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The impact of terrorism on U.S. defence contractors' stock returns:

a short-term event study

Abstract

This paper examines the effect of terrorist attacks in the United States on stock returns of U.S. defence companies for the period from 1995 to 2016. The focus is on four major attacks: Oklahoma, New York City, Boston and Orlando. A short-term event study and a CAR-regression analysis are performed. The results show no effect after the Oklahoma bombing, whereas after the 9/11 attacks a significant positive effect is observed. The attacks in Boston and Orlando result in negative abnormal returns. Furthermore, the severity of an attack has a considerable positive impact on defence stocks. Revenues from defence have a slightly positive effect, while a companies' size and return on assets do not affect the returns of defence stocks.

Keywords: Event Study; Regression Analysis; Terrorism; Efficient Market Hypothesis; Defence Companies

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1. Introduction

Although it is not a phenomenon of the last decade, terrorism has become one of the most discussed issues nowadays. According to the Global Terrorism Database, which provides a large set of data from 1970 through 2017, the number of terrorist attacks in the United States increased since 1995 and stagnated two years later. Subsequently, a major increase is observed from 2011 onwards. The number of casualties caused by terror attacks is to some extent constant over time, with surges perceived at the time of major terrorist incidents. These major incidents concern respectively the Oklahoma bombing in 1995, the airplane crashes into the Twin Towers and the Pentagon in 2001, the Boston bombing during the Boston marathon in 2013 and the nightclub shooting in Orlando in 2016.

Besides the dispersion of fear among societies and all other damage that is caused, terrorism has economic consequences as well. Since the start of the twenty-first century academics became more interested in these consequences of terrorism. Financial markets are an important field to measure the impact of disruptions such as terror attacks, because “prices of individual stocks reflect investors’ hopes and fears about the future, and taken in aggregate, stock price movements can generate a tidal wave of activity. Because of their liquidity, terrorist attacks, military invasions and other unforeseen disastrous occurrences can have serious implications for stocks and bonds” (Chen & Siems, 2004).

Several papers have been written on the impact of terror attacks on financial markets. Brounen and Derwall (2010) compared international price responses for several industries and found that local markets and industries that were directly affected by a terrorist attack experienced the strongest price reactions. Furthermore, their main results prove that financial markets are strongly affected by attacks, but quickly recover and turn back to normal.

A lot of studies focus on the impact on the airline sector. Drakos (2004) examined the effect of the 9/11 attacks on airline stocks and found a significant increase in volatility of the stocks, implying more uncertainty in this industry. Whereas the airline industry is a relatively vulnerable sector, defence companies seem to be more financially sound. According to Chesney et al. (2011), who analysed the impact of terrorism on a number of industries, the airline industry and the insurance sector perceived a larger impact relative to other industries such as defence, pharmaceutical, biotechnology, oil and gas industries. For these industries, the price reaction could turn out both positively and negatively. The authors suggested that the latter sectors generally react in a similar way to events such as financial crashes and natural disasters.

Hitherto, literature has been focussed on terror attacks all over the world and their impact on several markets. Furthermore, a lot of studies specifically concentrated on the effect of the 9/11 attacks on stock markets. However, there is little research conducted yet on the effect of terror attacks on defence stocks. In this paper, defence companies are firms that, besides the production of weapons, involve cybersecurity, technology systems, aerospace and communication systems.

As mentioned earlier, the number of terrorist attacks has been growing over the past few years and is not expected to change in the near future. Hence, it is in the investors' interest to do more research into this field. When the effect of terrorism on stocks of defence companies is known, investors can use this to make more rational and efficient choices in financial markets when such events occur. Therefore, it would be relevant to raise the following research question with regard to the major defence contractors in the United States:

Do terrorist attacks in the United States have an impact on the stock returns of U.S. defence companies?

To examine this question, the four major attacks in the United States are investigated: the Oklahoma bombing in 1995, the attacks in New York City in 2001, the Boston bombing in 2013 and the Orlando shooting, 2016.

An event study approach is used to test their effect on stock returns. The event studies are performed by means of the software Eventus. In addition, a regression analysis is conducted to test whether several other financials influence the stock returns. Based on annual reports and information from analysts, a list of the top 100 global defence companies is provided by the website *Defense News* (2017). To test whether attacks in the United States have an impact on the stock returns of top defence contractors in the U.S., only the U.S. defence companies within this top 100 are used. For these companies, daily stock prices for the estimation period and the test period are derived from the Compustat database.

The event takes place at t=0 and for the estimation period -the days prior to the event- a duration of 120 days is set. Additionally, an estimation window of 50 days is used to test for robustness of the abnormal returns. Because terrorist attacks are unpredictable, there is no effect expected for the days prior to the event. Hence, the event window only involves the days after the event, including t=0. The expected returns are computed by means of the market model.

The results in this paper show contradictory effects for the 9/11 attacks on the one hand and the attacks in Boston and Orlando on the other hand. The Oklahoma bombing shows no effect at all. Particularly, the effect of the attacks in 2001 on stock returns is significant and extremely positive for the whole industry. However, the effect of the other two attacks is significantly negative. In addition to these findings, a positive effect is observed for revenues from defence and the severity of an attack. Conversely, a company's size and return on assets (ROA) do not impact the stock returns.

The structure of this thesis is as follows. Firstly, theory and literature are discussed in Section 2, which also contains the hypotheses of this paper. A description of the data is given in Section 3 and the methodology is outlined in Section 4. The empirical results are discussed in Section 5. Finally, Section 6 contains conclusions, limitations and suggestions for future research.

2. Theory and literature review

2.1 The efficient market hypothesis

An important theory for this research is the efficient market hypothesis (EMH). Fama et al. (1969) introduced this theory and stated that an efficient market implies a market which adjusts quickly to new information, what simply means that investors should not be able to beat the market. In other words, the reaction of investors to available news should be visible in the stock price. One of the main assumptions this theory makes is that individual investors generally act rationally.

Market efficiency has three variants which are distinguished based on the nature of information. First of all, the weak form of market efficiency yields that all historical data is incorporated into the stock price. Secondly, the semi-strong form implies an efficient market as well but, in this form, all public information is incorporated. And finally, the strong form implies an efficient market in which all information is processed in todays' stock prices, including both public and private information (Fama, 1970). Only the semi-strong form is of importance in this paper, because in the case of unanticipated events there is no private information.

The EMH is part of the classical finance theory, which is mainly based on the concept of rational expectations. In the 1970s the efficient market model was very popular, but in the years thereafter criticism on the consistency of the model for the total stock market increased. In the 1990s, academics became more interested in human psychology and its relationship to financial markets. This marked the birth of behavioural finance (Shiller, 2003).

Several new concepts were introduced due to behavioural finance, one of them is investor sentiment. Baker & Wurgler (2007) defined it as follows: "Investor sentiment, defined broadly, is a belief about future cash flows and investment risks that is not justified by the facts at hand." That is to say, decisions are affected by emotions as well and therefore, investors do not act rationally at all times. Several papers have been written on this subject related to events such as terror attacks or financial events. Nikkinen & Vähämaa (2010) examined the impact of terrorism on market sentiment and found that terrorism has a strong impact. More specifically, they observed a downward shift in the expected value of the index studied.

2.2 Resilient markets

As mentioned in the introduction, Brounen & Derwall (2010) concluded that after the perceived price reactions in response to a terror attack, the market quickly recovered and turned back to normal. This phenomenon can be explained by the fact that markets are resilient. Each financial market acts in a different way and some might be more resilient than others. This supposition follows from the paper of Chen & Siems (2004) who found that markets in the United States were less damaged by the 9/11 attacks than other markets in the world, despite the fact that the attacks occurred on American soil. They argued that this could be explained by the fact that after the attacks, the U.S. capital markets were closed for four trading days. Instead of making decisions based on emotions, investors were now able to digest the information and make more rational decisions. Chen & Siems (2004) also found a growing level of market resilience in U.S. capital markets and concluded that this could possibly be explained by an efficient financial sector.

2.3 Related literature

There is a broad literature available on the impact of terrorism on financial markets. In this section a variety of papers and their results are highlighted. Table 1 provides an overview of the specifications for each of the discussed papers. This overview is supplemented with methodological aspects in section 4.

Table 1: An overview of the discussed literature related to this paper

Author(S)	Region	Time Period	Main Findings	Events
Barret et al. (1987)	Global	1962-1985	Negative price reactions, only significant the day after the event date. Market evaluates the information quickly.	78 airline crashes
Drakos (2004)	Global	2000-2002	Volatility of airline stocks significantly increased.	9/11 attacks in New York City
Eldor & Melnick (2004)	Israel	1990-2003	Market incorporates information efficiently. Permanent negative price reaction on stock markets, but not on foreign exchange markets. Several other factors play a role in the effect, i.e. target type, attack type, number of casualties.	639 attacks in Israel
Charles & Darné (2006)	Global	2001	Permanent and temporary impact on stock markets.	9/11 attacks in New York City
Blomberg, Hess & Jackson (2009)	Global	1968-2005	Positive price reaction for oil stocks on two conditions: 1.There needs to be a sort of monopoly power for oil companies. 2. Informational content on event must be great.	All attacks on firms' subsidiaries in countries of the top oil producers and exporters in the world
Brounen & Derwall (2010)	World's largest economies	1990-2005	Stronger and longer-lasting effect of the 9/11 attack on stock indices. Most influential impact of the 9/11 attack is a change in systematic risk.	31 attacks that directly involved the major economies
Karolyi & Martell (2010)	Global	1995-2003	Significant stock price reaction of -0.83% on the event date. Wealthier countries perceive a larger negative stock price reaction than less developed countries.	75 attacks directly targeted at 43 different firms
Chesney, Reshetar & Karaman (2011)	Global	1995-2005	Type of industry matters for the impact of attacks. Commodity and bond markets perceive a price reaction in both directions.	77 attacks in 25 different countries
Peleg et al. (2011)	Israel	2000-2006	'Normalisation of terror'. The relative intensity and severity of an attack did affect the market fluctuations. No evident impact in the long run on market activity.	90 Suicide bombings in Israel
Aslam & Kang (2015)	Pakistan	2000-2011	Negative price reaction the day before the event happens. Negative price reaction on the day an attack occurs. Positive price reaction on the day after the event. Market recovers rapidly.	300 attacks in Pakistan
Kolaric & Schiereck (2016)	US, Canada & Europe	2015-2016	Market is efficient regarding the adjustment of prices after the events.	Paris 2015, Brussels 2016
Procasky & Ujah (2016)	102 countries	2002-2011	Developing countries experience a larger decrease in credit rating relative to developed countries (long-term impact).	Specifications not mentioned
Aksoy & Demiralay (2017)	Turkey	1988-2015	Turkish stock market is sensitive to attacks. Foreign exchange market remains unaffected. Investment decisions heavily affected by terrorism. Volatility increase on Turkish stock market after attacks.	1666 attacks in Turkey

Karolyi & Martell (2010) analysed the impact of 75 terrorist attacks on the stock price of domestic and international publicly traded companies for the years 1995 to 2002. The sample contains attacks that directly targeted specific firms. McDonalds and Royal Dutch Shell were the firms targeted the most, respectively 10 and 9 times. The main finding of the paper is a significant stock price reaction of -0.83% on the day an attack occurred. Furthermore, the authors concluded that the impact of an attack is related to the wealth of a country where the attack occurred: wealthier countries perceived a larger negative stock price reaction than less developed countries.

Besides the degree of development of countries, other correlations with the impact of terrorism can be discerned as well. Chesney, Reshetar & Karaman (2011) distinguished between industrial, national, regional and global effects of attacks on stock markets. Additionally, they measured the effects for commodity and bond markets. First of all, the type of industry appeared to be an important factor. Particularly the insurance sector and the airline industry were more affected by terrorism relative to other types of industries. In contrast, the banking sector showed less susceptibility to this kind of events. For the aerospace, defence, pharmaceutical, biotechnology, oil and gas industries the results showed both positive and negative price reactions. Moreover, the authors concluded that in commodity and bond markets the price reaction is also perceived in both directions.

The research of Blomberg, Hess & Jackson (2009) focussed on how stocks of oil companies reacted to terrorist attacks and global conflicts. They distinguished several time periods to test for differences in price reactions using certain breakpoints, concerning the oil crises of 1973 and 1979 and the stock market crash of 1987. The authors argued that terror attacks have a larger effect if there is a minimal gap between global oil demand and supply. Another influential factor correlated with the impact on oil stocks is the presence of the OPEC (Organisation of the Petroleum Exporting Countries). This organisation showed strong characteristics of cartel behaviour and therefore had a form of monopoly power. This monopoly power is one of the two requirements for terrorism and conflicts to have a positive impact on oil stocks. The second condition is that there should be sufficient information on the terror incident, which could change investors' view of the market. Since cartel behaviour in this industry declined, oil prices did not rise when conflicts occurred.

According to Eldor & Melnick (2004), who only used Palestinian terror attacks as events to measure the effect on stock markets and foreign exchange markets in Israel, terrorism did not affect the foreign exchange markets, while in stock markets a negative price reaction was perceived. Additionally, they concluded that the type of an attack did matter to the impact on both markets. Both markets experienced a permanent effect in the case of suicide terrorism, whereas for other kinds of attacks they did not. The results also indicated that for different kinds of targets the stock market reacted differently, but the foreign exchange market was not affected. Furthermore, the number of victims affected both markets permanently as well. The final conclusion of the paper showed that markets efficiently incorporate information regarding terrorist attacks and that the way economies deal with terrorism could be partly justified by the concept of market liberalism, which remains unaffected by attacks. In accordance with this paper, the first hypothesis is the following:

Hypothesis 1*: Terrorist attacks have a significant negative effect on stock returns after an event occurred.*

Several papers have been written on the impact of specifically the 9/11 attacks on financial markets. Charles & Darné (2006) found sizable effects on international stock markets, both temporarily and permanently. Brounen & Derwall (2010) did research on the impact of terrorism on international stock markets. They focussed on terrorist attacks that directly affected the world's largest economies in the period of 1990 to 2005. Instead of measuring the effect on individual stocks, worldwide stock market indices were the main point of attention. In conformity with the paper of Charles & Darné (2006), the results of this paper indicated a much stronger and longer-lasting impact on stock indices in the case of the 9/11 attacks compared to the attacks in Madrid (2004) and London (2005). In addition, they concluded that the most influential impact of the 9/11 attack was a change in systematic risk. Another important finding is that the cross-sectional variation in systematic risk between industries could explain the different stock price reactions for different sectors.

Accordingly, Drakos (2004) focussed on the effect of terrorism on airline stocks taking the companies' risk profiles as reference points. As in the previous papers, the 9/11 attacks function as the main point of attention. Based on the empirical results Drakos concluded that the volatility of airline stocks in the period after the 9/11 incident significantly increased with respect to the period before the attacks. Therefore, airline stocks became more uncertain and consequences followed. For example, after 9/11, the cost of raising capital in the airline industry increased, which also meant that the possibilities to raise capital in this sector diminished.

To continue with the airline sector, Kolaric & Schiereck (2016) studied the impact of the Paris and Brussels attacks, of respectively 2015 and 2016, on airline stocks. Besides an event study methodology, the authors also used a regression with the cumulative abnormal returns (CAR) as the dependent variable. To measure the impact on the CAR, several variables have been used, including 'Brussels', 'EU', 'Size' and 'Net income'. The dummy variable 'EU', which indicates whether a headquarter is located in the European Union and the variable 'Net profits' did not seem to have any explanatory power to the perceived stock price reactions. In contrast, 'Size' had a significantly negative impact on the CAR. The main finding of this paper is that the market is efficient when it comes to price adjustments after the event. Airline stocks were negatively affected. The attack which directly targeted Brussels Airport had a surprisingly smaller effect on the stock prices than the attacks in Paris did.

In compliance with these results, the question is raised whether a company's size negatively affects defence companies' stocks as well and therefore, hypothesis two is the following:

Hypothesis 2**:** *The size of a defence company has a significant negative effect on stock returns.*

Barret et al. (1987) discussed the impact of unforeseen events on stock prices. The price reaction to airline crashes was the main point of attention. The results showed negative price reactions, which were only significant for the day after the event date. In accordance with the findings of Eldor & Melnick (2004), the information on the unforeseen event is processed quickly by the market. In addition, the authors tested for underreaction and overreaction, but the results did not show evidence for these phenomena.

Whereas most papers in this field focus on the impact on stock markets, Procasky & Ujah (2016) studied the long-term impact on the cost of debt. They measured the effect of the level of terrorism in 102 different countries on a country's credit rating using the S&P index. A comparison is made between developing and developed countries. The results showed that developing countries experienced a larger decrease in credit rating relative to developed countries, implying a higher cost of debt.

It is also possible that stock markets do not show any clear price reactions. Peleg et al. (2011) discussed the concept of 'normalisation of terror', which basically means that terrorism becomes more ordinary in daily life. They analysed the TA-100 index (Tel Aviv stock market) for the period of 2000 to 2006 and showed that the relative severity of an attack did affect the market fluctuations. But they did not find any evident impact on the market in the long run, which possibly implied constant market resilience and investors' faith in the market. Because Peleg et al. (2011) focussed on Israeli stock markets and these markets differ from U.S. stock markets, the effect of severity on stock returns is tested in this paper as well. Hence, the third hypothesis is:

Hypothesis 3: *The severity of an attack has a significant positive effect on stock returns.*

Considering the severity of attacks, Pakistan is one of the most heavily impacted and targeted countries in the world. According to the Global Terrorism Database, the number of casualties as well as the number of incidents in Pakistan in the period from 2001 to 2016 is largely increased. Aslam & Kang (2015) conducted research on the effect on Pakistani stock markets in the period of 2000 to 2011. They performed an event study methodology to measure the impact of 300 different attacks in Pakistan. Results showed that on the day an attack occurred the price reaction was -0.32%. Moreover, the authors found a significant price reaction of -0.24% on the day before an attack happened as well. They argued that the stock market anticipated on preliminary turmoil and rumours. Finally, the results showed a significant price reaction of 0.34% on the day after an attack, indicating a fast recovery of the market.

Another country that definitely must be mentioned is Turkey, which has known a lot from terrorist attacks. Aksoy & Demiralay (2017) measured the effects on Turkish financial markets, involving the foreign exchange market and the stock market. In addition, they focussed on how foreign investors in the Turkish stock market reacted to attacks. First of all, their results did not indicate any effect on the foreign exchange market, whereas the stock market did show some reaction. Secondly, the investment decisions by foreign investors appeared to be largely affected by such events. By means of a CAR-regression several factors that could possibly influence the effect were tested, including the city where the events took place, the terrorist organisation responsible for the attack, the region in which the event occurred and the type of an attack. Finally, they also observed an increase in volatility of Turkish stocks, indicating more uncertainty.

2.4 Explanatory variables

It is important to mention the reason behind the choice of the explanatory variables in this paper. First of all, a company's size in terms of total assets could be related to the strength of the effect. Because the variable *AssetsTotal* is not normally distributed, this paper takes the logarithm of total assets. Kolaric & Schiereck (2016) found a significant negative impact of a company's size in the airline industry. This means that major airlines experienced larger effects after an attack relative to smaller airlines.

However, another view implies that size has no impact at all for the reason that defence companies are, to a certain extent, diversified, protecting them from large fluctuations in specific industries. Hence, the firm-specific risk is diminished.

Secondly, a company's return on assets (ROA) might affect the level of impact on stock returns. Return on assets is an indicator of a company's profitability related to its total assets and gives investors an idea of how efficient the investments of a firm are. In fact, the same expectation holds for this variable. One can expect that the higher the ROA, the larger the impact is on a firm's stock. On the other hand, there could be no effect at all due to a high level of diversification within a firm.

The third variable used in this paper is revenues from defence relative to total revenues, given in percentages. It is expected that revenues from defence have a significant positive effect on the stock price, because investors might have an incentive to invest in protection after a major terrorist attack happens.

Corresponding with the findings of Peleg et al. (2011) this paper also uses severity as an explanatory variable. The authors perceived a significant effect of severity on the stock market and the same is expected in this paper for the reason that the higher the number of casualties, the higher the chance that investors act irrationally.

3. Data

3.1 Terrorist attacks

First of all, there is no clear consensus for defining terrorism; each country or region might have different definitions for this phenomenon. Because this paper is focussed on terrorism in the United States only, the definition of the U.S. Department of State is used, implying that "terrorism is premeditated, politically motivated violence perpetrated against non-combatant targets by subnational groups or clandestine agents, usually intended to influence an audience" (Sinai, 2008). This paper is focussed on the major attacks in the United States for the years of 1995 to 2016, based on the number of casualties. The data is derived from the Global Terrorism Database (GTD). This database provides data on terrorist attacks that took place all over the world between the years of 1970 and 2017. The next paragraphs provide some additional information on each attack.

Table 2: An overview of the major attacks in the United States, 1995-2016

Date	City	Perpetrator Group	Fatalities	Injured	Attack Type
1995/04/19	Oklahoma	Anti-government extremists	168	650	Bombing/explosion
		Total casualties		**818**	
2001/09/11	Arlington	Al-Qaida	189	106	Hijacking armed assault
2001/09/11	New York City	Al-Qaida	1382	7365	Hijacking armed assault
2001/09/11	New York City	Al-Qaida	1383	7366	Hijacking armed assault
		Total casualties		**17791**	
2013/04/15	Boston	Muslim extremist	2	132	Bombing/explosion
2013/04/15	Boston	Muslim extremist	1	132	Bombing/explosion
		Total casualties		**267**	
2016/06/12	Orlando	Jihad-inspired extremists	50	53	Hostage taking
		Total casualties		**103**	

Oklahoma 1995

On the 19th of April, 1995 a truck loaded with explosives exploded in front of the Alfred P. Murrah Federal Building in Oklahoma. The number of fatalities ran up to 168 and around 650 people were injured. The perpetrators were former U.S. Army soldiers and sympathised with a militant patriot movement. It was the deadliest terrorist incident ever in the United States before the 9/11 attacks occurred.

New York City 2001

On the 11th of September, 2001 members of the Islamic extremist group Al-Qaida hijacked four passenger airplanes. Two of them flew into the Twin Towers in New York City, the third crashed into a field in Pennsylvania and the last airplane hit the Pentagon. For simplicity, all four attacks are included when New York City is mentioned. According to the GTD, 2954 people were killed and the number of injured victims ran up to almost 15000. Furthermore, the number of total fatalities is still rising.

Boston 2013

The attack on the Boston marathon occurred the 15th of April, 2013. Two explosions near the finish line hit the crowd, resulting in 3 deaths and more than 260 injured people. The two brothers who perpetrated the attack were inspired by Islamic extremism, but acted on their own behalf.

Orlando 2016

On the 12th of June, 2016 an armed man started shooting in a gay nightclub in Orlando, Florida. This led to a massacre with 50 deaths and 53 injured. Although the attack was not claimed by Islamic State, the perpetrator did pledge allegiance to ISIL.

3.2 Sample selection

The companies are chosen based on the global top 100 defence companies for the year prior to the year the event took place and concern only the U.S. firms (2017). This top 100 does not provide any information before the year 2000, so the sample for the attack in Oklahoma concerns more or less the same group of companies as for the 9/11 attacks and thus might not be representative. The data contains 20 defence companies for the Oklahoma bombing, 24 for the 9/11 attacks and respectively 32 and 36 for the Boston and Orlando attacks. It must be stated that some of the companies only partly operate in the defence industry, so besides producing weapons, some of the firms also engage in other fields, such as the development of cybersecurity, technology systems, aerospace and communication systems. However, this is accounted for in the CAR-regressions, which is further discussed in Section 4.

Table 3: Descriptive statistics.

This table contains the descriptive statistics of the firms during the attacks in New York City, Boston and Orlando. *AssetsTotal* and *NetIncome* are in millions $. *ROA* is calculated as *NetIncome/AssetsTotal*. DefRev is calculated as *Revenues from defence/ Total revenues*. *Size* is the logarithm of *AssetsTotal*.

	Mean	Median	Min	Max	St.Dev
AssetsTotal	27645	5593	96.7	685328	89479
NetIncome	881	167	-6127	13641	2120
ROA	0.04	0.05	-0.34	0.17	0.06
DevRev	0.52	0.51	0.02	1	0.28
Size	8.70	6.63	4.57	13.44	1.69

3.3 Financials

In order to measure the effects of several financial factors on the cumulative abnormal returns, the financials are derived from the database Compustat. These financials include return on assets and total assets as an indicator of size. *Size* is defined as the logarithm of total assets. *ROA* is the net income divided by total assets and represents a firm’s profitability relative to its total assets. Both variables are based on the fiscal year prior to the event and are measured in U.S. dollars. Additionally, the previously mentioned problem of firms partly operating in the defence industry, is addressed by including the revenues from defence as a percentage of total revenues in the year prior to the event. This information is provided by the list of top 100 defence companies. The descriptive statistics per event are provided in Appendix A, Tables 7a, 7b and 7c.

4. Methodology

As stated in Section 2.3, an overview of the different methods used in the previously discussed papers is provided here:

Table 4: An overview of the methodology used in related literature

Author(s)	Estimation & Event Window	Benchmark Model	Methodology	Variables
Barret et al. (1987)	Estimation: t= -205; t= -6 Event: not clearly mentioned	Market model	Event study, CAR analysis	Not mentioned
Drakos (2004)	Not mentioned	Not mentioned	Recursive estimation procedure. Beta estimation: market model for individual airline stocks	Not mentioned
Eldor & Melnick (2004)	Not mentioned	Not mentioned	Econometric analysis for time series. "Methodology for decomposing the innovations in the market into the news from a terror attack and other white noise"	Dependent: stock exchange rate, foreign exchange rate, Dummy: major city, target type, attack type, Independent: victims injured, victims killed, number of attacks per day
Charles & Darné (2006)	Not mentioned	Not mentioned	Outlier detection methodology. They tested for effects of modelling the outlier-corrected series with a GARCH model	Not mentioned
Blomberg, Hess & Jackson (2009)	Not mentioned	Not mentioned	OLS and Standard asset-pricing model, including measures of terrorism	Dependent: actual returns, Dummy: terrorism=1 if incident in month, refineries=1 attack on oil refinery in month, Independent: fatalities scaled by 100, IV estimator
Brounen & Derwall (2010)	Estimation: t= -110; t= -11 Event: t= -10; t= +10	Mean-adjusted returns	Event study, Abnormal returns	Dependent: return on industry index, Independent: market return, Dummy: terror=1 if event occurs, 9/11=1 if attack is on 11/9/2001, Interaction: market return*post9/11
Karolyi & Martell (2010)	Estimation: t= -224; t= -11 Event: t= -10; t= +10	Market model	Event study, used AAR for equally weighted portfolios. Cross-sectional regression analysis of abnormal returns	Dependent: AAR on event date, Dummy: if U.S. firm=1, responsibility= 1 if group takes credit for an attack, Independent: market cap, polity4 (democracy index), education, GNI per capita, number of attacks on specific firm
Chesney, Reshetar & Karaman (2011)	Not mentioned	Not mentioned	1. Event study, used AR and CAR. 2. Non-parametric conditional contribution approach. 3. Filtered GARCH-EVT method	Not mentioned
Peleg et al. (2011)	Not mentioned	Not mentioned	Univariate autoregressive analysis	Dependent: adjusted closing price of the TA-100, Independent: first difference S&P 500 index, count, injured, killed, total casualties on a single day, attacks, days between attacks, total casualties on current day and previous 6 days
Aslam & Kang (2015)	Event: t= -1; t= +1	Not mentioned	Event study and multiple regression method	Dependent: KSE-index return Independent: targeted location, type of attack, number of casualties
Kolaric & Schiereck (2016)	Estimation: t= -257; t= -6 Event: t= -5;t= +5	Market model	Event study, measured based on CAARs.	Dependent: CAR, Dummy: if attack in Brussels = 1, if headquarter is located in EU=1, Explanatory: Company size, Net profits

Procasky & Ujah (2016)	Not mentioned	Not mentioned	Basic OLS, cross-sectional data	Dependent: S&P sovereign credit rating, Control: global terrorism index, GDP per capita, inflation rate, GDP per capita growth, national reserves to GDP per capita, exports, control of corruption, political stability
Aksoy & Demiralay (2017)	Estimation: t= -30; t= -11 Event: Only t=0	Mean-adjusted returns	Day-event study analysis	Dependent: CAR, Dummy: major cities (i.e. dummy Ankara= 1 if event is in Ankara), in the same way the following dummies were used: region, terrorist organisation, attack type

4.1 Event study approach

The event study method is a widely used approach in finance research. In most cases, an event study is used to measure the effect of an event on the price of securities. Examples of such events are: issues of new debt or equity, mergers & acquisitions and earnings announcements. However, the method can also be applied to events such as terrorist attacks or natural disasters (MacKinlay, 1997). The event study used in this paper is computed by means of the event study software Eventus, provided by Wharton Research Data Services (WRDS).

To perform an event study, the estimation window and the event window have to be set. In this paper two different estimation windows up until t= -10 are used to test for robustness of the abnormal returns, respectively of a duration of 120 and 50 days. The main event window yields t=0 and t=1. The days before t=0 are not taken into account, because there is no leakage of information in the case of terrorist attacks. Hence, no effect is expected for these days. If an event took place during the weekend or holiday when trading was not possible, the closing price for those days is not available. If this is the case, the closing price of the previous trading day is used.

4.2 Abnormal returns

To compute the abnormal returns, the normal returns have to be estimated. This paper uses the market model with the S&P 500 index to estimate these returns:

$$R_{it} = \alpha_i + \beta_i R_{MIt} + U_{it}$$

"where R_{MIt} stands for the return on the market index MI for period t and U_{it} denotes the error term. The intercept α_i can be interpreted as the part of the stock return that represents the constant influence of firm-specific factors with time. The slope β_i can be interpreted as determining the part of the stock return that is dependent on the market-wide, and therefore general, influences" (Van der Sar, 2015). With the normal returns being calculated, the abnormal returns can be determined by subtracting the normal returns form the actual returns. In addition, the abnormal returns can be averaged, yielding the AAR.

4.3 Cumulative abnormal returns

Subsequently, the abnormal returns can be accumulated to form the cumulative abnormal returns. Several CARs with different durations are determined, including CAR[0,1], CAR[0,2] CAR[0,5] and CAR[0,10]. Frequently, the surges are observed around the event day, hence CAR[0,1] is the most important indicator. To find the overall effect on the defence industry, the cumulative abnormal returns can be averaged, representing the CAAR.

$$CAAR = \frac{1}{N}\sum_{t=1}^{N} CAR_t$$

4.4 Significance tests

To test whether or not the abnormal returns are significantly different from zero, two significance tests are performed, a parametric and a non-parametric test. Firstly, the parametric Patell test is executed (Van der Sar, 2015). This test involves standardisation of abnormal returns, which can be defined as equation 1. In this formula, s_i stands for the standard deviation of the abnormal returns and s_i^2 can be calculated by equation 2. Additionally, the cumulative standardised abnormal returns (CSAR) can be computed by accumulating the SARs and the Patell test can be examined as in equation 3. Finally, by means of the z-score the following hypotheses are tested:

$$H_0: CAAR = 0$$
$$H_a: CAAR \neq 0$$

$$SAR_{it} = \frac{AR_{it}}{s_i} \qquad (1)$$

$$s_i^2 = \frac{1}{T_2 - T_1 + 1}\sum_{t=T_1}^{T_2} (AR_{it} + \overline{AR}_i)^2 \qquad (2)$$

$$z_{Patell} = \frac{1}{\sqrt{N}}\sum_{i=1}^{N} \frac{CSAR_i}{s_{CSAR_i}} \qquad (3)$$

The results are also verified with bootstrap significance levels. The bootstrap approach is a possible way to deal with outliers, which are frequent in small samples (Brooks, 2014). Efron & Tibshirani (1994) described the bootstrap method as follows: "The bootstrap is a computer-based method of statistical inference that can answer many real statistical questions without formulas." Furthermore, it computes confidence intervals by means of an algorithm.

A common problem in event studies is the phenomenon of event-induced variance. Widely used techniques in event studies could fail in the case of a different impact on different companies, what increases the dispersion of returns. Therefore, the null hypothesis in event studies is more often rejected than it should (Boehmer, Masumeci, & Poulsen, 1991).

In this paper the non-parametric Cowan generalised sign test is used to deal with the potential event-induced increase in variance. This test "examines whether the number of stocks with positive cumulative abnormal returns in the event window exceeds the number expected in the absence of abnormal performance" (Cowan, 1992). The generalised sign test consists of the following steps:

$$\hat{p} = \frac{1}{N}\sum_{i=1}^{N}\frac{1}{M_i}\sum_{t=T_0}^{T_1} S_{it} \qquad (4)$$

$$S_{it} = \begin{cases} 1 & if\ AR_{it} > 0 \\ 0 & if\ otherwise \end{cases} \qquad (5)$$

$$z_{gsign} = \frac{(\omega - N\hat{p})}{\sqrt{N\hat{p}(1-\hat{p})}} \qquad (6)$$

where $\hat{p}$ stands for the fraction of positive abnormal returns, N is the number of observations, M_i defines the number of non-missing returns in the estimation window, T_1 and T_0 denote respectively the latest and the earliest day in the estimation window. In equation 6, ω defines the number of stocks with positive cumulative abnormal returns. The following hypotheses are tested:

$$H_0: CAAR = 0$$
$$H_\alpha: CAAR \neq 0$$

4.5 OLS regression

In order to examine the impact of several factors on the cumulative abnormal returns, an OLS regression is composed in the following form:

$$CAR[0,T] = \alpha + \beta_1 Size + \beta_2 ROA + \beta_3 DefRev + \beta_4 S.NYC + \beta_5 S.Boston + \beta_6 S.Orlando + \varepsilon_i$$

where *CAR[0,T]* is the dependent variable examined for CAR[0,1] and CAR[0,2], *Size* is the natural logarithm of *AssetsTotal* measured in U.S. dollars, *ROA* defines the *NetIncome* in U.S. dollars divided by *AssetsTotal* in U.S. dollars, *DefRev* defines the revenues from defence as a percentage of total revenues. The variables *S.NYC, S.Boston* and *S.Orlando* are factor variables, indicating the severity of the different attacks in terms of casualties. The Oklahoma bombing is left out in this regression due to insignificant results, which is discussed in Section 5.

5. Results

5.1 Cumulative average abnormal returns

First of all, for each event the CAARs are listed in Table 5. There is no significant effect observed for the Oklahoma bombing. This is remarkable given the severity of the attack compared to the other attacks, but might be explained by the fact that the sample is not representative enough, as discussed in Section 3.2. In contrast, the 9/11 attacks show relatively high positive abnormal returns. Furthermore, the effect appears to be long-lasting. For both estimation windows the Patell test, the generalised sign test and the bootstrap significance levels reject the null hypothesis given a significance level of 0.05. However, only the bootstrap significance level of CAAR[0,10] for the 120 day estimation period is not significant at 5%. The overall effect of terrorist attacks on defence stocks based on the results is hard to determine, because there is a discrepancy between the results of the 9/11 attacks and subsequent events.

The CAARs for the Boston and Orlando attacks show slightly negative stock price reactions. For the Boston event CAAR[0,1], CAAR[0,2] and CAAR[0,5] are consistent and significantly negative for all tests, whereas the null hypothesis cannot be rejected for CAAR[0,10]. The same negative effect is observed for the Orlando shooting, but for this event only the CAAR[0,1] is significant for all tests at a 0.05 level.

Table 5: Cumulative average abnormal returns.
This table shows the CAARs for each event in the sample given an estimation window of 120 days and 50 days. The three significance tests are also included. The signs *,**, and *** denote statistical significance at the 0.10, 0.05 and 0.01 levels.

	ESTIMATION WINDOW= 120 DAYS				ESTIMATION WINDOW= 50 DAYS			
Event Window	**CAAR (%)**	**Patell (Z-Score)**	**Bootstrap Significance Levels**	**Generalised Sign (Z-Score)**	**CAAR (%)**	**Patell (Z-Score)**	**Bootstrap Significance Levels**	**Generalised Sign (Z-Score)**
OKLAHOMA N=20								
[0;+1]	-0.03	0.475	0.475	0.286	-0.15	-0.082	-0.244	-0.547
[0;+2]	-0.21	0.231	0.231	-1.058	-0.39	-0.141	0.070	-0.547
[0;+5]	0.43	0.649	0.649	0.286	0.06	0.071	0.522	-1.44*
[0;+10]	-0.47	-0.091	-0.091	-0.610	-1.16	-0.770	-0.479	-0.099
NEW YORK CITY N=24								
[0;+1]	8.72	10.143***	10.143**	2.872***	8.23	10.346***	10.346***	2.363***
[0;+2]	9.01	8.137***	8.137**	2.464***	8.52	8.244***	8.244**	2.771***
[0;+5]	10.95	6.145***	6.145**	2.464***	9.70	5.563***	5.563**	1.954**
[0;+10]	9.66	3.950***	3.950*	2.055**	10.03	4.363***	4.363**	2.363***
BOSTON N=32								
[0;+1]	-1.26	-3.703***	-3.706***	-3.363***	-1.18	- 3.515***	-3.500***	-3.021***
[0;+2]	-1.80	-4.677***	-4.607***	-3.363***	-1.66	-4.334***	-4.100***	-2.667***
[0;+5]	-2.66	-4.849***	-4.769***	-3.363***	-2.47	-4.411***	-4.207***	-3.021***
[0;+10]	-1.13	-1.774**	-1.719*	-0.887	-0.87	-1.441*	-1.343	-0.545
ORLANDO N=36								
[0;+1]	-0.75	-2.069**	-2.065***	-2.967***	-0.64	-2.498***	-2.428***	-2.056**
[0;+2]	-0.65	-1.156	-1.151**	-0.967	-0.59	-1.490*	-1.443**	-0.721
[0;+5]	-0.73	-1.019	-1.004*	-1.633*	-0.90	-1.511*	-1.440**	-2.389***
[0;+10]	-0.97	-1.285*	-1.240**	-1.300*	-1.32	-2.060**	-1.858***	-1.722**

With these results, hypothesis 1 (*Terrorist attacks have a significant negative effect on stock returns after an event occurred)* can be rejected, since not all events show negative reactions. A possible explanation for the contradictory reactions comes from the fact that after the 9/11 attacks, capital markets in the United States were closed for four trading days, which gave investors the opportunity to rationally digest the information (Chen & Siems, 2004). Additionally, investors might have invested in defence stocks with the idea of protection and the upcoming fight against terrorism, yielding high abnormal returns. The propensity to invest in defence stocks could have been strengthened by the speeches of former president George W. Bush on the 11^{th} and 14^{th} of September, 2001, in which he publicly announced the so-called War on Terrorism (Bush, 2008). An explanation for the relatively small and negative abnormal returns, in line with the paper of Peleg et al. (2011), is the phenomenon of 'normalisation of terror'. This concept states that terrorism has become part of daily life. Hence, it reduces the level in which stock returns are affected by terrorism. Finally, the smaller negative reactions for Boston and Orlando might point at the incorporation by markets of the possibility of future terrorist attacks, indicating that the market is more efficient than it was at the time of the 9/11 attacks.

In contrast to the CAARs in Table 5, the obtained cumulative abnormal returns are for most of the individual defence firms during the incidents in Boston and Orlando not significant on the day after the events. Therefore, no effect is observed for these individual firms. However, the cumulative average abnormal returns did show significance for these events, which indicates an effect on stocks for the industry as a whole. For the 9/11 attacks both the CARs (see Appendix B, Table 8a) and the CAARs are significantly different from zero, where the cumulative abnormal returns are significant for almost all of the individual firms in the sample. This implies an effect on the industry altogether as well as an effect on the individual firms.

5.2 Regression analysis

By means of a regression analysis, hypothesis 2 (*The size of a defence company has a significant negative effect on stock returns)* can be answered. The regression measures the impact of the factors *Size, ROA, DefRev* and *Severity.* Table 6 shows the coefficients and the corresponding t-stats executed with robust standard errors. In accordance with the results, we reject the hypothesis, so *Size* does not have a significant effect on the dependent variable CAR[0,T], and therefore, no effect on stock returns. The factor variable *Severity* is not taken into account in model 1 and 2 to test for robustness of the regression analysis. As one can see, in model 1 and model 2 S*ize* has a significant negative effect, but when *Severity* is added to the models this significance is no longer persistent. This is in contrast to the findings of Kolaric & Schiereck (2016), who found a significant negative impact of *Size* in the airline industry. However, it is consistent with the prediction made in Section 2.4, in which was stated that defence companies are diversified, implying less susceptibility to certain shocks in the market.

Table 6: Regression results.
This table shows the results of the regression: $CAR[0,T] = \alpha + \beta_1 Size + \beta_2 ROA + \beta_3 DefRev + \beta_4 S.NYC + \beta_5 S.Boston + \beta_6 S.Orlando + \varepsilon_i$. The explanatory variables are listed in the column on the left and the top row of the table shows the dependent variables. The models make use of robust standard errors. The numbers (1), (2), (3) and (4) denote the specific models. The numbers between parentheses represent the t-statistics. In regression 1 and 2 the factor variables are left out to test for robustness. For regression 3 and 4 the constant represents the factor variable *S.Orlando*. The coefficients are rounded to three decimals. The signs *, **, and *** indicate significance at the levels 0.10, 0.05 and 0.01.

	CAR[0,1] (1)	**CAR[0,2]** (2)	**CAR[0,1]** (3)	**CAR[0,2]** (4)
Size	-0.016***	-0.018***	-0.005	-0.008
	(-2.75)	(-2.83)	(-0.82)	(-1.15)
ROA	-0.204	-0.214	-0.161	-0.164
	(-0.87)	(-0.83)	(-0.82)	(-0.71)
DefRev	0.061*	0.078**	0.087***	0.104***
	(1.97)	(2.39)	(3.33)	(3.59)
S.Boston			-0.007	-0.015
			(-0.74)	(-1.36)
S.NYC			0.098***	0.089***
			(2.94)	(2.59)
Constant	0.136**	0.146**	0.004	0.023
	(2.55)	(2.45)	(0.07)	(0.36)
Number of obs.	83	83	83	83
R^2	0.1586	0.2011	0.3646	0.3704
Adj-R^2	0.1267	0.1708	0.3233	0.3295

Hypotheses 3 (*The severity of an attack has a significant positive effect on stock returns)* cannot be rejected based on the results in Table 6. The variable *S.NYC* is significant at a 0.01 level in models 3 and 4, implying that CAR[0,1] for the 9/11 attacks is 9.8% higher relative to the other attacks. Furthermore, the effect is persistent for CAR[0,2], which is 8.9% higher in case of the attacks in New York City. This is in line with the findings of Peleg et al. (2011), who also concluded that the severity of an attack has a significant impact on stock returns.

Whereas *Size* and *ROA* are not significantly different from zero and thus have no impact on stock returns, revenues from defence do have a significant impact. In model 1 *DefRev* is only significant at a 0.10 level. However, in model 2 *DefRev* is significant at a 0.05 level and in models 3 and 4 it is even significant at 0.01. Hence, the null hypothesis can be rejected and we can interpret this as an increase of 0.087% in CAR[0,1] if the defence revenues grow with 1%. The same interpretation holds for CAR[0,2]; an increase of 0.104% for each additional per cent in defence revenues. This finding is in conformity with the prediction made earlier, namely, that investors have the incentive to invest in protection against terrorism and are therefore more likely to invest in defence related stocks. Hence, the higher a firm's level of activity in the defence industry, the higher the abnormal returns.

The R^2 stands for the proportion of variance in CAR[0,T] that can be explained by the independent variables. Furthermore, the adjusted R^2 defines the proportion of variance that can be explained by only the explanatory variables which influence the dependent variable.

A change in adjusted R^2 is observed when we add *Severity* to the models. The adjusted R^2 of model 1 changes from 12.67% to 32.33%, while in model 2 it increases from 17.08% to 32.95%. This means that a large part of the explanatory power comes from the variable *Severity*.

It is important to examine whether the variance of the error term is constant for different values of the independent variables, implying homoscedasticity. The antonym of homoscedasticity is heteroscedasticity. All four models are tested for heteroscedasticity with the Breusch-Pagan test (Breusch & Pagan, 1979). The results of this test show homoscedastic errors for model 1 and 2, whereas for model 3 and 4 heteroscedasticity is observed (see Appendix C, Table 9). In this paper, robust standard errors are used to deal with the problem of heteroscedastic errors.

The error terms are also analysed by means of residual-versus-fitted plots (see Appendix C, Figures 1a and 1b). In these plots, a pattern in the error terms is observed that, indicates that the models suffer from omitted variable bias. The Ramsey RESET test, which tests for omitted variable bias, confirms this inference (see Appendix C, Table 10).

6. Conclusion

The impact of terrorist attacks on 112 different U.S. defence companies is examined for the period of 1995 to 2016, concerning four major attacks in the United States. After the first attack in the sample, the Oklahoma bombing, no significant effect is observed. This result can be ascribed to the fact that the sample is not representative for the time period in which the event occurred. In contrast, the subsequent major attacks in New York City, 2001, result in significant and extremely positive stock returns for the industry as a whole as well as for each of the firms individually. This can be explained by the tendency of investors to invest in protection, especially after an attack with such a large number of casualties.

For the Boston bombing and the Orlando shooting, a significant negative effect on stock returns is observed, but only for the industry as a whole. The large discrepancy between the negative and positive impacts of the different incidents can be explained by the concept of 'normalisation of terror'. Furthermore, diversification within the defence companies helps these firms to limit the firm-specific risk and thus possibly reduces the effects on stock returns. The findings of both positive and negative effects are in line with the paper of Chesney, Reshetar & Karaman (2011). In addition to the previous explanations, the U.S. stock market could have incorporated the possibility of future attacks since the 9/11 attacks occurred, indicating a more efficient market at the time of the subsequent incidents.

Moreover, the results show that company size and return on assets have no significant effect on defence stocks. In contrast, a firm's revenues from defence appear to have a significant positive effect. The larger the revenues from defence relative to total revenues, the higher the returns. This could also be justified by the tendency of investors to invest in protection. Furthermore, *Severity* is an important indicator for the effect of terrorist attacks on stock returns. This factor has a significant positive effect in case of the 9/11 attacks, for which the number of casualties is considerably high relative to the other attacks.

Finally, this paper is confined by its temporal scope and thus has a few caveats. First of all, the sample of defence companies is relatively small, consisting of 112 companies spread over all investigated events. In addition, only four major attacks have been studied, whereas attacks with a relatively low number of casualties are not included in the sample. More terror incidents and a larger number of firms could help us improve our inferences. Hence, our knowledge about the effects of terrorism on defence firms could be extended by means of a broader study. For example, one could study the effect of attacks in different countries on global defence companies, or other industries. Another challenge in this study comes from the fact that some firms belong for the major part to other industries. Due to time and data constraints they have not been left out in this study. However, this can be solved by including only the companies with a relatively high percentage of revenues from defence. Only a few variables are added to the regression analysis in this paper, what leads to omitted variable bias. There are other financial variables that could affect stock returns, such as market-to-book ratio or debt-to-equity ratio. Macroeconomic variables might influence the stock returns as well, but are not taken into account.

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Appendix A

Table 7a: Descriptive statistics New York 2001.
AssetsTotal and *NetIncome* are in millions $. *ROA* is calculated as *NetIncome/AssetsTotal*. DefRev is calculated as *Revenues from defence/ Total revenues*. *Size* is the logarithm of *AssetsTotal*.

	Mean	Median	Min	Max	St.Dev
AssetsTotal	9270	2100	96.7	42028	12471
NetIncome	348	51	-519	2128	659
ROA	0.04	0.04	-0.02	0.13	0.04
Defrev	0.50	0.51	0.11	0.94	0.27
Size	7.78	7.65	4.57	10.65	1.93

Table 7b: Descriptive statistics Boston 2013.
AssetsTotal and *NetIncome* are in millions $. *ROA* is calculated as *NetIncome/AssetsTotal*. DefRev is calculated as *Revenues from defence/ Total revenues*. *Size* is the logarithm of *AssetsTotal*.

	Mean	Median	Min	Max	St.Dev
AssetsTotal	37308	5767	919	685328	122384
NetIncome	1248	231	-350	13641	2656
ROA	0.04	0.05	-0.34	0.15	0.08
DefRev	0.56	0.55	0.03	0.95	0.28
Size	9.01	8.66	6.82	13.44	1.50

Table 7c: Descriptive statistics Orlando 2016
AssetsTotal and *NetIncome* are in millions $. *ROA* is calculated as *NetIncome/AssetsTotal*. DefRev is calculated as *Revenues from defence/ Total revenues*. *Size* is the logarithm of *AssetsTotal*.

	Mean	Median	Min	Max	St.Dev
AssetsTotal	31160	6024	484	492692	84144
NetIncome	905	230	-6127	7608	2194
ROA	0.05	0.05	-0.10	0.17	0.05
DefRev	0.51	0.48	0.02	1	0.29
Size	9.02	8.70	6.18	13.11	1.50

Appendix B

Table 8a: Cumulative abnormal returns, New York City.
This table shows the cumulative abnormal returns for each firm in the sample of the 9/11 attacks. The signs *, **, *** define the significance levels 0.10, 0.05 and 0.01 for the Patell test. CARs are in %.

COMPANY NAME	CAR[0,1]	CAR[0,2]	CAR[0,5]	CAR[0,10]
ALLIANT TECHSYSTEMS INC.	18.34***	16.30***	22.37***	25.57***
BOEING CO.	-17.96***	-24.87***	-28.71***	-23.06***
BTG INC.	10.74**	12.25**	23.54***	25.90**
COMPUTER SCIENCES CORP.	1.54	4.68	16.59*	5.66
CUBIC CORP.	8.18**	13.11***	12.62**	20.83***
DRS TECHNOLOGIES INC.	25.99***	27.16***	31.11***	33.74***
GENERAL DYNAMICS CORP.	10.69***	10.30***	15.81***	15.49***
HARRIS CORP.	15.30***	11.98***	20.04***	19.28***
HONEYWELL INTERNATIONAL INC.	-11.21***	-13.69***	-16.90***	-20.21***
JACOBS ENGINEERING GROUP INC.	7.69**	17.36***	8.95*	11.61*
L-3 COMMUNICATIONS HLDGS INC.	42.42***	35.53***	47.34***	44.28***
LOCKHEED MARTIN CORP.	15.51***	17.10***	13.60***	14.34**
NORTHROP GRUMMAN CORP.	18.14***	18.44***	26.48***	25.56***
OSHKOSH TRUCK CORP.	6.82*	6.95	2.88	-0.18
RAYTHEON CO.	27.71***	28.04***	37.22***	38.29***
ROCKWELL COLLINS INC.	-11.99***	-15.67***	-17.88***	-16.55**
STEWART & STEVENSON SVCS INC.	9.14**	2.69	2.26	0.63
TELEDYNE TECHNOLOGIES	22.56***	23.61***	24.30***	15.73*
TEXTRON INC.	-7.10***	-6.11***	-14.53***	-30.56***
TITAN CORP.	18.56***	25.28***	26.62***	24.69**
TRW INC.	2.72	-0.16	-6.89*	-7.25
UNITED INDUSTRIAL CORP.	15.05***	14.73***	9.75*	12.43*
UNITED TECHNOLOGIES CORP.	-23.43***	-19.57***	-27.50***	-24.34***
VIASAT INC.	3.79	10.79	33.80***	20.02

Table 8b: Cumulative abnormal returns, Boston.
This table shows the cumulative abnormal returns for each firm in the sample of the Boston bombing. The signs *, **, *** define the significance levels 0.10, 0.05 and 0.01 for the Patell test. CARs are in %.

COMPANY NAME	CAR[0,1]	CAR[0,2]	CAR[0,5]	CAR[0,10]
AAR CORP.	-3.33	-4.27	-6.19	-1.91
AECOM TECHNOLOGY CORP.	-4.19**	-4.43*	-6.47*	-9.83**
ACCENTURE PLC.	1.33	1.85*	-1.21	4.65**
ALLIANT TECHSYSTEMS INC.	-1.70	-2.58*	-3.19	-2.85
BALL CORP.	-1.29	-0.82	-1.22	-7.97***
BOEING CO.	-1.88	-1.20	-1.79	1.69
BOOZ ALLEN HAMILTON HOLDING COR.	-0.86	0.28	1.06	7.16*
CACI INTERNATIONAL INC.	0.34	0.81	1.12	2.49
COMPUTER SCIENCES CORP.	0.32	-0.71	-4.12	-4.16
CUBIC CORP.	0.28	0.52	-1.80	1.43
CURTISS WRIGHT CORP.	-2.49**	-1.97	-4.22**	-2.63
ENGILITY HLDGS INC.	-1.60	-2.11	0.19	4.44
FLUOR CORP.	-4.40***	-4.51**	-5.70**	-6.95*
GENCORP INC.	-2.23	-2.58	-3.50	-1.89
GENERAL DYNAMICS CORP.	-2.04*	-3.20**	-3.94**	4.13*
GENERAL ELECTRIC CO.	-0.41	-0.18	-7.11***	-4.91**
HARRIS CORP.	-2.93**	-3.18*	-0.90	2.39
HONEYWELL INTERNATIONAL INC.	-0.90	-1.54*	1.25	-2.15
HUNTINGTON INGALLS INDS INC.	-3.48**	-3.86**	-6.07**	-3.45
KBR INC.	-1.10	-0.80	-0.49	2.27
L-3 COMMUNICATIONS HOLDINGS INC.	0.99	-0.62	-0.16	-2.35
LOCKHEED MARTIN CORP.	-0.14	0.42	0.17	1.79
MANTECH INTERNATIONAL CORP.	-2.90	-1.53	-6.03*	-1.07
MOOG INC.	-0.47	-2.30*	-4.19**	-3.55
NORTHROP GRUMMAN CORP.	-0.27	-0.55	-0.18	3.86*
OSHKOSH CORP.	-0.75	-1.83	-3.26	-0.66
RAYTHEON CO.	-0.89	-0.88	-1.02	3.69*
ROCKWELL COLLINS INC.	-1.77*	-3.57***	-1.96	-2.14
SAIC INC.	3.34**	4.16**	3.97*	6.28**
TEXTRON INC.	-0.38	-12.02***	-11.52***	-12.87***
UNITED TECHNOLOGIES CORP.	-0.48	-0.83	-0.94	-5.61
VIASAT INC.	-3.95	-3.69	-5.81	-5.31

Table 8c: Cumulative abnormal returns, Orlando.
This table shows the cumulative abnormal returns for each firm in the sample of the Orlando shooting. The signs *, **, *** define the significance levels 0.10, 0.05 and 0.01 for the Patell test. CARs are in %.

COMPANY NAME	CAR[0,1]	CAR[0,2]	CAR[0,5]	CAR[0,10]
AAR CORP.	-1.59	-2.40	-1.75	0.42
AECOM TECHNOLOGY CORP.	-1.09	-2.25	0.22	-0.90
ACCENTURE PLC.	-0.16	0.83	0.36	-3.39
AEROJET ROCKETDYNE HOLDINGS INC.	-2.93	-2.61	-0.99	2.78
BALL CORP.	-2.31*	-2.30	-2.89	-4.34
BOEING CO.	-0.07	0.70	0.70	0.73
BOOZ ALLEN HAMILTON HOLDING CORP.	-0.55	-0.23	-1.74	-0.08
CSRA INC.	2.19	1.45	-2.00	3.36
CACI INTERNATIONAL INC.	-0.06	0.98	-0.71	-6.48
COMPUTER SCIENCES CORP.	-0.18	-0.14	-3.93	-5.64
CUBIC CORP.	0.01	-0.25	0.33	3.27
CURTISS WRIGHT CORP.	-1.86	-2.05	-2.66	-6.19*
ENGILITY HLDGS INC.	-1.93	-0.75	-0.33	1.58
FLUOR CORP NEW.	-2.64	-3.25	-2.46	-4.73
GENERAL DYNAMICS CORP.	-0.59	-0.22	-0.38	-1.11
GENERAL ELECTRIC CO.	0.26	2.47**	3.93**	2.93
HARRIS CORP.	1.03	1.70	3.14	3.82
HEWLETT PACKARD ENTERPRISE CO.	-2.55	-3.99	-0.71	-2.85
HONEYWELL INTERNATIONAL INC.	-0.18	0.25	0.54	-0.77
HUNTINGTON INGALLS INDS INC.	-1.32	-1.42	-1.37	-0.02
KBR INC.	-3.50	-5.16*	-6.78*	-6.98
L-3 COMMUNICATIONS HLDGS INC.	-0.84	-0.25	-1.86	-2.76
LEIDOS HOLDINGS INC.	0.25	0.65	-1.23	-0.82
LOCKHEED MARTIN CORP.	-0.46	0.27	-0.80	0.41
MANTECH INTERNATIONAL CORP.	2.31	1.71	0.38	3.00
MOOG INC.	-3.71	-3.03	0.23	-0.65
NORTHROP GRUMMAN CORP.	-0.72	0.13	-1.31	-1.64
ORBITAL ATK INC.	-1.60	-1.05	-1.81	-5.01
OSHKOSH CORP.	-1.51	-1.49	3.65	2.03
RAYTHEON CO.	-0.35	0.34	-0.51	0.95
ROCKWELL COLLINS INC.	-2.34*	-2.91*	-2.89	-3.73
SCIENCE APPLICATIONS INTL CORP.	4.07*	3.25	-0.03	2.29
TEXTRON INC.	-1.31	-2.16	0.05	-3.79
UNITED TECHNOLOGIES CORP.	0.25	0.33	0.36	-0.82
VECTRUS INC.	1.74	2.50	3.45	6.45
VIASAT INC.	-2.91	-2.97	-4.52	-6.36

Appendix C

Table 9: Results of the Breusch-Pagan test.
The following null hypothesis is tested: $H_0 = constant\ variance$

	Model 1	Model 2	Model 3	model 4
Chi2 test statistic	3.14	1.07	31.25	13.08
P-value	0.0763	0.3013	0.0000	0.0003

Figure 1a: Residuals-versus-fitted plot model 3

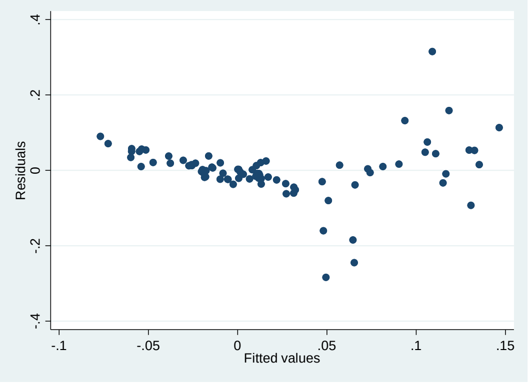

Figure 1b: Residuals-versus-fitted plot model 4

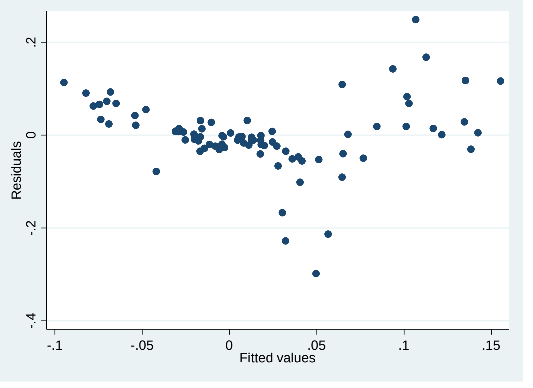

Table 10: Results of the Ramsey RESET test.
The following null hypothesis is tested: $H_0 = model\ has\ no\ omitted\ variables$

	Model 3	Model 4
F-statistic	16.77	18.87
P-value	0.0000	0.0000