

Stockholm School of Economics
Department of Finance
Bachelor Thesis
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BEHIND THE SCENES OF TERROR

A study of the drivers behind the market reaction of terrorist attacks

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18th of May 2014

Abstract

This paper investigates the underlying factors that cause negative market reaction from a terrorist attack. The data set examined includes 40 global terrorist attacks between 2000 and 2013 retrieved from the Global Terrorism Database. We find that one of the significant drivers behind the market reaction is the global reach of the event, e.g. how widely information and news about the attack is spread throughout the world. Moreover, the location of the attack proves to be a significant factor, where attacks taking place in advanced economy countries lead to higher negative returns on the stock market. On the contrary, the magnitude of the events, e.g. the fatalities of each event had no significant impact on the stock market. Plausible explanation of these results are discussed from a behavioral finance perspective, availability bias and weighing of evidence are theories that could explain these results. Furthermore the results indicate that even small scale terrorist attacks, could prove damaging for the stock market if spread virally through channels such as social media.

Keywords: Terrorism, Behavioral finance, Google search hits, Terrorist risk, Financial markets

Acknowledgements: We would like to thank our tutor Bige Kahraman, Assistant Professor at the Department of Finance at the Stockholm School of Economics (SSE), and to Micael Dahlén, Professor at the Department of Marketing and Strategy at SSE, for their invaluable input and insightful comments. Any remaining shortcomings are ours alone.

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Table of Contents

1. Introduction	1
2. Previous literature.....	3
3. Hypotheses	5
3.1 Price level effect of S&P 500 - event day	5
3.2 Price level effect of S&P 500 - post event	5
3.3 Impact from advanced economy countries.....	6
3.4 Impact from global reach	7
3.5 Impact from fatalities	9
4. Data	10
5. Method	14
5.1 Event study approach	14
5.2 Regressions.....	15
5.2.1 Regression of the advanced economy variable.....	16
5.2.2 Regression of the global reach variable.....	16
5.2.3 Regression of the fatalities variable.....	17
5.2.4 Winsorising	17
6. Results	18
6.1 Abnormal returns in the event window	18
6.2 Cumulative abnormal returns in the post event window	19
6.3 Regression advanced economy variable.....	20
6.4 Regression global reach variable.....	21
6.5 Regression fatalities variable.....	22
7. Discussion	24
7.1 Event day abnormal returns.....	24
7.2 Post event recovery	24
7.3 Impact of advanced economy countries	25
7.4 Impact of global reach.....	26
7.5 Impact of fatalities.....	27
8. Conclusion.....	28
8.1 General conclusion	28
8.2 Delimitations	29
8.3 Further research.....	29
9. References	31
10. Appendix	33

1. Introduction

On September 11th, 2001, four passenger planes were hijacked and heading for disaster. Two of the airplanes crashed into the World Trade Center complex and within two hours the 110th floor towers collapsed, another plane crashed into the Pentagon, the last plane was heading towards Washington D.C but was instead crashed in a field near Shanksville, Pennsylvania after the passengers onboard tried to overpower the perpetrators. On the following open trading day of the catastrophe the S&P 500 index fell by 5% and the stock market didn't recover to the same initial level until October 12th. The September 11th attack and the consequences for it demonstrates that investors need to be compensated for a new type of terrorist risk that investors and financial institutions are facing. Terrorism is an important geopolitical risk that has the potential to affect the global economy and financial market. In addition, there is also the impact of psychological fear of terrorism on economic behavior.

For investors, financial institutions and companies it is important to understand the magnitude of terrorist attacks in order to make an informed investment decision. Ours is not the first study of the effects of terrorism on global financial markets, but it is unique in one important dimension. While most papers research the effect terrorist attacks have on financial market, we seek to understand what some of the underlying factors are that drive this effect. Previous literature have largely focused on the consequences of the terrorist attacks, e.g. how stock markets and industries react to the events. A lot of focus have been put on large events such as the September 11th attack, understanding its consequences on both return and volatility of the market. While these research do shed further light on terrorism's role in the financial market, it does not explain why the market reacts as it does.

We look primarily at three factors that could be the underlying reasons for the negative abnormal effect on the event day. Firstly we look into the location of the attack and its effect on the stock market, we do this by studying attacks taking place in advanced economies. Secondly, we look at the global reach of the attack, e.g. how widely information and news about the attack is spread throughout the world using Google search hits as a proxy for this. Lastly, we look at the fatalities in each event and see if that could potentially explain the reaction of the market.

We put forward five hypotheses related to our topic. The first hypothesis is that terrorist attacks will have a significant negative impact on the S&P 500 index on the day of the event. Even though previous research is unequivocal in its standpoint that markets do react

negatively to terrorist attacks, a natural starting point in our analysis of terrorist events is to investigate if the sample we base our findings on does in fact show the negative effect on the stock market returns as predicted. Hypothesis number two is if there will be a reversal effect in stock prices in the days following the terrorist attack. Given the nature of the events we believe that the negative market reaction, which we anticipate on the event day, is due to overreaction rather than new available information regarding the companies in the index. Hypothesis number three is events taking place in advanced economy countries will have a larger effect on the market index compared to attacks taking place elsewhere. We believe as attacks in advanced economies are more personally relatable to investors, they will overreact compared to if the attack was taking place in a developing country. Hypothesis number four is the market impact of S&P 500 will be significantly correlated to global reach of the terrorist attack. We firmly believe in the theory of investor sentiment and that investor react to the global reach of the attack rather than the magnitude of the damage itself. The last hypothesis is there will not be any correlation or statistical significance between the number of fatalities and the S&P 500 index. We share a more behavioral finance view that investor decisions and reactions cannot always be rationally explained. As millions of people suffer each day we do not believe that the fatalities in each terrorist attack have a significant effect on the market reaction.

Our results indicate and support previous research within this field that terrorist attacks do have a significant effect on the market during the event date. Moreover, we can conclude the market experiences higher negative returns when the events take place in advanced economies. Plausible explanation for this could be the role of availability bias whereas investor overreact when news are more personal relatable. The main point of interest in our research is whether negative abnormal returns could be explained by increased global reach. We find significant results for the relationship between the variable, based on our Google search method, and returns during the event day. The results confirm our belief that investors react stronger to events that receive more attention. We could not find any evident support of the relationship between total fatalities and negative returns. This and the previous regression implies that people are more affected by the global reach of an event rather than the magnitude of the damage caused by the attack.

2. Previous literature

The literature on the relationship between terrorist attacks and the financial market are limited to an extent, however, financial and tragic human losses stemmed from terrorist attacks have interested researchers to investigate the motives and impacts of terrorism. Research has been conducted not only from an economics and finance point of view but also from a psychology and sociology perspective with the aim to understand and thus prevent future events from occurring. We have looked through the following articles and research papers in order to gain a deeper understanding in the current context of research in this area.

An article by Karolyi (2006) discusses and elaborates on what is known and more importantly, what is yet not known about the consequences of terrorism attacks on the financial markets. The paper provides a summary of the research that has been done to date (2006). Karolyi concludes that there are still plenty to learn and uncover about the effects of terrorism on financial markets. Arin, Cifferi and Spagnalo (2008) finds in their paper that there is a powerful impact from terrorism on the financial markets causing negative returns and rising volatility. This effect is further evident in Karolyi and Martell (2010) paper that reported a statistically significant negative stock price reaction around the days of the events. Furthermore, Chesney, Reshetar and Karaman (2010) conducted research on the effect of terrorism on specific industries. Similar to their report, we also use an event study approach to examine our hypotheses. Their findings show that there definitely is an impact, the airline and insurance industry is the most sensitive whereas the banking industry is the least sensitive. This result is in contrast to financial meltdowns where the banking and financial sector is usually the industry that gets affected the most. They concluded the best way for investors to diversify against terrorism risk is to invest in U.S treasury bonds followed by stocks in aero / defense and pharma / biotech industries. Chen and Wei (2005) also used an event study approach to examine the impact on U.S. market from seven terrorism and seven military attacks over the period of 1915-2001. The main conclusions of their paper is that financial markets are efficient in absorbing the shocks caused by terrorist attacks and can continue to function in an effective way despite of the events.

From a behavioral finance perspective, in terms of investor sentiment, Eldor and Melnick (2010) investigate the effect of news articles related to terrorism incidents on the Tel Aviv Stock Exchange. Their finding is that media coverage proves to be a source of the effect on the stock market. Eldor and Melnick (2004) had previously in 2004 found that suicide attacks and the number of victims in a terrorist incident creates a permanent effect on the

foreign exchange markets as well as the stock market. Drakos (2010) also looked at investor sentiment by applying a World CAPM from a sample of 22 countries, arriving at the conclusion that on the day of a terrorist attack the returns are lower.

Several studies and papers have been written about the September 11th attack alone and its impact on the financial market. This is no surprise as the September 11th attack is undeniably the largest terrorist attack to date in terms of media coverage, financial damage and property damage. Charles and Darné (2006) researched what effect the September 11th attacks in New York City had on various international stock exchanges, results showed both sizable temporary and permanent shocks. Ahmed and Farooq (2008) researched the impact of the September 11th attack on the stock market volatility. The authors studied the data of daily returns of the Karachi Stock Exchange and compared them between the pre 9/11 period and post 9/11 period. They found the level and movement of volatility changed drastically after the 9/11 attack, and concluded that this sudden change in volatility behavior could not be explained by the implementation of regulatory reforms. The Authors Carter and Simkins (2001) have a different approach and try to examine the stock returns of only airline companies and how they are affected by September 11th attack. They analyzed if the market reaction of the airline stocks on the first day of trading after the attack is same amongst each airline or if there are any differences due to firm characteristics. They found no statistical significance for firm characteristics such as leverage, size and performance. However, liquidity proved to be a deciding factor, where firms who could potentially have problems meeting their short-term obligations were penalized the most after the attack.

Our paper most closely relates to that of Eldor and Melnick (2010), we will have a more behavioral finance approach when analyzing our results. Analyzing whether the abnormal returns can be explained by investor sentiment and other variables.

3. Hypotheses

To answer our main research question, what are the main drivers of the market reaction when it comes to terrorist attacks, we have developed a set hypotheses to help us understand our main question.

3.1 Price level effect of S&P 500 - event day

As previously stated, several legitimate research have been done in the area of whether terrorism risk should be taken into account when making an investment decision. Abadie and Gardeazabal (2003) made a case study of the terrorist conflict in the Basque Country that broke out in the 1960's. Their findings imply that the conflict led to a 10 percent decrease in GDP per capita and that companies, with the main part of their business in the Basque Country, showed positive performance when the truce became credible in 1998-1999. Similar negative effects was found for the financial markets in Indonesia, Israel, Spain, Thailand, Turkey and UK following terrorist attacks, in a study by Arin, Ciferri and Spagnolo (2008). Karolyi and Martell (2006) studies the effect of terrorist attacks where public firms where targeted and found a significant negative stock price reaction of -0.83%.

Most previous research show similar results in this regard, and the conviction is that terrorist attacks in fact have significant negative impact on financial markets. However, there has been some disagreement regarding if the effect we can see is due to overreaction among investors or because of new information is revealed about the companies included in the index. Even though previous research is unequivocal in its standpoint, a natural starting point in our analysis of terrorist attacks is to investigate if the sample we base our findings on does in fact show the negative effect on the stock market returns as predicted.

Hypothesis 1: Terrorist attacks will have significant negative impact on the S&P 500 index at the date of the event.

3.2 Price level effect of S&P 500 - post event

The effect during the event day that we anticipate in hypothesis one could be explained in different ways and lead to different patterns in stock prices in the days following the event.

According to traditional finance theory such as the efficient market hypothesis, all investors act rationally and share prices reflect all available information about the company, and only new unexpected information will have effect on the current price level. If an event reveals new information regarding the companies included in the index, investors will update their beliefs according to the information available and prices will adjust to new levels. If this is the case prices will stay on that level even after the attack, unless new information is revealed.

In the field of behavioral finance we open up for that all investors are not fully rational and do not always adjust their beliefs correctly given the information available. This implies that the market value of a company can deviate from its fundamental value due to mispricing, which arise from trading by irrational investors. In the event of a terrorist attack, and if all investors are not fully rational, there can be an overreaction in the market leading to abnormal returns on the event day. This reaction can be caused by a sense of fear among investors and a following decrease in investor sentiment. If the abnormal returns, which we anticipate in hypothesis one, is due to an overreaction we can expect prices to reverse in the days after the attack, rather than staying on a constant or decreasing level.

In a study of the US and global capital markets' response to military and terrorist attacks dating back to 1915, made by Chen and Siems (2004), it is found that there is large differences in the time needed for various indexes to recover from such events. They explain the differences mainly by the strength of the banking and finance sector in the country, which can provide liquidity and minimize panic. Karolyi and Martell (2006) found that they cannot see the short-term reversal effect that they anticipated, assuming that the market reaction during the event day is due to overreaction.

However, given the finance theory and the nature of the events we believe that the negative market reaction, which we anticipate on the event day, is due to overreaction rather than new available information regarding the companies in the index. This implies that stock prices should go back to normal levels in the near future following the attack.

Hypothesis 2: *There will be a reversal effect on the S&P 500 index in the days following the terrorist attack.*

3.3 Impact from advanced economy countries

Terrorism risk has existed for many years, and there are some research on how the situation differs among different categories of countries. A paper written by Hamilton and Hamilton

(1983) show, by using stochastic models for social contagion, that countries that are less democratic, poorer and less well-educated are more likely to reverse the negative effect of terrorism than more open societies. Karolyi and Martell (2006) find, in a sample of 75 events where publicly traded firms are targeted, that attacks on firms that are domiciled in countries that are wealthier and more democratic are associated with larger negative share price reactions for that specific firm. The findings in both these papers are interesting and suggests that there is a difference in how a terrorist attack is perceived.

Contrary to these results, Eldor and Melnick (2004) find, in their study of 639 terrorist attacks in Israel, that the location of the attack does not have any significant effect on the reaction on the Israeli and foreign stock exchange. Even though this study does not analyze the difference between attacks in various countries, its results indicates that investors' reaction is not affected by the location of the attack.

In line with the first two studies, we believe that people feel that the magnitude of the event is larger and that it is more serious in its intent, taking place in a more developed country, where security levels are higher and the risk for substantial damage is larger. Moreover, we believe availability bias plays a key role in this scenario, it is a concept which describes how our perceptions of information and events may change based on our environment. Assuming the majority of the investors of S&P 500 comes from an advanced economy country, attacks taking place in these locations will have a bigger impact.

Looking at a broader index, rather than returns for a specific company, we believe that we can find similar differences in the market reaction dependent on in what type of country the event takes place.

Hypothesis 3: *The terrorist attacks taking place in advanced economy countries will have a larger effect on the S&P 500 index compared to events taking elsewhere.*

3.4 Impact from global reach

There are a lot of terrorist events taking place all over the world almost every day. According to the Country Reports on Terrorism 2013, published by the US Department of State, there was around 9700 terrorist attacks worldwide during 2013 resulting in over 17800 deaths and 32500 injured, private citizens and property being the most common target. Around 57% percent of these attacks took place in Iraq, Pakistan and Afghanistan, killing over 11800 people. The majority of these events are events that never get the attention from the broader

public, this could be due to lack of media coverage or that people do not find the news noteworthy enough to affect their every-day life, least of all their investment decisions. It is reasonable to believe that these events have low effect on returns in financial markets because of the lack of information regarding the event. Some of the events, however, gets massive media coverage at the time of the attack and people all over the world can access information about the course of events. In the middle of April there was an enormous spike in Google searches with the search term “Boston marathon bombings”, people all over the world wanted to get the latest news of the attack in one of the largest cities in USA (Google trends), S&P 500 fell 2.3% at the day of attack.

In previous research Suleman (2012) studies the effect of news of terrorism on stock returns and volatility KSE100 index, and finds that news leads to decreasing returns and increasing volatility. He also finds that the financial sector shows the strongest reactions to news compared to other sectors. Also, Melnick and Eldor (2010) studied the effect of newspaper articles on the Tel Aviv Stock Exchange. They found that media coverage was an important factor through which terrorism produces economic damage.

We are trying to measure the global reach of each specific attack in our sample of events, e.g. how widely information and news about the events are spread throughout the world. Much in line with the research made by Melnick and Eldor (2010), but trying to take a global perspective rather than limiting ourselves to the Israeli market, we want to see the effect of increased media coverage on the negative abnormal returns that we anticipate in hypothesis one. Behavioral finance and psychology theory identifies two characteristics of new evidence, the strength and weight of the message (Griffin and Tversky, 1992). Strength being the extremeness of the evidence and weight how credible or knowledgeable the evidence is. It is found that people in general have problem combining these two factors in a sufficient way in many situations. People tend to focus on the strength of the evidence, and then make some adjustment in response to its weight. High strength and low weight of evidence leads to overconfidence, as opposed to low strength and high weight, which will confuse people and create a sense of under confidence. In relation to this theory, Barberis, Shleifer and Vishny (1998), states that holding the weight of information constant, one-time strong news events should generate an overreaction, which would increase the price reaction in the stock market. The implications of this theory for our research is that it strengthens our belief that people will react stronger to how much coverage an attack gets, rather than the actual damage that the attack causes.

Given the above mentioned we believe that increasing attention and coverage for the event will increase the market reaction to the event.

Hypothesis 4: *The market impact of S&P 500 will be significantly correlated to global reach of the terrorist attack.*

3.5 Impact from fatalities

In 2013 as a result of 9 700 terrorist attacks there was a combined death and injury count of over 50 000 people, the death of an individual causes social, economic and psychological damage for the society as a whole. We share a more behavioral finance view that investor decisions and reactions cannot always be rationally explained. The fatalities from the attack might cause fear amongst investors and thus result in emotional, rather than rational investment decisions. From these views we derive the hypothesis that fatalities in terrorist attacks have an effect on investor behavior.

Hypothesis 5: *The market impact of S&P 500 will be significantly correlated to fatalities of the terrorist attack.*

4. Data

There are two different sets of data that we use. The first data set consists of daily prices of the index used to measure the effect of the terror attacks, the S&P 500. The data set is retrieved from The Center for Research in Security Prices (CRSP) and includes daily prices from January 2000 to December 2013. We compute the daily percentage returns defined as:

$$R_t = \frac{P_t}{P_{t-1}} - 1$$

Where R_t is the return on the index for period t , P_t is the price of the index at the end of period t and P_{t-1} is the closing price for the index for the previous period.

The second data set includes information of our selected terrorist attacks. The data is retrieved from the Global Terrorism Database, which includes more than 125 000 cases around the world from 1970 to 2013. Each of the events in the data set has information regarding date of the attack, country, perpetrator, nature of the target and number of people killed or injured in the attack. The terrorist attacks that we have included must fulfill the following criteria from the Global Terrorism Database in order to qualify as a “terrorist attack”:

- The act must be aimed at attaining a political, religious, economic or social goal.
- There must be evidence of an intention to coerce, intimidate, or convey some other message to a larger audience (or audiences) than the immediate victims.
- The action must be outside the context of legitimate warfare activities, i.e. the act must be outside the parameters permitted by international humanitarian law (particularly the admonition against deliberately targeting civilians or non-combatants).

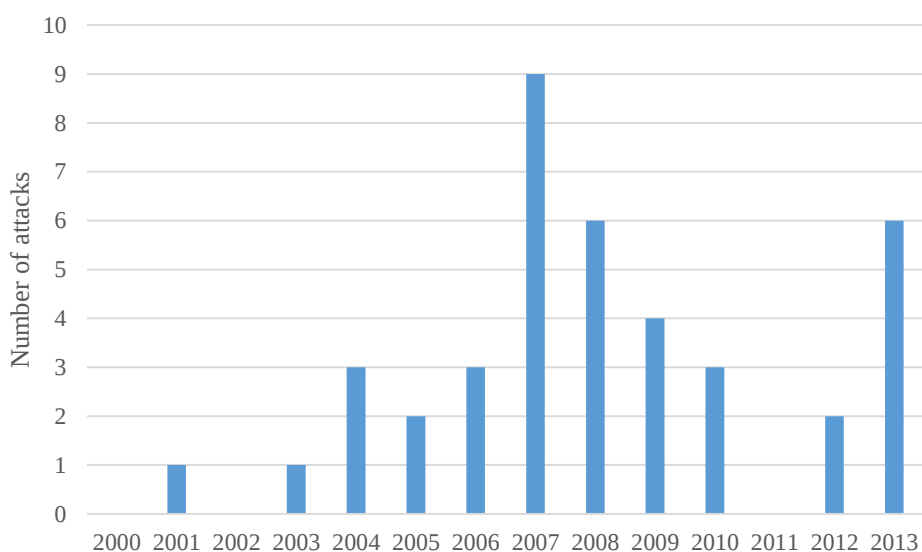
We have also excluded all ambiguous cases and terrorist events that are considered unsuccessful. Out of our sample we have then selected the top 100 events globally ranging from 2000-2013 that has had the highest number of total fatalities. Out of these 100 we want to include the top 40 events that have the highest level of global reach, which can be assumed to have had the largest impact on people over the world. We have used average Google search

hits from three consistent search phrases as a proxy for this. The following search methods have been used:

- Name of the attack, retrieved from Wikipedia - for example “The September 11th attack”
- Date and city of the attack - for example “September 11 2001 New York City”
- Date city of the attack + The Guardian - for example “September 11 2001 New York City The Guardian”

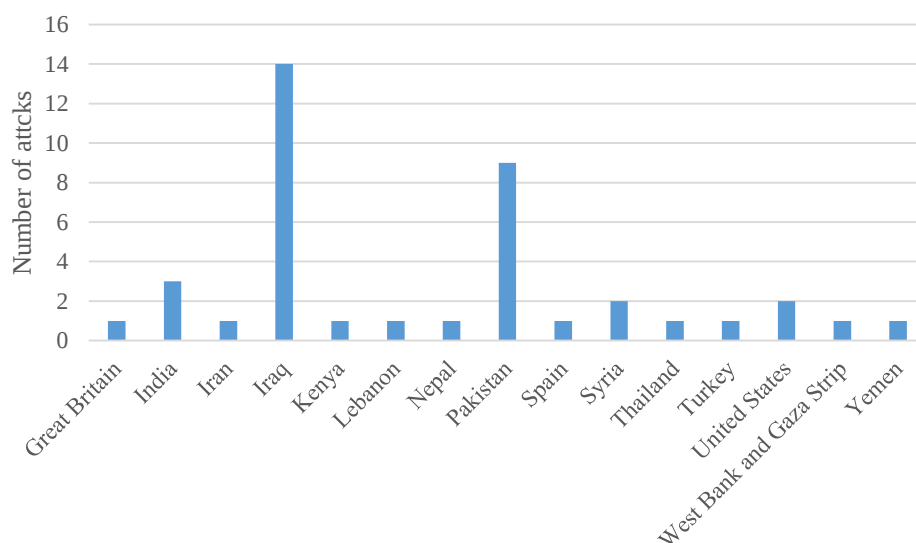
Out of all the potential newspaper magazine we chose The Guardian because it has the largest global audience of any UK quality newspaper website (Comscore, December 2012).

Figure 1: Yearly distribution



Note: Number of terrorist attacks per year for the events in our sample. Sample period: 2000-2013

Figure 2: Geographical distribution



Note: Number of terrorist attacks per country represented in our sample. Sample period: 2000-2013

Our data is unique, in relation to previous papers (see papers by Karolyi and Martell (2010), Melnick and Eldor (2010), Arin, Ciferri and Spagnolo (2008), Chen and Siems (2003), and Eldor and Melnick (2004)), since we are the first that we know of that make use of the extensive archives provided by the Global Terrorism Database. Also, we are not limiting ourselves to studying the effect in a specific country, but rather taking a global perspective, including attacks that take place worldwide and using more recent events, dating up to December 2013. Since we want to capture the true market reaction to the events that we choose, we are observing the effect on the S&P 500 index, which is a broad index and frequently referred to as a close proxy to the market portfolio. In addition to this, our method of choosing events aims to capture those events that have affected most people over the world, without manually and subjectively picking events that we find interesting.

While we find the applied method serving its purpose, we realize that many events with large impact are not included in our sample. One reason for this could be low total number of fatalities, falling out of the first 100 events picked, based on that number. As an example the attacks by Anders Breivik in Norway 2011 had extensive global reach according to the Google search hits method but did not qualify for our sample due to a too low number of fatalities.

Also, a general problem with using Google search hits is that it is highly dependent on the search phrase that we use. Some of our searches get unexpectedly lot of hits if the

event coincides with other big news or is too general per se. We try to limit this effect by applying the same rule for search phrases for all events and deciding phrases that captures the news of the event accurately. Also, the use of average hits should limit the effect of extreme values.

Another problem with this method that should be considered is that more recent events probably will get more search hits than earlier events. This is because the number of search hits tends to decline over time as the subject becomes less relevant as well as the maturity of internet has evolved over time.

5. Method

In this part the methods to answer our research questions are presented. Initially, we describe the event study approach used to estimate the effect on the financial markets from the events in our sample. Thereafter, we present the regression models used to try to explain the reasons behind the reaction in the financial markets.

5.1 Event study approach

To measure the impact of the selected events we have chosen to apply the event-study methodology (Brown and Warner, 1984). This methodology is based on the efficient market hypothesis, which in turn states that all stock prices should adjust and reflect new information that has become available. With this methodology we test the hypothesis we have regarding the abnormality of market's return due to the unexpected information in form of a terrorist attack. We compute abnormal returns on the index using a mean-adjusted return approach. This approach assumes computation of the event-day abnormal return on the index in the following way:

$$AR_t = R_t - \bar{R}$$

Where AR_t is the abnormal return at the event day and R_t is the return on the index at the date of the attack. For the events where we could not find the return during the specific event date, we used the return for the following trading day, these are events that took place on a weekend, on a holiday or on another day when the market was closed down (such as the September 11 attacks). $\bar{R}$ is the mean return on the index during the estimation window. This return is calculated during a period of 30 trading days prior to the event of the terrorist attack and is used to estimate the normal average return for the S&P 500 index:

$$\bar{R} = \frac{1}{30} \sum_{t=-1}^{t=-30} R_t$$

We also estimate the performance of the index for 10 days, or two weeks of trading, in the post-event window to investigate if we can see any reversals in stock prices after the event:

$$CAR_t = \sum_{j=1}^{j=10} AR_j$$

In the post-event window we calculate the cumulative abnormal return rather than the average return over the period. Cumulative abnormal return is a better measure to capture the magnitude of the impact on the stock market following the event compared to the abnormal return. Strong negative cumulative abnormal returns during the post-event window would mean that the event has large impact on stock prices. While if we can see positive cumulative abnormal returns in the post-event window would mean that prices bounce back quickly and that the shock in returns during the event day was more of a short term effect. Figure 3 gives an overview of the chosen timeline.

Figure 3: Timeline for comparison

Estimation window	Event day	Post-event day
$T_{-30}-T_{-1}$	T_0	T_1-T_{10}

A common concern with the event study is that the event of interest is usually not unexpected news. The news of an IPO or merger tend to leak out prior to the time of the actual event reducing the reaction when the official news comes out. However, the unanticipated nature of a terrorist attack makes it unlikely that our analysis will suffer from problems of partial anticipation that sometimes plague event studies.

5.2 Regressions

As a next step in our research we are trying to explain the negative abnormal returns that occur during the event day. We do that by running regressions with three explanatory

variables constructed on the basis of the events in our sample. The first variable separates the sample into two groups based on the country in which the event took place, the second captures the global reach of the event and the third counts the total number of killed and injured in the attack.

5.2.1 Regression of the advanced economy variable

To answer hypothesis three we are using a dummy variable separating our sample of terrorist attacks into two groups based on the country the event took place. The separation is made into advanced economy countries and other countries. The group of advanced economy countries are based on the term used by the International Monetary Fund to describe developed countries, introduced in 2010 and includes 34 countries, most of them in Europe. A country is considered an advanced economy if it has high gross domestic product per capita, high degree of industrialization and a high standard of living (World Economic Outlook, 2015).

In our sample we have 4 events that took place in an advanced economy and 36 in other countries. The dummy variable takes the value 1 for advanced economies and the value 0 for all other countries. We use the following specification as our first regression:

$$AR_i = \alpha_i + \beta_1 * Advanced\ economy\ dummy_i + \varepsilon_i$$

Where AR_i is the abnormal return during the event day for event i and the Advanced economy dummy specifies which kind of country the event took place in. The regression is performed with robust standard errors to control for heteroscedasticity.

5.2.2 Regression of the global reach variable

In next step to try to explain abnormal returns during the event day and to answer hypothesis four we have constructed a global reach variable. This variable is based on the average Google search hits that we used to choose the attacks in our data set; higher number of average search hits implies greater global reach. An event with a high global reach is assumed to have had larger impact on people around the world, and potentially larger impact on the financial markets. The variable is regressed on abnormal returns during the event day according to the following formula:

$$AR_i = \alpha_i + \beta_1 * Global\ reach_i + \varepsilon_i$$

Where AR_i is the abnormal return during the event day for event i and *Global reach* measures the reach of event i . The regression is performed with robust standard errors to control for heteroscedasticity.

5.2.3 Regression of the fatalities variable

In the last step we introduce a third independent variable, fatalities, which varies with the total number of people killed and injured for each event that is included in our data set. This number is based on the data received from the Global Terrorism Database. The variable is regressed on abnormal returns on the event day to investigate if the number of fatalities in an event has significant effect on people's behavior and the reaction in the market.

$$AR_i = \alpha_i + \beta_1 * Fatalities_i + \varepsilon_i$$

Where AR_i is the abnormal return during the event day for event i and *Fatalities* is the total number of people killed or injured in event i . The regression is performed with robust standard errors to control for heteroscedasticity.

5.2.4 Winsorising

After having plotted scatter diagrams of the explanatory variables we can conclude that both the fatalities variable and the global reach variable have extreme values. One reason for this is due to the problem regarding high number of Google search hits explained in the data section, even though we are using a method to minimize the effect of extreme values. Also, the high number of total fatalities in the September 11 attack affects the fatalities variable.

In order to handle these outliers, we have used the method called winsorising. In other words, we have replaced the values exceeding the percentile 95-value with the percentile 95-value and the values that fall below the percentile 5-value with the percentile 5-value.

6. Results

In this part we outline our empirical results. Section 6.1 and 6.2 examines the effect on financial markets from terrorist events, both on the event date and in the post event window. Based on our findings, sections 6.3 through 6.5 try to explain what factors that contribute to increasing negative effect in the financial markets.

6.1 Abnormal returns in the event window

We begin by examining the ground pillar in our research, if the terrorist events in our sample have significant effect on financial markets.

Table 1: Descriptive statistics for estimation window mean return, event window return and abnormal return

	Estimation window mean return	Event window return	Abnormal return
Negative return	16	28	29
Positive return	24	12	11
Max	0.3944%	3.7130%	3.8517%
Mean	0.0005%	-0.4616%	-0.4622%
Median	0.0264%	-0.4084%	-0.4984%
Min	-0.6039%	-4.9216%	-4.5980%
Std. Dev	0.0018	0.0154	0.0157
Observations	40	40	40

Table 1 show descriptive statistics for the mean return in the estimation window, the event window return and abnormal return for the events in our sample. The table suggests that 24 of 40 observations have positive market returns in the estimation period while only 12 of 40 have positive returns at the time of the terrorist event. This results in negative abnormal returns for 29 of 40 events with an average of -0.46%.

Table 2: Results from t-test of abnormal return

Variable	Abnormal return
Constant	-0.0046* (0.0025)
Observations	40
* p < 0.1. ** p < 0.05. *** p < 0.01. Standard errors in parentheses.	

The table above describes the negative effect on the financial markets from all 40 events in our sample. We find that negative abnormal returns are -0.46% at a 10% significance level.

6.2 Cumulative abnormal returns in the post event window

As a next step we want to look into the magnitude of the effect of terrorist attacks on the financial markets. Cumulative abnormal return is calculated for a 10 days period for each event in our sample.

Table 3: Descriptive statistics for the post event window

	Cumulative abnormal return 10 days after event day
Negative return	15
Positive return	25
Max	7.76%
Mean	0.72%
Median	1.02%
Min	-12.46%
Std. Dev	0.0362
Observations	40

Table 3 shows descriptive statistics for cumulative abnormal returns in the post event window. 25 of the events show positive cumulative abnormal returns 10 days after the event, although, 15 of the events have negative cumulative abnormal returns, the mean is positive. When running a regression on cumulative returns for all events in our sample we get the following results:

Table 4: Results from t-test of cumulative abnormal returns in the post event window

Variable	Post event CAR
Constant	0.0072 (0.0057)
Observations	40
* p < 0.1. ** p < 0.05. *** p < 0.01. Standard errors in parentheses.	

The regression table displays that the constant is positive and indicates the right tendency that the market recovers during the days after the attack. However, the results are not significant on any level.

6.3 Regression advanced economy variable

In the first part of our event study we concluded that abnormal returns as a results of terrorist events are negative. In this section and the following sections we are going to try to find some factors, specific for each event, which can contribute to explain why returns drop at the time of the event. The first variable is the advanced economy dummy variable. This variable divides the events in our sample into two groups, based on the definition by the International Monetary Fund, and takes the value 1 for advanced economies and the value 0 for other countries. Table 5 shows descriptive statistics for the two groups.

Table 5: Descriptive statistics for group of countries

	Advanced economy	Other	Total
Max	0.24%	3.85%	3.85%
Mean	-2.07%	-0.28%	-0.46%
Min	-4.60%	-3.82%	-4.60%
Observations	4	36	40

The majority of the attacks took place in other countries other than advanced economies and we can see that both groups have negative average abnormal return in the event window. Abnormal returns over all seem to be lower for the advanced economy group; both the maximum and minimum return recorded is lower than for the group of other

countries, as well as a lower average. When the variable is regressed on abnormal returns for all events we get the following results:

Table 6: Advanced economy regression

Variable	(1) Abnormal return
Advanced economy	-0.0179* (0.0093)
Constant	-0.0028 (0.0024)
Observations	40
R-squared	0.12

* p < 0.1. ** p < 0.05. *** p < 0.01. Standard errors in parentheses.

From the results we conclude that the advanced economy dummy variable has effect on the negative returns during the event day, significant at a 10% level. Table 6 shows that the return is 1.79% lower for events that take place in an advanced economy than in the group of other countries.

6.4 Regression global reach variable

In a next step to try to explain the negative abnormal market returns during the day of the terrorist attack that we have identified, we have constructed a variable to measure the global reach of each specific event. The variable is based on the results from our Google search hits method and is winsorised at 5% level to exclude outliers. Table 7 shows descriptive statistics of the variable.

Table 7: Descriptive statistics global reach variable

	Global reach
Max	59 133 333
Mean	3 844 138
Median	869 834
Min	380 050
Std. Dev	10 480 440
Observations	40

Table 8 shows the results from the regression of the global reach variable on abnormal returns on the event date.

Table 8: Global reach regression

Variable	(1) Abnormal return
Global reach	-8.68e-10*** (2.82e-10)
Constant	-0.0019 (0.0024)
Observations	40
R-squared	0.159

* p < 0.1. ** p < 0.05. *** p < 0.01. Standard errors in parentheses.

The results show that the variable is significant and that a higher level of global reach of the event contributes to lower returns during the event day.

6.5 Regression fatalities variable

The last step to try to explain negative abnormal returns is by running a regression with the fatalities variable, which is constructed by the total number of people killed or injured in the event. The variable is winsorised at 5% level to exclude outliers. Table 9 shows descriptive statistics of the variable.

Table 9: Descriptive statistics fatalities variable

	Fatalities
Max	1382
Mean	361
Median	270
Min	213
Std. Dev	230
Observations	40

When running the regression we get the results shown in table 10.

Table 10: Fatalities regression

Variable	(1) Abnormal return
Fatalities	-2.38e-05 (1.52e-05)
Constant	0.0037 (0.0060)
Observations	40
R-squared	0.075
* $p < 0.1$. ** $p < 0.05$. *** $p < 0.01$. Standard errors in parentheses.	

The results in the table display that abnormal returns decrease with increasing number of fatalities, the results are not significant on any level.

7. Discussion

7.1 Event day abnormal returns

From the results we can conclude that terrorist attacks have significant negative impact on a broad market index, which is consistent with our first hypothesis, it is also in line with the results in previous research based on various data samples, which concludes that in fact terrorism has significant impact on stock prices. While our results are substantial, they are only one fourth of the size of the impact documented by Karolyi and Martell (2006) for events where publicly traded firms were the direct target of the attack.

The effect that we see in our sample can depend on various factors, we can divide it into direct and indirect costs of a terrorist event (Johnston and Nedelescu, 2005). In some cases, such as the September 11 attack or the London bombings in 2005, the event had large direct costs and damaged substantial physical assets. Also, a company or industry can be the direct target of the attack, suffering substantial losses leading to decreasing stock prices in the market.

Along with the direct costs, there are also indirect costs that affect the financial system. Normally the indirect costs of terrorism are significantly larger than the direct costs, examples of indirect costs are change in investors' consumption and investment behavior on a short-term horizon. While both type of costs contribute to the negative reaction on the market, it is the indirect cost that is the primary factor for a market downturn.

In either case there is a significant short-term terrorism risk that affects the market, a risk that can be substantial in more extreme cases like the September 11 attack when the NYSE and NASDAQ remained closed for six consecutive days following the attack.

7.2 Post event recovery

In the previous section we found out that terrorist attacks in fact have significant effect on financial market, question still stands if it is a long lasting effect or is it a temporary mispricing due to fear?

We could not find any significant results that indicate whether abnormal returns continue to be negative or bounce back in the days following the attack. This is quite puzzling and not in line with the effect we anticipated in hypothesis two. The regression displays that the constant is positive and indicates a right tendency that the market recovers during the days

after the attack following the negative return shock from the terrorist attack. However, lack of significance in our results implies that we cannot draw any conclusions regarding if the negative returns on the event day occur as a consequence of overreaction among investors, or if new information have led change in fundamentals. Karolyi and Martell (2006) came across the same problem in their study of market returns following terrorist attacks, they find no significant returns in the post event window and concluded that there is no short-term reversal of the reaction as one would expect.

7.3 Impact of advanced economy countries

From the results of the first regression we can conclude that the market reaction is stronger for events that take place in advanced economy countries, which indicates that our dummy variable contributes to explain what factors lead to increasing negative returns. A plausible explanation for this might be that these attacks tend to have larger economic damage. The attacks in New York, Madrid and London all suffered substantial losses of physical assets. In addition the September 11 attack was directed towards the center of the financial industry, creating massive chaos and a weeklong closedown of the US market.

Stronger market reactions can also depend on stronger influence on investor sentiment, the mood of market participants. The attack of an advanced economy may create a greater sense of fear, leading to a flight from risk by sentiment, or irrational investors. This greater sense of fear, can be explained by the role of availability bias. Availability bias is a concept which describes how our perceptions of information and events may change based on our environment. As individuals, our reasoning and action are strongly influenced by what we deem as personally relevant, dramatic and recent. Hence, investors might overreact, as the attacks in advanced economy countries are more relatable to their own environment.

Even though the sample of events in advanced economy countries are quite small, the results are in line with previous research made by Karolyi and Martell (2006), who concludes that the impact of terrorist attacks differs according to the country in which the incident occurred. More exactly attacks in countries that are wealthier and more democratic are associated with larger negative share price reactions.

7.4 Impact of global reach

From the regression of our global reach variable we can conclude that the results are significant. From this we can conclude that a high level of global reach leads to a higher negative return, in absolute terms, on the event day. This finding is thought-provoking from several aspects, one plausible interpretation is that investors react and are affected more to what they are being exposed of rather than the actual magnitude of the events. This reaction could be further explained by studying the theory of the strength and weight of new information (Griffin and Tversky, 1992). Holding the weight of information constant, strong one-time news events should generate an overreaction, which would increase the price reaction in the stock market. If we assume that an event with higher reach, according to our variable, has higher strength of the message brought forward, and that people have problems in combining these two factors in a sufficient way, then high reach will lead to overconfidence in beliefs among investors. Overconfident investors will overestimate their ability to assess the damage from a terrorist attack and whether it is time to exit the market. A large number of overconfident investors with negative beliefs in the market will lead to increasing negative returns on the event day.

Our findings are in line with the results concluded by Melnick and Eldor (2010) in their paper. The economic damage caused by a terrorist attack increases with the amount of media coverage, or in our case, the global reach measured through Google search hits.

Lastly, what we can derive from our conclusions and that of related papers is that the magnitude of terrorist attacks aren't the deciding factor for how the stock market will react, but rather the positioning and coverage of the event. This finding is valuable and insightful, as it implies if the goal of the terrorist attack is to disturb the stock market, rather than purely focusing on the magnitude of the attack, more focus should be put on making sure the event have a high reach level. In the previous era where traditional media was the only way for investors to receive information, it would make sense to spread terror by creating big headlines from large scale terrorist attacks. This is no longer the case as we live in a new era of technology with an ever increasing social media presence. Thus terrorist could potentially use social media such as Twitter and Facebook as a weapon of terror. A prime example of this phenomenon would be the recent cruel beheadings by Islamic State of Iraq and Syria, even though the victims of these beheadings were few, video recordings and news of the events spread virally in social media.

7.5 Impact of fatalities

In the last of our regressions, of the fatalities variable, we could not find any significant results whether total number of killed and injured in the attack have any effect on the market reaction during the event day. This effect is not in line with what we anticipated in hypothesis five and our belief that the damage of the event, measured in people killed and injured in the attack rather than economic damage, has impact on negative abnormal returns and investor behavior.

These results indicates that it is not what truly happened in the event, or the magnitude of the damage, that has the largest impact on market returns. Even if hundreds of people die in an attack, if the news of the event does not reach the public there will not be a large reaction in the market.

8. Conclusion

8.1 General conclusion

In this paper we aim to study the market reaction to terrorist attacks, both at the time of the event and in the following days. As a second part we want to contribute to the existing literature on the subject by introducing three factors that possibly could explain the magnitude of the market reaction. In particular we study the effect on returns during the event day if the event takes place in an advanced economy country, has a higher level of global reach or higher amount of fatalities. To do this we use a unique data set, based on a consistent Google search hits method.

The results that we receive support what is found in most previous research on the subject, that terrorist attacks, in fact, have significant negative impact on returns in the financial markets at the event date. The effect that we see is not as large as what is found by previous authors such as Karolyi and Martell (2006), but still a substantial effect on a broad index from events taking place worldwide. Unfortunately we cannot find any support in our sample regarding returns in the post event window. The lack of results make it difficult to draw conclusions whether the downturn during the event day is due to an overreaction among investors or if the attack updates expectations about fundamentals that lead to lasting price changes.

In our attempt to explain negative returns during the event day we start out by dividing the events into two groups depending on the country in which the attack took place. We find support for our belief that negative returns are higher for events that take place in advanced economy countries. Plausible reasons for this could be larger economic damage and damage of physical assets, but also higher impact on investor sentiment and a sense of fear among investors.

The main point of interest in our research is whether negative abnormal returns could be explained by increased global reach, or news coverage, of the event. We find significant results for the relationship between the variable, based on our Google search method, and returns during the event day. The results confirm our belief that investors react stronger on events that get more attention.

In a last step we measure the actual damage of the attack in total number of killed and injured. The results we receive do not support any relationship between total fatalities and

negative returns. This and the previous regression implies that people are more affected by the global reach of an event rather than the magnitude of the damage caused by the attack.

Looking back to our main question, what are the main drivers of the market reaction when it comes to terrorist attacks, we find that the country that the event takes place in and the global reach of the event drive returns, while total number of fatalities does not.

8.2 Delimitations

Our main deficiency is that we use a rather small sample for our research. While the data sample that we use is diverse, with events taking place all over the world, we believe that our conclusions could have been more general using a significantly larger sample. This, in particular, might have been an issue in the results regarding the impact on negative abnormal returns from events taking place in an advanced economy country. Dividing our sample into two groups we get a low number of observations in the advanced economy group, which we base our results on.

Moreover, deficiencies in our method of choosing events may affect the results that we receive. Firstly, using Google search hits as a method may be problematic since average search hits lies at the ground of the global reach variable, which we use as a proxy for the impact of the event worldwide. When studying the descriptive statistics for the global reach variable we can see that the standard deviation is very high and that the mean and the median are quite different. This indicates that we have some extreme values and, even though we are winsorising our data to limit the effect of outliers, these values might have impact on our results. Secondly, despite Google being the most globally used search engine, we realise that its user base is primarily from western countries as it is for example banned in China. This probably have had an effect on the results making them slightly biased towards western countries, this could also explain why the attacks taking place in advanced economy countries have generated a higher level of search hits.

8.3 Further research

For future research we suggest further investigation of the relationship between negative returns during the event day and the actual damage of the attack. This could be done by measuring the economic damage of assets, rather than fatalities in our study, and observe if

this can explain the market reaction. In addition to this, further research within the context of global reach would be beneficial. For example one could look at smaller scale terrorist events such as the recent ISIS beheadings, which despite its small magnitude have received a lot of engagement through social media and other media channels. This could be interesting to look into further to conclude global reach indeed significantly impacts market returns. This would also prove to be interesting to use other metrics instead of Google search hits, such as Facebook likes or Twitter retweets as proxies for global reach.

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10. Appendix

Table A: List of terrorist attacks (1/2)

Date	Country	City	Average Google search hits	Fatalities	Name	Advanced economy
2001-09-11	United States	New York City	59133 333	1382	September 11 attacks	1
2003-11-20	Turkey	Istanbul	1063 333	240	2003 Istanbul bombings	0
2004-03-02	Iraq	Baghdad	2934 433	225	2004 Ashura bombings in Iraq	0
2004-03-11	Spain	Madrid	723 333	523	2004 madrid train bombings	1
2004-03-21	Nepal	Bedi	950 000	734	N/A	0
2005-07-07	Great Britain	London	14684 333	367	7 July 2005 London bombings	1
2005-09-14	Iraq	Baghdad	616 667	702	14 September 2005 Baghdad bombings	0
2006-03-12	Iraq	Baghdad	654 333	312	N/A	0
2006-07-12	India	Mumbai	3769 333	1004	2006 Mumbai train bombings	0
2006-11-23	Iraq	Baghdad	495 000	459	23 November 2006 Sadr City bombings	0
2007-01-22	Iraq	Baghdad	622 000	248	22 January 2007 Baghdad bombings	0
2007-02-03	Iraq	Baghdad	745 667	366	February 3. 2007 Baghdad market bombing	0
2007-02-03	West Bank and Gaza Strip	Gaza City	595 667	217	N/A	0
2007-03-16	Iraq	Albu Issa	412 000	252	N/A	0
2007-04-18	Iraq	Baghdad	692 667	275	18 April 2007 Baghdad bombings	0
2007-04-28	Iraq	Karbala	1237 000	247	Imam Abbas Mosque bombing	0
2007-06-19	Iraq	Baghdad	655 500	279	2007 al-Khilani Mosque bombing	0
2007-07-04	Pakistan	Islamabad	355 233	214	Siege of Lal Masjid	0
2007-10-18	Pakistan	Karachi	500 000	391	2007 Karachi bombing	0
2008-02-01	Iraq	Baghdad	887 667	220	1 February 2008 Baghdad bombings	0
2008-03-11	Pakistan	Lahore	4099 000	227	2008 Lahore bombings	0
2008-04-12	Iran	Shiraz	3186 333	212	2008 Shiraz explosion	0

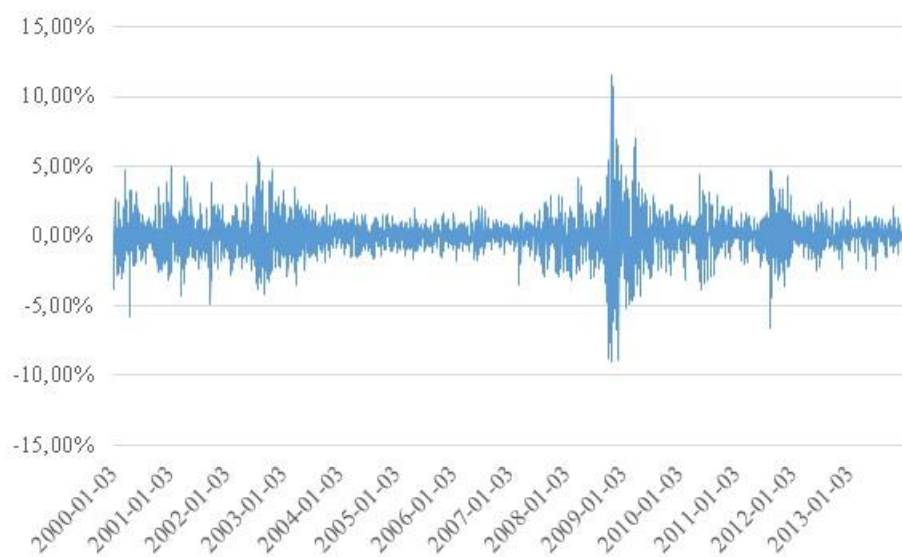
Note: *Average Google search hits* is the results from our Google search method. *Fatalities* is the total number of killed and injured in each terrorist attack, retrieved from the Global Terrorism Database. Names denoted as *N/A* are for events where we could not find an official name. Events that took place in an *advanced economy* are denoted with 1 and other countries with 0.

Table B: List of terrorist attacks (2/2)

Date	Country	City	Average Google search hits	Fatalities	Name	Advanced economy
2008-07-28	Iraq	Kirkuk	1058 333	210	N/A	0
2008-09-20	Pakistan	Islamabad	449 133	261	Islamabad Marriott Hotel bombing	0
2008-10-30	India	Assam	1709 667	272	2008 Assam bombings	0
2009-03-27	Pakistan	Jamrud	3893 633	215	2009 Jamrud mosque bombing	0
2009-05-27	Pakistan	Lahore	647 000	230	May 2009 Lahore bombing	0
2009-08-19	Iraq	Baghdad	654 667	654	19 August 2009 Baghdad bombings	0
2009-10-25	Iraq	Baghdad	708 000	436	25 October 2009 Baghdad bombings	0
2010-05-28	India	Midnapore	3912 133	255	Jnaneswari Express train derailment	0
2010-07-01	Pakistan	Lahore	1340 667	219	July 2010 Lahore bombings	0
2010-09-01	Pakistan	Lahore	852 000	240	September 2010 Lahore bombings	0
2012-03-31	Thailand	Hat Yai	366 000	414	2012 Southern Thailand bombings	0
2012-05-10	Syria	Damascus	1473 333	427	10 May 2012 Damascus bombings	0
2013-02-21	Syria	Damascus	1122 333	263	February 2013 Damascus bombings	0
2013-04-15	United states	Boston	50296 667	267	Boston marathon bombings	1
2013-08-15	Lebanon	Beirut	2210 000	330	August 2013 Beirut bombing	0
2013-09-21	Kenya	Nairobi	974 667	273	Westgate shopping mall attack	0
2013-09-22	Pakistan	Peshawar	394 100	218	September 2013 Peshawar bombings	0
2013-12-05	Yemen	Sanaa	457 667	283	2013 Sana'a attack	0

Note: *Average Google search hits* is the results from our Google search method. *Fatalities* is the total number of killed and injured in each terrorist attack, retrieved from the Global Terrorism Database. Names denoted as *N/A* are for events where we could not find an official name. Events that took place in an *advanced economy* are denoted with 1 and other countries with 0.

Figure A: Daily returns S&P 500



Note: The figure displays daily returns on the S&P 500 over time, from January 3rd 2000 to December 31st 2013.