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TITLE:

Terrorism and the Norwegian stock market

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Terrorism and the Norwegian stock market

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1 Contents

1.1 Figure list

1.2 Table list

Acknowledgements

This paper is our final step towards our master's degree in business administration at University of Stavanger, Norway. Through our master thesis we have gotten the opportunity to use the economic models and theories we have learned during these two years, as well as given us an insight into a topic we consider to be societal and incredibly exciting.

We would like to give a special thanks to our supervisor Kristoffer Wigestrand Eriksen for all the help and motivation provided in writing our thesis "*Terrorism and the Norwegian stock market".* This would not be possible without your help.

"One of the funny things about the stock market is that every time on person buys, another sells, and both think they are astute."

- William Feather

Abstract

Terrorism has increased drastically and have almost become a part of our everyday life; how does this affect the Norwegian stock market? In 1970 there was 651 registered terrorism attacks worldwide, in 2016 this number had increased to 13 488. With more and more terrorism attacks, have our reactions changed?

In this paper we examine the effects of eleven terrorism attacks from 2001 to 2017 on Oslo Stock exchange. We used event study, a dataset containing all large terrorism attacks this millennium and a dataset with historical stock market data.

The results from our study indicates that terrorism affects OSE in a negative matter. Seven of eleven attacks have negative abnormal return the day after the attack. Eight of eleven attacks have significant cumulative abnormal return 0 to 5 days and 0 to 10 days after the attack.

Our study finds a relationship between how many killed and injured in the attack and reaction in the stock market, indicating that bigger attacks causes bigger reaction.

2 Introduction

In the recent decades we have seen a dramatic increase in the number of terrorism attacks worldwide. From 651 registered attacks in 1970 to 13488 in 2016, which implies an increase of almost 2 118 % (GTD, 2017). As the number of attacks grow, it becomes increasingly important to clarify how terrorism affects both nationally and globally. Not only through life lost, but also economic consequences.

In 2004 the UN Security Council and the District General defined terrorism in the paper Resolution 1566 (2004) as:
"Criminal acts, including against civilians, with the intent to cause death or serious bodily injury, or taking of hostages, with the purpose to provoke a state of terror in the general public or in a group of persons or particular persons, intimidate a population or compel a government or an offence within the scope of and as defined in the international conventions and protocols relating to terrorism are under no circumstances justifiable by considerations of a political, philosophical, ideological, racial, ethnic, religious or other similar nature."

Terrorist organizations try to affect the economy by causing fear which undermines the investor confidence and reduces their motivations to spend instead of save (Johnston & Nedelescu, 2006). From 1970 to 2016 terrorist attacks has killed 383 554 people worldwide. If we compare the rate of terrorism in Western Europe in 1970 to 2016 we find an increase of 449 % in the number of attacks, and 205 % in people killed. Which on average yield a 14 % yearly increase (GTD, 2017).

Stock markets are highly influenced by investors assumptions about the future. Today global capital markets are closely linked, which makes news spread faster than ever before with major spillover effects between the markets (Chittedi, 2015).

Every country in the world is trying to protect itself from the effects of terrorism in any way possible. Terrorism does not only affect a nation through loss of human life, and capital spent to prevent it, but also through changed opinions about the future. There has been a large growth in research on terrorism attacks and stock market reactions the last decade, but non-of the research includes the Norwegian stock market.

As terrorism has become a bigger part of our everyday life, we find it crucial to investigate if the investor behavior changes in the days surrounding a terrorist attack happening in Norway, or other OECD countries. Previous research, which will be presented in the Previous Empirical Research part of chapter 4, has shown significant deviation from the expected stock market path in the day of, and the days after a terrorist attack in the stock markets under investigation. The global economy is closely linked together, so how does this affect Norway?

2.1 Purpose

The purpose of our study is to identify and explain if, and in what way, terrorism attacks affect stock market movement and investors behavior on Oslo Stock Exchange (OSE).

2.2 Motivation

Terrorism is one of our times biggest challenges. As explained in the introduction we have had a major increase in the number of terrorist attacks and news coverage associated with the attach over the last decades. An attack does not only affect us through loss of human capital and structural damages, it also aims to create fear and change people's expectations regarding their, and our collective future. Which further, hypothetically, affects investor behavior and stock market returns. We want to investigate if a terrorist attack in fact does change the investor behavior and cause abnormal stock market returns on OSE, and try to explain why it does, or doesn't.

Several studies have been conducted to reveal linkage between terrorism attacks and stock market movement in different countries. Since the number of attacks close to our home, Norway, has increased dramatically, we find it both community relevant and interesting to investigate if we can find a linkage between terrorism attacks and abnormal behavior on OSE. Our findings can also help the Norwegian Government and Private Corporations be better prepared for the economic consequences of future attacks through increased adaptability on their economic incentives, and an improved response.

2.3 Research Question

The main objective in this study is to examine if terrorism affect the Norwegian stock market.

A suitable research question is therefor:

Does terrorism affect Oslo Stock Exchange?

2.4 Methodology

To answer our research question, we use the constant mean return approach from event study methodology. Almost all research done to investigate abnormal stock market return for one or several events is done by using the event study approach. We have not found a more precise or efficient way to solve our research question, we will therefore stick with it. The reason we are using the constant mean return method is because we are investigating the Norwegian stock market as a whole, and therefor don't have the opportunity to compare a couple of selected securities to the rest of the market as in the market model.

In event studies one calculates normal return of a security, which is the return without the event, and the abnormal return caused by the event. In our case the event is an unexpected terrorism attack. We will by comparing normal and abnormal stock market returns try to calculate and explain the impact terrorism attacks has on the Norwegian stock market.

To test the robustness and decrease the probability of committing a type 1 or type 2 error we are preforming a t-test.

2.5 Structure/Outline

The first part contains the introduction chapter. Where we present the purpose of and motivation behind the thesis, and our research question. Followed by a short summary of the selected methodology.

Further we give a detailed demonstration of the thought process behind the events selected, and a short summary of Oslo Stock Exchange. This, before going through the theoretical background, and methodology used. A more detailed presentation of each event individually is given in the following "Historical Retrospect" chapter.

In the last part we go through the analysis done, and the results we got. Before finishing with a discussion and conclusion based on how our research question are explained through the findings.

3 Background and Categorization

All information about terrorism attacks in this chapter is collected from the Global Terrorism Database created by University of Maryland (GTD,2017). Which is a database containing all terrorism attacks from 1970 to 2016.

In the period between 1970 and 2016 (unfortunately, the Global Terrorism Database does not include data from 2017 and 2018), 170 350 terrorist attacks accrued worldwide. 383 554 people were killed, and another 496 117 injured. From the first documented year the attack frequency has increased dramatically with only 651 registered attacks in 1970, and a total of 13 488 in 2016 (historical data is represented in figure 1). The year with highest exposure was 2014 with 16 860 registered terrorism attacks.

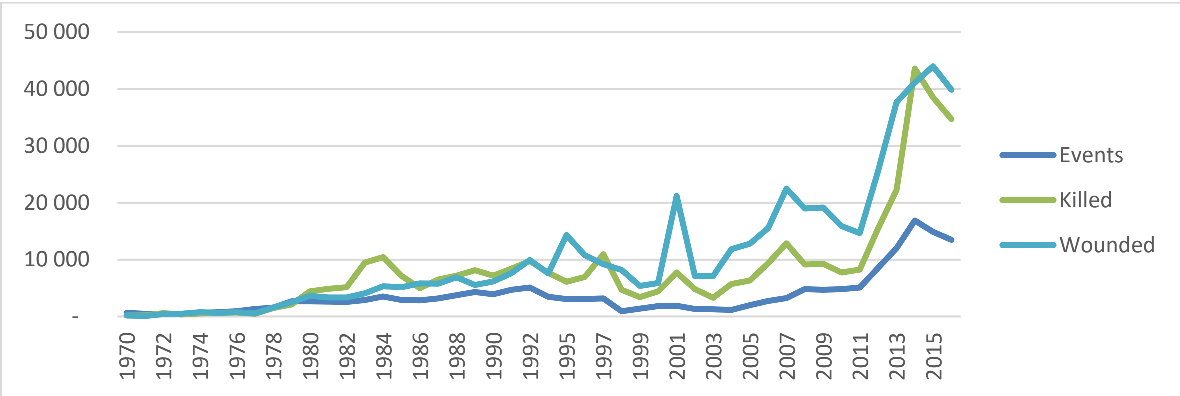

Figure 1: Historic Terrorism Data 1970-2015

3.1 Event Criteria

Since the attack frequency is high, and our timeframe limited, we had to do several limitations to decide which attacks to include in our study.

First, we decided to only include attacks happening in the 21th century. This because we expect a significant change in the stock market reaction to terrorism attacks throughout the decades. Not just because information is much more available today then earlier, but also because we think that the large increase in attack-ratio, and news coverage has changed people's reaction significantly. Though, this is an interesting subject, it's not the one we are investigating.

Between 2000 and 2016 a total of 100 586 terrorist attacks killed 243 210 and injured 360 452 people, with a drastic increase in attack frequency and the number of fatalities from 2011 and forward as shown in Figure 2.

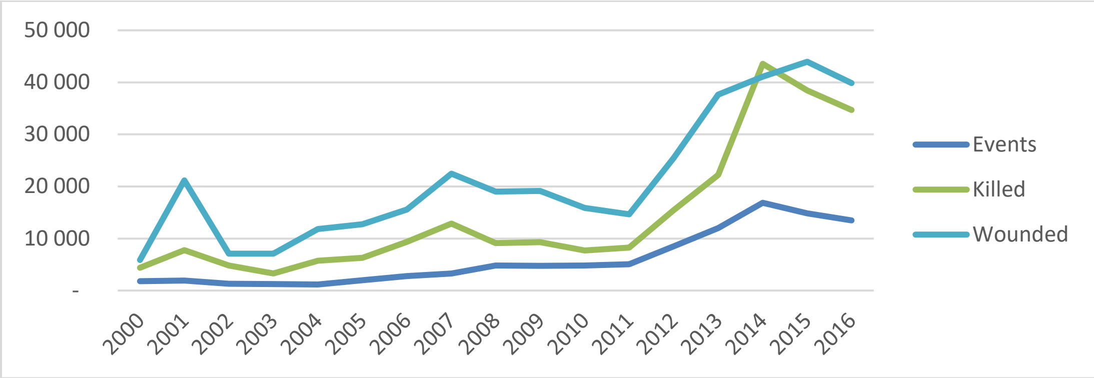

Figure 2: Historic Terrorism Data 2000-2016

To prevent inclusion of small, irrelevant attacks we put restraint on the minimum number of casualties. This to secure an adequate level of news coverage, and influence. We concluded that the adequate level would be satisfied when the event had more than 50 casualties (dead + injured), where minimum 2 had to be killed. In two cases, the restraint has been disregarded due to the event happening close to Norway, and as a result of that made an adequate level of influence.

Our study is focusing on how events are affecting OSE, we therefor decided to only include events happening in countries similar to Norway, and/or with a large impact on the Norwegian economy. This made us only include events happening in countries who is a part of the Organization for Economic Co-operation and Development (from now on called OECD). OECD is an organization working too promote economic cooperation, growth and stabilization in its member countries, and the global economy (Develpoment, 2018). A list of the OECD countries is shown in table 1. Be aware that some of the OECD countries are excluded from our research due to low similarity and/or no terrorism attacks. We started by eliminating countries not in Europe or US.

AUSTRALIA	FINLAND	ITALY	NORWAY	TURKEY
AUSTRIA	FRANCE	JAPAN	POLAND	UNITED KINGDOM
BELGIUM	GERMANY	KOREA	PORTUGAL	UNITED STATES
CANADA	GREECE	LATVIA	SLOVAK REPUBLIC	
CHILE	HUNGARY	LUXEMBOURG	SLOVENIA	
CZECH REPUBLIC	ICELAND	MEXICO	SPAIN	
DENMARK	IRELAND	NETHERLANDS	SWEDEN	
ESTONIA	ISRAEL	NEW ZEALAND	SWITZERLAND	

Table 1: List of OECD countries

Considering a major part of our study is to investigate the effect on the event day, and the days following, we only selected events taking place on trading days on OSE. This because we expect a considerable difference in the instant reaction, and the reaction we would get a few days after the attack. But also, to check for any effect earlier on the day of the attack.

As mentioned above some of the attacks fitting our criteria were excluded from our study. One of the attacks we decided to exclude was the West event in US in 2013. That was done because the main goal of the attack was to hurt a specific company, and not the economy as a whole. West Fertilizer Plant, which was the target, is also operating in an industry with little or no influence on OSE. We also excluded a plane crash in the Mediterranean Sea in Greece in 2016 due to the fact that it`s still unsure if terrorists were involved. Technicians found some explosives but has not been able to conclude if it was an accident or not. No terrorism organization has claimed responsibility.

Two events are included even though they don’t meet all our criteria. The first one is in Munich 2016. The event fails to meet our minimum casualties’ criteria but is included because it happened in a country with strong linkage to Norway and the Norwegian economy. The second event included happened in Stockholm in 2017, which also fail to meet our minimum casualties` criteria. Its included because Sweden is one of our neighboring countries therefor got a lot of news coverage and a lot of spillover effects to Norway.

Final events

LOCATION	DATE	TARGET	ORGANIZATION	CASUALTIES (INJURED)
NEW YORK, US	11.09.2001 Tuesday	Government, Business, Airport and Aircraft, Private Citizens and Property	Al-Qaida	2 781 (14 861)
MADRID, SPAIN	11.03.2004 Thursday	Transportation	Abu Hafs al-Masri Brigade	191 (1800)
LONDON, UK	07.07.2005 Thursday	Transportation	Secret Organization of Al-Qaida in Europe	56 (784)
UTØYA, NORWAY	22.07.2011 Friday	Government, Private Citizens and Property	Right-wing extremist	77 (75)
BOSTON, US	15.04.2013 Monday	Private Citizens and Property	Muslim extremists	3 (264)
PARIS, FRANCE	13.11.2015 Friday	Business, Private Citizens and Property	Islamic State of Iraq and the Levant	123 (416)
NICE, FRANCE	14.07.2016 Thursday	Private Citizens and Property	Jihadi-inspired extremists	87 (433)
MUNICH, GERMANY	22.07.2016 Friday	Private Citizens and Property	Right-wing extremists	10 (27)
BERLIN, GERMANY	19.12.2016 Monday	Private Citizens and Property	Jihad-inspired extremists	12 (48)
STOCKHOLM, SWEDEN	07.04.2017 Friday	Private Citizens and Property	Jihad-inspired extremists	5 (14)
MANCHESTER, UK	22.05.2017 Monday	Private Citizens and Property	Islamic State of Iraq and the Levant	22 (116)

Table 2: Final events selected to our study

3.2 Oslo Stock Exchange

The chapter contains a general explanation of Oslo Stock Exchange and the OBX Index which provides the stock market data used in our analysis. At the end you will get a comparison between OSE and three major stock markets.

General info

On the 8th of September 1818 King Car Johan signed the first Stock Exchange Act in Norwegian history, and OSE opened its first offices in April the following year. At the time, the main activity on the exchange was currency trading and the purchase and sale of bills of exchange. It did not become a commodity exchange until the start of the next year and started listing financial instruments on a limited scale in 1881. At that time, railway shares accounted for the major part of the listed securities (O. n. Staff, 2018c)

Today OSE`s has a unique position for companies operating in the energy, shipping and seafood sectors, and it its objective is to be the central marketplace for listing and trading of financial instruments in the Norwegian market and Norway`s only regulated marketplace for trading in stock, equity and other securities like derivatives and bonds. Divided into the five different marketplaces Oslo Børs, Oslo Axess, Merkur Market, Nordic ABM and Oslo Connect (O. n. Staff, 2018c).

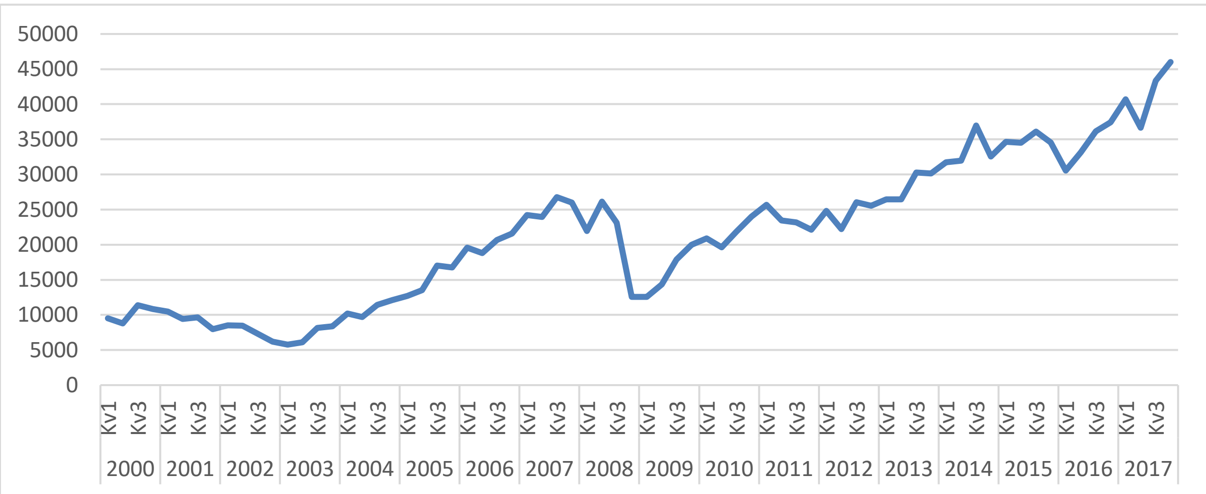

Figure 3: Development on OSE from 2000-2017

Since late year 2003 we have experienced steady growth on the stock market except for the financial crises in 2008 (as shown in figure 3). This has made OSE an attractive site for both domestic and foreign investors.

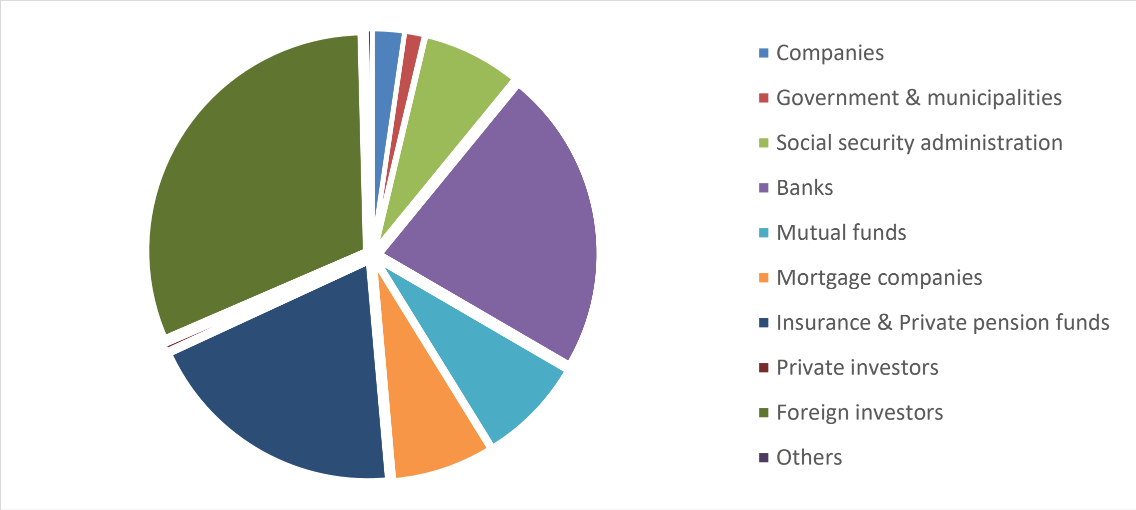

Figure 4: Ownership structure on OSE 2016

As we can see from Figure 4 the tree largest influencers on OSE in 2016 was foreign investors, Banks and private pension fonds (in that order). Private investors was the smallest participants with a total share of only 0,4% (O. n. Staff, 2016). The ownership structure indicates that OSE is controlled by large organizations with investments interests in several different countries. This is also supported by the fact that Morgan Stanley and Merrill Lynch owned about 25 % of the total market in April 2018 (Skarsård, 2018).

OBX Total Return Index

The OBX Index is a tradeable part of OSE containing the 25 most liquid firm based of six months of sales. Its dividend adjusted, revised and capped on a half-year basis according to UCITS III. Between the revision dates the number of shares for each member is held if not something extraordinary comes up(O. n. Staff, 2018a).

Comparison

	OSE	LSE	DAX	NYSE
GENERAL INFO	Norways only market for trading and listig of financial instrimetns (O. n. Staff, 2018b)	World leading market for trading and admission of debt, equity and other securities (l. c. Staff, 2018)	One of the most traded index derivatives globally containing 30 of the largest and most liquid German companies (d.-i. c. Staff, 2018)	The largest stock market in the world when measured by market capitalization (i. c. Staff, 2018)
GOAL	Be the central marketplace for listing and trading of financial instruments in the Norwegian market (O. n. Staff, 2018b)	Provide attractive, efficient and well-regulated markets for companies, investors and intermediaries, such as stockbrokers (l. c. Staff, 2018)	Operate as an efficient, transparent and secure financial markets (d.-i. c. Staff, 2018)	Help companies acquire capital to raise the world (i. c. Staff, 2018).
LARGEST SECTORS	Energy, Shipping and Seafood (O. n. Staff, 2018b)	Mining, Banking and General Industrial (l. c. Staff, 2018)	Automobile, Pharma & Healthcare, Chemicals and Insurance	Energy, Agriculture & Metals and Finance (d.-i. c. Staff, 2018)
INSTITUTIONAL INVESTORS	68,5 % (O. n. Staff, 2016)	82 % (l. c. Staff, 2017)	52% (b. d. Staff, 2015)	39% (Adinolfi, 2016)
PRIVATE INVESTORS	0,4 % (O. n. Staff, 2016)	8 % (l. c. Staff, 2017)	11% (b. d. Staff, 2015)	41% (Adinolfi, 2016)
FOREIGN INVESTORS	31,1 % (O. n. Staff, 2016)	10 % (l. c. Staff, 2017)	37% (b. d. Staff, 2015)	20% (Adinolfi, 2016)

Table 3: Comparison of OSE, LSE, DAX and NYSE.

In Table 3 we present a comparison between OSE and three other major stock markets (LSE, DAX and NYSE). The table show a lot of differences between OSE and the other three stock markets. The other three are global, world leading stock markets while OSE is operating in a much smaller scale. It’s also a big difference in which industrial sectors has the largest market share in the different markets. OSE`s leading industries are for example shipping, energy and seafood while the DAX index in Germany is led by companies operating in the automobile, pharma & healthcare industries.

The only notable similarity between the stock markets is that the largest investor group on OSE, LSE and DAX are institutional investors, while the largest group on NYSE is private investors. Private investors are the smallest group in all the other three stock markets. The foreign investor group are in all cases the middle group.

4 Theory

In this chapter we will go through some of the theory used in our study. Starting with the efficient market hypothesis (from now on called EMH), then behavioral finance before some criticism of both theories, ending with an overview of previous research.

4.1 Efficient Market Hypothesis

Capital markets is defined as efficient if security prices fully and correctly reflects all relevant information (Malkiel, 1989). Security prices will only change when new information is available. New information and price changes is unpredictable, resulting in security prices following a random walk. The random walk makes predicting market movements impossible, so no investor can beat the market consistently on a risk-adjusted basis. This is reasoned by the three basic assumptions: 1. The investor is rational, 2. If the investor is irrational, they behave randomly and cancel each other out without affecting the price, and 3. If the investors are systematically irrational arbitragers are eliminating their influence on price (Fama, 1970). The logic of the random walk idea is that if the flow of information is unimpeded and information is immediately reflected in stock prices, tomorrow's price change will only reflect tomorrows news, and be independent from price changes today. Thus, neither technical analysis (study of past stock prices to predict future prices) or fundamental analysis (analysis of financial information such as company earnings and asset values to select undervalued stock) would enable investors to achieve returns greater than those obtained by holding a randomly selected portfolio of individual stocks with comparable risk. (Malkiel, 2003)

Eugene Fama (1970) splits market efficiency into three different subsets (weak, semi-strong and strong form):

1. Weak-form efficiency:

Weak-form efficiency assumes that future prices not can be predicted by analyzing historic ones. Which implies that excess returns not can be earned in the long run by using investment strategies based on historical share prices or other historical data. This because share prices exhibit no patterns in asset prices, and future prices are only dependent upon information not contained in the price series, since prices must follow a random walk. EMH does not require that prices remain at or near equilibrium, only that market participants not are systematically able to profit from market inefficiencies. However, while EMH predicts that all price movement is random, many studies have shown a marked tendency for the stock markets to trend over time periods of weeks or longer (Saad, Prokhorov, & Wunsch, 1998).

2. Semi-strong-form efficiency:

Assumes that no excess returns can be earned by trading on publicly known information because share prices adjust rapidly and unbiased. The fast and unbiased price adjustment makes it impossible to reliably produce excess returns with fundamental or technical analysis techniques (Ackert & Deaves, 2009).

3. Strong-form efficiency

Both private and public information are reflected in share prices, so no excess returns can be made. Strong- form efficiency can only occur in markets where legal barriers to private information becoming public, and trading laws are universally ignored (Ackert & Deaves, 2009).

The EMH assumption that security price always reflects all available information, and only a change if the available information changes has made event studies a significant financial research methodology. Due to the fact that the event study methodology estimates the financial impact of an event with the help of price fluctuations in the event period (Bodie, 2009).

4.2 Behavioral Finance

A major part of our research involves explaining potential abnormalities in the stock market return surrounding our selected terrorism attacks based on how the market reacts to new information. Unlike the traditional EMH does behavioral finance try to explain market inefficiencies with human psychological theories and suggests that investors decision-making is highly influenced by psychological and emotional factors. Which can cause investors to deviate from rational behavior. This is supported by findings done by F.R. Birau in the article Behavioral Finance Paradigm And Its Implications On Investment Decisions from 2011 where she finds strong linkage between the primary human feelings and interference on stock market decision making. In our case the most relevant feelings are fear, panic and anxiety as they can be experienced in connection with a terrorist attack.

In the article “What Is Fear” written by Alex Niles in 2014 he defines fear as an emotional response induced by a perceived threat, that causes a change in brain and organ function, as well as in behavior. If an investor feels fear, panic and/or anxiety it may, as explained above, cause errors in his/her financial decision-making. It may, for example, cause a risk averse behavior leading the investor away from investing in the stock market, to selling. As a higher investor share move from the demand to the support side the stock market experiences a drop-in price and a downwards trend.

According to behavioral finance investors misinterpret information with the basis of the following three theories:

1. Irrational Behavior
   Irrational behavior is experienced when investors asses the available information about as stock inaccurate, and because of that takes an irrational investment decision. This can for example happen if investors connect to much importance to recent news (Goedhart, Koller, & Wessels, 2005).

2. Systematic Patterns of Behavior
   The share price of a company does not reflect the company`s actual value because a large part of the investor group shares an irrational behavior pattern. This can be patterns of overconfidence, overreaction and overrepresentation(Goedhart et al., 2005).

3. Limits to Arbitrage in Financial Markets
   Limits to arbitrage in financial markets are experienced when a large part of the investors interpret a resent strong performance as a sign of strong future performance and starts driving up a company`s stock price. This, because some investors expect that a company who surprise the market in one quarter also will do it in the next. If not enough other investors notice this myopic overpricing and respond by taking short position, the share price will not reflect the company`s real value (Goedhart et al., 2005).

4.3 Criticism

It’s been written a lot of critics against EMH and behavioral finance. We will now present some of it.

The base assumption for EMH is that the market can process new information in a way that fully reflects the stock price. This requires investors process new information in a better way than everybody else which sounds totally irrational (Yen & Lee, 2008).

In his article Inefficient markets: An introduction to behavioral finance from 2000 Andrei Sheifer questions the strength of the three basic efficient market assumptions and concludes that they may be much weaker than generally assumed. He also states that research show that investors are not Bayesian. Which means that their judgments and decisions are systematically influenced by how a problem is framed (a Bayesian investor is always critical and objective to new information and changes the future view as new information comes). Sheifer also gives evidence indicating that individuals behave systematically, and that arbitrage is limited in real-world situations undercutting a basic EMH assumption.

In 1998 Eugene Fama writes the article Market Efficiency, long-term returns, and behavior finance in defense of the EMH arguing the market efficiency defense against all critics by showing that underreactions are as common as overreactions to new information, and that pre-event abnormal returns are as frequent as post-event reversal. Therefor evening out all abnormalities in the long run.

Burton G. Malkiel does also come to the defense of an efficient market in his article The efficient market hypothesis and its critics from 2003 stating that the anomalies patterns not are robust and dependable in different periods of the sample. Some of the patterns could even only reflect better proxies of risk measuring and self-destruct in the future as many of the patterns already have done.

There has been found a lot of evidence against the assumption of an efficient market and EMH, but it’s still the preferred method when doing an event study. This is due to the fact that an efficient market is used as the base when calculating abnormal returns and return deviations. But it is important to take necessary reservations as the market not necessarily is efficient (Yen & Lee, 2008).

In case of behavioral finance does Xue Zhang, Hauke Fuehres and Peter A. Gloor In the article Predicting Stock Market Indicators Through Twitter “I hope it is not as bad as I fear” from 2011 compare peoples feature view through data collected on Twitter with stock market performance of the Dow Jones Index the following day. They discovered that on days with a lot of emotions (people expressed a lot of hope, fear and/or worry) the Dow Jones Index goes down the following day. On days with less emotion, the index goes up the next day.

Another explanation is that individuals are projection bias, which means that individuals assume that their tastes or preferences will remain the same over time. The individual will therefor often over or underestimate the real news value. When a projection bias individual gets bad news, it will not fully foresee the negative interpretation of future information, which causes a tendency towards continuation of drop in price(Loewenstein, O'Donoghue, & Rabin, 2003).

4.4 Previous Empirical Research

In this chapter we will first present a table with a summary of previous empirical research, and then discuss who our research compliments it.

ARTICLE	GOAL	METHODOLOGY	RESULT/RELEVANT FINDINGS
THE EFFECTS OF TERRORISM ON GLOBAL CAPITAL MARKETS CHEN & SIEMS (2004)	Investigate if historical terrorism and military attacks are associated with a statistically significant negative abnormal return in the U.S. capital markets. Are resent attacks negative in global markets, and can the banking/financial sector help minimize the crises?	Event study done after the excess returns approach with event window t = -30 to t = -11	U.S. capital markets are more resilient and better to absorb shocks than earlier. Which partly can be explained by a banking/financial sector promotes market stability and squelch panic. 9/11: NYSE: AR -4.55%, CAR6: – 7.72%, CAR11: -3.98% (AR and CAR6 significant) DAX: AR -7.61%, CAR6 -7.78%, CAR11 -10.64% (AR and CAR6 significant) LSE: AR -5.29%, CAR6 -4.77%, CAR11 -9.04% (All significant)
THE IMPACT OF TERRORISM ON FINANCIAL MARKETS JOHNSTON & NEDELESCU (2006)	Draw lessons for effective policy and regulatory responses to protect financial systems in the face of terrorism attacks	Presents data on reaction of financial markets to the terrorist attacks, describes authorities' crisis management responses and analysis their effectiveness	Diversified, liquid, and sound financial markets were efficient in absorbing the shocks of the financial markets to the 11 September attack in New York and 11 March 2004 attack in Madrid
THE PRICE OF TERROR: THE EFFECTS OF TERRORISM ON STOCK MARKET RETURNS AND VOLATILITY	Investigate if financial markets show that terrorism has significant impact on both stock markets and the stock market volatility, and the magnitude of these effects are larger in emerging markets.	VAR-GARCH (1,1)-in-mean model	Finds statistically significant causality effects, both in mean and in variance, in all six countries under examination

ARIN, CIFERRI & SPAGNOLO (2008)			
STOCK RETURNS AND VOLATILITY FOLLOWING THE SEPTEMBER 11 ATTACKS: EVIDENCE FROM 53 EQUITY MARKETS NIKKIEN, OMRAN, SAHLSTROM & AIJO (2008)	September 11 attacks matter, and why not?	GARCH (1,1) model and Mann-Whitney test	The impact of the attacks resulted in significant increases in volatility across regions and over the study period
THE IMPACT OF TERRORIST ATTACKS ON INTERNATIONAL STOCK MARKETS BROUNEN & DERWALL(2010)	Does terrorism attacks affect the stock market more than other unanticipated disasters?	Event-study	Attacks produce mildly negative price effects. The September 11th attack where the only one that caused long/term effects on financial markets. 3/11/04 Madrid: U.S: AR -4,4 %, CAR6 2%, CAR11 -5% U.K: AR -4,9%, CAR6 -4,6%, CAR11 -4,3% DAX: AR -5%, CAR6 -5,9%, CAR11 -6,2% 6/7/05 London: U.S: AR 1%, CAR6 3,3%, CAR11 3,3% UK: AR -2%, CAR6 1%, CAR11 0,9%
TERRORISM AND THE STOCK MARKET KAROLYI & MARTELL(2010)	Examines the stock price impact from 75 different terrorism attacks between 1995 and 2002	Event-study	Statistically significant negative stock price reaction of -0.83%. Attacks on firms in more democratic countries had bigger negative impact.
TERRORISM AND CAPITAL MARKETS: THE EFFECTS OF THE MADRID AND LONDON BOMB ATTACKS KOLLIAS, PAPADAMOU & STAGINNIS (2011)	Investigate the effects of the terrorism incidents in Madrid 2004 and London 2005	Event-study and GARCH family models with event window t = -30 to t = -11	Widespread negative abnormal return in the Spanish market after Madrid, but not in London after the attack in 2005. The English market also rebound quicker. 3/11/02 Madrid: AR -2.10%, CAR6 -5.10%, CAR11 -4.41% (all insignificant) 6/7/05 London: AR -1.49%, CAR6 -0.84%, CAR11 -1.27 (all insignificant)
STOCK MARKETS AND TERRORIST ATTACKS: COMPARATIVE EVIDENCE FROM A LARGE AND A SMALL CAPITALIZATION MARKET	Does a market's reaction to terrorism change through time? Dies market size and maturity determine reactions? Does reactions depend upon either the type of targets or the perpetrators of the attack?	Event-study and a GARCH (1,1) model	Attacks weighted by the number of fatalities and injuries affect significantly stock market volatility Small capitalization markets are more sensitive to terrorism attacks in which prominent businesspersons are the victims.

KOLLIAS, MANOU, PAPADAMOU & STAGIANNIS (2011)			
HOW DIFFERENT TERRORIST ATTACKS AFFECT STOCK MARKETS ASLAM & KANG (2015)	How does different terrorism attacks affect the Pakestanian KSE-100 index	Event study	Stock market reaction increases with number of people killed, and stock markets contains information about future attacks
TERROR ATTACKS AND STOCK-MARKET FLUCTUATIONS: EVIDENCE BASED ON A NONPARAMETRIC CAUSALITY-IN-QUANTILES TEST FOR THE G7 COUNTRIES BALCIAR, GUPTA, PIERDZIOCH & WOHAR(2016)	How does terrorism attacks effect stock-market fluctuations in the G7 countries	Nonparametric causality-in-quantiles test	Attacks often have significant effects on return, and only significant effect on volatility for Japan and the UK. Attacks mainly affect the tails of the conditional distribution of stock-market returns. No significant cross border effects.
TERRORISM, MILITARISM, AND STOCK RETURNS JEFFREY, CHRISTIAN & JOEL (2016)	Examines the effect of 28 terrorism and military events on stock returns	Event-study	Lower returns for industries predicted to be most hurt. High impact events are followed by significantly lower returns. Market worse on day of terror, and opposite the day after. Lower returns following events inside the USA or where the USA was the prime target.
TERRORISM AND STOCK MARKET LINKAGES: AN EMPIRICAL STUDY FROM A FRONT-LINE STATE ARIF & SULEMAN (2017)	Investigate the impact of prolonged terrorism activities on stock prices of different sectors listed in the KSE-100 index.	Terrorism impact factor index	Significantly negative effect. Stock market fluctuations are efficient and promptly reflects the terror effect. Different industries react differently to terrorism attacks.

Table 4: Previous research overview. AR is representing Event-day AR, CAR6 is representing 6-day CAR, and CAR11 are representing 11-day CAR

Previous research suggests a strong linkage between terrorism attacks and abnormal stock market returns both on the event day and for the days following. If we look at table 4 its shown that negative abnormal return is accumulated on the stock markets in U.K., U.S., Germany and Spain for the 11.09.01 attack in New York, 11.03.02 attack in Madrid and 07.06.05 attack in London. If we look at the cumulative abnormal return 6 days after the attacks the 9/11 attack caused a decrease of 4% on the DAX Index, and a decrease of 7% in the U.S., and U.K. In case of the Madrid attack a negative abnormal return of almost 5% on U.S., U.K. and DAX Index. The only positive cumulative abnormal return associated with the attack is found after 6 days in U.S. For the London attack all returns are actually positive except AR on the event day in the U.K. It’s also found evidence that indicates that Western markets are better than other markets at absorbing shocks when the attack is done against civilians, but display a stronger negative reaction when attacks are done against companies. It’s also shown that different industries react differently to the events. A study done on the KSI 100 index does even suggest that stock markets can predict future events.

Research done in a number of different stock markets does also find correlation between the number of causalities, stock market reaction and volatility. When the number of causalities increase, so does the negative reaction and the volatility.

All previous research is mainly done in either countries with a lot of international influence like U.S., U.K., Spain, Germany or in countries with a high intensity of terrorism attacks like Pakistan. The main difference between our research and the once presented above is that we are conducting it on a much smaller, protected stock market. Norway is perceived as a much safer country, located in a quieter place than those previously investigated. So, our findings can help reveal if there is a different between stock market reactions in countries with a higher probability if a terrorist attacks accruing, and countries with a lower probability. It`s also interesting to investigate if OSE`s unique company composition makes it react differently to the others.

5 Event studies

In this chapter we will present the methodology, event studies, used in this study. MacKinlay (1997) have been the primary source of information in this chapter.

As stated in the chapter about EMH in an efficient market security prices reflect fully all available information. Given an efficient and rational market will security prices reflect the effect of an event immediately. Therefore, one can use event studies to measure the impact of a specific event on the value of a firm or on the stock market using financial data. Event studies can be used by observing security prices over a relatively short time period to measure the impact of an event (MacKinlay, 1997).

A common model used for event studies is the framework made by A. Craig MacKinlay (1997). From his framework we have illustrated a step by step model for conducting event studies. This model is first illustrated by a list, and then we will go further into each step of the model.

1. Define the event of interest and the event window.
2. Determine the selection criteria
3. Define estimation window
4. Measure normal return
5. Define null hypothesis
6. Measure abnormal return
7. Testing the hypothesis

1. Define the event of interest and the event window

Defining the event of interest is self-explaining, you need to define the event you want to study before you start studying it. There are many events that might have an impact on the stock market, it might be an earnings announcement, a PR disaster or a terrorist attack.

An event window is the timeframe of the event one wants to study. It is important to choose the correct length of the event window. A too short event window will no capture the entire impact of the event, while a too long event window might include other events. If the event is a terrorist attack the event window will start with the day of the attack (day 0). It might be expanded to several days, where it is common to include the day of the attack and the day(s) after. (MacKinlay, 1997)

2. Determine the selection criteria

To determine which firms to include in the study one need to determine the selection criteria. This might be firms from a specific industry, country or size. When determine the selection criteria it is important to consider data availability. (MacKinlay, 1997)

3. Define the estimation window

Before deciding on which model to use for measuring normal and abnormal return one must determine the estimation window. Estimation window is the period one use to calculate normal return. It is most common to use the period before the event as the estimation window. To make sure the event window does not influence the results, this period should not be included in the estimation window. When using daily stock data, it is normal to use an estimation window which is 30 days or 60 days before the event. More about the timeline of the study is illustrated under measuring abnormal return. (MacKinlay, 1997)

4. Measure normal return

MacKinlay (1997) defines normal return as the expected return without conditioning on the event taking place. There are several models for calculating normal return which can be separated in to two categories:

1. Statistical models which uses statistical assumptions to measure normal return and does not include any economic arguments.
2. Economic models which includes economic arguments as well as statistical assumptions. Economic models have the advantage that they are more precise than statistical.

In statistical models one imposes the assumption that assets returns are jointly, multivariate normal and independently and identically distributed through time. The most common statistical models for calculating normal return is the constant mean return model and the market model. (MacKinlay, 1997)

Economic models are, as stated above, statistical models with economic restrictions. The two most common economic models are the Capital Asset Pricing Model (from here on CAPM) and The Arbitrage Pricing Theory (from here on APT). CAPM was very popular in event studies in the 1970's but is no longer used as the results may be sensitive to the specific CAPM restrictions. (MacKinlay, 1997)

Brown and Warner (1980) found that more complicated models than the marked model did not give the researcher any advantage. Actually, more complicated models could make the researcher worse off than if he had used constant mean return or market model.

Before we go closer into the models we need to identify some notations.

Event date: τ=0
Event window: τ=T1+1 to τ=T2
Estimation window: τ=T0+1 to τ=T1
Post event window: τ=T2+1 to τ=T3
Length of the estimation window: L1=T1-T0
Length of the event window: L2=T2-T1
Length of post event window: L3=T3-T2

4.1 The constant mean return model

The constant mean return model is a statistical model which assumes the mean return of a security is constant through time. (MacKinlay, 1997)

The constant mean return model is:

$$\hat{R}_{i\tau} = \frac{1}{EST}\sum_{i=1}^{i} R_{i\tau}$$

Where $\hat{R}_{i\tau}$ is the estimated normal return for security i for period τ and EST is the length of the estimation window. (MacKinlay, 1997)

4.2 The market model

The market model is also a statistical model where the key assumption is that there is a stable linear relationship between the market return and the security return.

The markets model is:

$$\hat{R}_{i\tau} = \alpha_{\tau} + \beta_{i} R_{m\tau} + \varepsilon_{i\tau}$$

$$E(\varepsilon_{i\tau} = 0) \qquad\qquad var(\varepsilon_{i\tau}) = \sigma^2_{\varepsilon_{\tau}}$$

Where period-τ returns on security i are $R_{i\tau}$, and for the market portfolio, $R_{m\tau}$. $\varepsilon_{i\tau}$ is the zero-mean disturbance term and the parameters are α_i, β_i and σ^2 for the market model. The market model might be an improvement over the constant mean return model as the position of the return that is related to variation on the market is removed and therefore the variance of the abnormal return is reduced. (MacKinlay, 1997)

5. Define the null hypothesis

The normal hull hypothesis (from now on H_0) in event studies are that there is no abnormal return. (MacKinlay, 1997) Which gives

H_0: $AR_{i\tau} = 0$ and $CAR_{i\tau} = 0$

H_1: $AR_{i\tau} \neq 0$ and $CAR_{i\tau} \neq 0$

6. Measure abnormal return

After calculating the normal return one need to calculate abnormal return to identify the event's impact om the security prices. (MacKinlay, 1997)

The abnormal return is the actual return after the event over the event window minus the normal return. For event date τ the abnormal return for firm i is:

$$AR_{i\tau} = R_{i\tau} - \hat{R}_{i\tau}$$

Where $AR_{i\tau}$ is the abnormal return, $R_{i\tau}$ is the actual return and $\hat{R}_{i\tau}$ the estimated normal return for time period τ.

Using the constant mean return model for a 60-day event window the estimation will be as follow:

$$AR_{i\tau} = R_{i\tau} - \left(\frac{1}{60}\sum_{-60}^{-1} R_{i\tau}\right)$$

The distribution of the sample abnormal return of a given observation in the event window under H_0 is

$$AR_{i\tau} \sim N(0, \sigma^2(AR_{i\tau}))$$

Aggregation of abnormal return

To calculate overall inference for each event, you must estimate abnormal return. Further, cumulative abnormal return (from now on CAR) is used to consider a multiple period event window. CAR is the sum of the included abnormal returns, where $T_1 < \tau_1 \leq \tau_0 \leq T_2$. Where $CAR_i(\tau_1,\tau_2)$ is the sample CAR from τ_1 to τ_2. (MacKinlay, 1997)

$$CAR_i(\tau_1, \tau_2) = \sum_{\tau=\tau_1}^{\tau_2} AR_{i\tau}$$

As L_1 increases, the variance of CAR_i is

$$\sigma_i^2(\tau_1, \tau_2) = (\tau_2 - \tau_1 + 1)\sigma_{\varepsilon_i}^2$$

At H_0 the cumulative abnormal return distribution is

$$CAR_i(\tau_1, \tau_2) \sim N(0, \sigma_i^2(\tau_1, \tau_2))$$

Test of the null hypothesis can be conducted given the null distribution of the abnormal return and cumulative abnormal return.

The abnormal return observations must be aggregated for the event window and across observations for the event. For this aggregation it is assumed that there is not any overlap of the included securities in the event window, in other words clustering. The sample aggregated abnormal return for period τ given N events is

$$\overline{AR}_\tau = \frac{1}{N}\sum_{i=1}^{N} AR_{i\tau}$$

And for large L_1, its variance is

$$var(\overline{AR}_\tau) = \frac{1}{N^2}\sum_{i=1}^{N} \sigma_{\varepsilon_i}^2$$

The average abnormal returns can then be aggregated over the event window for each security i for any interval in the event window.

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

$$var\left(\overline{CAR}(\tau_1,\tau_2)\right) = \sum_{\tau=\tau_1}^{\tau_2} var(\overline{AR_\tau})$$

One can form the CAR's security by security and then aggregate through time.

$$\overline{CAR}(\tau_1,\tau_2) = \frac{1}{N}\sum_{i=1}^{N} CAR_i(\tau_1,\tau_2)$$

$$var\left(\overline{CAR}(\tau_1,\tau_2)\right) = \frac{1}{N^2}\sum_{i=1}^{N} \sigma_i^2(\tau_1,\tau_2)$$

To test the null hypothesis inferences about the cumulative abnormal returns can be drawn using

$$\overline{CAR}(\tau_1,\tau_2) \sim N\left[0, var\left(\overline{CAR}(\tau_1,\tau_2)\right)\right]$$

H0 can be tested using

$$\theta_1 = \frac{\overline{CAR}(\tau_1,\tau_2)}{var(\overline{CAR}(\tau_1,\tau_2))^{0,5}} \sim N(0,1)$$

7. Test statistics

The tests presented below has been done to check the robustness of our results and prevent wrongful conclusions.

Before one can conduct hypothesis testing one have to define the hypothesis to be tested. As stated under point 5, this will be H_0: CAR=0 in this paper. As our alternative hypothesis H_1 is CAR≠0 we must conduct a two-sided hypothesis test. When conducting a hypothesis test, one tries to decide whether to accept or reject the null hypothesis, by finding a significant difference between the population mean and hypothesized value. The higher t-value, the more likely to reject H_0 (Stock & Watson, 2007).

To find the t value we use the formula

$$t = \frac{\bar{X} - \mu}{s\sqrt{n}}$$

Where $\bar{X}$ is the average CAR, μ is the expected value of CAR, H_0, in this study 0. s is the standard deviation of CAR and n the number of observations (Stock & Watson, 2007).

After finding the t-value one has to decide the significance level of the test. The most common significance levels are 5% and 10%. With a significance level of 5%, the probability of conducting a type 1 error is 5% (Wooldridge, 2015). A type 1 error is rejecting the null hypothesis when it is true. A type 2 error is failing to reject the null hypothesis when it is false (Banerjee & Chadhury, 2009).

6 Historical retrospect

In this chapter we are going to give a short presentation of the terrorist attacks, important financial news and/or stock market fluctuations the day of the attack. The important financial news and stock market fluctuations included in this chapter might both be caused by the attack or other uncorrelated financial events which might cause errors in our results.

We did a search in Retrievers database for news articles on the date of the attack, the day after, two days after and one week from the attack with the search word "terror" (terrorism in Norwegian). Table 5 show the results from the search for each terrorism attack. This gives an indication for how much publicity the attack got in the Norwegian news. The search includes news presented on paper, online, TV and radio.

WHERE	DATE	DAY 0	DAY 1	DAY 2	DAY 0 - 7
NEW YORK	11.09.2001	152	201	169	980
MADRID	11.03.2004	13	47	45	289
LONDON	07.07.2005	14	96	64	291
UTØYA	22.07.2011	13	105	27	983
BOSTON	15.04.2013	4	17	49	148
PARIS	13.11.2015	36	61	51	994
NICE	14.07.2016	34	64	200	590
MUNICH	22.07.2016	144	103	12	492
BERLIN	19.12.2016	9	34	71	252
STOCKHOLM	04.04.2017	23	33	31	381
MANCHESTER	22.05.2017	15	51	130	418

Table 5: Media coverage in Norway

September 11th, 2001 – New York

19 al-Qaeda terrorists hijacked four Boeing 767 airplanes crashing two of the planes into the twin towers of the World Trade Center in New York City. The third plan hit Pentagon outside Washington D.C., and a fourth crashed into a field in Pennsylvania. Almost 3000 people were killed and 14 900 injured during what is described as the most brutal attack in American history (GDT, 2017). Even though this attack happened in New York, Washington and Pennsylvania are we in this paper calling this attack New York because that was where the biggest part of the attack happened.

Financial news:

- US market was closed after the attack (H. n. Staff, 2001)
- Hug setback on most European stock markets (H. n. Staff, 2001)
- Brent Crude Oil price increase by 1 dollar (H. n. Staff, 2001)
- Statoil stock increase of 13 % (H. n. Staff, 2001)
- Telenor stock increase 4,6 % (H. n. Staff, 2001)

March 11th, 2004 – Madrid

In the middle of rush hour Islamic extremists detonated a total of ten bombs on trains and train stations on Madrid`s commuter line. A total of 191 people was killed and more than 1800 injured in the attack. (GTD, 2017)

Financial news:

- No relevant news

July 7th, 2005 – London

During the morning rush hours four suicide bombers attacked London`s public transportation system in four different locations. Three of the bombs detonated inside underground subway trains, and the last one on a double-decker bus. A total of 56 people was killed and 784 were injured in an attack that later was claimed by both Abu Hafs al-Masri Brigades and al-Qaida (its believed that al-Qaida was responsible) (GTD, 2017).

Financial news:

- Statoil started the day down 5 % and ended down 2 % (N. n. Staff, 2005)
- Hydro started down 6 % and ended down 2,9 %(N. n. Staff, 2005)
- Oil price decline throughout the day (N. n. Staff, 2005)

July 22th, 2011 – Utøya

A Norwegian right-wing extremist detonated a car bomb between the governmental building and Norway`s Oil and Energy Department building in Oslo, Norway killing eight people and injuring 15 (GTD, 2017).

After detonating the car bomb, he shot and killed 69 injuring 60 more, dressed as a police officer at the annual youth summer camp for the Norwegian Labor Party on Utøya. In total 77 people were killed and 57 injured during the attack (GTD, 2017). Even though this attack happened both in Oslo and on Utøya are we calling it Utøya as this was where the biggest part of the attack happened.

Financial news:

- No relevant financial news

April 15th, 2013 – Boston

Two bombs hidden inside backpacks, containing BB-like pellets and nails, exploded 12 seconds apart near the finish line of the Boston Marathon. The attack killed three spectators and injured 264 more (C. c. Staff, 2017), and where carried out by two Muslim extremist brothers with links to the former Soviet republic of Kyrgyztan (H. c. Staff, 2014).

Financial news:

- Oil price down 1 dollar(T. n. Staff, 2018)

November 13th, 2015 – Paris

IS conducted eight coordinated attacks in Paris, France. The attacks were spread around the city with three suicide bombers inside Bataclan, one outside and three near Stade de France. Three more were carried out against a café, restaurant and one bar. ISIL was fast to take responsibility for the attacks who cost 137 lives, with 413 more injured (GTD 2017). Out of the 20 attackers nine is dead, 10 arrested and one still free (v. n. Staff, 2015).

Financial news:

- No relevant financial news

July 14th, 2016 – Nice

A Muslim extremist drove a lorry 2 km through a crowd celebrating the French national day on Promenade des Anglais in Nice, France (nrk.no Staff, 2016). 86 people were killed, including the attacker, and 443 injured during the attack (GTD, 2017).

Financial news

- No relevant financial news

July 22th, 2016 – Munich

A 18-year-old German-Iranian shoot and killed 10 people, injuring 36 more at a McDonald`s restaurant outside Olympia shopping mall, inside the shopping mall and in front of an electronics store(t. c. Staff, 2016).

Financial news:

- Around 1 dollar drop in crude oil price(T. n. Staff, 2018)
- Statoil down 2,9 % (NTB.no Staff, 2016b)
- DNO down 3,4 % (NTB.no Staff, 2016b)
- PGS down 4 % (NTB.no Staff, 2016b)
- Yara down 3,1 % (NTB.no Staff, 2016b)

December 19th, 2016 – Berlin

In the evening a truck, driven by a Pakistani asylum seeker drove into a busy Christmas market at Breitscheidplatz in the heart of Berlin. The truck ploughed through people killing 12 and injuring 48 more. Later the same day IS claimed responsibility for the attack (M. d. Staff, 2016).

Financial news:

- Strong growth in seafood stock due to an improvement in the relationship between Norway and China (NTB.no Staff, 2016a).
- Brent crude oil fell with almost 1 dollar (T. n. Staff, 2018)

April 4th, 2017 – Stockholm

Shortly before 3 pm an Uzbek Jihadi inspired extremist stole a brewery truck and smashed it into a crowd in central Stockholm killing 5 and injuring 14 more. The truck ended its killing run by crashing into the Ahlens City Department Store (Thompson, Nilsson, & Megaw, 2017).

Financial news:

- Seadrill stock down 37,8 % (N. n. Staff, 2017)
- Brent crude oil price increased by 1 dollar (T. n. Staff, 2018)

May 22th, 2017 – Manchester

A suicide bomber detonated a home-made bomb when people were making their way home after a concert at Manchester Arena in Manchester. The bomb was detonated in the arenas foyer between the main area and neighboring Victoria Station. Shortly after the attack Islamic State claimed responsibility for the attack killing 22 and injuring 116 people (B. c. Staff, 2017)

Financial news:

- No relevant financial news

7 Expected results

Based on the EMH theory presented in chapter 4 stock market prices are always reflecting all available information and therefore, only new information can change the prices. In an event of a terrorist attack irrational behavior caused by irrational investors is either random and they cancel each other out, or rational investors are exploiting the arbitrage opportunity created. In both cases the market is brought back to equilibrium. If new information affecting the stock market is created by the terrorism attack, the market will process the new information efficiently and all abnormalities will be eliminated. Behavioral finance on the other hand argue that investors behave irrational when faced by new information, like the one caused by a terrorist attack. This because they are highly affected by psychological and emotional factors like fair, anxiety or panic. Which makes them evaluate the new information irrationally. For example, if they attach to much importance to recent, or events happening close to their home country. So, the two major economic theories explaining investor behavior is split.

Previous empirical research finds a strong linkage between terrorism attacks and stock market fluctuations. Both for countries similar to Norway like UK, US and Spain, but also for countries like Pakistan, where the effect interestingly was measurable even one day before the attack. We do not think the same result will be given in our study of OSE due to the fact that Pakistan has a lot higher attack frequency, and consequently the investors are more sensitive to future attacks. For the attacks happening in countries similar to Norway previous research has found a negative stock market return both the day of, and the day following a terrorist attack. It's also revealed that for most cases the negative stock market effect, and volatility increases with the number of causalities.

As found by Chen & Siems (2004) when investigating U.S. capital markets, we expect the earlier attacks to have a stronger effect than the newer ones because of increased market stability made by the banking and financial sector in Norway. But also, as a result of evolution among the investors. The number of attacks and the news coverage has increased significantly since the early 2000`s so our prediction is that a stock market investor in 2018 are influenced to a much lesser degree by a terrorist attack then he or she would have been 20 years earlier.

In chapter 3.2 we describe and compare three of the world's largest stock markets (LSE, DAX, NYSE) and OSE. Her we find a lot of differences between the markets. The only main similarity is that institutional investors are the biggest shareholders on OSE, LSE and DAX markets. The fact that previous research has found negative stock market reactions in different stock markets, like for example the US and the UK, may indicate that different investor and stock compositions don't change the reactions significantly.

We expect to find somewhat similar reactions on OSE as found in previous research. Which in general means a significant negative effect right after the attack, and a correction shortly after. In economic terms we expect our AR0 to be significant and our CAR`s to be insignificant. This also agrees with the EMH.

Since only 0,4% of the investors on OSE are private investors we expect that there are not as many panic reactions in the market as on other stock exchanges where private investors have more influence. This because institutional investors, in most cases, own stock in a larger number of countries than a private investor and so they are more exposed to terrorism attacks. We think the increased exposure has led to better practice for handling new attacks in the most rational way possible. It’s important to note that none of the terrorist attacks analyzed in this paper is directly affecting one of the tree main sectors on OSE (energy, shipping and seafood). We will on account of that make the reader aware that we expect an attack to one or more of those sectors to affect OSE stronger than the attacks we are analyzing.

As found in previous research we expect the effect of an attack to increase with the number of causalities. We cannot find a rational reason why this should not apply to OSE. On the basis of that we expect New York 2001, Madrid 2004, London 2005, Paris 2015 and Nice 2016 to have a strong effect due to their high number of causalities.

Since the attack on Utøya in 2011 is the only attack in Norway we expect this attack the have the biggest effect on OSE. But as this attack happened near closing on a Friday and the next open trading day was Monday, the effect might have been reduced by the time gone before investors could react.

For the terrorism attack in Boston 2013 and Manchester 2017 we do expect a stock market reaction because of the attacks comparable nature and casualty size. Both attacks did also happen on a Monday, so we expect the stock market reaction to be immediate, but a lot less significant than Utøya and the attacks with the highest number of casualties.

We do not expect the Stockholm 2017 attack to have a significant effect on OSE due to the low number of casualties and because most of the investors on OSE are either foreign or institutional. If private investors had been a more significant shareholder group, we think that the case would have been different due to Stockholm`s geographical location. The Munich and Berlin attacks in 2016 are also expected to have a love impact as a result of a low number of casualties.

To summarize we expect the attacks happening in Norway, or with a high casualty count to have the highest significance and strongest negative stock market effect. We are, however, more uncertain about how fast the reaction disappears. This because for traditional EMH the investor is rational, so the reaction is instantaneous and has a quick drawback to equilibrium price. Behavioral finance on the other hand, expects an irrational investor, a stronger effect and a longer correction time. The expected reaction in behavioral finance can somewhat meet the criteria in EMH because they both end up with equilibrium price, but in a longer period of time. We conclude that our expected reaction time is short due to arguments in EMH and findings in previous research.

8 Analysis

In this chapter we will specify how we conducted our analysis and which estimation models we have decided to use.

To analyze OSE we used a data set collected from www.investing.com which contained data from the OBX Index. The OBX index contains the 25 most traded securities on OSE based on a six months turnover rating (O. n. Staff, 2018a). We found the fact that only the 25 most traded securities are included in the OBX index as a strength being it`s likely that the most traded firms are those who's affected the greatest by a change in investor behavior after terrorism attacks. Less traded securities would only cause noise in our findings.

To conduct our event study, we used the step by step approach described in chapter 5.

1. Define the event of interest and the event window

The events selected are shown in table 5. Our selection process is described in Chapter 3 part 3.1.

Where	Date
New York, US	11.09.2001
Madrid, Spain	11.03.2004
London, UK	07.07.2005
Utøya, Norway	22.07.2011
Boston	15.04.2013
Paris, France	13.11.2015
Nice, France	14.07.2016
Munich, Germany	22.07.2016
Berlin, Germany	19.12.2016
Stockholm, Sweden	07.04.2017
Manchester, UK	22.05.2017

Table 6: Events of interest

We have determined to use the attack date as our day 0, and our event window goes from day 0 to day 10. The reason for this is that previous research has found the reactions to be arriving shortly after the attack, and decreases within a few days

2. Determine the selection criteria

As we are investigating terrorism attacks effect on the Norwegian stock market as a whole, and not firm specific reactions our selection criteria are the OBX index which contains the 25 most traded firms on OSE. More about why we have selected OBX and not the whole OSE can be found in the start of this chapter.

3. Define the estimation window

In our research we have concluded to use two different event windows and therefore done two separate analysis. Event window for the first analysis is from 60 to 1 days (day-1) prior to the event. The event window used in our second analysis is from 30 to 1 days prior to the event. This is partly due to recommendations done by MacKinlay (1997) when using the constant mean return model, and because we wanted to make sure our results were not affected by the length of the estimation window. In our research the two main factors we wanted to test for was seasonality and clustering.

4. Measure normal return

We decided to use the constant mean return model to measure normal return. Since Brown and Warner (1980) found that more complicated models than the constant mean return, and the market model usually don’t yield better results we wanted to use one of those due to our limited timeframe. In the market model you compare security data to market data. In our research we are analyzing the market as a whole and not only a few selected securities, so the market model approach cannot be used. The constant mean return model, however, fits perfectly.

We measured normal return using these two formulas for 60 and 30-days estimation window respectively.

$$\hat{R}_{i\tau} = \frac{1}{60}\sum_{-60}^{-1} R_{i\tau}$$

$$\hat{R}_{i\tau} = \frac{1}{30}\sum_{-30}^{-1} R_{i\tau}$$

5. Define the null hypothesis

As the theories presented in this thesis indicates that an event such as a terrorist attack should not cause reactions in the stock market we decided to use these hypothesis:

H_0: AR = 0 and CAR = 0
H_1: AR ≠ 0 and CAR ≠ 0

6. Measure abnormal return

To measure abnormal return we took the actual return minus the normal return:

$$AR_{i\tau} = R_{i\tau} - \hat{R}_{i\tau}$$

Where $AR_{i\tau}$ is abnormal return, $R_{i\tau}$ is the actual return and $\hat{R}_{i\tau}$ is the estimated normal return for period τ.

7. Hypothesis testing

To test the significance of our results we conducted a t-test

$$t = \frac{\bar{X} - \mu}{s\sqrt{n}}$$

Where x^ is the average AR (CAR), μ is the expected value of AR (CAR), H_0, in this study 0. s is the standard deviation of AR (CAR) and n the number of observations.

We used a 5% significant level, so the t value had to be higher than 2 and 2,42 for 60 and 30 days estimation window respectively, and 10% significance level.

9 Results

In this chapter we will present the results of our analysis. Since several attacks happened at the end of the trading day or after closing we included the day after the attack in the results as well as the day of the attack.

Table 7 is an overview of the results of our analysis showing estimated normal return ($\hat{R}$) and abnormal return for the day of, and the day after the attack. Cumulative abnormal return from day 0 to day 2, day 0 to day 5 and day 0 to day 10 is also included. We have also included their cumulative abnormal returns based of the two different event windows 30 and 60 days prior to the attack. the significance levels shown are the result of our conducted t-test. It is important to note that all numbers are presented in percentage terms, and that * and ** represents a significance level of 5 and 10 %. The numbers without * are not significant.

		$\hat{R}$	AR DAY 0	AR DAY 1	CAR 0-2	CAR 0-5	CAR 0-10
NEW YORK	30 days	-0,342	0,502	-3,248	-2,865	-5.012**	-12.912**
	60 days	-0,246	0,406	-3,435	-3,151	-7.182**	-13.960**
MADRID	30 days	0,323	-2,723	-0,393	-5.65*	-5.05**	-8.087**
	60 days	0,331	-2,731	-0,401	-5.673*	-5.096**	-8.171**
LONDON	30 days	0,480	-2,810	2,380	-1,059	-2.928**	-6.566**
	60 days	0,187	-2,517	2,673	-0,182	-1.173*	-3.349**
UTØYA	30 days	0,039	0,015	-0,029	3.033**	-2,292	-15.735**
	60 days	-0,055	0,245	0,065	0.465**	-1,730	-14.705**
BOSTON	30 days	-0,009	-0,501	-0,051	-2.762**	-1.034**	1,783
	60 days	0,042	-1,552	-0,102	-2.902**	-1.34**	1,222
PARIS	30 days	0,125	-0,490	0,510	1,261	1.599*	0.924**
	60 days	0,045	-0,409	0,595	2,509	2.08**	1.806**
NICE	30 days	0,056	0,194	0,154	-0,197	1,626*	-1,222
	60 days	0,105	0,145	0,105	-0,346	1,328	-1,769
MUNICH	30 days	0,115	-1,145	-1,185	-2.166**	-3.752**	-4.279**
	60 days	0,116	-1,115	-1,186	-2.169**	-3.758**	-4.29**
BERLIN	30 days	0,281	-0,531	-0,371	-1.554*	-1.208**	-1.095**
	60 days	0,165	-0,415	-0,255	-1.204*	-0.507**	0.191**
STOCKHOLM	30 days	-0,004	0,074	0,294	0,143	-1,354	1,008
	60 days	0,000	0,070	0,290	0,131	-1,379	0,962
MANCHESTER	30 days	0,168	-0,018	-0,478	-0,044	-1.598**	-3.448**
	60 days	0,086	0,064	-0,396	0,203	-1.104*	-2.542**

Table 7: Analysis results

Figure 3 is an illustration of OBX from 2001 to 2017 with the terrorist attacks used in our analysis. A closer overview of OBX around the time of each attack is enclosed in appendix chapter 13.1.

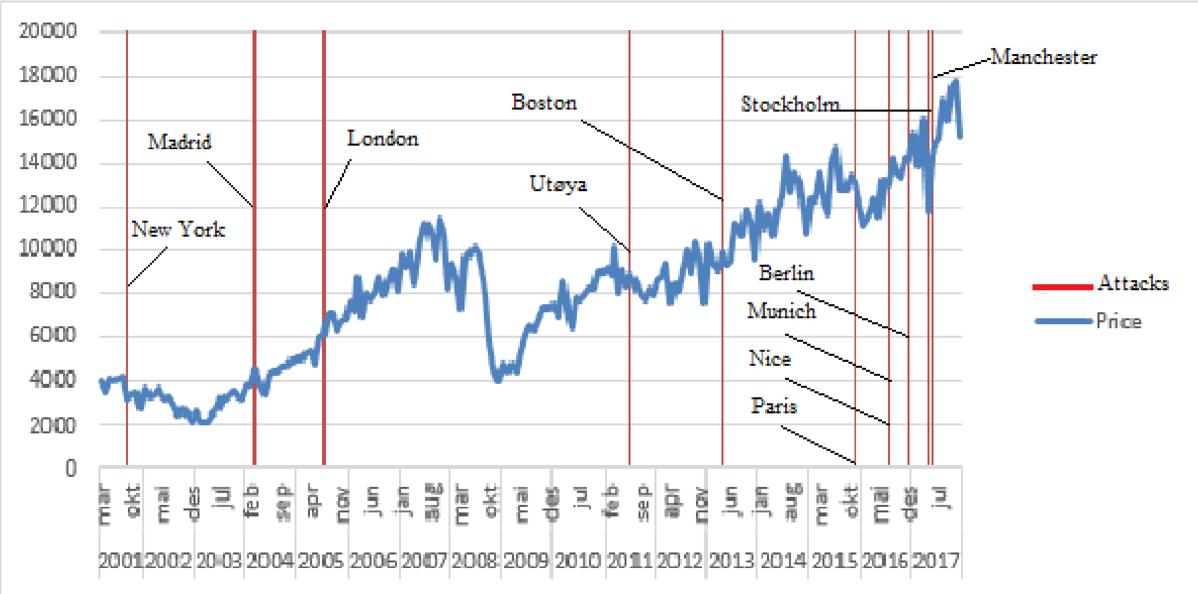

Figure 3: Overview of OBX and terrorism attacks from 2001 to 2017

With a 30-day estimation window we find a negative price reaction in 64% of the cases on the event day, with an average reaction of – 0.342% and 55 % on the following day, with an average reaction of – 0,224%.

For a 60-day estimation window there is a negative price reaction of 55% on both the day of, and the day following the attacks. Accumulating an on average reaction of – 0.23% on event day, and -0,19% the following.

Strongest negative effect on OBX for the event date on both 30- and 60-days estimation window did come from the London, Madrid and Munich-events (in that order). One thing that's interesting is that OBX had closed before the Munich-event happened. The London-event happened shortly after opening, and Madrid shortly before.

Only New York, Utøya, Nice and Stockholm where correlated with a positive abnormal return. The most obvious similarity for the three events, except Nice, is that they all happened close to the end of the trading day on OSE. Nice happened after the trading day was over. It is also worth to mention that the Manchester-events abnormal return goes from negative to positive if we change the estimation window from 30- to 60-days.

For Day 1, the largest negative abnormal returns are accumulated after New York, and Munich-events. The New York-event had a huge impact on the global economy, so a negative reaction in this case is as expected. More interesting is though is a negative abnormal return of -1,186% after the Munich-event, which is a much smaller event on a global scale.

A 30-days estimation window gave positive abnormal return on day 1 after the attacks in London, Paris and Stockholm. On the other hand, for a 60-day event window also Utøya became positive.

Only Utøya, Boston and Munich have a significant CAR 0-2 on a 5% level. Madrid and Berlin are significant at a 10 % level. The rest has an insignificant reaction. For CAR 0-5 only Utøya and Stockholm have insignificant reactions, while all the other events show significant reactions on a 10 % level. At CAR 0-10 Utøya goes from being insignificant, to significant on a 5 % level, and Boston moves the opposite way. Stockholm and Boston are the only two events that's not significant at a 5 % level.

Figure 4 illustrates the relationship between CAR_{0-10} and people killed and injured in each attack. New York is omitted from this chart because it is such an extreme in total people killed and injured and therefor would make the chart unreadable for the other events. The total number of killed and injured after the attack in New York was more than 17 600 while the next biggest attack, Madrid, had less than 2 000 injured and killed. From this chart one can see that there might be a relationship between killed and injured and abnormal return. The correlation between killed, injured and CAR_{0-10} are 0,5.

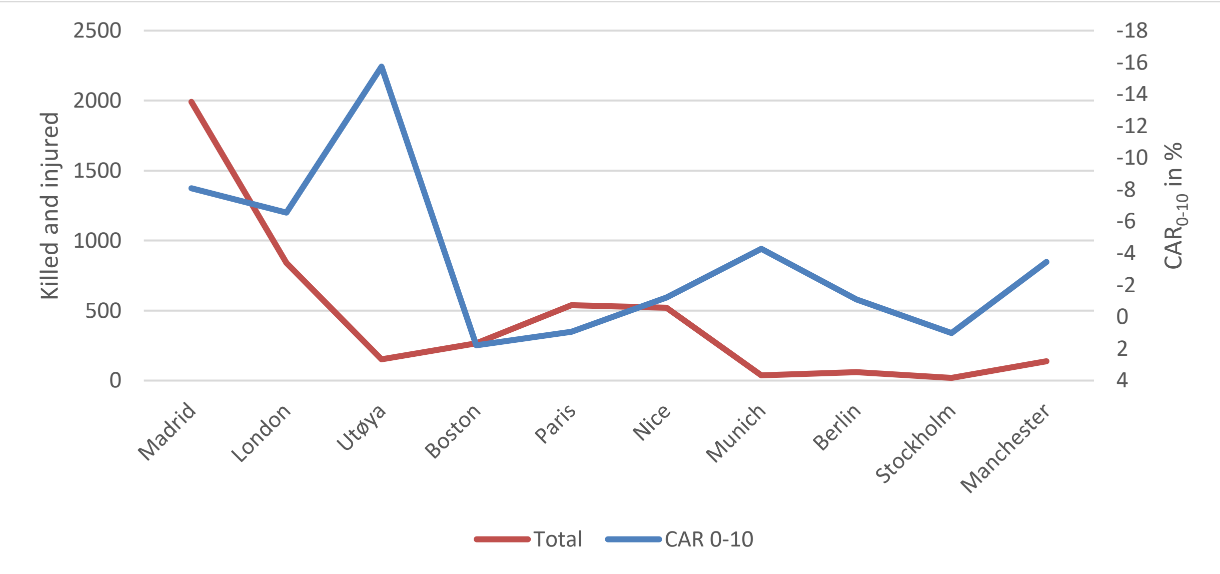

Figure 4: Relationship between CAR_{0-10} and people killed and injured

Figure 5 illustrates the relationship between distance from Oslo to the attack in km and abnormal return day 0. This illustration indicates that there is no relationship between distance and reaction in stock market. A correlation of 0,05 also indicates the same.

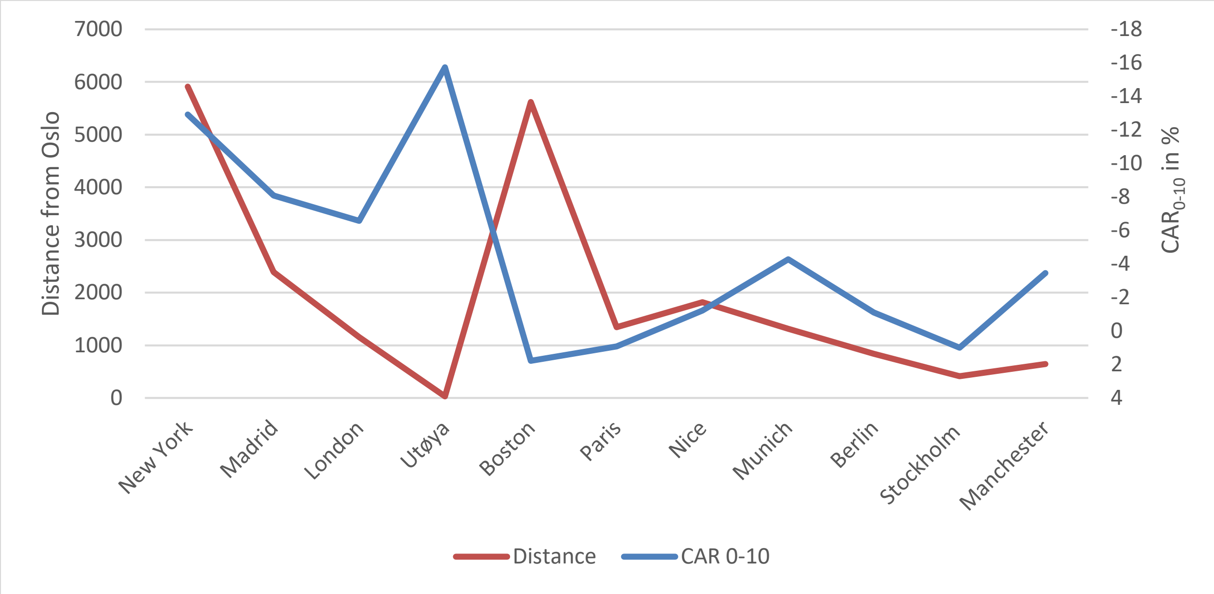

Figure 5: Relationship between distance from Oslo to the attack in KM and CAR_{0-10}

Figure 6 illustrates the relationship between media coverage 7 days after the results and CAR_{0-10}. The relationship between these two variables seems strong in this illustration. Only exception being the attack in Paris where the media coverage was extremely high while the reaction in the stock market was low. The correlation for these variables was 0,49.

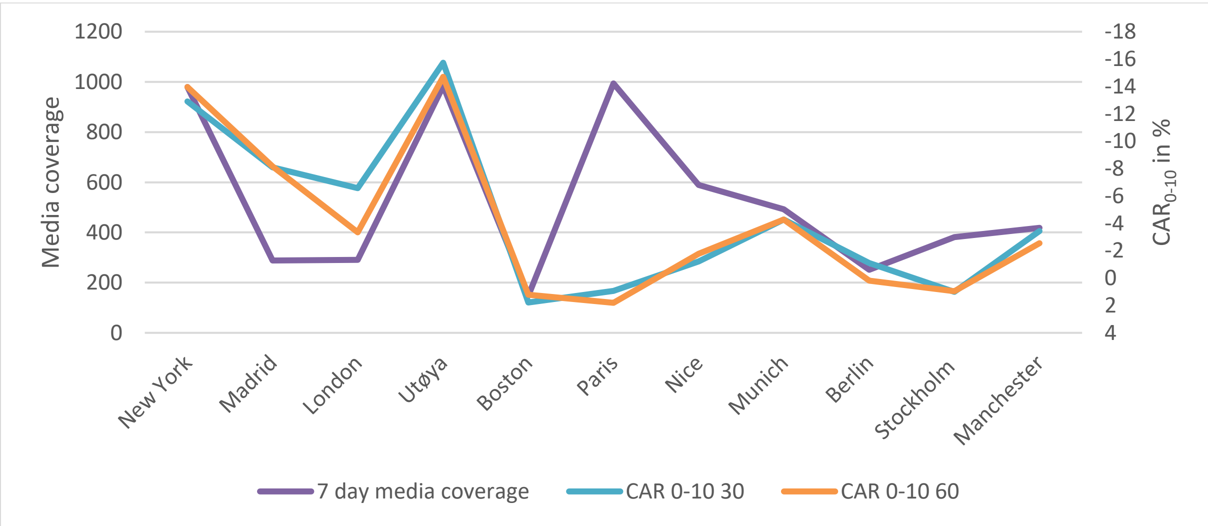

Figure 6: Relationship between media coverage and CAR_{0-10}

After illustrating the relationship, we run a regression to check if there is a correlation, the results are shown in figure 7. With adjusted R-squared of 0,22 the results were not as expected, none of the coefficients was significant. An important notice about this regression is that we only had eleven events. I would be interesting to see how these numbers would change with more attacks.

. regress car010 killed wounded distance mediacoverage

Source	SS	df	MS			
Model	178.158163	4	44.5395407	Number of obs	=	11
Residual	158.690988	6	26.448498	F(4, 6)	=	1.68
				Prob > F	=	0.2705
				R-squared	=	0.5289
				Adj R-squared	=	0.2148
Total	336.849151	10	33.6849151	Root MSE	=	5.1428

car010	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
killed	.0467855	.0404902	1.16	0.292	-.0522904	.1458613
wounded	-.0094685	.0074029	-1.28	0.248	-.0275828	.0086458
distance	.0012917	.0012451	1.04	0.340	-.0017551	.0043385
mediacoverage	-.0104188	.0089598	-1.16	0.289	-.0323426	.011505
_cons	.3719947	5.6813	0.07	0.950	-13.52964	14.27363

Figure 7: Regression results from stata

Figure 8 illustrates the trend in abnormal return over time, with a clear decreasing trend.

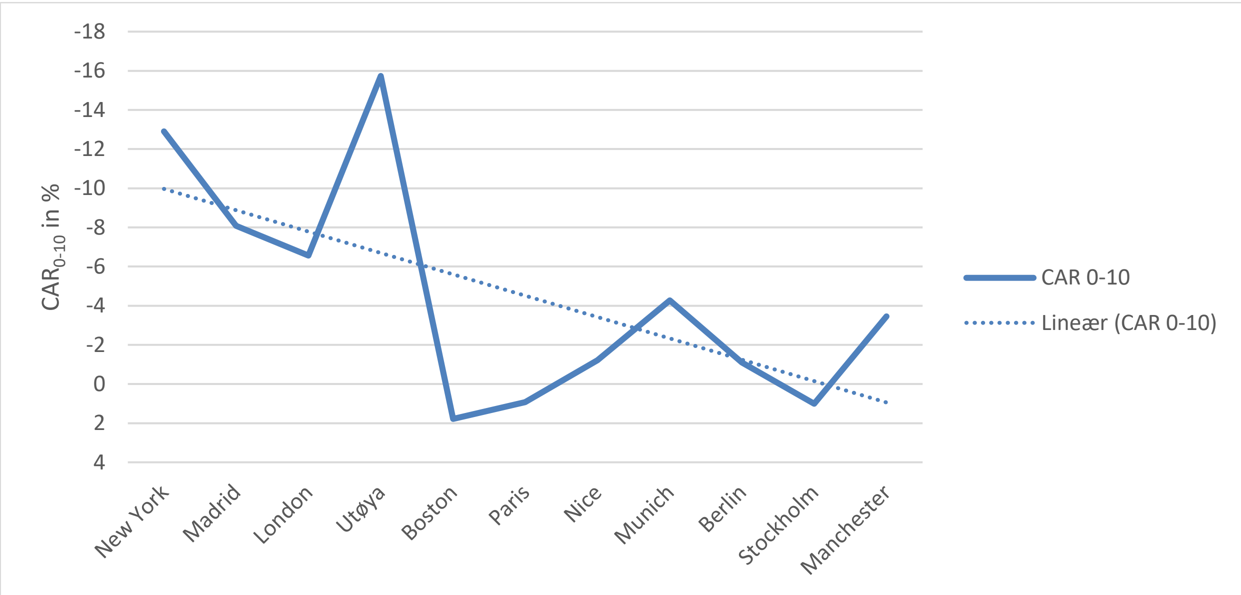

Figure 8: CAR 0-10 trendline

It is important to notice that the attacks in Nice and Munich, and Stockholm and Manchester happened very close in time. So, the estimation window for the attacks in Munich and Manchester includes the attacks in Nice and Stockholm. This kind of clustering might affect our results for these attacks, something we have tried to account for by using two different event windows and analyzing the stock market data for each attack separately.

10 Discussion

In the EMH part of the theory chapter we explained how rational investors would exploit arbitrage options created by irrational investors to recreate market equilibrium. If some investors reaction to a terrorist attack causes the stock prices to deviate from its true value, other, rational investors, will exploit the arbitrage option causing the price to move back into equilibrium. With this theory in mind our events should cause a spontaneous reaction because of a creation of new information, and a correction shortly after. Our results do not support the historical EMH view, due to the fact that a few of the attacks have a significant $CAR_{0\text{-}2}$ at 5% level while 8/11 attacks have a significant $CAR_{0\text{-}10}$ at 5% level.

Previous research has found that there is a reaction shortly after the attack and stabilization within a few days. We expected to find somewhat similar results as previous research. Our results show an insignificant $CAR_{0\text{-}2}$ for the New York, London, Paris, Nice, Stockholm and Manchester attacks. Which indicates that there is no significant reaction immediate after the attack. However, it is important to have in mind that the London, Paris, Nice and Stockholm attacks all happened either on Thursday or Friday and therefor day 1 and/or day 2 will registered as Monday and/or Tuesday the following week. This may have affect our results because the investors got extra days to adapt to the new information.

It is also worth considering that expect from the attacks in Madrid and London all other attacks happened near or after the trading day had ended. We therefor attach less importance to the Day0 findings for these attacks, because we do not think OSE has a predictive stock market reaction like the one found by F. Aslam and H-G. Kang when investigating attacks happening in Pakistan, and the effect they had on the KSE100 index in the article How Different Terrorist Attacks Affect Stock Markets from 2015. This, because we expect that the significantly higher attack frequency experienced in Pakistan compared to Norway has made the investors on the KSE100 more aware of events that potentially can provoke a terrorist attack, and therefore has an increased ability to predict future attacks. Causing the investor to act more carefully.

The three biggest attacks, in terms of casualties', New York, Madrid and London, did all have negative abnormal return the day of or the day after the attack (the day after in New York as this happened near closing). None had a $CAR_{0\text{-}2}$ significant at 5% level, but all $CAR_{0\text{-}5}$ and $CAR_{0\text{-}10}$ was significant at 5% level, expect London with 60 days estimation window which was significant at 10% level. This might indicate that bigger attacks cause bigger reactions in the stock market.

The attack in Stockholm was the only one that did not have any significant CAR, and no negative abnormal return the day of, or the day after the attack. This is also the attack with the lowest number of casualties'. This might indicate that the number of casualties might reduce the effect an attack has on the stock market, which is consistent with results found in previous research. The relationship between stock market reaction and the attacks CAR are illustrated in figure 4. This indicates a strong relationship between casualties, and CAR. Even though it in figure 4 locks like there is a correlation between these variables, the correlation coefficient of 0,5 is not as strong as indicated in the figure.

Utøya was the attack we were expecting to have most effect on OSE as it happened in Norway. The attack happened just before closing on a Friday, and the abnormal return the day of and the day after the attack is positive. CAR_{0-2} was significant at 5% level and is positive both with 30 days and 60 days estimation window. CAR_{0-5} was not significant and negative, while CAR_{0-10} was negative and significant at 5% level. CAR_{0-10} was the highest CAR_{0-10} off all the attacks, which might indicate that this attack had a strong impact on the Norwegian stock market, just not as quick as we expected it to be. We think some of the explanation for Utøya having the most significant CAR_{0-10} may be because the attack caused investors view about investing into the Norwegian economy to changed. Considering the attack, and statements done by the terrorist after the attack where he claimed that he worked for a major terrorist organization planning a series of attacks against Norway in the near future. Norway may no longer have been seen as equally shielded from the rest of the world, and uncertainty may have spread among investors, causing the market to drop. The lack of showing strength and empowerment from the Norwegian government after the attack can also have caused some of the reaction on CAR_{0-10}, since Chen and Siems found that showing strength and empowerment was one of the main reasons the capital markets in the U.S recovered so fast compared to other stock markets after the 9/11 attacks in their article The effect of terrorism on global capital markets form 2004. Some reasons why this attack did not have the expected effects right after the attack might be because it happened in July (this is explained further down). And the fact that it did happen late Friday afternoon, so the investors could not react properly before the marked opened again Monday morning. At this time the shock and fear from the attack might have settled. Maybe the fact that it was a single Norwegian who conducted the attack made people less afraid than if it had been an international terrorism organization.

Figure 5 illustrates the relationship between distance from the attack to Oslo in KM. This indicates that there is no relationship. With a correlation of 0,05 we think it`s reasonable to conclude that there is no correlation between the variables. This might be because distance is more about what we feel close to than what is actually close. An attack in a town you regularly visit probably feel closer than an attack closer in km in a town you've never been to.

Another interesting result is that we find a stronger reaction on OSE from the early attacks, compared to the later ones. This might be because the investors are getting more used to terrorism attacks than earlier. It`s also important to remember that OSE is mainly own by foreign or institutional investors that most likely own stock in a number of different exchanges globally and due to that has developed guidelines to counter irrational behavior. The declining trend can be both because of a change in investors reaction or a decline in the number of casualties'. We find it most likely it's a bit of both, though it's something that's need further research.

Figure 6 illustrates the relationship between media coverage and $CAR_{0\text{-}10}$. Looking at $CAR_{0\text{-}10}$ with 60 days estimation window we find a clear relationship, which looks bigger than it is with a correlation of 0,49. Paris is the only attack where media coverage caused by the attack was much higher than the attack's stock market reaction. This might indicate that increased media coverage causes a stronger stock market reaction. However, it is important to pay attention to that the independent variable "Media Coverage" in our research is estimated based on how many times the word "terror" (terrorism in Norwegian) is mentioned in Norwegian press. This may create errors because the word "terror" may have been mentioned in other contexts, and we do not take into account the global media coverage caused by the attack.

Looking at the trend on OBX 60 days before and 30 days after the attack we find that around the attack in New York there was a clear trend decrease (Figures for all attacks can be found in appendix chapter 13.1). It is a potential stabilization just before the attack, but after the attack OBX is dominated by a decrease. The attack in Madrid happened in the middle of a decline on OBX which strengthened a few days after the attack. We find the same trend for the attacks in Boston and Berlin. The attacks took place when OSE were in the middle of a trend decrease, which may cause errors to our findings due to a strengthening of a potential trend decrease caused by the attacks, or make it look like the attack made a reaction that’s only caused by the market trend. The trend in the market might also increase or decrease our results. Both the attack in New York and Madrid have a decreasing trend in the market and high CAR_{0-10}, while the attack in Manchester have an increasing trend in the market and a low CAR_{0-10}.

On the other hand, if we look at Utøya OSE had a peak right around the attack with a huge fall in price shortly after. The attack in Paris happened in the middle of a valley in OSE with a huge increase shortly after the attack. Looking at the attacks in Nice and Munich we find that the attack in Nice happened when the market was increasing, while the attack in Munich happened after the increasing trend had changed to a negative trend.

It’s worth noticing that we find approximately the same reaction on our CAR`s for OSE as found on DAX and LSE for the New York attacks. If we instead look at the Madrid attack the abnormal return found on OSE is only half as strong as the one found on stock markets in the U.S., the U.K., and Germany. While the reaction in Norway is strongly strengthened, its relatively stable in the three other countries. For the London attack we found a negative reaction on OSE on all estimations except for abnormal return one day after the attack, while previous research has found a steady growth on both the stock market in the U.S., and the U.K., except for on the event day in the U.K.

11 Conclusion

In this paper we try to answer if terrorism affects the Norwegian stock market, with the help of the constant mean return model known from event study.

Based on our results we find indications that terrorism attacks affect OSE negatively. The reaction was strongest for the early attacks, with a decreasing trendline. If the trend decrease is due to investors adapting to a world with terrorism, a decrease in total number of casualties or other factors are not answered in this paper.

The fact that attacks don’t show significance before CAR_{0-5} and CAR_{0-10} may indicated that the reaction from the attacks on OSE are slower than previous research done on other stock markets imply. This is something the Norwegian government and policy makers should be aware of, so they can learn from globally leading stock markets where the opposite reaction have been found. Be aware that underlying market trends can have caused errors in our results, and there are major differences in liquidity, structure and size between OSE and world leading stock markets as the those in the U.S., the U.K., and Germany. But we find it crucial to exchange experiences and cooperate with others in the effort of reducing the impact of future terrorism attacks. How close the attack is (in km) to Oslo does not affect the reaction in the stock market.

There are several questions our study does not answered which could be interesting for further research of OSE. Such as how OSE reacts compared to other markets for the same attacks? Why does OSE react stronger than other stock markets over time? How OSE reacts to attacks in countries not as close as the ones we study? Is there a significant correlation between injured and/or killed and the stock market? How would OSE react to attacks on the markets that are biggest on OSE, energy, shipping and seafood?

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13 Appendix

13.1 Results for each attack

September 11th, 2001 – New York

	ACTUAL	30 DAYS		60 DAYS	
	Change%	AR 30	CAR 30	AR 60	CAR 60
DAY -1	-2,50	-2,16		-2,25	
DAY 0	0,16	0,50	0,50	0,41	0,41
DAY 1	-3,59	-3,25	-2,75	-3,34	-2,94
DAY 2	-0,46	-0,12	-2,87	-0,21	-3,15
DAY 3	-1,66	-1,32	-4,18	-1,41	-4,56
DAY 4	-1,17	-0,83	-5,01	-0,92	-5,49
DAY 5	-1,94	-1,60	-6,61	-1,69	-7,18
DAY 6	-3,41	-3,07	-9,68	-3,16	-10,35
DAY 7	-4,92	-4,58	-14,26	-4,67	-15,02
DAY 8	-6,35	-6,01	-20,27	-6,10	-21,12
DAY 9	4,82	5,16	-15,10	5,07	-16,06
DAY 10	1,85	2,19	-12,91	2,10	-13,96

Table 8: Results after New York 2001

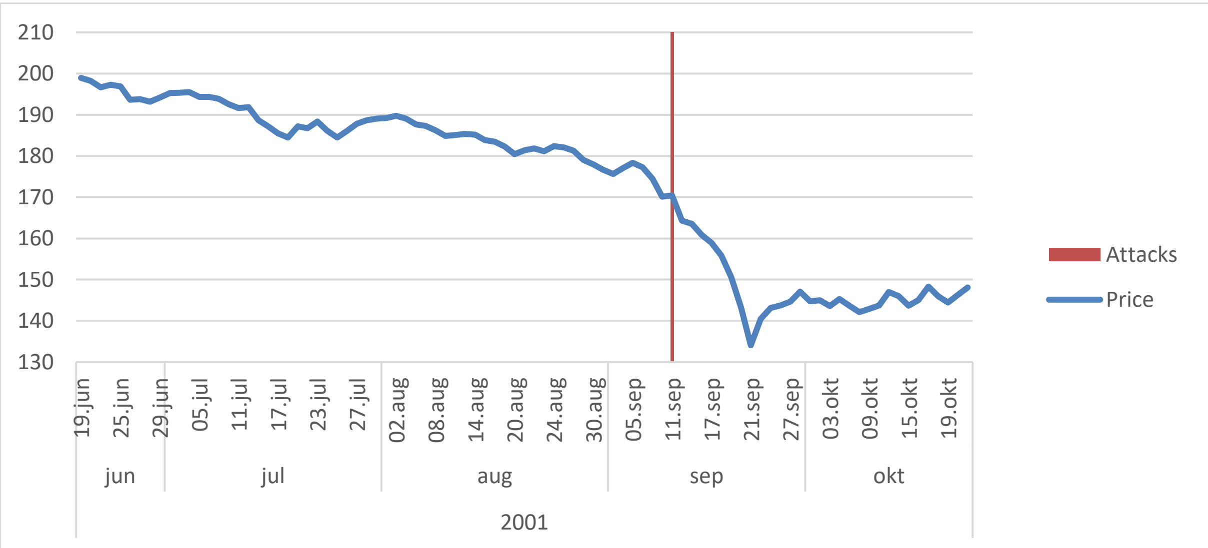

Figure 9: OBX 60 days before and 30 days after the attack in New York 2001

March 11th, 2004 - Madrid

	ACTUAL	30 DAYS		60 DAYS	
	Change%	AR 30	CAR 30	AR 60	CAR 60
DAY -1	-1,01	-1,33		-1,34	
DAY 0	-2,40	-2,72	-2,72	-2,73	-2,73
DAY 1	-0,07	-0,39	-3,12	-0,40	-3,13
DAY 2	-2,21	-2,53	-5,65	-2,54	-5,67
DAY 3	0,43	0,11	-5,54	0,10	-5,57
DAY 4	1,06	0,74	-4,81	0,73	-4,85
DAY 5	0,08	-0,24	-5,05	-0,25	-5,10
DAY 6	-0,22	-0,54	-5,59	-0,55	-5,65
DAY 7	-2,55	-2,87	-8,47	-2,88	-8,53
DAY 8	1,29	0,97	-7,50	0,96	-7,57
DAY 9	-0,11	-0,43	-7,93	-0,44	-8,01
DAY 10	0,17	-0,15	-8,09	-0,16	-8,17

Table 9: Results after Madrid 2004

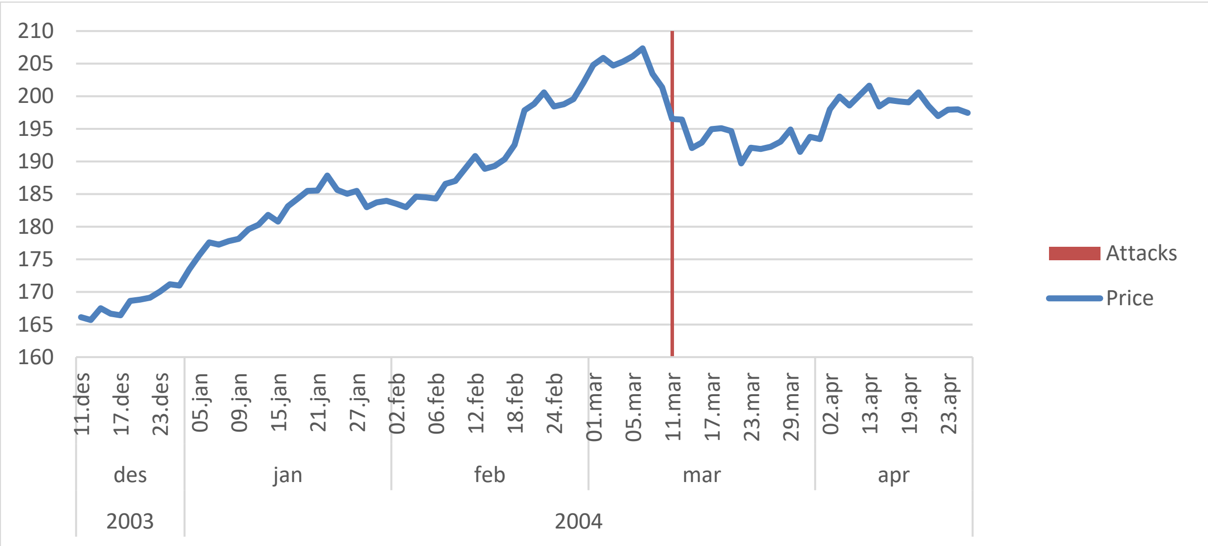

Figure 10: OBX 60 days before and 30 days after the attack in Madrid 2004

July 7th, 2005 – London

	ACTUAL	30 DAYS		60 DAYS	
	Change%	AR 30	CAR 30	AR 60	CAR 60
DAY -1	1,82	1,34		1,63	
DAY 0	-2,33	-2,81	-2,81	-2,52	-2,52
DAY 1	2,86	2,38	-0,43	2,67	0,16
DAY 2	-0,15	-0,63	-1,06	-0,34	-0,18
DAY 3	-0,83	-1,31	-2,37	-1,02	-1,20
DAY 4	0,43	-0,05	-2,42	0,24	-0,96
DAY 5	-0,03	-0,51	-2,93	-0,22	-1,17
DAY 6	-1,01	-1,49	-4,42	-1,20	-2,37
DAY 7	-0,01	-0,49	-4,91	-0,20	-2,57
DAY 8	0,32	-0,16	-5,07	0,13	-2,43
DAY 9	-0,75	-1,23	-6,30	-0,94	-3,37
DAY 10	0,21	-0,27	-6,57	0,02	-3,35

Table 10: Results after London 2005

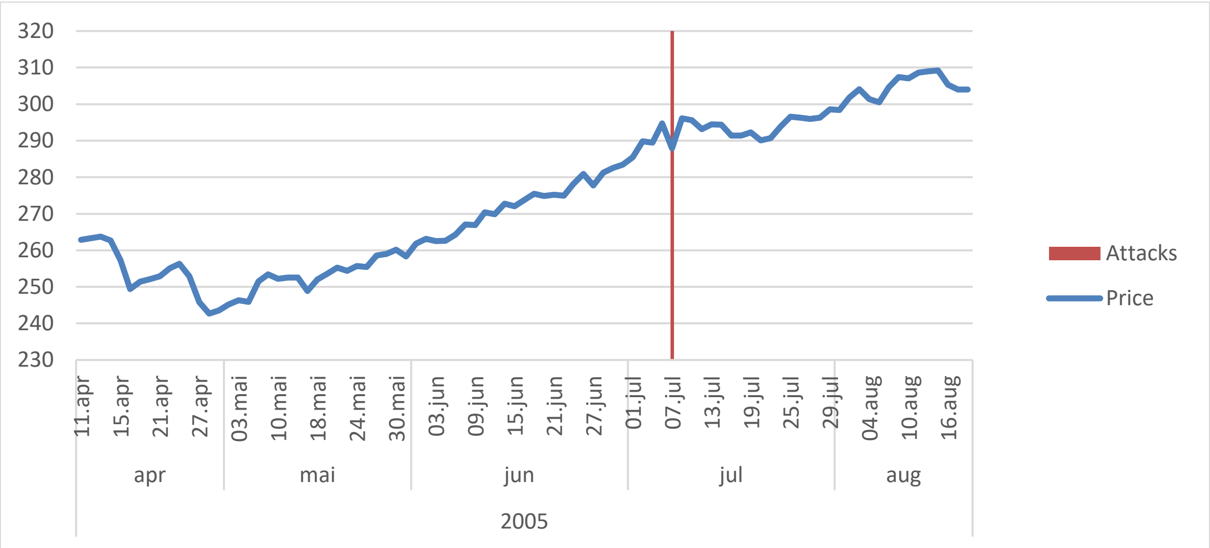

Figure 11: OBX 60 days before and 30 days after the attack in London 2005

July 22th 2011 – Utøya

	ACTUAL	30 DAYS		60 DAYS	
	Change%	AR 30	CAR 30	AR 60	CAR 60
DAY -1	0,83	0,79		0,89	
DAY 0	0,19	0,15	0,15	0,25	0,25
DAY 1	0,01	-0,03	0,12	0,07	0,31
DAY 2	0,10	0,06	0,18	0,16	0,47
DAY 3	-1,53	-1,57	-1,38	-1,48	-1,01
DAY 4	0,18	0,14	-1,24	0,24	-0,78
DAY 5	-1,01	-1,05	-2,29	-0,96	-1,73
DAY 6	-1,42	-1,46	-3,75	-1,37	-3,10
DAY 7	-2,27	-2,31	-6,06	-2,22	-5,31
DAY 8	-1,98	-2,02	-8,08	-1,93	-7,24
DAY 9	-4,83	-4,87	-12,95	-4,78	-12,01
DAY 10	-2,75	-2,79	-15,74	-2,70	-14,71

Table 11: Results after Utøya 2011

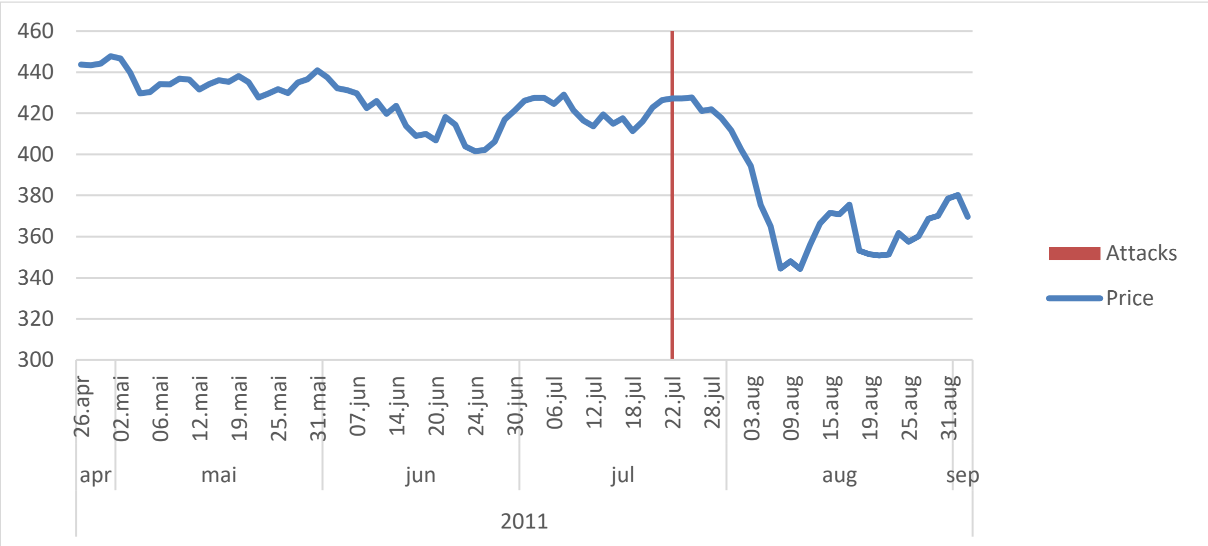

Figure 12: OBX 60 days before and 30 days after the attack at Utøya 2011

April 15th, 2013 - Boston

	ACTUAL	30 DAYS		60 DAYS	
	Change%	AR 30	CAR 30	AR 60	CAR 60
DAY -1	-0,69	-0,68		-0,73	
DAY 0	-1,51	-1,50	-1,50	-1,55	-1,55
DAY 1	-0,06	-0,05	-1,55	-0,10	-1,65
DAY 2	-1,22	-1,21	-2,76	-1,26	-2,92
DAY 3	0,77	0,78	-1,98	0,73	-2,19
DAY 4	1,14	1,15	-0,83	1,10	-1,09
DAY 5	-0,21	-0,20	-1,03	-0,25	-1,34
DAY 6	1,37	1,38	0,35	1,33	-0,01
DAY 7	0,66	0,67	1,01	0,62	0,61
DAY 8	1,24	1,25	2,26	1,20	1,81
DAY 9	0,07	0,08	2,34	0,03	1,83
DAY 10	-0,57	-0,56	1,78	-0,61	1,22

Table 12: Results after Boston 2013

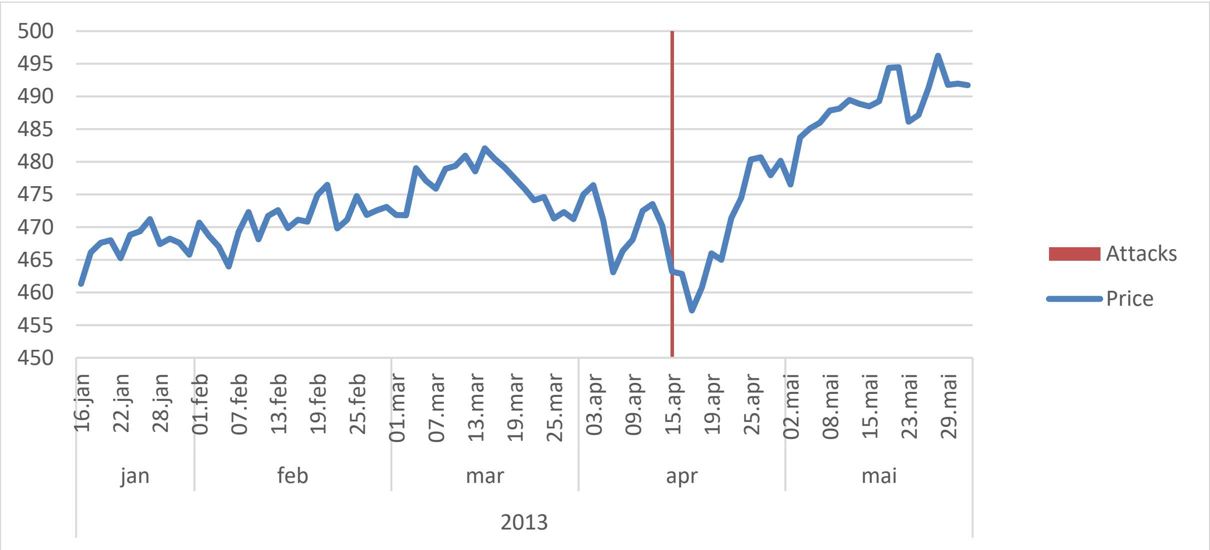

Figure 13: OBX 60 days before and 30 days after the attack in Boston 2013

November 13th, 2015 - Paris

	ACTUAL	30 DAYS		60 DAYS	
	Change%	AR 30	CAR 30	AR 60	CAR 60
DAY -1	-2,19	-2,08		-1,99	
DAY 0	-0,36	-0,58	-0,58	-0,49	-0,49
DAY 1	0,64	0,55	-0,03	0,64	0,16
DAY 2	1,36	1,31	1,29	1,40	1,56
DAY 3	1,05	0,66	1,95	0,75	2,32
DAY 4	0,00	0,01	1,96	0,10	2,42
DAY 5	-0,34	-0,52	1,44	-0,43	2,00
DAY 6	-0,13	-0,29	1,15	-0,20	1,80
DAY 7	0,15	-0,17	0,98	-0,08	1,73
DAY 8	-0,17	-0,21	0,78	-0,12	1,61
DAY 9	0,57	0,46	1,24	0,55	2,17
DAY 10	-0,46	-0,61	0,63	-0,52	1,65

Table 13: Results after Paris 2015

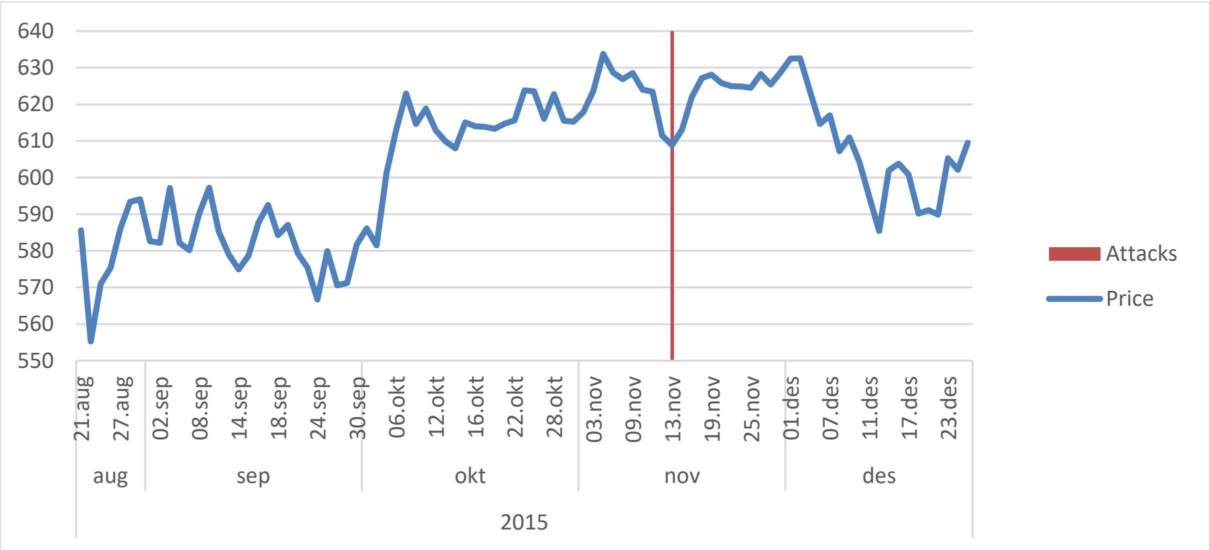

Figure 14: OBX 60 days before and 30 days after the attack in Paris 2015

July 14th, 2016 – Nice

	ACTUAL	30 DAYS		60 DAYS	
	Change%	AR 30	CAR 30	AR 60	CAR 60
DAY -1	0,36	0,30		0,25	
DAY 0	0,25	0,19	0,19	0,14	0,14
DAY 1	0,21	0,15	0,35	0,10	0,25
DAY 2	-0,49	-0,55	-0,20	-0,60	-0,35
DAY 3	0,90	0,84	0,65	0,79	0,45
DAY 4	-0,05	-0,11	0,54	-0,16	0,29
DAY 5	1,14	1,08	1,63	1,03	1,33
DAY 6	-1,03	-1,09	0,54	-1,14	0,19
DAY 7	-1,07	-1,13	-0,59	-1,18	-0,98
DAY 8	0,28	0,22	-0,36	0,17	-0,81
DAY 9	0,45	0,39	0,03	0,34	-0,46
DAY 10	-1,20	-1,26	-1,22	-1,31	-1,77

Table 14: Results after Nice 2016

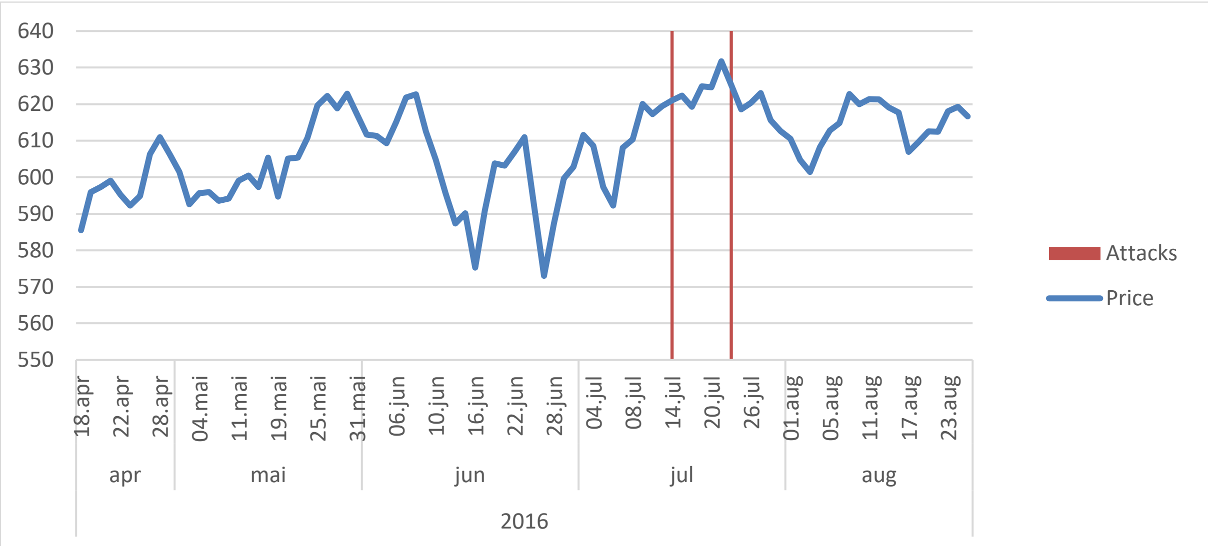

Figure 15: OBX 60 days before and 30 days after the attack in Nice 2016

July 22th 2016 – Munich

	ACTUAL	30 DAYS		60 DAYS	
	Change%	AR 30	CAR 30	AR 60	CAR 60
DAY -1	1,14	1,02		1,02	
DAY 0	-1,03	-1,15	-1,15	-1,15	-1,15
DAY 1	-1,07	-1,19	-2,33	-1,19	-2,33
DAY 2	0,28	0,16	-2,17	0,16	-2,17
DAY 3	0,45	0,33	-1,83	0,33	-1,84
DAY 4	-1,20	-1,32	-3,15	-1,32	-3,15
DAY 5	-0,49	-0,61	-3,75	-0,61	-3,76
DAY 6	-0,34	-0,46	-4,21	-0,46	-4,21
DAY 7	-0,95	-1,07	-5,27	-1,07	-5,28
DAY 8	-0,54	-0,66	-5,93	-0,66	-5,94
DAY 9	1,13	1,01	-4,91	1,01	-4,92
DAY 10	0,75	0,63	-4,28	0,63	-4,29

Table 15: Results after Munich 2016

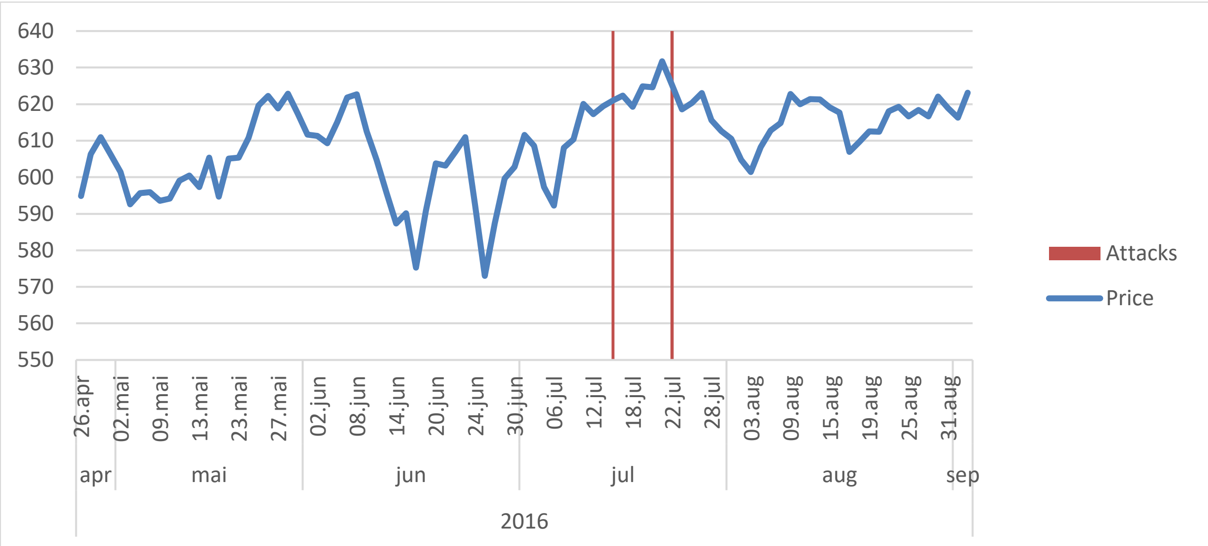

Figure 16: OBX 60 days before and 30 days after the attack in Munich 2016

December 19th, 2016 – Berlin

	ACTUAL	30 DAYS		60 DAYS	
	Change%	AR 30	CAR 30	AR 60	CAR 60
DAY -1	0,76	0,48		0,60	
DAY 0	-0,25	-0,53	-0,53	-0,41	-0,41
DAY 1	-0,09	-0,37	-0,90	-0,25	-0,67
DAY 2	-0,37	-0,65	-1,55	-0,53	-1,20
DAY 3	0,36	0,08	-1,48	0,20	-1,01
DAY 4	0,25	-0,03	-1,51	0,09	-0,92
DAY 5	0,58	0,30	-1,21	0,42	-0,51
DAY 6	0,29	0,01	-1,20	0,13	-0,38
DAY 7	0,11	-0,17	-1,37	-0,05	-0,44
DAY 8	-0,36	-0,64	-2,01	-0,52	-0,96
DAY 9	1,12	0,84	-1,17	0,96	0,00
DAY 10	0,36	0,08	-1,09	0,20	0,19

Table 16: Results after Berlin 2016

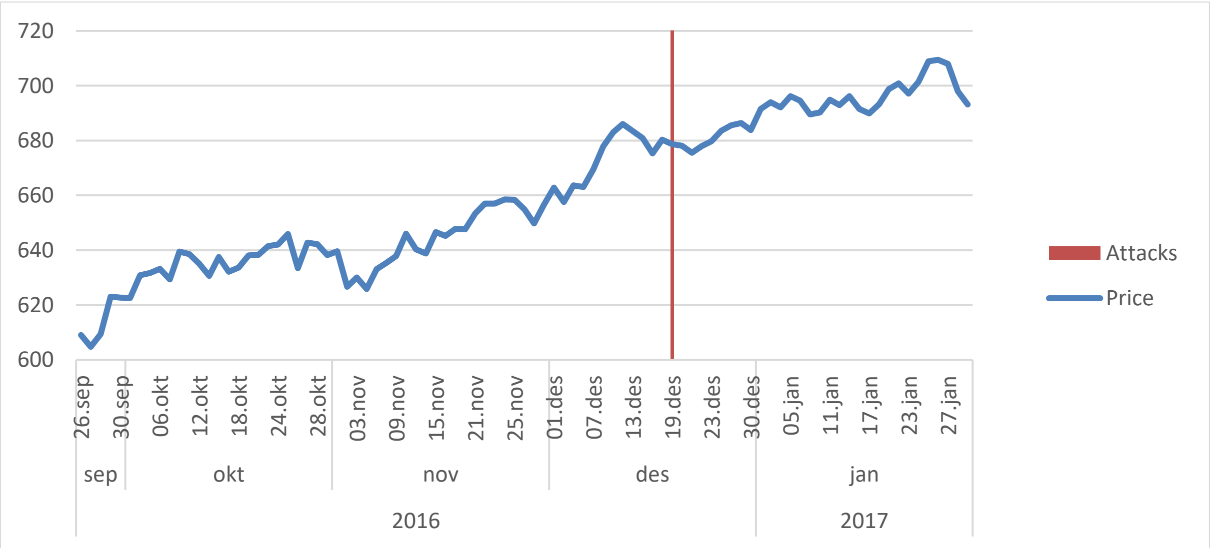

Figure 17: OBX 60 days before and 30 days after the attack in Berlin 2016

April 7th, 2017 – Stockholm

	ACTUAL	30 DAYS		60 DAYS	
	Change%	AR 30	CAR 30	AR 60	CAR 60
DAY -1	-0,16	-0,16		-0,16	
DAY 0	0,07	0,07	0,07	0,07	0,07
DAY 1	0,29	0,29	0,37	0,29	0,36
DAY 2	-0,23	-0,23	0,14	-0,23	0,13
DAY 3	0,57	0,57	0,72	0,57	0,70
DAY 4	-1,65	-1,65	-0,93	-1,65	-0,95
DAY 5	-0,43	-0,43	-1,35	-0,43	-1,38
DAY 6	0,15	0,15	-1,20	0,15	-1,23
DAY 7	-0,06	-0,06	-1,26	-0,06	-1,29
DAY 8	1,23	1,23	-0,02	1,23	-0,06
DAY 9	1,02	1,02	1,00	1,02	0,96
DAY 10	0,00	0,00	1,01	0,00	0,96

Table 17: Results after Stockholm 2017

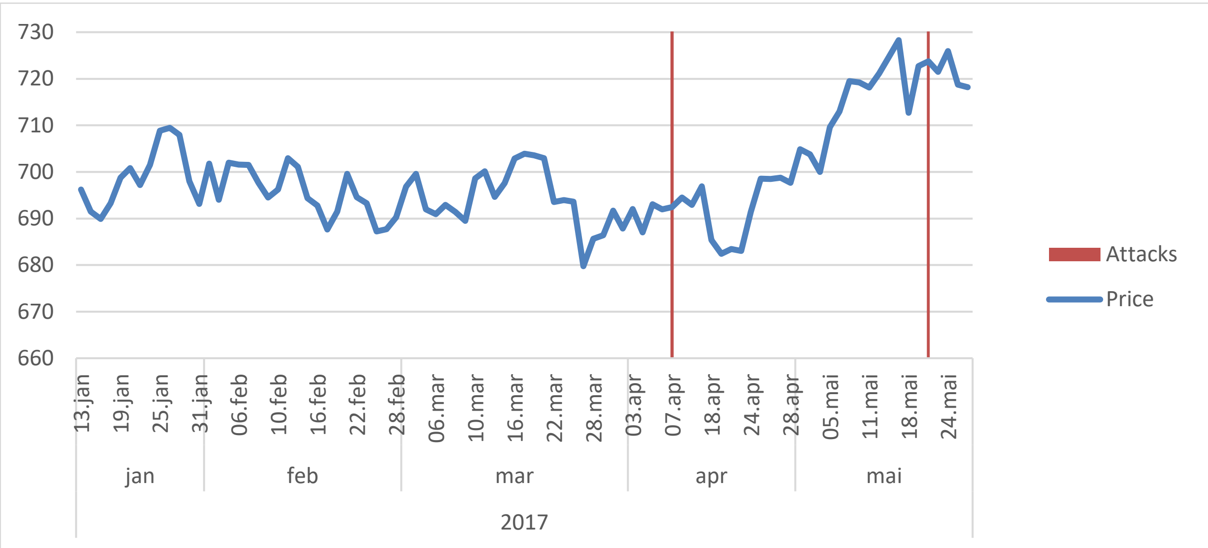

Figure 18: OBX 60 days before and 30 days after the attack in Stockholm 2017

May 22th 2017 – Manchester

	ACTUAL	30 DAYS		60 DAYS	
	Change%	AR 30	CAR 30	AR 60	CAR 60
DAY -1	1,41	1,24		1,32	
DAY 0	0,15	-0,02	-0,02	0,06	0,06
DAY 1	-0,31	-0,48	-0,50	-0,40	-0,33
DAY 2	0,62	0,45	-0,04	0,53	0,20
DAY 3	-0,99	-1,16	-1,20	-1,08	-0,87
DAY 4	-0,08	-0,25	-1,45	-0,17	-1,04
DAY 5	0,02	-0,15	-1,60	-0,07	-1,10
DAY 6	-1,11	-1,28	-2,88	-1,20	-2,30
DAY 7	0,40	0,23	-2,64	0,31	-1,99
DAY 8	-0,16	-0,33	-2,97	-0,25	-2,23
DAY 9	-0,38	-0,55	-3,52	-0,47	-2,70
DAY 10	0,24	0,07	-3,45	0,15	-2,54

Table 18: Results after Manchester 2017

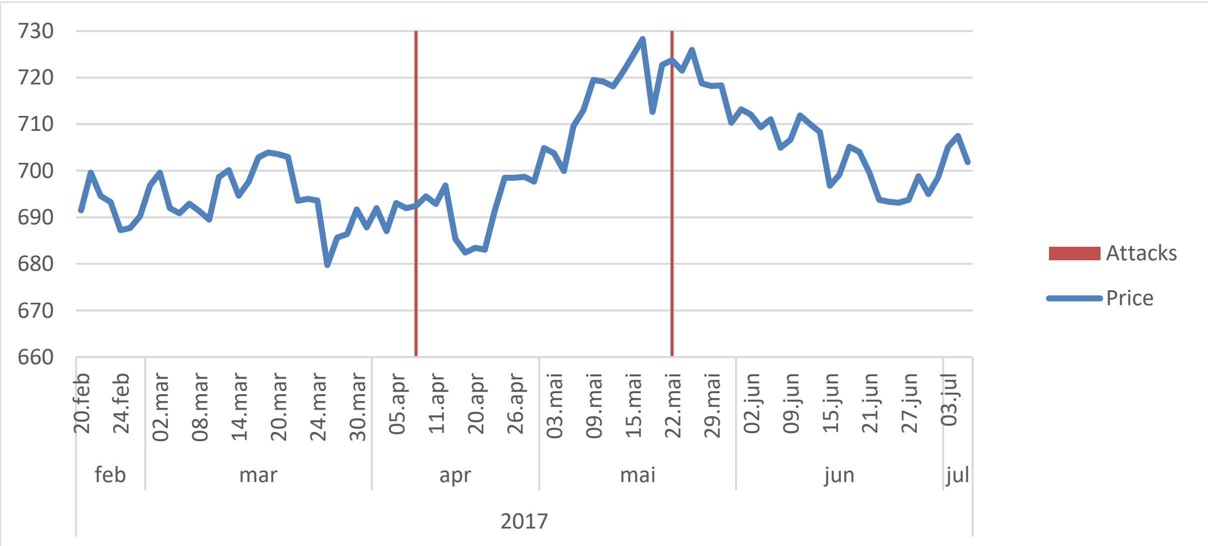

Figure 19: OBX 60 days before and 30 days after the attack in Manchester 2017