London bombings, and showed a weak to no response for other attacks in the sample (Ramiah, Cam, Calabro & Ghafouri, 2010).

2.2.3 Effects on industry stocks

A number of academics have focused on specific industries in their research on financial markets. In their study on 9/11 stock market effects, Carter and Simkins (2002) specifically look at the airline stock returns. The impact on these stocks, their results indicate, differs from one airline to another. There seems to be a rational reason for this difference. If an airline company is able to cover its short-term obligations (as measured by the ratio of cash and equivalents to total assets), then this is supposedly seen by investors as a signal for a lower probability of bankruptcy. No evidence however is found for measures of size, leverage, firm performance, nor for involvement in the hijackings. Drakos (2004) investigated airline stocks in the aftermath of 9/11 as well. He reveals that the systematic risk (undiversifiable risk), as well as the volatility of airline stocks has significantly increased since 9/11. At the same time, unsystematic risk has also increased, but less than the systematic risk.

Other than airline stocks, hotel stocks have been found to be severely affected by the phenomenon of terrorism (Chang & Zeng, 2011; Chen, Kim, & Kim, 2005).

Insurance companies have been found to be vulnerable as well: insurance stock prices declined after the 9/11 attacks (Cummins & Lewis, 2003).

Terrorism can also have an impact on the world's major defence companies, although it is a positive one this time. Berrebi and Klor (2008), in their study on Israeli companies in the defence, private security and anti-terrorism industries, report significant positive reactions for these types of companies, as opposed to significant negative impacts on other industries. They use event study methodology to arrive at this result. A more recent paper uses the same tool and finds similar results for global defence company

stocks in the aftermath of the Paris attacks: a positive effect of the attacks on these defensive companies' stock returns is found (Apergis & Apergis, 2016).

Chesney et al. (2011) look at, among other things, the effects on specific industries. They find a significant effect on such industry indices as insurance, travel, airline, oil and gas, financial and banking, defence and pharmaceutical/biotechnology. While the effects for the first three indices are clearly negative, those for the remaining turn out to be both positive and negative.

Cam (2007) assessed the price and volume effect of the New York, Madrid and London attacks for different industries in different countries, and it was revealed that the travel and leisure and the leisure good sectors seemed to be the most sensitive sectors while the health care and financial sectors were considered most resilient.

The effects of the 9/11, Madrid and London terrorist events on Greek bank stocks were analysed in a paper by Liargovas and Repousis (2010). The findings seemed to indicate that only the first of the cited attacks had an impact on these stocks, for which the authors point to the dominant position of the U.S. economy worldwide as a plausible explanation.

In a Turkish study, the tourism sector was found to be more affected by terror incidents than other sectors (Christofis et al., 2013).

2.2.4 Effects on stocks of firms targeted

Karolyi and Martell (2006) studied terrorist attacks that were targeted at publicly traded firms in the United States. Using event study-analysis, they looked at the effect on stock price, for which they found a statistically significant negative reaction. Furthermore, they calculated the average decrease in market capitalization and were able to show that losses are bigger when the attack takes the form of kidnappings (human capital losses) rather than bombings (physical losses) and when the firm is located in a richer or a more democratic country.

Another paper that has investigated the effects of terrorism on American firms shows these firms experiencing abnormal volatility on the day of the attack, and this effect is larger for attacks on firms situated in richer or more democratic countries. Effects last

for at least fifteen days after the attack. Developing countries, in contrast to others, anticipate terror incidents and the market adapts itself, resulting in lesser uncertainty of the stock market in these countries. Also, the authors point out that terrorism events remain specific to the firm, and only spread out to other companies in the industry when political and religious motives are at the base of the attack (Essaddam & Karagianis, 2014).

2.2.5 Effects on bond, currency, and other markets

There are financial studies that go beyond the stock market. A paper we mentioned earlier by Eldor and Melnick (2004), not only looked at stocks but also at currencies. They report effects for currency markets after some attacks.

The research done by Chesney et al. (2011) not only investigated stock markets but also other types of financial instruments: they examined the impact on bond, gold and commodity markets and find significant effects, sometimes positive and sometimes negative. Not all these reactions are easy to explain, as they are sometimes counter-intuitive or incoherent across attacks. Also, the authors point out that the moment the effects occur - on the event-day only, in the post-event window or both – depend on the type of market.

Another example is the research done by Morgan and Murtagh (2009), studying the debt markets. These authors report an increase in loan spreads in the United States as a result of the 9/11 attacks.

3 Operational definitions

In this chapter we attempt to define and delimit the main concepts of this thesis. We first describe the phenomenon of terrorism. Next, we briefly define what we consider as Europe in this study. Then, we explain how we look at terrorism in Europe, and finally we describe what the stock market is and how we consider it for the purposes of this thesis.

3.1 Terrorism

Defining terrorism is not an easy task. Schmid (2011), who has dedicated a large chapter in his handbook on terrorism to the problem of defining the term, points out that there seems to be no international consensus around one definition. How to describe what terrorism is then? What to base us on? No agreed upon definition has been adopted by the UN, and thus Schmid argues that it is more desirable to leave the definition of terrorism to academics instead of governments, legislators, the media, victims, terrorists themselves, or religious leaders. Unfortunately, terrorism is hard to define; academics and other experts have been struggling in their quest to find a suitable definition for the word. Nevertheless, some consensus was found around a definition in which academics agree on the core elements. The latest version of this academics consensus definition was established in 2011. It is composed of 12 parts, of which the first one is the core dimension and reads:

> *Terrorism refers, on the one hand, to a doctrine about the presumed effectiveness of a special form or tactic of fear-generating, coercive political violence and, on the other hand, to a conspiratorial practice of calculated, demonstrative, direct violent action without legal or moral restraints, targeting mainly civilians and non-combatants, performed for its propagandistic and psychological effects on various audiences and conflict parties (Schmid, 2011, p. 86)*

In the 11 other parts of the definition, different aspects of the phenomenon are clarified, such as the contexts in which terrorist acts occur, their victims and targets, and the concept of terror. The definition in its entirety can be found in the appendix.

3.2 Europe

What we consider as Europe are the 28[1] member states of the European Union, plus the four countries forming the European Free Trade Association (EFTA).

3.3 Terrorism in Europe

Terrorism is a global and recurring phenomenon. In Europe it has been present especially since the beginning of the 70's (Engene, 2007). In Western Europe, since then and up until now, the number of terror attacks amounts to over 16 000 (Global Terrorism Database, n.d.). Notable terrorist groups were the Irish Republican Army (IRA) and the Euskadi Ta Askatasuna (ETA), among several others (Dechesne, 2011). More recently we can cite the extreme right-wing inspired killings in Oslo (BBC, 2012). Although some may think the contrary, observers state that terrorism levels in Europe have been much higher in the past than in recent times (Luxton, 2016). Nonetheless, looking at the past 15 years, two events strongly remain in collective memory: the bombings that took place in Madrid and London in 2004 and 2005 respectively.[2] The attacks in Madrid were the worst in over fifteen years (BBC, n.d. (a)) and were sometimes referred to as "Europe's 9/11" (Garton Ash, 2004), the London bombings were the worst single terrorist attack on British soil (Rodgers, Qurashi, Connor, 2015). Subsequently no attacks of the same magnitude occurred in Europe, up until the recent resurgence of terrorism in Europe, starting in 2015 with the terror attacks in Paris, followed by the Brussels bombings in early 2016. Within the timeframe of the last 15 years, we can thus distinguish two periods of high-impact terrorism, which are

[1] Although the outcome of the "Brexit"-referendum resulted in a decision to leave the EU, this decision is not yet executed at the time of writing and as such the country is still part of the EU.
[2] There have of course been other terror-related incidents in the past 15 years. However, these attacks were on a smaller scale ("lone wolves" attacks, mostly), were on a specific target and thus not aiming at an entire population, for which less reaction from the market is expected (the shootings of 7th and 9th January 2015 on the Charlie Hebdo offices in Paris), or were a combination of both (the shootings of 22nd July 2011 in Oslo).

separated by ten "calmer" years (the years between 2005 and 2015). In this section we briefly discuss the four events that together form the picture of terrorism in Europe in recent years: the bomb attacks of 11th March 2004 in Madrid, the bomb attacks of 7th July 2005 in London, the bombings and shootings of 13th November 2015 in Paris, and the bombings of 22nd March 2016 in Brussels.

11th March 2004 : Madrid bomb attacks

On the morning of 11th March 2004, ten bombs exploded on four commuter trains of the Madrid train system, killing 191 people and wounding over 1800. The bombs were hidden in sports bags and backpacks. Al Qaeda-inspired Islamic extremists have been designated as responsible for the bombings. Charges were pressed to over 25 suspects (CNN, 2016). The attacks took place three days before Spain's general elections and were the deadliest terror attack in Western Europe since the Lockerbie bombing in 1988 (Goodman, 2014).

7th July 2005 : London bomb attacks

Three explosions on three subway trains left over 50 people dead and more than 700 injured during rush hour in London on the morning of 7th July 2005. It was the work of Islamic extremist suicide bombers, who had hidden explosives in their backpacks. Later that morning, a fourth kamikaze detonated his explosives on a double-decker bus (CNN, 2015; Morgan, 2015). Two weeks later, on 21st July, again in London's transportation system, four men attempted to blow themselves up, but their bombs failed to explode. The police found a fifth unexploded bomb in a park some days later. The suspects of these failed bombings were traced and taken into custody and are now serving prison sentences (BBC, 2015a).

13th November 2015: Paris bombings and shootings

The Paris terror attacks on 13th November 2015 were a series of attacks that occurred in different parts of the city and for which terrorist group Islamic State of Iraq and the Levant (ISIL) has claimed responsibility. 130 people were killed and hundreds wounded.

The night began with three explosions at a football stadium, provoked by suicide bombers. The latter did not manage to enter the stadium. One bystander was killed, not counting the three kamikazes. The French President was among the spectators in the stadium and was rushed to safety. Meanwhile, gunmen opened fire on several bars and restaurants, in different locations in Paris' nightlife neighbourhoods. The highest number of casualties was to be deplored in a concert hall where a sold-out rock concert was going on. Attackers forced themselves into the venue, armed with assault rifles and suicide belts. They fired into the crowd, took hostages and made their bomb belts explode upon arrival of the police (BBC, 2015b).

22nd March 2016: Brussels bombings

At 08.00 two bombings killed over 30 people and injured many more when two suicide bombers detonated their luggage filled with explosives inside the entrance hall of Zaventem Airport. A third terrorist fled the scene, leaving his unexploded luggage behind. An hour later there was another explosion, this time in a subway train in Brussels' EU district. Again, a suicide bomber was responsible. The attacks were claimed by ISIL (BBC, 2016).

3.4 Stock prices

How is a stock price established? According to Euronext, the stock price is the price that is set by matching the best sell offers with the best buy offers (Euronext, n.d. (a)). This happens through supply and demand. The supply is fixed: it is the number of shares a company has issued at a certain point in time. Demand can be seen as the investors who want to buy the stock from someone else. If a lot of people want to buy at the current price and not a lot of people want to sell, the price goes up until more people are willing to sell. The opposite effect takes place when few people want to buy: the price drops. This is the basic mechanism of how a stock price is determined. But what kinds of things affect the fact that people want to buy or sell shares? Euronext lists a number of factors that can have an impact (Euronext, n.d. (b)). First, stocks are part of an index. For an index, its fluctuations in value reflect the combined price movements of the stocks in the

index. Secondly, for an individual stock, the financial health of the company is important. Past and present earnings and dividends play a role, but investors most importantly look at the future prospects. According to the website of the LSE (LSE, n.d.), information about the performance of a company can be found in the financial results and trading updates that companies publish, as well as notifications about significant events. Companies are obliged to publish all events that could have an impact on the stock price. Other sources of information about company performance are external: for instance the press, stockbroker reports and specialist magazines or websites can inform the investor with useful information. Given that stock prices tend to anticipate the future, good company prospects can make a price rise and vice versa. Thirdly, the health of the industry is a factor as well: if the industry is growing, stock prices are likely to go up. Economic trends are indicators that are also taken into account by investors. A healthy economy, for which signs could include a rising GDP, low inflation, low interest rates, low unemployment rates, government budget surplus, a lower cost of living, etc, increases the probability of firms making money. Favourable economic indicators tend to make stock prices rise. Finally, Euronext learns us that world and national events (such as a terror attack) might impact stock prices. An event makes a stock price fall if its impact is considered increasing uncertainty or having negative consequences for the economy, the industry or the firm. The opposite is true for an event that investors think will be good for the economy: this tends to make the stock price rise.

In our study we use indices and see them as a proxy for the stock market, as many analysts do when they observe the stock market or as academics happen to do when they conduct research. With regard to studies on the impact of terrorism on the stock market, the works of Chesney et al. (2011) and Chen and Siems (2004) are two examples where indices were used.

Our study uses stock data from four sources: global, European, national and sectorial. The indices we use are the following.[1]

- Global indices: *MSCI World*[2], *MSCI World ex Europe*;
- European indices: *EURO STOXX 50*, *STOXX Europe 600*, *MSCI Europe*; *MSCI Europe ex Spain, MSCI Europe ex UK, MSCI Europe ex France, MSCI Europe ex Belgium;*

[1] Regarding the company constitution of these indices and how these indices are calculated, we refer to the websites of the respective index providers.
[2] MSCI stands for Morgan Stanley Capital International.

- National indices: *IBEX 35*, *Madrid Stock Exchange General Index, FTSE 100*[1], *FTSE 350*, *CAC 40*, *CAC All-Tradable*, *BEL 20, BEL All-Share*;
- Sectorial indices: all "industry" (as in the ICB terminology[2]) indices of the *STOXX Europe 600*, *STOXX Europe TMI Aerospace & Defense.*

We also used individual stock data for the following companies: *National Express Group, LHR Airports, Associated British Ports Holdings, BBA Aviation, ADP (Aéroports de Paris), Groupe Eurotunnel, Fraport, Aena, G4S, Securitas.*

With this data we examine if the terror attacks we selected have provoked significant changes in the prices of representative indices and stocks in Europe. We do so by analysing the data on three sublevels: the European, national and sectorial. Following what Brounen and Derwall (2010) note in their event study, we know that individual stocks of firms within an industry could be differentially sensitive to terror events and that these effects could jointly cancel out at an index level. We will not do analyses on the firm level however, because in most cases terror attacks are not targeted at specific firms, and because we think that a clear effect on an industry is only valid if it affects more than only one firm.

[1] FTSE stands for Financial Times Stock Exchange.
[2] The Industry Classification Benchmark (ICB), a classification system sponsored by FTSE Russell, is a taxonomy we will use, as explained later on, to identify and select relevant industries.

4 Research questions

In this chapter we show how we arrived at our research problem and how we decided to investigate it, or in other words, which questions we try to answer in order to examine this research problem.

The vast majority of the literature on terrorism and equity markets reports negative effects of the former on the latter. But, the Paris and Brussels attacks being recent events, as of today there are very few studies that have looked at their effects on the stock market. Kollias, Stephanos, et al. (2011) did research into the stock price effects of the Madrid and London bombings and found overall negative reactions. As such we wonder if the two more recent attacks have provoked similar effects: we would find it interesting to have a combined, up to date view of how the European markets have reacted to terrorism in Europe in recent times.

Some news reports could provide us with clues as to the markets' reaction on the latest two attacks. BBC News reported no sign of panicked trading on the European indices after the Paris attacks (BBC, 2015c), and neither did CNN for the global and American markets (Egan, 2015). Bloomberg news talked about a market reaction after the Paris and Brussels attacks that remained only small (Bloomberg, 2015; Bloomberg, 2016a; Bloomberg, 2016b). The Brussels attacks didn't provoke negative returns for European and U.S. stock markets at closing time, according to CNN (Kottasova, 2016). These articles do, however, report negative returns for tourism and airline stocks. The preceding reports inspire us to scientifically examine if there were some abnormal effects noticeable or not after Paris and Brussels attacks and if so, where. We therefore conduct research into the stock market effects of the Madrid, London, Paris and Brussels terror attacks. We focus on European markets and on three levels of analysis: the European, the country, and the industry level. *In concreto* we try to seek answers to the following eight research questions, which will be examined separately in the results section:

Research question 1: How did the four terror attacks impact the *general European* stock markets, considering these markets' usual returns?

Research question 2: How did the four terror attacks impact the *general European* stock markets, comparing to the impact of these attacks on the global stock markets?

Research question 3: How did the four terror attacks impact the general stock markets of the *country under attack,* considering these markets' usual returns?

Research question 4: How did the four terror attacks impact the general stock markets of the *country under attack,* comparing to the impact of these attacks on the European stock market?

Research question 5: How did the four terror attacks impact the European stocks of the *individual industries*, considering the industries' usual returns?

Research question 6: How did the four terror attacks impact the European stocks of the *individual industries*, comparing to the impact of these attacks on the other industries?

Research question 7: How did the four terror attacks impact the European stocks of *those specific industries that are expected to feel more impact from terrorism*, considering these industries' usual returns?

Research question 8: How did the four terror attacks impact the European stocks of *those specific industries that are expected to feel more impact from terrorism*, comparing to the impact of these attacks on the other industries?[1]

[1] Remark with regard to research questions 7 and 8. The answer to the question which could be the exact industries that fall under this category is treated in Chapter 5, further on in this thesis.

5 Methodology

Our research problem can be examined in different ways. One of them is the event study methodology. This methodology is widely used to examine the effects of an event on - most often - stock prices. It is a method that combines simplicity with reliability (Fama, 1991) and is often used in research on the impact of terrorism on stock prices. Therefore we opted for this procedure in order to find answers to our research questions.

But, within this methodology, there is no one-way clear procedure to follow. This chapter treats the specific tools we used to arrive at our results in depth, the choices we made along the way, as well as the problems we encountered and how we tried to solve them. Step by step we describe the event study procedures we used and why.

The chapter starts with some theoretical and historical background, before explaining in detail the two main event study procedures we employ in this thesis, which are, as we call them, the *mean model* and the *market model*. Next, some critical distance from theory and methodology is taken. Finally, we outline in detail how we tackled the problem of operationalizing the effect of terrorism on specific industry stocks.

5.1 The event study

5.1.1 Theoretical foundations

The use of an event study as a means of evaluating the impact of a certain event on stock prices does not operate in a theoretical vacuum. In an influential paper, Fama (1970) provided economists with a new theory, that he called the Efficient Markets Hypothesis (EMH). This theory states that in efficient markets, prices on a stock market fully reflect all available information. When new information becomes available, the prices will adapt themselves to this news and include this information. In efficient markets, the fact that a stock experiences significant change in price on the day of a particular event can be seen as a reaction to that event, provided that there was no other event that happened that day (Malkiel, 1991, Event Study Metrics, n.d.). Fama (1970) further subdivided his hypothesis into three levels:

(1) the **weak form** of market efficiency, that states that the current stock prices reflect all past prices;
(2) the **semi-strong form** of market efficiency, saying that the prices reflect all publicly available information (so including past prices);
(3) the **strong form** of market efficiency, suggesting that all market information is incorporated into the actual stock price (thus this level comprises the two previous levels as well). Public as well as private information is already accounted for in the stock price.

Another way of viewing these three levels is as follows (Malkiel, 1991). Weak form efficiency states that if markets are efficient, technical analysis is useless. Technical analysis means analysing past prices to predict future ones. The reason for this is that this kind of information will already be included in current prices. What the theory implies, then, is that future prices depart randomly from previous ones: there is no relation between current and past prices. This thesis has also been coined "random walk" in finance literature.

Semi-strong efficiency involves that neither technical nor fundamental analysis is useful to predict prices. Fundamental analysis looks at the fundamental value of a company in order to judge the price of its stock, by taking a look at, among others, the earnings and assets of the company.

The strong form of market efficiency suggests that even insider information would not provide for a benefit for an investor.

In a follow-up paper that he wrote 20 years later, Fama (1991) slightly changed the foregoing concepts. The notion of weak-form tests (= How well do past returns predict future returns?) now covers the more general area of *tests for return predictability*. Semi-strong-form tests (= How quickly do security prices reflect public information announcements?) changes its name to *event studies*. Finally, strong-form tests (= Do any investors have private information that is not fully reflected in market prices?) are now being called *tests for private information*.

What we thus find here is that an event study is a research method that is typically considered as a test of the semi-strong form of market efficiency (Fama, 1991). Indeed, what an event study does is check if some publicly available information has had an

effect on the stock prices. As such, it can be examined whether markets are efficient. If no other significant event happened that day that could explain a fluctuation in price, then the price difference can be seen as stemming from the event (Event Study Metrics, n.d.). In what follows, we take a closer look at what an event study is and how it is conducted.

5.1.2 History and background

We used the event study methodology to investigate our research questions. The event study is a methodology that is widely used to examine the effects of an event on - most often - stock prices. It has been applied to events such as mergers and acquisitions, earnings announcements, issues of new debt or equity, and announcements of macroeconomic variables such as the trade deficit. Over time, it has also become a popular tool to investigate the impact of terrorism on stock prices.

One early study from the '30s, seen as the first one in this domain, examined the effect of stock splits on stock prices. Next, studies in the '60s by Ball and Brown and Fama, Fisher, Jensen, and Roll respectively treated the effects of earnings and stock splits on stock prices and, while doing so, introduced the methodology that we use today. A lot of interesting event study research followed, among which are studies on the average abnormal return for target shareholders during takeovers, on mergers, on abnormal returns and competition dynamics, on the announcement of equity issues, on the announcement of debt issues, and on the announcement of debt financing. Two specifically influential papers worth mentioning are those of Brown and Warner, who, in the '80s, proposed some modifications to the methodology (Campbell, Lo & McKinlay, 1997).

Other interesting contributions to the literature include papers on the event study methodology (Binder, 1998), and the theory and empirics behind it (McWilliams & Siegel, 1997).

The number of event studies has seen a tremendous growth from the '80s on and is now a considerable part of the financial literature (Kothari & Warner, 2008).

Event studies are most often used by gathering a relatively high number of events of the same kind, after which the aggregated stock price reaction is statistically tested for significance. This way, researchers want to find out, towards a more theoretical goal, if a certain type of event provokes a stock market reaction. However, event studies can also be conducted individually. In the literature on the impact of terrorism on stock markets, event studies are used quite often, as could be concluded from our literature review, and both kinds of studies exist within that domain of research. There are terrorism studies that collect a high number of terror attacks, look at the statistical significance of the aggregated reactions, and in that way aim at generalisation: does terrorism provoke a stock market reaction? Then, there are also papers that look at only one or a few terror attacks, aiming to describe what the reaction was after these specific events, or how the reaction might have evolved between attacks. Our study is to be situated under this second category.

The event study methodology is popular among researchers examining the effect of terrorism on stock because it is a relatively simple but at the same time reliable way to examine the effects of an event (Fama, 1991). It can trace “abnormal” changes resulting from an unpredicted event (Kollias, Manou, et al., 2011). Moreover, what makes terrorism an interesting subject for an event study is its surprise effect (Karolyi & Martell, 2006). It is rarely anticipated, and as such there is often no risk of investors already calculating its effects during a period of time preceding the event, which is a problem that can sometimes be encountered while doing event studies (Campbell et al., 1997).

5.1.3 Different ways of conducting event studies

There is a wide array of possibilities for the conduction of event studies. The common factor in all of them is that the prices of the index or security that is being studied are measured against a benchmark. This is usually an estimation of a return that we would have seen had the event not occurred (Schweitzer, 1989). What that benchmark looks like exactly, depends on the type of methodology one decides to use. Following Cam (2007), the main differences lie, on the one hand, between event studies that use regression techniques and those that do not, and on the other hand between event studies that use a mean adjusted model and those that use a market adjusted model to

measure abnormal returns. Given the goals of our study, we chose to use two types of event studies. The first one uses a mean adjusted model and is based on the non-regression methodology as described by Brown and Warner (1985). Here, the average of previous returns is subtracted from the return on the event date. The second type of event study we conduct consists of a simple regression technique, in what Campbell et al. (1997) call the market model, and Brown and Warner (1985) the OLS market model. In this case we regress our data against market data.

The assumptions that underlie both methods are different, but each method can provide us with useful insights. The aims of our study are straightforward: on the one hand, we want to investigate what the "net" impact of an event is on a certain index. This is where the mean adjusted model comes in. The mean model technique shows us how profoundly – or not – an index is affected by a certain event, *given what the usual returns of this index are*. For this purpose we cannot use regression, because we cannot regress the data on itself.

On the other hand, we aim to see if differences exist between a certain index and the market. We want to know if the index was affected more severely – or not – than the market. This time we are able to apply regression technique, because we have a second data series (the market). We could have opted for an alternative method here: Brown and Warner (1985) also propose a non-regression market adjusted technique, where they subtract the returns of the market index from the index that is examined. However, we prefer to use regression analysis because it incorporates risk.

Other, more sophisticated event study methods exist, such as the Fama–French three-factor model, the Capital Asset Pricing Model (CAPM) model or the Generalized AutoRegressive Conditional Heteroscedasticity (GARCH) model (Campbell et al., 1997; Cam, 2007). Nonetheless, the additional precision of these methods being rather small and given the complexities of their set-ups (Cam, 2007; Binder, 1998; Brown & Warner, 1980), we chose not to make use of them in this study.

5.1.4 Mean model methodology

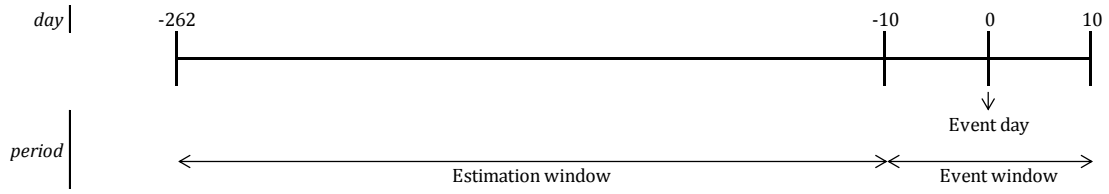
Our first of two methods employed in this thesis is the mean model methodology. In this section we explain in detail what this entails, and how we put it into practice. An

example of a study that has used this procedure is the one of Brounen and Derwall (2010).

In our study, we use daily stock returns. Daily historical prices and returns were collected for the index under investigation. We obtained these prices and returns from a Bloomberg terminal. For each event, data was collected starting from thirteen months before the event up until one month after it. Trading days with missing returns were eliminated from the dataset, as well as the subsequent trading day, like it is prescribed by Brown and Warner (1985).

Next, the *event window* was determined (Benninga, 2014). These are the days that are looked at more closely in order to verify if an effect occurred. It is a window through which we observe if a change is noticeable or not, and which also lets us isolate a certain timeframe around the event. It is a zone that comprises a certain number of days before the event and after. In the literature, researchers take a look at this period at points in time that can range from 2 days to 5 or 10 trading days after the event. For our event studies, an event window of 10 days before up until 10 days after the event was maintained, totalling for an event window of 21 days. These pre- and post-event periods have a grounded reason of existence (Kothari & Warner, 2008). The function of the days leading up to the event lies in the aim to already try and notice some anticipation of the occurring of the event. Terrorism being considerably less, or not at all, predictive, this part of the event window is of somewhat less importance for this study, but nevertheless we still want to include it. The post-event period however can provide us with useful information given that stock prices may take some time to adapt to newly acquired information, or can show if yes or no an impact lasts longer than the event day itself.

Figure 5.1: Visual presentation of our event study lay-out



(own visualisation, based on Campbell et al., 1997)

The next step is to obtain the 252 returns (which represent the average number of trading days in a year) that lead up to the event window. This array of returns is what

we call the *estimation window* (Benninga, 2014). The arithmetic average is now calculated of those returns. We subtract that number from every trading day's real return and as such obtain what we call *abnormal returns* (AR). These returns characterize the part of the stock movement of that day that is not due to the general movements of the index as expected from past fluctuations. These general movements are accounted for by the average we calculated. As such, what remains is a return that is "abnormal" and that refers to something else than the normal movement of the index. The theory behind it is that these returns would not exist had the event not occurred. Abnormal returns are visible on every event day, because expected returns can never be completely accurately calculated: stocks are impacted by a very large number of investor decisions, which are based on all kinds of reasons. But, at some occasions the abnormal returns are of a size such that they deviate significantly from the abnormal returns we are used to see. They stand out sufficiently from abnormal returns of other trading days so that we can say that the general index movements alone cannot explain their existence. These abnormal returns are what we call statistically significant. If such an abnormal return is encountered on the day of occurrence of the event that we are studying, we can believe this event to have had an impact. We will see further on how to calculate statistical significance of abnormal returns.

Following Brown and Warner (1985), we can use the following procedures to estimate the abnormal return for every security and for every day in the event window. Let $R_{i,t}$ be the observed return for index i at day t. Let $AR_{i,t}$ define the abnormal return for index i at day t:

$$AR_{i,t} = R_{i,t} - \bar{R}_i$$

$$\bar{R}_i = \frac{1}{252} \sum_{t=-262}^{-11} R_{i,t}$$

The next step in our process is the calculation of the sum of the abnormal returns for a number of days following the event, which we call the *cumulative abnormal returns* (CAR). In the literature, the number of days that is generally looked at is 3, 6 and/or 11 days after the event, which correspond to the 2, 5 or 10-day length of the post-event period. For instance, the 3-day CAR is the sum of the abnormal return on the event day (day 0), the day after the event day (day 1), and the second day after the event day (day

2). This gives us a sum of three abnormal returns, hence the term 3-day CAR. Algebraically, let $CAR_i(t_1, t_2)$ be the cumulative abnormal return for index *i* between two days, t_1 the event day and t_2 3, 6 or 11 (Kothari & Warner, 2008):

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

What is now left for us to do is to make sure the abnormal return on the event day and the cumulative abnormal return are *statistically significant*. Basically, if an abnormal return is statistically significant, then this indicates that the event provoked a stock reaction that was sufficiently different from the average return of the index to not be attributable to random chance. Consequently, a negative abnormal return of 5% does not have the same meaning for every index: it could be huge for one index, but "usual business" for another one (one that is more volatile and experiences these kinds of changes more often).

Our hypotheses are the following (Müller, 2015):

H0: The event does not have an impact on returns

H1: The event has an impact on returns

For the abnormal return obtained at the event day, we do a statistical significance test by dividing that abnormal return by the standard deviation of the abnormal returns of the estimation window. For the CAR, we divide them by the square root of the variance multiplied by the number of days in question, being three (Müller, 2015).

For both ARs and CARs we obtain t-values. We decide to look at 5% and 10% significance levels. For the former, if the value we obtain is lower than *-1,96* or higher than *+1,96*, we can reject our null hypothesis. This means that we can say with less than 5% chance of being wrong that there is an impact of the event on the stock returns of the event day. In other words, there is only a 5% chance that the abnormal return we found is due to random chance. In the same way, for a 10% level, if the value obtained is situated between *1,64* and *1,96* (positive or negative), we reject our null hypothesis.

5.1.5 Market model methodology

We treated the first of our models, the mean model, above. The second one is what we will call the market model. For the market model execution, again we collected historical price and return data and we delimited the event and estimation windows. However, this time we not only collected data for the index we needed, but also for the index that served as the market portfolio for the former index. For instance, if we wanted to do an event study on the *STOXX Europe 600 Travel & Leisure* index, the market index we used was the *STOXX Europe 600*, and we needed data for both of them.

An example of a study that has conducted this method of event study, is the one by Karolyi and Martell (2006).

The main difference in method is that now we will not be calculating an average return, but instead create a simple econometric model that is based on 252 returns of the sector and market index. Following Benninga (2014), intercept and slope (beta) are calculated, which provides us with the information we need to calculate the *expected returns* for the trading days in the event window. These are the returns that we would expect to see, based on how the stock price relationship between the sector index and the market index was characterised in the 252 days preceding the event window. They can be seen as the overall movements of the stock market. Once we have calculated these expected returns, we are able to check for any *abnormal returns* (AR). We obtain these by subtracting the expected returns we calculated from the actual returns of the index. What we get are returns that are not explained by the model we calculated beforehand, and that are as such abnormal. The next step is to look if there is an abnormal return noticeable on the day of the event. Again this procedure is followed by the calculation of *cumulative abnormal returns* (CARs), in the same way as we saw above.

Following Brown and Warner (1985), let $R_{i,t}$ be the observed return for index i at day t. Let $AR_{i,t}$ define the abnormal return for index i at day t. Let $R_{m,t}$ be the return for market index m at day t. Define $\hat{\alpha}$ as the estimator for the intercept and $\hat{\beta}$ as the estimator for the slope:

$$AR_{i,t} = R_{i,t} - \hat{\alpha} - \hat{\beta} R_{m,t}$$

The hypotheses remain the same as for the mean model; however, the testing of the *statistical significance* of the abnormal returns occurs in a different way. We now do a statistical significance test by dividing the abnormal return by the standard error of our regression (Benninga, 2014), which is the market model equivalent of the standard deviation we used in the mean model. Once again we obtain t-values. The decision rules remain the same as described earlier for the mean model.

5.1.6 Remarks

We conclude this section by treating some issues that arose when conducting our research. We describe them below and show how we managed to find solutions for them.

Event day choice for Paris

The Paris attacks occurred at night, starting around 9 o'clock in the evening (BBC, 2015b). Stock markets were already closed by then. That is why it is only logical that the event day we used to look at the effects of these attacks, was the first trading day *after* the attacks, being Monday 16th November 2015. In all the event studies we conducted, we used this day as the event day for the Paris attacks.

Length of the post-event period

We calculated, as we explained above, the 3, 6 and 11-day CARs. However, in the results section we decided to limit ourselves to 3-day CARs only. We did so for presentation reasons and because the few significant results we found at the 5- or 10-day level did not offer us sufficiently useful additional information to maintain them in the tables: they would create more noise than that they would provide us with useful insights. Or, stated more concretely, we did not find stock market effects that only popped up after 5 days after the event or later. The event day ARs and the 3-day CARs suffice here to draw a picture of the stock market effects on the indices and for the attacks we used. We will sometimes mention 6- or 11-day CARs, but rather by way of illustration: to show how long an effect that started right after the event (event day or two days later) has actually lasted. The function of a table is to provide an overview of information that can be easily

comprehensible and visible. Therefore, and because no important information is lost, we thought it better, in this case, to concentrate on 3-day CARs only.

Contamination of the two indices in the market model

For the market methodology a specific problem arises. When we benchmark a certain index or company group against the market index, the results will be slightly biased because the former is also part of the latter. For a small part, there will thus be a comparison of the index with itself, which could potentially hide an impact that we might have seen otherwise. What to do about this? In some cases, the proportion of the index or company group in the market index will be so limited that there is hardly any difference in outcome. However, in other cases the weight is too significant, and then the exclusion of the index or company group is needed.

In the results section, we will mention for each market model analysis if it did or did not exclude the index or company group being studied from the broader market index. Sometimes we deemed the index or group of companies to be of little weight in the totality of the market index, and we chose to leave it in. The alternative, which would involve creating a new dataset (one that doesn't include the index or company group in question), is often not executable due to the lack of specific information that would be needed.

Estimation window contamination

As stated above, we use an estimation window of 252 trading days in this study (with an exception for certain industries, as will be explained later on). This creates a certain problem for the calculations of the abnormal returns following the Brussels attacks. These happened in March 2016. The estimation window needed would thus have to go back to approximately March 2015. However, another terror attack happened in the middle of this estimation window: the Paris attacks in November 2015. If we would maintain this estimation window, then we would be using a contaminated estimation window to calculate the abnormal returns for Brussels. The best solution for this problem seems to be the use of a new test of statistical significance, developed by Aktas, de Bodt, and Cousin (2007) and called the *two-state market model test* (TSMM).

However, this is a test that is only executable for market model methods. When using mean methodology, this test cannot be applied. That is why we use another solution. Three simple detours around the problem could be (1) using the same estimation period as we used for the Paris attacks, (2) using an estimation window that is very short and stops at the end of November 2015 (which would leave us with approximately 70 trading days, or three months instead of twelve), or (3) using a mix of these: using an estimation period of 252 days but that does not include the second half of November 2015.

Because we prefer a more lengthy estimation window, and because a very short one would oddly stand out from the event studies conducted around the other attacks, we do not choose option 2. This leaves us with options 1 and 3, of which we decide to choose the former for convenience reasons.

Bear in mind that the length of an estimation window is *in se* already an arbitrary choice. The results achieved only reflect this choice and should thus be interpreted with this in mind. Consequently, the choice of solution for our contamination problem should not dramatically change the interpretation of our results.

5.2 Critical views

The EMH and the event study methodology, like all theories and procedures, are not free of criticism. We briefly look at the main remarks.

The EMH is an influential theory in finance. Malkiel (2003) however points out that, while in the earlier years the theory was generally agreed upon, it has been questioned in more recent times. In contrast to the assumptions of the EMH, many have begun to believe that stock prices are at least partially predictable, via technical or fundamental analysis. Moreover, many of them claimed these analyses could allow investors to earn extraordinary rates of return. Indeed, where evidence is generally supportive on the weak form of efficiency, results are mixed for the semi-strong form, and for the strong form evidence seems non-supportive (Fabozzi, Jones, & Johnson, 2002).

Malkiel (2003) examined the critiques on the theory. Without going into technical details, the author addresses some of the subjects the opponents of the EMH adhere to,

such as predictable patterns based on valuation parameters, or cases where inefficiency is supposed, such as the internet bubble of the late '90s. Malkiel concludes that the markets, although never perfectly efficient, overall tend a lot more to efficiency and unpredictability than to inefficiency and predictability. And even if anomalous behaviour of stock prices exists, he finds, there has not yet been found a way to exploit them.

Given that the event study has become a valued research method by many, and that its statistical properties are known by now, critique on event studies is less spread out and mainly summarizes to concerns about the reliability of long-horizon studies. These are the studies that are more fitted to test for market efficiency, as opposed to the short-horizon studies that have rather been linked to understanding corporate policy decisions or to accounting research (Kothari & Warner, 2008).

Nevertheless, there are of course some shortcomings to event studies. If it is difficult to precisely determine the event date, and/or if the event is spread out over a longer period (legislation, for instance), then the event study will be of lesser use or may even provoke incorrect conclusions. These risks do not seem to threaten our specific study, as terrorist attacks take place at a specific moment. Secondly, event contamination can occur, which is the phenomenon of another event happening on the same day or in the same period as the event that is being studied, which makes the results difficult to interpret. It is therefore important to verify for the absence of other events around the event day, which we will do later on. Finally, it is not always easy to accurately estimate the firms' expected, or normal returns (Schweitzer, 1989). It seems little can be done about this problem.

5.3 Industry identification and index selection

This section revolves around the problem of putting in practice our goal of examining not only general stock market consequences of terrorism, but also investigating how terrorism impacted stocks on an industry level. We consecutively determine the industries to select, how we can collect our data, and how we will proceed using this data. We do this for our two pairs of research questions about industries.

5.3.1 Industries in general

First we need a way to investigate if there was an impact noticeable on certain industries, from a broad outlook on the general economy. Therefore we need an overview of all industries and we need data for all of these industries. For that we need to be in possession of exact industry names or codes. However, industries aren't always easy to define, and different organisations use different classification systems. One interesting industry taxonomy is the *Industry Classification Benchmark* (ICB), a classification system sponsored by FTSE Russell. Their classification table consists of 10 industries that are further split up into 19 supersectors, 41 sectors and 114 subsectors.[1] It is a clear and logical system, and a useful one for the purposes of our study. The 19 supersectors are sufficiently specific, without being too large in number, and thus we choose to base our industry analysis on the supersector level.

The advantage of the ICB classification is that there is a well-known index provider that uses the same taxonomy to constitute their sectorial indices. This makes it easy to collect data. STOXX Ltd. is a global index provider, and offers sectorial breakdowns for two of its main indices, the *STOXX Europe 600* and the *STOXX Europe Total Market Index (TMI)*. We opt for the former: we base our analysis on the 19 supersector indices of the *STOXX Europe 600*. Historical stock prices for these indices can be found on a Bloomberg Terminal.

Doing so, we want to give a general overview of the stock market effects of terrorism on the main activity domains of the economy. We will look at the abnormal return of these supersectors, and this through a mean and through a market model.

5.3.2 Specific industries

Here, as opposed to the previous section, we want to ask the question if there are certain industries for which we could expect an impact. If so, how do we know which ones, and how do we find suitable data for them? We discuss this below.

[1] The table can be found in the appendices.

Selection

The industries that tend to feel an impact – be it positive or negative - of terrorist attacks are mainly situated in the tertiary sector. Not taking into consideration those terror attacks that are targeted at or that are impacting specific firms (see for instance Karolyi and Martell (2006) for that matter), there are some industries for which there is evidence that they can be *more* vulnerable to terrorism than others. In our literature review we mentioned several studies that have found that the tourism, airlines and insurance industries are such industries. On the other hand, there are industries that have been found to experience *less* damage, or that have even seen their business forecasts improve after a terror attack. More specifically we can identify the defence, private security and anti-terrorism industries, for which Berrebi and Klor (2008) found evidence in support.

Below, we give a quick overview of our hypotheses for these industries. We briefly explain why we intuitively expect investors in these industry stocks to react in a certain way when terror attacks occurred in Europe. Later on we will have to find out if our hypotheses are confirmed by the data.

Insurance industry: terrorist acts often result in tremendous costs, for life- and non-life insurers alike. Investors see these costs as threatening to future probability, and fear more attacks and thus more losses in the future.

Travel industry: airplanes and airports have been targeted by terrorist groups on many occasions already. For an airline company, the costs of a terror attack on one of their planes are significant. But most importantly, stockholders expect that people will become more afraid of flying, and that they will resort to alternative means of transportation, or simply travel less. A decline in passenger traffic will be the result, affecting future profit goals. This effect increases when the terror attack is targeted at a tourist destination or on tourists. Next to airplanes and airports, trains, buses, train stations, and subway systems are also typical targets picked by terrorists. When an attack occurs, the consequences are similar as those for an attack on an airplane.

Leisure industry: investors think that a country affected by a terror attack is likely to experience strong declines in tourist numbers, because tourists fear new attacks. While tourism in the country under attack will decline, tourism in other countries may as well,

because people know that tourists and tourist destinations are often targeted by terrorists. This is a major threat for the profitability of companies in these industries.

Private security industry: after a terror attack, reinforcing security is one of the top priorities of governments and companies alike. Private security companies are among the actors that are often invoked to perform this task, and will see demand for their services grow.

Defence/weapon/anti-terrorism industry: after an attack, governments want to fight back against the terrorist group responsible and will increase defence spending. The industry specialized in making war materials and military equipment sees a rise in its orders.

Data collection

Once again we base ourselves on the ICB classification.[1] We identified five relevant company groups: *Aerospace & Defense*, *Transportation Services*, *Business Support Services*, *Travel & Leisure*, and *Insurance*. ICB further explains them as follows.

2710 Aerospace & Defence (sector)

According to the ICB, the companies in this subsector are "Manufacturers, assemblers and distributors of aircraft and aircraft parts primarily used in commercial or private air transport. (...) Producers of components and equipment for the defence industry, including military aircraft, radar equipment and weapons."

2777 Transportation Services (subsector)

The ICB defines the companies of this group as "Companies providing services to the Industrial Transportation sector, including companies that manage airports, train depots, roads, bridges, tunnels, ports, and providers of logistic services to shippers of goods. Includes companies that provide aircraft and vehicle maintenance services." It is important to specify that not all companies in this category are relevant for our study. A selection has to be made, so as to exclude providers of logistics services, among others, because these corporations do not have a direct sensitivity to terrorism (be it positive or negative).

[1] The table can be found in the appendices.

2791 Business Support Services (subsector)

These companies, the ICB states, are: "Providers of nonfinancial services to a wide range of industrial enterprises and governments. Includes providers of printing services, management consultants, office cleaning services, and companies that install, service and monitor alarm and security systems." Again, a selection of relevant companies is needed. In particular for this subsector we only need to take into consideration the security companies.

5700 Travel & Leisure (supersector)

The ICB table shows us that these are companies situated in the Airline, Gambling, Hotel, Recreational Services, Restaurants & Bars, or Travel & Tourism subsectors.

8500 Insurance (supersector)

These are companies that offer Full Line Insurance, Insurance Brokers, Property & Casualty Insurance, Reinsurance or Life Insurance, as shown by the ICB table.

We mentioned earlier how the index provider STOXX Ltd. has based his sectorial indices on the ICB taxonomy. The company offers sectorial breakdowns for two of its main indices, the *STOXX Europe 600* (subdivided in supersector-level indices) and the *STOXX Europe Total Market Index (TMI)* (subdivided in supersector- and sector-level indices). At first glance, the following sectorial indices already seem appropriate for use in our study:

- *STOXX Europe TMI Aerospace & Defense*
- *STOXX Europe 600 Insurance*
- *STOXX Europe 600 Travel & Leisure*

Historical stock prices for these indices can be found on a Bloomberg Terminal.

We have now found data for three of our five company groups. We still need data on the two subsectors we identified. The most detailed level of STOXX indices appears to be the sector level. As a result, we will not be able to use subsector indices in our analysis, simply because they do not exist. Theoretically we could include their respective sector indices, but then we would have to include the other subsectors of that sector as well,

which would affect our results. It would not be in line with our research question, given that our results would be biased by the presence of companies from subsectors that lack a link with terrorism. But even if we were able to find official subsector data, there would still be a bias, because not all companies in the two subsectors that we selected belong to the criteria we are using. *In concreto* this means that we need to look at individual companies, and select from the STOXX collection those firms we are interested in. Therefore, we have to look, for each of our two subsectors, and for each event date, at the historical component lists of the corresponding sector index at that moment. Doing so, and leaving out the time series with too much missing data, we maintain the following companies as presented in table 5.2[1]:

Table 5.2: Overview of content of two specific mini-sector portfolios, created by selecting the relevant STOXX Europe 600 companies - for each attack date and only including companies for which sufficient data is available

	Madrid	**London**	**Paris**	**Brussels**
COMPANIES LISTED ON STOXX EUROPE 600				
Transportation Service companies				
TNU	•			
Ferrovial		•		
Flughafen Zuerich			•	•
National Express Group	√			
LHR Airports	√	√		
Associated British Ports Holdings	√	√		
BBA Aviation	√	√	√	
ADP (Aéroports de Paris)			√	
Groupe Eurotunnel			√	√
Fraport			√	√
Aena				√
Security companies				
Group 4 Falck	•			
G4S		•	√	√
Securitas	√	√	√	√

LEGEND:

• indicates that the company was listed on the STOXX Europe 600 index at the time of the attack, but suffers of missing data.

√ indicates that the company was listed on the STOXX Europe 600 index at the time of the attack AND that it has a sufficient number of price data, allowing it to be part of the portfolio.

[1] For company descriptions, we refer to Bloomberg.

(source: own visualisation, data from Bloomberg)

In cases where the economic activity we were looking for constituted only one of many operations of the company, we decided not to include the company, because reliable interpretations of the results would then not be possible (ISS for instance, is a company that provides security services, but offers a broad array of other services too, among which cleaning and catering. We therefore did not include it here.).

Methodology

Per domain and per attack we looked at the average abnormal return of the companies, and this through a mean and through a market model. Missing data issues made us decide to only use half of the length of the estimation window used for the other levels: its length is thus 126 days for the Transportation Service companies and the Security companies.

We collected data of individual stocks, as compared to previous times, where we gathered index data. We do not want to have an abnormal return for each stock; instead we want one for Security and one for Transportation Services in general. Therefore we need to place the data of each individual stock next to each other and in the end obtain what Brown and Warner (1985) call a *mean day excess return* and what others (and us as well) call an *average abnormal return* (AAR), for instance see Binder (1998). Working this way also provides for an extra reliability to our results: we control for events that may have had an impact on one firm alone.[1]

The AAR for the event day is calculated as follows (based on Brown & Warner, 1985), with N_0 as the number of indices or firms we included and $AR_{i,0}$ the abnormal return for index *i* at the event day:

$$AAR_0 = \frac{1}{N_0} \sum_{i=1}^{N_0} AR_{i,0}$$

Next, just like we calculated the CARs on the individual level, we now calculate the average CARs or the CAARs (*Cumulative Average Abnormal Returns*). This is done as

[1] However, unfortunately, sometimes there is only one firm in the group.

follows: let $CAAR(t_1, t_2)$ be the cumulative average abnormal return between two days, t_1 the event day and t_2 3, 6 or 11.

$$CAAR(t_1, t_2) = \sum_{t=t_1}^{t_2} AAR_t$$

Statistical significance is calculated differently this time. Hypotheses and interpretation of t-values remained unchanged, but the way we calculate the test statistic is not the same as we saw above. Following Brown and Warner (1985), the test statistic for event day *t* (in this case t = 0) is:

$$AAR_t / \hat{S}(AAR_t)$$

where:

$$AAR_t = \frac{1}{N_t} \sum_{i=1}^{N_t} AR_{i,t}$$

$$\hat{S}(AAR_t) = \sqrt{(\sum_{t=-262}^{t=-11} (AAR_t - \overline{AAR})^2) / 251}$$

$$\overline{AAR} = \frac{1}{252} \sum_{t=-262}^{t=-11} AAR_t$$

and where N_t is the number of indices or firms we included whose abnormal returns are available at day *t*.

6 Empirical findings

In this chapter we perform the application of our methodology on our dataset. We consecutively look at the impact on the European stock market, on the country that suffered the attack, on the industries, and finally we examine if certain other specific industries, which could be expected to feel an impact of terrorism, did or did not experience an impact. We do so for the attacks of Madrid, London, Paris and Brussels, and for each of these levels and attacks we employ the two methods of mean model and market model that we explained earlier. For each subsection we present a table containing the abnormal returns and 3-day cumulative abnormal returns. Not all of these values will be statistically significant, which is why we also need to look at the corresponding t-values. These are indicated in parentheses below the (cumulative) abnormal returns. Doing so, we can look if certain abnormal returns are significant and if yes, which. Finally, in conclusion of each of the subsections, we return to the research questions we previously put forward and try to answer them with the results we found. At the end of this chapter, we summarise our results by looking at the results of the different subsections altogether. Important to mention is that we do not discuss our results: this is treated in the next chapter. Here we only look at the pure findings.

6.1 Impact on the European stock market

6.1.1 Impact compared to previous returns

As explained in Chapter 5, we distinguish two ways of looking at the impact on the European stock market, and the first one involves looking at the usual returns of the relevant indices. For this, we use the average of the returns generated over a certain time period previous to the event. We then subtract that average from the actual returns generated in the event period. For each attack, we thus compare the returns of the day of the attack with what is considered to be an "average" return for that index, based on previous returns. What this allows us to do is examine if the returns of an index on the day of the attack are abnormal *compared to the usual returns of that index*. As such, an index is compared to itself.

When one wants to obtain an image of the European stock market, several index possibilities exist. We decided to select three indices that are amongst those most often used by analysts: the *EURO STOXX 50*, *STOXX Europe 600*, and *MSCI Europe.* We calculated the abnormal returns (ARs) and cumulative abnormal returns (CARs), and the results we obtained are summarized in table 6.1.

Table 6.1: Abnormal returns for three general European indices, based on average returns

	MADRID		LONDON		PARIS		BRUSSELS	
Index	Event day AR	3-day CAR	Event day AR	3-day CAR	Event day AR	3-day CAR	Event day AR	3-day CAR
EURO STOXX 50®	**-3,16%****	**-6,16%****	**-1,73%****	0,56%	0,00%	1,98%	0,14%	-1,85%
	(-2,12)	(-2,38)	(-2,43)	(0,46)	(0,00)	(0,78)	(0,09)	(-0,68)
STOXX® Europe 600	**-2,79%****	**-4,64%****	**-1,88%****	-0,10%	0,25%	2,49%	-0,10%	-1,53%
	(-2,35)	(-2,26)	(-3,22)	(-0,10)	(0,20)	(1,17)	(-0,07)	(-0,63)
MSCI Europe	**-2,79%****	**-4,60%****	**-1,88%****	-0,08%	0,24%	2,56%	-0,21%	-1,88%
	(-2,34)	(-2,22)	(-3,20)	(-0,08)	(0,19)	(1,18)	(-0,17)	(-0,87)

Notes: T-statistics are in parentheses.
** Statistically significant at the 0.05 level.

Table 6.1 shows us that significant abnormal returns are found for the Madrid and London attacks. The findings are quite uniform over the indices. This means that we can assume that these attacks had a significant impact on European stocks. However, the abnormal returns for the two terrorist attacks differ in two ways from one another. First, the Madrid returns provoked larger ARs than the London bombings. The abnormal returns approach -3%, whereas those for the attack that occurred one year later do not exceed the -2% margin. Secondly, for Madrid, the 3-day CARs are still significantly negative (with even a significantly negative 6-day CAR that we found for *EURO STOXX 50*), whereas the impact of the London attacks seems to have been of shorter duration, because we see non-significant 3-day CARs. The stock markets seem to have recovered fairly quickly from the London attacks compared to the Madrid attacks. Indeed, when we take a look at the time the stock prices needed to rebound (i.e. being the number of days needed to return to the pre-attack level), we see an average for the three indices of 17 days for Madrid, and only 1 to 2 days for London. These findings are in line with earlier research (Kollias, Stephanos, et al., 2011).

Notwithstanding these results, the main eye-catcher in this table is the difference we see between the two older attacks and the two contemporary ones. For the Paris and Brussels attacks, the findings show no significant negative returns whatsoever.

These results suggest a high sensitivity of the European equity markets to the first two attacks and no reaction of these markets to the last two – at least from a day-to-day perspective.

Research question 1: How did the four terror attacks impact the *general European* stock markets, considering these markets' usual returns?

The Madrid and London bombings were found to have significantly impacted the European stocks, while the Paris and Brussels attacks were not. Another finding is that the stock market seemed less sensitive to terror after London than after Madrid: the impact was less severe and of shorter duration.

6.1.2 Impact compared to the global stocks

In this section, as opposed to the previous one, we do not want to look at average returns but we are wondering how the index did as compared to the market. Therefore we use as our benchmark not the previous returns of the same index, but an entirely new index: one that represents the broader market in which our first index is situated. Again we obtain abnormal returns; however, their interpretation differs from those we obtained before. This time, the abnormal returns we find should be viewed as *abnormal to the market* instead of abnormal given the historic returns of the index itself. We look at the results for the *MSCI Europe* index and as the market index we use the *MSCI World* index, from which Europe is excluded.[1] As such, the question we try to answer here is if the attack provided for a difference in impact between the European and global stocks: is there some kind of local, European effect?

[1] In this section where the market model methodology is being applied, we only use *MSCI Europe* because it is fairly easy to calculate its corresponding market index (an *MSCI World ex Europe* index). This is however very difficult to do for the other European indices we mentioned previously.

Table 6.2: Abnormal returns for the *MSCI Europe* index, with *MSCI World ex Europe* index as market index

	MADRID		LONDON		PARIS		BRUSSELS	
	Event day AR	3-day CAR	Event day AR	3-day CAR	Event day AR	3-day CAR	Event day AR	3-day CAR
MSCI Europe	-1,21%	**-2,55%****	**-1,69%****	-0,25%	-0,70%	0,09%	-0,05%	0,17%
	(-1,61)	(-1,96)	(-3,76)	(-0,33)	(-0,89)	(0,06)	(-0,07)	(0,12)

Notes: T-statistics are in parentheses.
** Statistically significant at the 0.05 level.

Table 6.2 shows us that for three out of four attacks, we observe no abnormal returns on the event day. Only for the London bombings are there significant abnormal returns. For the London terror attacks we can therefore reject our null hypothesis, while for the Paris and Brussels attacks we cannot. These results seem to indicate that, for all but the London attacks, the impact of the attack was not particularly different on the European equity markets as compared to the global ones. As such, this would imply that the impact of the Madrid bombings on the world markets was thorough, just like it was on the European markets, and that the impact of the Paris and Brussels attacks on the world markets was not statistically significant, just like for the European markets (at least from a day-to-day perspective).

The exception is thus the July 2005 London terror attack, after which the European indices performed worse, relatively to the world index. The latter seems less impacted by it. When we look at the abnormal returns of the *MSCI World ex Europe* index for that day using mean analysis, we indeed find a non-significant abnormal return for 7th July 2005 of -0,34% (t-value of -0,49). This suggests that the global stocks were not impacted by the London bombings, as opposed to the Madrid bombings that occurred one year earlier.

A second effect that we can point out concerns the CARs. Only for Madrid do we see significant 3-day CARs. This would suggest that, although the impact of the Madrid bombings was severe on both global and European markets, the former managed to recover faster from them than could the latter. By way of illustration, the number of days *MSCI Europe* needed to rebound from Madrid was approximately 17, for *MSCI World ex Europe* that number was only 4. Also, we calculated the 6-day CAR for Madrid and found that it is still significantly negative.

Research question 2: How did the four terror attacks impact the *general European* stock markets, comparing to the impact of these attacks on the global stock markets?

Results suggest there was no significant impact for the Madrid, Paris and Brussels attacks. However, after the London bombings, the European market was seen more impacted than the world market. In terms of recovery, the results suggest no differences in impact except for Madrid, where the European market needed more time to recover than the world market.

6.2 Impact on the country that suffered the attack

For each of the four countries involved, we attempted to analyse the impact on, firstly, the main national index and secondly, a broader national index containing at least one hundred stocks. The indices we chose to include are the following:

For Spain, *IBEX 35* and *Madrid Stock Exchange General Index*; for the UK, *FTSE 100* and *FTSE 350*; for France, *CAC 40* and *CAC All-Tradable* (previously known as SBF 250) and for Belgium, *BEL 20* and *BEL All-Share*.

6.2.1 Impact compared to previous returns

First, the impact as based to the own index' usual historical returns is examined.

Table 6.3: Abnormal returns for two main indices of the country under attack, based on average returns

	MADRID		LONDON		PARIS		BRUSSELS	
Index	Event day AR	3-day CAR	Event day AR	3-day CAR	Event day AR	3-day CAR	Event day AR	3-day CAR
IBEX 35	**-2,30%****	**-7,69%****						
	(-2,01)	(-3,88)						
Madrid General	**-2,18%****	**-7,38%****						
	(-2,18)	(-4,26)						
FTSE 100			**-1,42%****	0,11%				
			(-2,55)	(0,11)				
FTSE 350			**-1,43%****	0,19%				
			(-2,69)	(0,21)				
CAC 40					-0,15%	1,84%		
					(-0,11)	(0,75)		

CAC All-Tradable	-0,17%	1,77%		
	(-0,13)	(0,77)		
BEL 20			0,10%	-1,66%
			(0,09)	(-0,83)
BEL All-Share			0,23%	-1,54%
			(0,18)	(-0,68)

Notes: T-statistics are in parentheses.
** Statistically significant at the 0.05 level.

Table 6.3 shows what seems to be a similar reaction as the one we saw with the European indices: severe and lasting negative stock market effects for Madrid, less severe and shorter effects for London, and no effect for Paris and Brussels. Indeed, here again we see negative event day abnormal returns for Madrid and London only, with those of Madrid being more pronounced. Significantly negative CARs are only found for Madrid, and this effect seems to have lasted a rather long time, as further calculation shows that 6-day CARs (*IBEX 35*) and 6- and 11-day CARs (*Madrid Stock Exchange General Index*) are significantly negative.

Research question 3: How did the four terror attacks impact the general stock markets of the *country under attack,* considering these markets' usual returns?

Results suggest that the Madrid and London bombings significantly impacted the stocks of respectively Spain and the UK, while on the contrary the Paris and Brussels attacks did not significantly impact the French and Belgian indices. Another finding is that the UK's stock market seemed less sensitive to terror after London than did Spain's stock market after Madrid: the impact was less severe and of shorter duration.

6.2.2 Impact compared to the European stocks

Here, we want to again do a comparison of our chosen index with the market index. In this section we would like to find out if there is a significant difference in effect on the stock market of the country where the attack occurred, as compared to the other European stocks. In other words, is there evidence of some kind of "local" impact? Thanks to the market model methodology we can look for answers to this question. The market index used here is the *MSCI Europe* index, but in a form that does not include the stocks from the country in which the attack occurred. For instance, *MSCI Europe*

excluding Spain is used for the Madrid attacks. Table 6.4 shows the abnormal returns that were calculated this way.

Table 6.4: Abnormal returns for two main indices of the country under attack, with the *MSCI Europe ex <country>* index as market index

	MADRID		**LONDON**		**PARIS**		**BRUSSELS**	
Index	Event day AR	3-day CAR	Event day AR	3-day CAR	Event day AR	3-day CAR	Event day AR	3-day CAR
IBEX 35	0,08%	**-3,97%****						
	(0,16)	(-4,67)						
Madrid General Index	-0,08%	**-4,11%****						
	(-0,20)	(-5,71)						
FTSE 100			-0,22%	-0,29%				
			(-0,83)	(-0,64)				
FTSE 350			-0,27%	-0,19%				
			(-1,12)	(-0,46)				
CAC 40					-0,49%	-1,08%		
					(-1,18)	(-1,51)		
CAC All-Tradable					-0,48%	-0,99%		
					(-1,31)	(-1,54)		
BEL 20							0,32%	0,06%
							(0,89)	(0,10)
BEL All-Share							0,48%	0,43%
							(1,28)	(0,66)

Notes: T-statistics are in parentheses.
** Statistically significant at the 0.05 level.

We find no evidence of any abnormal return on the event day that would indicate a difference in impacts between a country that suffered an attack, and the European stock indices. Thus, our results suggest that national and European stock markets seem to have experienced the same (lack of) effects on the event day, and that the stock markets of the country that was hit did not record significantly lower returns than the European stock markets.

We do however find significantly negative CARs for Madrid. This seems to indicate that after the bombings in its capital, Spain's stock market suffered a more lasting impact than the European indices did. When we look at CARs that go further than three days, we find that they are significant up until 6 days after the bombings (6-day CAR of -2,74% for *IBEX 35* (t-value: -2,28) and of -2,88% for the *Madrid Stock Exchange General Index* (t-

value: -2,83). This means that after 6 days, there is still an adverse effect noticeable. After 6 days, the effect disappears.

When we look at the rebound time needed for both levels, we find 17 days for both the *IBEX 35* index and the *MSCI Europe excluding Spain* index. Where does this difference come from then? It stems from the size of the consecutive negative returns that we found, which were significantly bigger for the Spanish indices than for the European ones. In other words, the difference in 3-day CAR impact that existed between the Spanish and European stock markets was not due to a longer recovery period (because they both needed the same amount of days to rebound) but because Spain recorded standardised returns during a certain number of days following the attacks that were more negative for Spain than they were for Europe. According to our findings, that number of days – the days needed for Spain to erase this impact - was between 6 and 11 days after the bombings (it is possible to calculate the exact number of days but we do not consider that relevant here).

Research question 4: How did the four terror attacks impact the general stock markets of the *country under attack,* comparing to the impact of these attacks on the European stock market?

No significant impacts of the attacks were found, with one exception for Madrid, where the national indices seem to have recorded more profound losses during a number of days after the bombings than did the European ones.

6.3 Impact on industries

The previous sections studied general stock market effects, or in other words, over all industries altogether. What we want to do now is find out how every industry separately reacted to the attacks. We look at all industries, we do not make a selection based on any intuitive expectations yet; we will do so later.

Again we want to look at our problem in two different ways. We first want to compare the industry's reaction to an attack given the returns the industry usually encounters. If a significant impact is found, this indicates that this return is particularly deviating from what the industry is used to experience. Secondly, we want to investigate if the industry

in question felt an impact that was significantly different than what the totality of the market experienced. Consequently, an industry may seem robust based on the first method, but may have recorded significant abnormal returns based on the second, and thus have felt an adverse impact. And vice versa.

Note that we will not use the words *supersector*, *sector* or *subsector* anymore; for convenience reasons we will only use the word *industry*, employing it as a generalising word for every group of companies, regardless of its place in the ICB classification.

6.3.1 Impact compared to previous returns

How was each industry affected by each of the four attacks? Table 6.5 provides us with an answer.

Table 6.5: Abnormal returns for the supersectors of the *STOXX Europe 600* index, based on average returns

	MADRID		LONDON		PARIS		BRUSSELS	
Supersector	Event day AR	3-day CAR	Event day AR	3-day CAR	Event day AR	3-day CAR	Event day AR	3-day CAR
Automobile Parts	**-3,69%****	**-5,66%***	**-2,07%****	0,93%	0,04%	2,43%	0,57%	-1,78%
	(-2,09)	(-1,85)	(-2,39)	(0,62)	(0,02)	(0,79)	(0,32)	(-0,58)
Banks	**-2,75%****	**-4,86%****	**-1,78%****	-0,02%	-0,44%	1,59%	-0,75%	**-4,54%***
	(-2,13)	(-2,18)	(-2,82)	(-0,02)	(-0,30)	(0,63)	(-0,51)	(-1,80)
Basic Resources	**-2,43%***	-3,66%	**-2,52%****	-1,10%	-0,32%	2,40%	-0,80%	-4,29%
	(-1,64)	(-1,42)	(-2,40)	(-0,60)	(-0,15)	(0,67)	(-0,39)	(-1,20)
Chemicals	**-3,09%****	**-4,99%***	**-1,67%****	0,19%	0,34%	2,20%	0,52%	-0,46%
	(-2,03)	(-1,89)	(-2,36)	(0,15)	(0,23)	(0,89)	(0,36)	(-0,18)
Construction Materials	**-2,42%****	**-3,74%***	**-1,72%****	-0,10%	0,53%	2,66%	0,68%	-0,34%
	(-2,09)	(-1,86)	(-2,60)	(-0,08)	(0,40)	(1,15)	(0,51)	(-0,15)
Financial Services	**-2,70%****	**-3,65%***	**-1,76%****	0,30%	0,35%	2,27%	0,43%	-1,72%
	(-2,43)	(-1,90)	(-3,16)	(0,31)	(0,25)	(0,94)	(0,31)	(-0,71)
Food & Beverage	-0,91%	**-2,89%***	**-1,61%****	-0,31%	0,47%	2,44%	-0,46%	-0,92%
	(-0,91)	(-1,68)	(-2,77)	(-0,31)	(0,39)	(1,17)	(-0,38)	(-0,44)
Health Care	**-2,89%****	-3,02%	-1,13%	-0,40%	0,18%	2,86%	0,48%	-0,58%
	(-2,36)	(-1,42)	(-1,46)	(-0,30)	(0,14)	(1,29)	(0,37)	(-0,26)
Industrial Goods & Services	**-2,91%****	**-4,91%****	**-1,85%****	0,55%	0,49%	2,99%	0,10%	-1,32%
	(-2,67)	(-2,59)	(-2,81)	(0,48)	(0,41)	(1,45)	(0,08)	(-0,64)
Insurance	**-3,92%***	**-7,07%****	**-2,31%****	0,30%	0,24%	2,31%	-0,75%	**-3,63%***
	(-1,89)	(-1,96)	(-2,87)	(0,21)	(0,19)	(1,05)	(-0,59)	(-1,65)
Media	**-2,83%***	**-5,08%***	**-2,11%****	-0,24%	-0,27%	2,02%	0,11%	-1,06%
	(-1,74)	(-1,80)	(-2,59)	(-0,17)	(-0,22)	(0,96)	(0,09)	(-0,50)

Oil & Gas	**-2,48%***	-3,66%	**-2,21%****	-1,41%	1,04%	**5,52%***	0,17%	-2,68%
	(-1,86)	(-1,59)	(-2,68)	(-0,99)	(0,60)	(1,83)	(0,10)	(-0,89)
Personal & Household Goods	**-2,72%****	**-4,62%****	**-2,16%****	-0,43%	0,63%	2,22%	-0,90%	-0,95%
	(-2,33)	(-2,29)	(-3,30)	(-0,38)	(0,48)	(0,97)	(-0,68)	(-0,42)
Real Estate	**-1,70%****	**-2,48%****	**-2,23%****	-0,61%	0,85%	2,77%	-1,08%	-3,05%
	(-2,38)	(-2,01)	(-3,71)	(-0,58)	(0,66)	(1,24)	(-0,84)	(-1,37)
Retail	**-2,93%****	**-4,41%****	**-2,43%****	-0,49%	0,18%	2,07%	-0,20%	-2,56%
	(-2,60)	(-2,26)	(-4,07)	(-0,48)	(0,14)	(0,92)	(-0,15)	(-1,13)
Technology	**-4,02%****	**-6,46%***	-2,02%	2,19%	0,18%	2,00%	0,77%	-0,45%
	(-1,96)	(-1,82)	(-1,62)	(1,01)	(0,13)	(0,83)	(0,56)	(-0,19)
Telecommunications	**-2,74%****	**-5,27%****	**-1,71%****	0,77%	0,49%	2,08%	-0,41%	-2,21%
	(-2,09)	(-2,33)	(-2,31)	(0,60)	(0,36)	(0,88)	(-0,30)	(-0,94)
Travel & Leisure	**-2,99%****	**-4,89%****	**-2,90%****	-0,78%	-1,43%	0,40%	-1,88%	-2,39%
	(-2,19)	(-2,07)	(-3,82)	(-0,59)	(-1,14)	(0,19)	(-1,50)	(-1,10)
Utilities	**-2,79%****	**-5,65%****	**-1,70%****	-0,11%	0,52%	2,03%	-0,81%	-1,15%
	(-2,63)	(-3,08)	(-2,53)	(-0,10)	(0,41)	(0,92)	(-0,64)	(-0,52)

Notes: T-statistics are in parentheses.
* Statistically significant at the 0.1 level.
** Statistically significant at the 0.05 level.

We see a clear distinction between the left hand side and the right hand side of table 6.5. Just like we saw earlier with the general European and country levels, we reject the null hypothesis and find a statistically significant impact of the Madrid attacks, both on the event day and afterwards (but no significant 6- or 11-day CARs were found), and we also find a statistically significant impact of the London bombings on the event day, albeit smaller than the one after Madrid. Four industries are the exception to this rule: *Food & Beverage*, *Oil & Gas*, *Health Care* and *Technology*. Results suggest that each one of them - for Madrid or London on the event day or for Madrid after three days, depending on the case - felt a lesser impact than the remainder of the industries. Of these four industries, Health Care is the only one that does so twice.

On the right hand side of the table we see that the robustness of the markets against the Paris and Brussels attacks we found earlier not only seems to be an aggregated phenomenon, but could be extended to almost all separate industries. With the exception of *banks* and *insurance* companies, for which a significant stock impact can be noted three days after the Brussels bombings, and the *Oil & Gas* industry, which was

impacted in the same way after Paris, none of the industries record abnormal returns on the event day or for the three day period after the attacks.

Research question 5: How did the four terror attacks impact the European stocks of the *individual industries*, considering the industries' usual returns?

Our findings showed a statistically significant effect of the Madrid and London bombings on almost all industries, while the Paris and Brussels attacks left most industries unaffected, as they impacted only one and two industries respectively. The Madrid bombings, our results suggest, had a more lasting effect than the London bombings, and provoked a more severe reaction as well. This is true for almost every industry.

6.3.2 Impact compared to the total market

A whole different story is told when we take a look at the relationship between each industry and the market. Table 6.6 shows our results.

Table 6.6: Abnormal returns for the supersectors of the *STOXX Europe 600* index, with the *STOXX Europe 600* index (supersector itself excluded) as market index

	MADRID		LONDON		PARIS		BRUSSELS	
Supersector	Event day AR	3-day CAR	Event day AR	3-day CAR	Event day AR	3-day CAR	Event day AR	3-day CAR
Automobile Parts	-0,20%	0,01%	0,27%	1,07%	-0,32%	-0,50%	0,74%	-1,54%
	(-0,20)	(0,01)	(0,52)	(1,19)	(-0,33)	(-0,30)	(0,78)	(-0,93)
Banks	0,23%	-0,04%	0,16%	0,05%	-0,75%	-0,97%	-0,66%	-1,48%
	(0,59)	(-0,06)	(0,61)	(0,11)	(-1,18)	(-0,88)	(-1,04)	(-1,34)
Basic Resources	0,53%	1,19%	-0,57%	-1,09%	-0,66%	-0,35%	-0,72%	-1,83%
	(0,62)	(0,81)	(-0,65)	(-0,73)	(-0,44)	(-0,13)	(-0,48)	(-0,70)
Chemicals	-0,11%	-0,13%	0,37%	0,28%	0,04%	-0,46%	0,70%	**-1,58%***
	(-0,13)	(-0,08)	(0,97)	(0,43)	(0,09)	(-0,53)	(1,40)	(-1,83)
Construction Materials	-0,02%	0,18%	0,11%	-0,03%	0,27%	0,29%	0,81%	-1,29%
	(-0,04)	(0,17)	(0,29)	(-0,05)	(0,53)	(0,33)	(1,57)	(-1,44)
Financial Services	-0,25%	0,37%	-0,35%	0,37%	0,07%	-0,29%	0,56%	-1,24%
	(-0,58)	(0,49)	(-0,97)	(0,59)	(0,15)	(-0,36)	(1,21)	(-1,56)
Food & Beverage	0,88%	-0,03%	-0,28%	-0,27%	0,25%	0,40%	-0,41%	-1,06%
	(1,30)	(-0,02)	(-0,65)	(-0,37)	(0,45)	(0,41)	(-0,74)	(-1,10)
Health Care	-0,50%	1,00%	0,26%	-0,37%	-0,07%	0,75%	0,61%	-1,21%
	(-0,72)	(0,82)	(0,39)	(-0,33)	(-0,12)	(0,71)	(1,01)	(-1,16)
Industrial Goods & Services	-0,55%	-1,05%	0,21%	0,65%	0,25%	0,81%	0,19%	**-1,24%****
	(-1,19)	(-1,33)	(0,86)	(1,55)	(0,74)	(1,40)	(0,58)	(-2,14)

Insurance	-0,82%	-2,39%	**-2,40%****	0,32%	-0,02%	0,01%	**-0,67%***	**-1,14%***
	(-0,69)	(-1,16)	(-2,99)	(0,23)	(-0,04)	(0,01)	(-1,69)	(-1,65)
Media	0,73%	0,68%	0,10%	-0,16%	-0,54%	-0,15%	0,20%	-1,09%
	(1,01)	(0,55)	(0,22)	(-0,20)	(-1,14)	(-0,19)	(0,41)	(-1,33)
Oil & Gas	-0,03%	0,34%	-0,63%	-1,45%	0,80%	3,23%	0,27%	-1,50%
	(-0,04)	(0,23)	(-0,94)	(-1,24)	(0,65)	(1,53)	(0,22)	(-0,71)
Personal & Household Goods	-0,12%	-0,40%	-0,21%	-0,38%	0,39%	-0,19%	**-0,90%****	-1,19%
	(-0,28)	(-0,53)	(-0,72)	(-0,74)	(0,85)	(-0,24)	(-1,97)	(-1,51)
Real Estate	-0,69%	-0,83%	**-1,33%****	-0,58%	0,62%	0,69%	-1,02%	-0,97%
	(-1,19)	(-0,83)	(-2,48)	(-0,63)	(0,89)	(0,58)	(-1,47)	(-0,81)
Retail	-0,54%	-0,50%	**-0,84%****	-0,45%	-0,09%	-0,29%	-0,11%	-1,12%
	(-1,05)	(-0,56)	(-2,41)	(-0,75)	(-0,19)	(-0,35)	(-0,24)	(-1,36)
Technology	-0,07%	-0,02%	1,17%	**2,52%***	-0,10%	-0,41%	0,91%	-1,28%
	(-0,06)	(-0,01)	(1,38)	(1,71)	(-0,15)	(-0,38)	(1,43)	(-1,16)
Telecommunications	-0,08%	-0,99%	0,28%	0,90%	0,22%	-0,35%	-0,33%	-1,23%
	(-0,12)	(-0,82)	(0,62)	(1,15)	(0,40)	(-0,36)	(-0,59)	(-1,27)
Travel & Leisure	-1,17%	-1,80%	**-2,95%****	-0,77%	**-1,70%****	-1,70%	**-1,84%****	-0,95%
	(-1,42)	(-1,27)	(-3,89)	(-0,59)	(-2,79)	(-1,61)	(-3,02)	(-0,90)
Utilities	-0,66%	**-2,23%****	-0,25%	-0,06%	0,28%	-0,15%	-0,75%	-1,34%
	(-1,16)	(-2,27)	(-0,48)	(-0,07)	(0,47)	(-0,15)	(-1,27)	(-1,31)

Notes: T-statistics are in parentheses.
* Statistically significant at the 0.1 level.
** Statistically significant at the 0.05 level.

Here we verify if a certain industry was impacted more thoroughly than the totality of other industries. What immediately stands out is that very few industries significantly did so. Based on the findings in table 6.6, only 13 significant results are found, on a total of 152 values (19 sectors x 4 attacks x 2 periods). Only one of the significant results is positive, and none of the significant results are significant for all four attacks. Also, not one terror attack provoked an adverse effect on more than three industries. We can however perceive a certain pattern through time for the *Travel & Leisure*, as well as for the *Insurance* industry. Both of them record at three occasions significant negative abnormal returns compared to the market. Especially for the Travel & Leisure industry the results are quite robust, with a statistical significance at the 0.05 level. Moreover, according to our findings these stocks felt an impact at three of the four attacks.

A final finding is that more adverse sectorial effects were noticed after the London and Brussels attacks, than after the Madrid and Paris attacks.

Research question 6: How did the four terror attacks impact the European stocks of the *individual industries*, comparing to the impact of these attacks on the other industries?

Based on our empirical evidence, the attacks seem to have provoked very little impact of this kind. Our findings suggest that not one terror attack provoked an adverse effect on more than three industries and that not one of the industries was adversely affected by all four attacks. However, one industry showed to be adversely impacted by three out of four attacks: the *Travel & Leisure* industry. Furthermore the *Insurance* industry was seen impacted by two attacks, of which one left an effect that was still visible after 3 days.

6.4 Impact on specific industries related to terrorism

The focus of this section is different than in the previous one. While in the previous section we wanted to know for every existing industry if it was sensible to the attacks, this time the goal is different: here we do not pursue completeness anymore, but we simply look if certain specific industries, of which it could be *expected* that they react to terrorism, indeed did so.

We do not aim for completeness here because the industries we look into now are very small (they are on the ICB sector or subsector level or even lower). Of course it is possible that, next to the ones we will discuss below, still other small industries were sensitive to the four terror attacks. Further research might always be conducted so as to investigate for all smaller-scale industries. But it is not the question we want to ask here. Here we base ourselves on previous findings of academics, and we want to find out if thee evidence we find for the four European attacks is in line with the results found by these authors.

Thus, this section wants to find out if there was a reaction from the specific industries we selected earlier on, based on their vulnerability or robustness to terrorism: the goal of this section is to find out if and how the following industries reacted, based on empirical evidence: the *Insurance* industry and the *Travel & Leisure* industry (the data

was retaken from the previous section), the *Aerospace & Defence* industry, the *Security* industry, and the *Transportation Services* industry.

6.4.1 Impact compared to previous returns

First we look at how each industry reacted based on its own historic returns.

Table 6.7: Abnormal returns for a selection of specific industries out of the *STOXX Europe 600* index, based on average returns

	MADRID		LONDON		PARIS		BRUSSELS	
Supersector	Event day A(A)R	3-day CA(A)R	Event day A(A)R	3-day CA(A)R	Event day A(A)R	3-day CA(A)R	Event day A(A)R	3-day CA(A)R
Aerospace & Defence	**-3,21%****	**-5,74%****	**-2,53%****	-0,12%	1,14%	**4,20%***	0,07%	-1,39%
	(-2,05)	(-2,11)	(-2,96)	(-0,08)	(0,80)	(1,71)	(0,05)	(-0,57)
Insurance	**-3,92%***	**-7,07%****	**-2,31%****	0,30%	0,24%	2,31%	-0,75%	**-3,63%***
	(-1,89)	(-1,96)	(-2,87)	(0,21)	(0,19)	(1,05)	(-0,59)	(-1,65)
Security	-3,68%	-5,09%	-0,51%	2,22%	**3,08%****	**5,45%****	0,80%	-0,52%
	(-1,42)	(-1,14)	(-0,32)	(0,81)	(2,18)	(2,23)	(0,57)	(-0,21)
Transportation Services	**-2,44%****	**-3,39%****	**-2,70%****	-0,69%	-1,41%	0,99%	**-1,99%***	-0,82%
	(-2,87)	(-2,31)	(-3,74)	(-0,55)	(-1,34)	(0,54)	(-1,73)	(-0,41)
Travel & Leisure	**-2,99%****	**-4,89%****	**-2,90%****	-0,78%	-1,43%	0,40%	-1,88%	-2,39%
	(-2,19)	(-2,07)	(-3,82)	(-0,59)	(-1,14)	(0,19)	(-1,50)	(-1,10)

Notes: T-statistics are in parentheses.
* Statistically significant at the 0.1 level.
** Statistically significant at the 0.05 level.

Aerospace & Defence

Following the Madrid and London bombings, this industry did not escape the negative returns that were being felt over almost all industries in Europe, our results suggest. We do however observe a significantly positive 3-day cumulative abnormal return after the Paris attacks (that lasts until a significant 6-day CAR even). For Brussels we did not find an impact.

Insurance

Based on our findings, it seems the insurance industry suffered, as many other industries, from the Madrid and London bombings. The negative impact statistically was significant. However, we found robustness of these companies after Paris. For Brussels it seems as if the reaction needed some time, as the event day AR is not significant but the 3-day CAR is.

Security

We see a positive reaction after the Paris attacks. No specific impact was found for Brussels. Not in the least, the lack of impact of this industry after the Madrid and the London bombings seems to contain information that is interesting: notice how we did not find a significant negative impact of the security industry here. This is exceptional given our earlier results, which indicated a clear negative impact of these attacks on almost all industries as well as on European and national indices.

Transportation services

For these types of companies, the same goes for many other industries: our results show significant negative effects after Madrid and London. No impact was recorded after the Paris attacks. However, for Brussels we did find an effect.

Travel & Leisure

Again we see that the Madrid and London bombings seemingly provoked significant negative abnormal returns, this time for travel and leisure firms. No effect was identified after the Paris or Brussels attacks.

Research question 7: How did the four terror attacks impact the European stocks of *those specific industries that are expected to feel more impact from terrorism*, considering these industries' usual returns?

The Madrid and London bombings made us reject the null hypothesis for four out of five industries: only the Security industry did not record a significant reaction. For Paris and Brussels the reactions seemed more mixed. We see sporadic evidence of positive reactions of the *Aerospace & Defence* and *Security* stocks and of negative reactions of the *Insurance* and *Transportation Services* stocks. For not one of the selected industries the findings suggest a continued impact throughout the different attacks.

6.4.2 Impact compared to the total market

Let us study how these industries fared when we compare to a market index.

Table 6.8: Abnormal returns for a selection of specific industries out of the *STOXX Europe 600* index, with the *STOXX Europe 600* index as market index

	MADRID		LONDON		PARIS		BRUSSELS	
Supersector	Event day A(A)R	3-day CA(A)R	Event day A(A)R	3-day CA(A)R	Event day A(A)R	3-day CA(A)R	Event day A(A)R	3-day CA(A)R

Aerospace & Defence [b]	-0,25%	-0,80%	-0,56%	-0,05%	0,89%	1,73%	-0,11%	2,04%
	(-0,27)	(-0,50)	(-0,93)	(-0,05)	(1,22)	(1,37)	(-0,16)	(1,62)
Insurance [a]	-0,82%	-2,39%	**-2,40%****	0,32%	-0,02%	0,01%	**-0,67%***	**-1,14%***
	(-0,69)	(-1,16)	(-2,99)	(0,23)	(-0,04)	(0,01)	(-1,69)	(-1,65)
Security [b]	-0,67%	-0,66%	2,04%	2,31%	**2,80%****	**3,35%****	0,84%	0,46%
	(-0,28)	(-0,16)	(1,50)	(0,99)	(2,89)	(2,00)	(0,87)	(0,28)
Transportation Services [b]	**-1,34%***	-1,58%	**-1,34%****	-0,60%	**-1,54%****	-0,47%	**-1,87%****	0,27%
	(-1,70)	(-1,16)	(-2,23)	(-0,58)	(-2,57)	(-0,45)	(-2,35)	(0,20)
Travel & Leisure [a]	-1,17%	-1,80%	**-2,95%****	-0,77%	**-1,70%****	-1,70%	**-1,84%****	-0,95%
	(-1,42)	(-1,27)	(-3,89)	(-0,59)	(-2,79)	(-1,61)	(-3,02)	(-0,90)

Notes: T-statistics are in parentheses.
* Statistically significant at the 0.1 level.
** Statistically significant at the 0.05 level.
[a] The sector was excluded from the market index.
[b] The sector itself was not excluded from the market index because of its low weight in it.

Aerospace & Defence

For not one of the attacks we see these stocks stand out against the market; this suggests they behaved like the market and were not adversely affected by the attacks, be it positively or negatively.

Insurance

As we said before, insurance stocks in our study reported significant abnormal returns at three occasions, which were concentrated at London and Brussels. For the other two attacks we found no adverse effect.

Security

While it looks like these stocks were not immune to the general impact that the market suffered after the Madrid and London bombings, our results suggest that they did stand out positively after the Paris attacks. However, no such effect is visible for Brussels.

Transportation services

For all four attacks, we find this industry to be significantly more negatively affected than the market on the event day.

Travel & Leisure

Except for Madrid, where its losses did not stand out against those of the market, the travel and leisure stocks significantly felt more negativity than the market on the event day, our results show.

Research question 8: How did the four terror attacks impact the European stocks of *those specific industries that are expected to feel more impact from terrorism*, comparing to the impact of these attacks on the other industries?

First, our results suggest that none of the attacks left a clear effect on all of these industries. We do see, however, more significant results after London, Paris and Brussels, as compared to Madrid: when there were adverse sectorial effects, these occurred predominantly in the last three attacks. Secondly, most of the industries did not record a continued impact throughout the different attacks. However, the *Travel & Leisure* industry recorded significantly negative impacts for three out of four attacks, and the *Transportation Services* industry did so for all four. Insurance and security stocks, though, experienced less significant results. But when they did, they went in the direction we had expected them to. Finally, for the *Aerospace & Defence* industry, we did not find any adverse effect at all, surprisingly.

6.5 Overall view of the findings

In this section we want to try and look from a wider point of view to the results we have found above, by considering all research questions combined.

While we found that every attack left some kind of impact on the stock markets, the nature of these impacts was different between attacks. If we ask the question whether there is a certainty of reaction of the general stock markets to large terror attacks, the answer is clearly negative. It seems this is an important conclusion from what we have found above: based on what we found, it would be wrong to say that the four major terror attacks have all profoundly impacted the European stock markets. When we used an index' own previous returns to estimate impact, we saw at multiple occasions a clear distinction between the earlier attacks of Madrid and London, which provoked serious negative stock market impact, and the more recent Paris and Brussels attacks, which were characterised by an (overall) absence of significant negative abnormal returns.

Does this mean that there was no stock impact at all after these two more recent events? No. There were still effects found, only were they not as broad as before. They have come to be situated on the industry level: it is there that a statistically significant impact, if any, was felt. It is important to emphasize the words "if any": indeed, not always was there after Paris and Brussels a reaction of certain industries. But, our findings suggest that *if* investors decided to sell as a reaction to a terror act, mainly the investors of certain industries did so. With regard to the question of *which* industries can be classified under this finding, our answer would be that there were several, but that there seems to be an emphasis on the industries of *Insurance* and *Travel & Leisure*, as these industries recorded more significantly negative impacts than others.

Interestingly, we saw in our market comparison approach that already during the London attacks some industries were adversely affected. This was not the case after the Madrid bombings, where, according to our results, such a phenomenon was rare. However, the difference between London and the more recent attacks is that after London almost all industries were still impacted, as opposed to Paris and Brussels, where almost no industries were impacted. Thus, the adverse reaction after London indicates that certain industries were even *more* (if negative) or *less* (if positive) impacted than others, while those after the recent attacks indicate that they were the *only* ones that were impacted.

Summarising, when we look from Madrid to Brussels, it seems there has been an evolution from effects on the general market to a possibility, but not certainty, of effects on some industries, among which the Travel & Leisure and the Insurance industry in particular proved to be sensitive.

A second question we asked ourselves regarding the impact on industries was if the findings of previous studies that did research into the effects on specific industries sensitive to terror could be supported with new evidence. Based on these studies, we reasonably expected a reaction of five specific industries. Overall we see that these industries were almost all negatively influenced by London and especially Madrid. For the more recent attacks, either they didn't react, or they behaved in the way we would have thought them too. Thus, for the recent attacks, they didn't react every time, but when they did, it was in the expected direction.

What can we conclude on a geographical level? It seems that on a broad geographic level the impact was felt less than on a smaller one, or at most the same impact was felt. We did not find an impact that was stronger on a broader geographical level. We can see evidence of this by looking at the comparison between European and global stocks. We saw that while the European markets seemed to need a long time to recover from the Madrid bombings, the world markets seemed to do so quickly. Our results also suggested that - albeit it was less a severe one than the one from the year before – the European markets suffered an impact of the London bombings, while we found no evidence of these bombings impacting the global markets. For Paris and Brussels we cannot say, based on our findings, that the European or the global markets were significantly impacted. The same goes for the effects we see when we look at the comparison between national stocks and European ones: the Spanish national stocks were found significantly more impacted than the European ones in the aftermath of the Madrid bombings. For the other attacks, the impact severity was not found significantly different for national or European stocks.

This being said, we found no one-on-one relationship between geographical levels. In other words, sometimes our results showed that the broader market felt less impact, and sometimes that it felt the same impact. We did not find a clear pattern as to which one occurred when.

Finally, when looking at all research questions combined, one thing keeps standing out that has not yet been addressed. It is the observation that there is often no significant 3-day CAR. Only for the Madrid bombings did we find a reaction to terrorism that lasted longer than the event day itself (for example: we calculated that after the Madrid bombings the *EURO STOXX 50* recorded significant CARs (mean model) until 6 days after the attack, and this index needed 17 days to get more or less back to its pre-attack level). For London, we found an impact only on the event day. For Paris and Brussels we did not find a general impact; we found that some industries were impacted, but again most of them only on the event day. For some of these industries we did not find an impact on the event day but we did on the 3-day CAR; still, even then the impact did not last for a long time. What this suggests is that the effect of the last three attacks seems to have been of very short duration compared to the one of Madrid. In Chapter 7 we interpret the duration of this impact found after Madrid.

7 Discussion and tentative explanation of the findings

Finding empirical evidence and knowing what it means are two different things. This study is not explanatory; it merely has a descriptive goal. That should not withhold us, however, from thinking a bit further than the sole observation of our findings. In this chapter, let us try to find possible explanations for the results we encountered in the previous chapter.

First of all, it must be repeated that stock movements are the subject of many different reasons and motivations. There are multiple sources of new information coming out every single day, and this is no different for a day when a terror attack occurs. It is therefore nearly impossible to calculate the net impact of the terror act on the stock prices. However, when there is a significant change in stock price, and no other major event occurred on the same day that could make us expect a rough stock price reaction, we can attribute that effect to the attack, based on the assumptions of the EMH.

7.1 Muted reactions after Paris and Brussels attacks

Our first finding was that the Madrid and London bombings significantly impacted the European stocks, while the Paris and Brussels attacks have not. How could this be explained? Have the general stock markets become more resilient through time? Eldor and Melnick (2004), in their study examining terror attacks in Israel from 1990 to 2003, found no evidence that markets became desensitized to terror attacks over time. Yet, maybe there is some sort of habituation for terrorism in more recent times. Baumert (2010) and Baumert et al. (2013) state that markets overreact less nowadays than when 9/11 occurred, and that they evaluate the real economic consequences of a terrorist attack more objectively. Analysts have seen markets become desensitized to terror attacks over time, as they become more commonplace and their shock value diminishes (Shell, 2016). Investors know that these types of events will occasionally happen (Egan, 2015). They have also come to understand the real economic impact of terror attacks, and are able to disconnect their shocked, emotional reaction at the tragic human losses

from their rational analysis of what the pure economic impact of the attack might be (Pisani, 2015). For most of the attacks, that impact remains limited. A terror attack of much larger proportions and shock value would be needed to really scare investors (Shell, 2016). According to some, consumers, instead of cancelling purchases, will rather tend to postpone them (The Economist, 2015; Pisani, 2015). Others say consumers will not be dictated how they have to live their lives, and as such refuse to adopt much change in their lifestyles after an attack (Egan, 2015). Anyhow, there does not seem to be a lasting general negative impact on consumer spending overall according to these analysts.

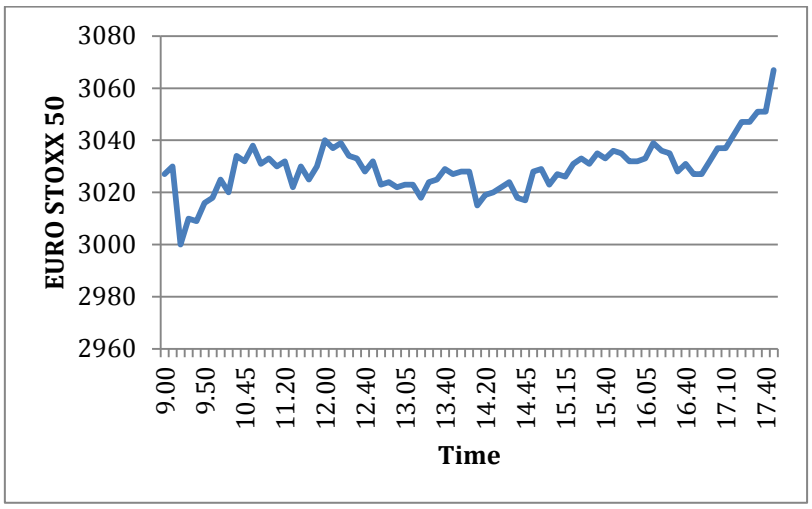
Alternatively the Paris and Brussels attacks may have come less as a surprise, given the threats issued by ISIL and the events of the last few years and months. Indeed, according to Baumert (2010) and Baumert et al. (2013) investors have become more accustomed to the terrorist threat, incorporating the associated risk more systematically into share prices. As such, it could be that the Paris and Brussels attacks were already incorporated in the stock prices beforehand. Stock markets only react to 'unexpected' events, and terrorist attacks may not be one of those anymore (Pisani, 2015; DePillis, 2016).

For Paris, the fact that there was a whole weekend between the attacks and the opening of the stock markets may have played a role: investors had two days to let the facts sink in, think it through and act less emotionally once the stock markets opened on Monday (Egan, 2015).

Still other observers point to the faith that investors have that central banks will do everything in their power to prevent a recession in the immediate aftermath of a terrorist attack. Such procedures have been performed by central banks after the 9/11 and after the London attacks (Lim, 2015). Johnston and Nedelescu (2005) inform us that such measures have been very effective in reducing stock markets effects of terror attacks. Similarly, Chen and Siems (2004) point to more monetary and fiscal policies that become more flexible and appropriate through time and may better assure markets and promote stability by providing proper levels of liquidity in times of need. These same authors also cite technological improvement as a reason that markets can become more resilient: communications and information acquisition and transmission are more timely and accurate.

But does all this mean that there was no effect of the Paris and Brussels attacks on European stock markets at all? Let's look at the intraday graph for 22nd March 2016, the day of the Brussels bombings.

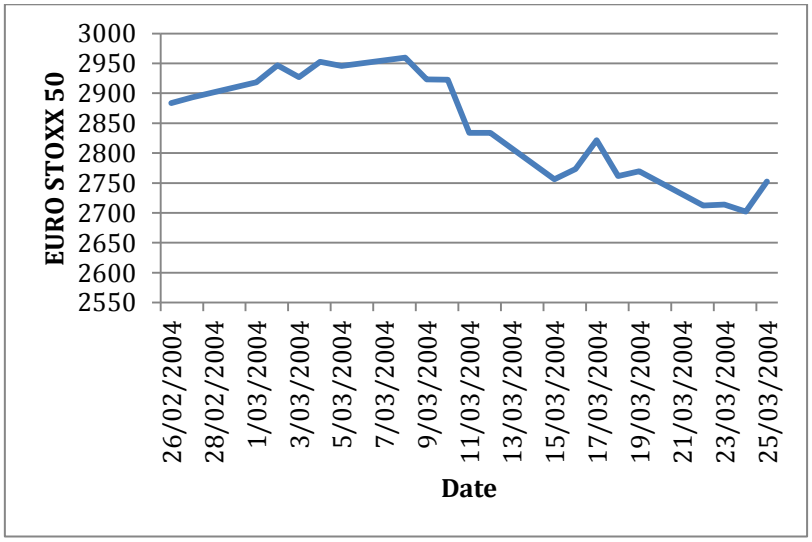
Figure 7.1: Intraday price movement of *EURO STOXX 50* on 22nd March 2016



(Source: own visualisation, data from Bloomberg)

Figure 7.1 shows that there is a decline in stock prices, around 1%, but this decline is followed by a quick recovery. All in all, it only took around one hour and a half to get back to the previous level. The attacks occurred at 8am and 9am. The index opened with a decline between 9am and 9.30am, but by 10.40 am the stock markets had already made up the losses. By means of comparison, let's look at a 20-day graph of Madrid (from 10 trading days before the bombings until 10 trading days after):

Figure 7.2: 20-day price movement of *EURO STOXX 50* around 11th March 2004



(Source: own visualisation, data from Bloomberg)

In Figure 7.2 we see a negative effect that lasted several *days*. It started the day of the bombings, with further price dips in the days following. After 10 trading days, the index was far from rebounding to its pre-attack price level (we saw earlier that it eventually took 17 days to do so).

7.2 Lesser reaction after London than after Madrid

Another finding is that the stock market seemed less sensitive to terror after London than after Madrid: the impact was less severe and of shorter duration, findings that are in line with those of Kollias, Stephanos, et al. (2011). As a tentative explanation for these differences, the cited authors point to the fact that in London the attacks were carried out by suicide bombers, as opposed to Madrid. Thus, in London the terrorist threat ceased to exist immediately, while in Madrid police had to start looking for the suspects. Secondly, they mention that in Madrid the security forces did not know who was responsible for the attacks and with which motive. A third possible explanation they name (applicable to the stocks listed on the LSE only however) are the effective institutional arrangements made by the LSE during the London bombings: special measures were put into action to avoid too much panic selling and also to keep the trading ongoing.

Also, it could be that the trend towards non-reaction against terror attacks had already started, but maybe this trend is only valid for attacks that do not pose a direct threat to finance or economy. The 7/7 bombings were carried out in the financial heart of Europe, and also the world. Who knows, similar attacks at another location might have left an investor reaction that was as muted as those seen after the Paris and Brussels attacks.

Then there is another potential explanation. We mentioned earlier on that an event study is a powerful tool that can measure the effect of a certain event, provided that no other event occurred. However, when looking at the period after the Madrid bombings, we find two news items for which one could reasonably expect a possibility of some kind of stock market reaction. First, Spain's general elections took place three days after the attacks, and they had an unexpected outcome. The conservative government lost power in the election, amid suspicions that they misled the public by claiming that ETA was to blame for the bombings (BBC, n.d. (b)). Second, on the day before the elections, al-Qaeda

claimed the attacks in a video message (BBC, 2004). How to deal with this info? Couldn't it be that these events, instead of the bombings triggered negative stock market reactions, or had an enlarging effect of the reactions to the bombings? One could argue that the event study isn't valid in this case. We should thus only conclude that we found significant negative abnormal returns in this period, but we cannot for sure attribute them to the terror attacks. We still chose to maintain Madrid in our study, though, because we observed that other authors have performed event studies on the Madrid bombings as well (among others Kollias, Stephanos, et al., 2011; Chesney et al., 2011; Brounen and Derwall, 2010) and did not mention anything about this issue. We could interpret the fact that they decided to do so as a sign that they found no particular problems with it. Indeed, we can identify some potential reasons that this problem might not be as considerable as first thought. First, given that no other event happened on the day of the bombings, nor the day after, the event day AR and the 2-day CAR are not influenced by any other important news items. These abnormal returns can be considered stemming from the terror attacks only. Second, the claiming of the attacks by Al Qaeda can be seen as an inherent part of the attacks. Third, we actually do not know if investors were in fact pessimistic about the outcome of the elections. Fourth, even if the outcome of the elections *did* provide reasons for investors to be pessimistic, there is little reason to believe this should have an effect on stock market indices on the European level. As such, only the Spanish indices are expected to possibly have felt some influence.

7.3 Differences in impact between geographical levels

We discussed above that the results suggest that the broader the geographic level, the less the impact was felt, but sometimes the same impact was felt. It is of course logical that the impact felt by those markets that were operating on a larger scale was never stronger than the impact felt by the local markets. They operate in a larger area and are less sensitive to local events: they are more spread out and contain several smaller markets, and not only the one where the terror attack occurred. But, what is less intuitive is that some of the evidence indicates no difference in reaction between the broader index level and the more local one. This is more particularly the case for the Paris and Brussels attacks. The reason could be obvious, though: these attacks did not

provoke any (general) impact at all on the local level, so it cannot feel “less than no” impact on a broader level. But then there is also the case of the London bombings: the European markets were not less impacted by them than were the UK national ones. Here, maybe the reason is that London, “the City”, is the most important financial centre of Europe, if not of the world.

7.4 General industry impacts

From a mean perspective, almost all industries were impacted by the Madrid (event-day and 3-day) and London attacks (event-day). However, some of them were not impacted on one of these moments (Basic Resources, Food & Beverage, Health Care, Oil & Gas, Technology). Second, none of the industries were impacted by Paris or Brussels, except for two (Banks, Oil & Gas). From a market perspective, some industries were seen to be significantly impacted by one attack (Chemicals, Industrial Goods & Services, Personal & Household Goods, Real Estate, Retail, Technology, Utilities).

We will not go into detail by trying to find explanations for these particular industries that on these particular moments recorded an out of the ordinary reaction. These are one-time outliers; no pattern is visible. Sometimes an intuitive reasoning could explain why a certain industry reacted in a certain way (for instance a more robust reaction of the Health Care industry could be explained by investors expecting increasing demands of medication and health care services), but specific industry-related factors may have played a role too. Therefore we may have to need to look at industry-specific news that happened on the event days.

We do however see that for two sectors there is evidence for more than one significant reaction. These are the Insurance and the Travel & Leisure industries. We discuss potential explanations of these reactions in the following section.

7.5 Specific industry impacts

Here, we concentrate on the impacts on the five specific industries we have selected earlier on. These were significantly impacted at several occasions, but at others they

were not. Also, sometimes they reacted in an opposite way as thought. When industries reacted the way we had expected them to, no explaining is necessary. But when they didn't, we want to find out why.

We expected to see a positive reaction of the Aerospace & Defence stocks after a terror attack. The results give a mixed view with regard to this thesis. At first it seems as if this industry is not impacted by terrorism any differently than the general market: high negative impacts are recorded after Madrid and London, and no impact after Paris and Brussels. However, during the 3-day period after the Paris attacks this industry recorded, based on average returns, a significantly positive abnormal return. This was also found by Apergis and Apergis (2016). We do not know, though, if it might have been - more than the terror act itself- the air strikes launched by France in Syria (Doherty, 2015) that have provoked this result (which were themselves a reaction against the terror attack, a retaliation); it might also be a mixture of both.

The Insurance industry reacted as expected for three out of four attacks. Only after Paris were they robust and did they not feel a negative impact. How come? Given that analysts had expected a negative reaction prior to the first trading day after the Paris attacks (Wearden, 2015), this is strange. Maybe the fact that there was a weekend in between had something to do with it. But then again, for the Travel & Leisure industry this didn't make a difference. Another explanation might be the limited physical damage resulting from the attacks - in Paris the attacks mainly consisted of shootings rather than bomb blasts – or still the overall young age of the victims (few life insurances to pay out).

Just like for Aerospace & Defence industry, we expected to see a positive reaction of the security companies to the different terror attacks. This expectation is more or less confirmed. What we found were the absence of a negative reaction in contrast to other stocks (Madrid and London) or clear positive reactions (Paris). The fact that it did not record significant positive abnormal returns after the Brussels bombings however, is surprising. When we take a closer look at the individual companies, which are Securitas and G4S, we see an enormous difference in impact: while Securitas showed a positive abnormal return of almost 4%, G4S recorded a negative abnormal return of more than 2% (both based on past average returns, as compared to the market). After the Paris attacks, both companies experienced positive returns, but Securitas much more than G4S. So there is a big difference in the way investors of these companies reacted to these

two terror attacks. How to explain this? Maybe investors in one company see a terror attack as "good" news for business, while in the other investors see the negative consequences such an attack can have for the security business as well. Indeed, it seems as if the positivity effect we expected is not so self-evident. For instance, according to some security managers these companies need a healthy economy to successfully do business, and if that is not the case due to terror attacks, the security business loses as well. Also, the focus on safety indeed increases, but budgets do not follow: these companies say they have to do better with the same money (Cools & Goethals, 2016). Furthermore, the increase in demand that occurred after the Paris attacks did not constitute pure profit, they say, because additional costs for training of newly recruited staff have to be incurred as well as for the payment of overtime by security guards (Rasking, 2016).

The Transportation Services and the Travel & Leisure industries reacted as we expected them to, with returns that were more negative than the market.

Overall we see that these industries were almost all negatively influenced by London and especially Madrid. For the more recent attacks, either they didn't react, or they behaved in the way we would have thought them too. Thus, for the recent attacks, they didn't react every time, but when they did, it was in the expected direction. Maybe the absences of reaction that were sometimes visible can be explained by the phenomenon of stock market resilience we mentioned earlier.

7.6 Final remarks

7.6.1 The literature

Where does this leave us in comparison with previous findings in the research on terrorism and the stock market? Do the stock market reactions against the Paris and Brussels attacks confirm or contradict previous research?

Multiple times, the studies we mentioned found negative stock price reactions to terrorism. However, in a number of them (for instance Chen & Siems, 2004)) it could be seen that terror attacks do not *always* provoke negative effects on the stock market. Paris and Brussels seem to constitute new empirical support for this thesis.

Also, Baumert et al. (2013), as well as Chen and Siems (2004) reported a diminishing impact of terrorism over time. Our findings might be interpreted in that same direction.

Looking at duration, many studies report effects on the stock markets that are short-lasting, which seems to be the case for the four attacks in this study as well.

On an industry level, those industries typically cited as vulnerable more or less coincide with those we have found to have been impacted by the Paris and Brussels attacks; however, some of these industries did not feel an impact after Paris and/or Brussels.

Apart from other industries, Chesney et al. (2011) also found impacts on the oil & gas, financial, banking and pharma/biotech industries, but we did not find evidence that confirms this in our study.

The outcomes of several studies are not in line with our findings for the Paris and Brussels attacks. For instance, Eldor and Melnick (2004), in their study on the Israeli stock market, found that suicide attacks had a permanent effect. They also found that the number of people injured and killed had a permanent effect. These findings do not coincide with the Paris and Brussels attacks, given that these attacks left little impact but were carried out (completely or in part) by suicide bombers and that the Paris attacks resulted in a high number of victims. Eruygur and Omay (2014) talk about a certain threshold level for the intensity of terrorist activities which, once surpassed, would provoke a statistically significant impact on the stock market. Given that both the Paris and Brussels attacks surpassed the threshold but did not record statistically significant impacts, our evidence does not confirm these authors' findings. Drakos (2010) describes how the psychosocial impact of an attack amplifies the impact on the stock markets. However, the Paris and Brussels attacks can be seen as events provoking high psychosocial impact, but did not record significant stock market disruptions.

7.6.2 Terrorism in Europe in perspective

We saw that Paris and Brussels had little impact on the stock market. The 2004 and 2005 bombings were more pervasive for the markets, especially the ones in Madrid. But where does this impact situate compared to the general fluctuations in the stock market, or compared to other events impacting the stock market? Let's look at the severity of

some stock market losses, in order to have an approximate idea of where the impact of terrorism stands. The negative returns of the main European indices recorded on 11th March 2004 were situated between -2% and -3%. By way of example, the outcome of the UK referendum in favor of a "Brexit", resulting in the UK leaving the European Union, has left European (and global, for that matter) stock markets on 24th June 2016 in the red at a far more thorough level (for instance, a -8,62% loss for the *EURO STOXX 50* index[1]). A quick look at the worst single-day losses in recent history indeed seems to indicate that the terror attacks in Europe were not among the top stock market loss drivers for this continent. Next to the UK leaving the EU, other examples of large negative stock market reactions for the *EURO STOXX 50* were the 2008 financial crisis (several large negative returns were recorded in the fall of 2008, with a bottom of -7,88% on 10th October), bad global economic outlooks in August 2011 (The Guardian, 2011) – with a bottom of -6,12% on 10th August 2011 - and a series of global financial events in the Summer of 2015: loan problems in Greece and stock market turbulence in China (The Guardian, 2015) – with a bottom of -5,35% on 24th August 2015. Note that terrorism can definitely have severe consequences for the stock market (the 9/11 attacks provided for a negative return of -6,41% of the *EURO STOXX 50*), but the four attacks that make out the subject of this study were not among the main stock market losses in Europe in recent times.

Of course, for one to have a reliable answer to these questions, event study or other scientific methodology should be applied, but at least these numbers provide us with an indication.

We also saw above that there were, overall, for the last three attacks, very few significant 3-day CAR reactions. The effects of these attacks were thus of very short duration. Only the Madrid bombings left a more lasting impact. The *EURO STOXX 50* needed 17 trading days to more or less get back to the level that existed before the bombings. Again we could ask ourselves the question if this is a long time or not, compared to other events. Let's look at the four events we mentioned above and see how long the *EURO STOXX 50* needed to rebound. For 9/11 we find 22 days. The financial crisis of 2008 provoked an impact such that the pre-crisis level was reached only at the end of 2014, or six years later. Only in mid-March 2012 the *EURO STOXX 50* got back to

[1] Source : Bloomberg.

the level it was on before 1st August 2011, which is a period of more than seven months. The same index needed until the end of November 2015 to recover from the negative returns that started in mid-August 2015, which amounts to approximately three months. This shows that the Madrid bombings were not among the events with the longest lasting impacts.

Concluding, when we put them in perspective, it seems as if the terror attacks that we looked at did not leave a fierce impact and were only transitory. This is a good thing of course. Still, it is worth repeating that this is merely the financial side of looking at the phenomenon: the psychological effects and the lives lost and others ruined due to these attacks are horrific consequences that last way longer and pierce much deeper than the effects one can perceive from a financial point of view.

7.6.3 Horizon

Secondly, we want to mention that in this study we looked at the short-term effects of four terror attacks on stock markets. Long-term effects on the stock markets were not studied but will potentially come to exist, as analysts have pointed to possible consequences for free trade, immigration and globalization, for the Schengen area and more broadly the EU project, for the "Brexit"-referendum (immigration proved to be an important argument used by the "Leave" camp), to consequences in the form of costs of extra policing, surveillance and security checks, and finally the possibility of an enduring instead of sporadic terror campaign. However, the muted reaction of the stock markets after Paris and Brussels suggest, at least, that investors do not expect these effects (Shell, 2016; The Economist, 2015).

7.6.4 Theory

This thesis is a descriptive one and does not aspire to provide a theory. Based on these results, could we propose, for instance, a theory regarding stock market reaction differences through time? Could we say for sure that the stock market reaction to terrorism in Europe has evolved from sensitive to relatively numb? Could we say for sure that European terrorism's impact on European stock markets has moved from generally impacting the entire market to only potentially impacting certain industries?

No. We only looked at four events, and that is very little for one to develop a theory. It suffices that for one of those four events an important parameter of the attack adversely affected the impact. For instance, Paris was the only one of the four attacks where there was a weekend in between the attack and the opening of the markets. It is possible that this has affected the impact on the stock prices. As such, we do not know if and which other characteristics of the Paris and Brussels attacks, next to their period in time, might have played a role in the generally muted reaction of the stock markets.

The reason we only have four events to look at, is two-fold. First, because – luckily – terrorism attacks remain relatively rare (although their frequency has been increasing rapidly in the last two years). Secondly, because, as we already mentioned, terror attacks are not the kind of drivers that will impact stock markets the most. As a consequence, the only times a terror attack will überhaupt be visible, is when it is of a certain magnitude and shock value. Terrorist acts of this kind are rare.

The future will show if the increased numbness and the shift to industries we found for the two latest terror attack impacts is indeed a change that is here to stay. Will the next large-scale terror attack continue to have little effect on the stock markets? Or will the reaction be more thorough this time, maybe because of the specific characteristics of the attack? For instance what happens when a business district is targeted? Or when the number of victims runs in the thousands? Will the effects be the same? Also, we could imagine that although we saw with Brussels and Paris that markets have reacted mutedly to terror attacks in recent times, a *sustained* series of deadly terror attacks could have a more pronounced impact (Alam, 2013; Cunningham, 2016, Baumert et al., 2013). So maybe future terror attacks that in characteristics and impact are no different than those of Paris and Brussels, will in that scenario come to have a lot more impact. If terror attacks occur more often there could be a more destabilizing effect on economy and business.

Whatever it may, time will tell, as new attacks will provide researchers with new data, because sadly they are expected to continue to occur.

7.6.5 Implications for investors

As stated above, this study is not concerned with, nor does it allow, predicting how future terror attacks in Europe might impact the European stock markets. Econometric models that incorporate different variables and that use a larger set of attacks seem more adequate for this purpose. Nevertheless, is there something we could learn from our findings regarding portfolio selection? What managerial advice could we give? It seems as if attacks of the same characteristics as the ones that occurred in Paris or Brussels not necessarily impact the European or country general indices. However, investors that before Paris or Brussels worried about terrorism and thus avoided buying or maintaining stocks in the insurance or travel and leisure industries were better off, given that these stocks experienced some impact of the attacks. But, even then, investors that did hold such stocks when the Paris or Brussels attacks occurred saw the negative effects fading away quickly.

8 Conclusion

In the past couple of years, terrorism has not seen a slowdown, as attacks still continue to occur in all corners of the world. In Europe, after a period of relative calm, the phenomenon has known resurgence in the last few years, with two large-impact attacks, one in Paris and one in Brussels, as the culminating events of this trend.

This thesis has tried to create an image of how large-impact terrorism in Europe has affected European stock markets in the last 15 years. Therefore, we examined how stock markets reacted to the 2004 Madrid bombings, the 2005 London bombings, the 2015 Paris attacks and the 2016 Brussels attacks. We did so using the event study methodology, a popular tool to investigate the impact of certain events on stock prices, which we applied to historical prices of relevant stock indices. We employed this methodology in two ways: first, we wanted to examine if there was an effect on an index given its average of past returns, and secondly we were curious to find out if there was an effect on an index when looking at the return that would be expected based on the relationship of the index with the market in previous periods.

We used eight research questions in order to examine the impact on the general European stock markets, on the general stock markets of the country under attack, on the European stocks of the individual industries, and finally on the European stocks of those specific industries that are expected to feel more impact from terrorism, be it positive or negative. We looked at each of these four levels through the two different methods of event studies: first by considering the markets' usual returns, and then by comparing with the market returns.

Overall, our findings can be summarised as follows. First, the four large-impact terror attacks in our study did not all show a profound effect on the stock markets. Our results displayed a broad, general effect for the two earlier attacks, the one in Madrid and the one in London, and this on the European and national level, with the effect of the Madrid bombings being the most severe and lasting longer. However, we did not find an impact when we looked at stock price reactions of the two more recent terror acts: markets seemed robust to these events. This does not imply, though, that no impact was felt. There was still some evidence of significant stock price reactions, but instead of coming

in the form of an impact on general indices and on all industries indifferently, this time the impact was situated on the level of certain industries. The two recent attacks seem to only have impacted some industries, while an overall effect was not found. The above does not mean that the industries that felt an impact, be it positive or negative, did so after *both* of the attacks. In other words: our results suggest that the Paris and Brussels attacks resulted in very muted reactions by investors, but when investors reacted, which they only did sporadically, they did so by particularly selling or buying stocks of certain industries. Among these, especially the Travel & Leisure and the Insurance industries can be mentioned.

As to possible explanations for these results, one might think of some sort of habituation for terrorism that has taken place in recent times. Other potential reasons could be that investors calculated for the impact of a potential attack in the stock prices beforehand, given the multiple threats issued by ISIL over the recent years. Still other explanations might be the faith people have that central banks will take appropriate measures, or the characteristics of the individual attacks, such as the weekend that was in between the Paris attacks and the opening of the stock market and that might have prevented any forms of panic selling.

Second, based on the literature we identified five industries that are likely to feel an impact from terrorism. Subsequently we found that these industries were almost all negatively influenced by London and especially Madrid. For the more recent attacks, either they didn't react, or they behaved in the way we would have thought them too. Thus, for the recent attacks, they didn't react every time, but when they did, it was in the expected direction. This could be explained by the same reasons mentioned for the results found on the broad indices. In case of absence of reaction of a certain industry, other explanations could be identified as well, this time on the level of that specific industry.

Third, in our findings the broader geographic general indices, when compared to the more local indices, either suffered less (by feeling less impact or by recovering more quickly), or either felt an identical impact. We did not find evidence for a broader level feeling more impact. This seems logical given that this level is more spread out and contains several smaller markets, which makes it less sensitive to local events. Another interesting finding here though is that the London bombings did not seem to account for

a difference in impact between the European markets and the UK national ones. The European market, while being larger, did not seem to have felt less of an impact of these attacks than the UK market. Maybe this is the case because London is the financial centre of Europe.

There are limitations to this study. Methodological choices had to be made. The mere choice of using an event study as our tool to answer our research questions can potentially affect the outcome: maybe different methodological instruments would have rendered different results. But also the choice of event study type, the choice of market index, the choice of estimation window, the choice of statistical test, among other things, could have influenced the results. Secondly, the findings have little predictive power. However, this study being descriptive, it does not provide information as to what stock market reaction is to be expected at the occurrence of the next terror attack. Finally, we want to stress that it is very difficult to find exact answers for a subject like this one. The clear net impact of these terror attacks on the stock market will probably never be *exactly* known. For that, too many uncontrollable factors exist and too many assumptions need to be made. Nevertheless we think that it is a topic worth investigating, and we hope this thesis gave an insight in the matter and contributed to the research in the field of terrorism and its impact on the stock market.

Potential ideas for further research into this topic include investigating any long-term impact of the four terror attacks on the European stock markets. Other aspects we have not treated are volatility, or the effects on other financial products such as bonds, commodities or gold. It could also be interesting to include all terror attacks in Europe after, say, WWII, in order to have an image that is broader in time and contains more attacks. Still a different extension would be to compare in detail the impact of terror attacks with that of other catastrophic events such as earthquakes or floods, or other events that have been known to affect stock markets, such as political changes or economic forecast announcements. From a theoretical point of view, it could be interesting to find out if terror attacks that target financial or economical centres have a different impact than those that do not.

By applying event study methodology on different kinds of European stock indices, this thesis has aimed to draw a picture of the stock market impact of high impact terrorism that occurred in Europe over the past 15 years. It has done so by examining four terror

attacks, starting with the bombings that occurred in March 2004 in Madrid, going up until the attacks that took place in Brussels in the same month twelve years later. Unfortunately, the research doesn't stop here. It is unlikely that large impact terror attacks will cease to occur in the future, and it remains to be seen how these new attacks will impact the stock markets. Terrorism is of all times: the bombings in Madrid were not the first terror attack on European soil, and there is little indication that those in Brussels will be the last. Only time will tell which consequences this will have; for investors, but in wider regard for all people alike.

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Appendices

Appendix 1. ICB structure for company classification.

Table A.1: ICB structure for company classification.
General industries selection is indicated in blue; specific industry selection in yellow. (Source: FTSE Russell, ICB.)

Industry	Supersector	Sector	Subsector
0001 Oil & Gas	0500 Oil & Gas	0530 Oil & Gas Producers	0533 Exploration & Production
			0537 Integrated Oil & Gas
		0570 Oil Equipment, Services & Distribution	0573 Oil Equipment & Services
			0577 Pipelines
		0580 Alternative Energy	0583 Renewable Energy Equipment
			0587 Alternative Fuels
1000 Basic Materials	1300 Chemicals	1350 Chemicals	1353 Commodity Chemicals
			1357 Specialty Chemicals
	1700 Basic Resources	1730 Forestry & Paper	1733 Forestry
			1737 Paper
		1750 Industrial Metals & Mining	1753 Aluminium
			1755 Nonferrous Metals
			1757 Iron & Steel
		1770 Mining	1771 Coal
			1773 Diamonds & Gemstones
			1775 General Mining
			1777 Gold Mining
			1779 Platinum & Precious Metals
2000 Industrials	2300 Construction & Materials	2350 Construction & Materials	2353 Building Materials & Fixtures
			2357 Heavy Construction
	2700 Industrial Goods & Services	2710 Aerospace & Defense	2713 Aerospace
			2717 Defense
		2720 General Industrials	2723 Containers & Packaging
			2727 Diversified Industrials
		2730 Electronic & Electrical Equipment	2733 Electrical Components & Equipment
			2737 Electronic Equipment
		2750 Industrial Engineering	2753 Commercial Vehicles & Trucks
			2757 Industrial Machinery
		2770 Industrial Transportation	2771 Delivery Services
			2773 Marine Transportation
			2775 Railroads
			2777 Transportation Services
			2779 Trucking

		2790 Support Services	2791 Business Support Services
			2793 Business Training & Employment Agencies
			2795 Financial Administration
			2797 Industrial Suppliers
			2799 Waste & Disposal Services
3000 Consumer Goods	3300 Automobiles & Parts	3350 Automobiles & Parts	3353 Automobiles
			3355 Auto Parts
			3357 Tires
	3500 Food & Beverage	3530 Beverages	3533 Brewers
			3535 Distillers & Vintners
			3537 Soft Drinks
		3570 Food Producers	3573 Farming & Fishing
			3577 Food Products
	3700 Personal & Household Goods	3720 Household Goods & Home Construction	3722 Durable Household Products
			3724 Nondurable Household Products
			3726 Furnishings
			3728 Home Construction
		3740 Leisure Goods	3743 Consumer Electronics
			3745 Recreational Products
			3747 Toys
		3760 Personal Goods	3763 Clothing & Accessories
			3765 Footwear
			3767 Personal Products
		3780 Tobacco	3785 Tobacco
4000 Health Care	4500 Health Care	4530 Health Care Equipment & Services	4533 Health Care Providers
			4535 Medical Equipment
			4537 Medical Supplies
		4570 Pharmaceuticals & Biotechnology	4573 Biotechnology
			4577 Pharmaceuticals
5000 Consumer Services	5300 Retail	5330 Food & Drug Retailers	5333 Drug Retailers
			5337 Food Retailers & Wholesalers
		5370 General Retailers	5371 Apparel Retailers
			5373 Broadline Retailers
			5375 Home Improvement Retailers
			5377 Specialized Consumer Services
			5379 Specialty Retailers
	5500 Media	5550 Media	5553 Broadcasting & Entertainment
			5555 Media Agencies
			5557 Publishing
		5750 Travel & Leisure	5751 Airlines

	5700 Travel & Leisure		5752 Gambling
			5753 Hotels
			5755 Recreational Services
			5757 Restaurants & Bars
			5759 Travel & Tourism
6000 Telecommunications	6500 Telecommunications	6530 Fixed Line Telecommunications	6535 Fixed Line Telecommunications
		6570 Mobile Telecommunications	6575 Mobile Telecommunications
7000 Utilities	7500 Utilities	7530 Electricity	7535 Conventional Electricity
			7537 Alternative Electricity
		7570 Gas, Water & Multiutilities	7573 Gas Distribution
			7575 Multiutilities
			7577 Water
8000 Financials	8300 Banks	8350 Banks	8355 Banks
	8500 Insurance	8530 Nonlife Insurance	8532 Full Line Insurance
			8534 Insurance Brokers
			8536 Property & Casualty Insurance
			8538 Reinsurance
		8570 Life Insurance	8575 Life Insurance
	8600 Real Estate	8630 Real Estate Investment & Services	8633 Real Estate Holding & Development
			8637 Real Estate Services
		8670 Real Estate Investment Trusts	8671 Industrial & Office REITs
			8672 Retail REITs
			8673 Residential REITs
			8674 Diversified REITs
			8675 Specialty REITs
			8676 Mortgage REITs
			8677 Hotel & Lodging REITs
	8700 Financial Services	8770 Financial Services	8771 Asset Managers
			8773 Consumer Finance
			8775 Specialty Finance
			8777 Investment Services
			8779 Mortgage Finance
		8980 Equity Investment Instruments	8985 Equity Investment Instruments
		8990 Nonequity Investment Instruments	8995 Nonequity Investment Instruments
9000 Technology	9500 Technology	9530 Software & Computer Services	9533 Computer Services
			9535 Internet
			9537 Software
		9570 Technology Hardware & Equipment	9572 Computer Hardware
			9574 Electronic Office Equipment
			9576 Semiconductors

			9578 Telecommunications Equipment

Appendix 2. The Revised Academic Consensus Definition of Terrorism (taken in its entirety from Schmid (2011, p. 86))

1. Terrorism refers, on the one hand, to a doctrine about the presumed effectiveness of a special form or tactic of fear-generating, coercive political violence and, on the other hand, to a conspiratorial practice of calculated, demonstrative, direct violent action without legal or moral restraints, targeting mainly civilians and non-combatants, performed for its propagandistic and psychological effects on various audiences and conflict parties;

2. Terrorism as a tactic is employed in three main contexts: (i) illegal state repression, (ii) propagandistic agitation by non-state actors in times of peace or outside zones of conflict and (iii) as an illicit tactic of irregular warfare employed by state- and non-state actors;

3. The physical violence or threat thereof employed by terrorist actors involves single-phase acts of lethal violence (such as bombings and armed assaults), dual- phased life-threatening incidents (like kidnapping, hijacking and other forms of hostage-taking for coercive bargaining) as well as multi-phased sequences of actions (such as in 'disappearances' involving kidnapping, secret detention, torture and murder).

4. The public (-ized) terrorist victimization initiates threat-based communication processes whereby, on the one hand, conditional demands are made to individuals, groups, governments, societies or sections thereof, and, on the other hand, the support of specific constituencies (based on ties of ethnicity, religion, political affiliation and the like) is sought by the terrorist perpetrators;

5. At the origin of terrorism stands terror – instilled fear, dread, panic or mere anxiety - spread among those identifying, or sharing similarities, with the direct victims, generated by some of the modalities of the terrorist act – its shocking brutality, lack of discrimination, dramatic or symbolic quality and disregard of the rules of warfare and the rules of punishment;

6. The main direct victims of terrorist attacks are in general not any armed forces but are usually civilians, non-combatants or other innocent and defenceless persons who bear no direct responsibility for the conflict that gave rise to acts of terrorism;

7. The direct victims are not the ultimate target (as in a classical assassination where victim and target coincide) but serve as message generators, more or less unwittingly helped by the news values of the mass media, to reach various audiences and conflict parties that identify either with the victims' plight or the terrorists' professed cause;

8. Sources of terrorist violence can be individual perpetrators, small groups, diffuse transnational networks as well as state actors or state-sponsored clandestine agents (such as death squads and hit teams);

9. While showing similarities with methods employed by organized crime as well as those found in war crimes, terrorist violence is predominantly political – usually in its motivation but nearly always in its societal repercussions;

10. The immediate intent of acts of terrorism is to terrorize, intimidate, antagonize, disorientate, destabilize, coerce, compel, demoralize or provoke a target population or conflict party in the hope of achieving from the resulting insecurity a favourable power outcome, e.g. obtaining publicity, extorting ransom money, submission to terrorist demands and/or mobilizing or immobilizing sectors of the public;

11. The motivations to engage in terrorism cover a broad range, including redress for alleged grievances, personal or vicarious revenge, collective punishment, revolution, national liberation and the promotion of diverse ideological, political, social, national or religious causes and objectives;

12. Acts of terrorism rarely stand alone but form part of a campaign of violence which alone can, due to the serial character of acts of violence and threats of more to come, create a pervasive climate of fear that enables the terrorists to manipulate the political process.