# The Effect of Oil Price Shocks on Oil Related Shipping Sectors

## An Event Study

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## Abstract

The purpose of this thesis is to assess how deterministic both positive and negative daily shocks are to oil related shipping segments. However, the effects of oil price changes on these industries are twofold. Firstly, as the shipping industry is a major consumer of oil-based energy, the price of oil greatly affects the overall profitability of voyages. Secondly, the activity levels in many shipping industries are vastly dependent on the production of oil.

Furthermore, as crude oil has become the most traded commodity in the world, scholars in finance and economics have studied the effects of its changes on returns of various indices and independent companies. Consequently, we want to extend on the existing body of research by investigate abnormalities in the returns achieved from daily shocks of the crude oil prices, and its effect on shipping segments related to the oil value chain.

We will carry out an extensive investigation by measuring the short-term value effect of daily shocks in crude oil prices, for companies within the drilling-, Offshore Support Vessel- (OSV), crude oil-, and product tanker segments. Our dataset consists of a total of 43 publicly listed companies on different stock exchanges from 2006-2015.

The results are summarized as follows: (1) Though there are differences across the companies included in our analysis, daily shocks in crude oil prices seems to create fluctuations in our portfolio of shipping firms in general. (2) The drilling-, OSV- and crude tanker segments react in a similar pattern as a result of a negative shock in crude oil price, though only the drilling and OSV segments yield statistically significant results. (3) Even though we find a pattern of positive results for drilling, OSV and crude oil tankers during positive shocks, the results lack significance and are thus considered to be less conclusive. (4) There seems to be no relation from shocks in the crude oil prices on the stock returns of product tanker firms.

The findings are consistent with previous research and our arguments for conducting this thesis, where a generalization of crude oil prices across the maritime industry will yield conflicting results compared to a segmentation of the industry. Our findings enhance the understanding of oil price shocks, and its effect on asset prices of firms within shipping industries, and should be of interest to both scholars and market participants.

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# 1 Introduction

The rapid decline in crude oil prices from the second half of 2014 has severely affected equity markets worldwide, where the crude oil prices fell from the highs of ~$120 per barrel during the summer of 2014 to ~$30 per barrel in the end of 2015. As production reached record levels during 2014 and 2015, averaging 95.6 million barrels per day, the demand only amounted to 93.7 million barrels per day (U.S. Energy Information Administration, 2015). Though the new price level was not unique by historical standards, the expeditious drop in crude oil prices has led to vast corrections throughout global financial markets. As a majority of the world's oil exporters are seemingly reluctant to hit the brakes, previous price levels for crude oil seem increasingly distant.

As markets and companies are still trying to recover and attempting to cope with the new reality, the question of how affected the different industries are to such drastic changes in crude oil prices remains unanswered. The question has been raised in academia and also market participants. Though the results have varied, El-Sharif et al. (2005) found that the equity returns earned by UK-listed oil and gas firms are primarily affected by the stock market as a whole, but also to changes in crude oil prices. Similarly, Sadorsky (2001) found a significant positive relationship between the Canadian oil and gas index and crude oil prices, where a 1% change in oil price lead to a change of 0.305% in the value of the index. For the practitioners, an understanding of the risks affiliated with the industry is of vast importance for both those directly involved in the day-to-day basis but also investors.

Furthermore, the growth of emerging economies such as China and India has become increasingly important for crude oil prices. Basher & Sadorsky (2006) documented strong evidence of oil price risk affecting stock market returns in 21 emerging markets. Lin et al. (2010) found mixed evidences from the influence of oil production shocks on stock prices in Greater China, the determinant being whether the shock stems from a supply- or demand aspect. In contrast, Cong et al. (2008) found no statistically significant relationship between oil price shocks and the Chinese stock market.

In their analysis covering the effect of fluctuations in crude oil prices and the tanker market, Poulakidas & Joutz (2009) found that an increased demand for oil leads to a raise in the tanker rates. Furthermore, in their analysis of 19 different shipping firms from 1989 to 1993, Grammenous & Marcoulis (1996) discovered that shipping returns were negatively related to changes in the oil price.

From the findings above, we register at least two evident observations. Firstly, there seems to be a vast amount of research covering the topic of oil price fluctuations and its effects on broad market indices, sectors and individual stocks. However, this is of no surprise, as crude oil is the most traded commodity in the world and thus a large amount of research can be attributed to its development. As the findings vary, the causal effect from the extensive literature seems to divide the conclusions amongst researchers.

Secondly, there seems to be a lack of research which breaks down the shipping industry into its various segments, before individually analysing the effects of oil price shocks. As will be further elaborated in this research, the different industries' dependence and reactions towards changes in the crude oil prices are expected to vary. Further, the segments included in our analysis are either directly involved in the exploration and production of crude oil, or a support function to its value chain. Due to the lack of relevant literature for the effects of oil price shocks on various shipping segments, it seems important to investigate whether they are affected by sudden drops and rises in the price of crude oil.

## 1.1 Research question

The research question will act as the core throughout this thesis, and further guide the overall direction of our analysis. Our analysis will evaluate the direct effect of crude oil price shocks to the share prices of different shipping companies. Therefore, the research question needs to be specific, measurable and relevant, as the main goal of our thesis is to present an unambiguous answer to the questions raised. As a result, we have formulated the following research question:

*How do oil price shocks affect the share prices for shipping companies in segments which are related to exploration, extraction and transportation of oil?*

Our research question will act as a pointer for the remainder of our research, whilst also providing the following sub-questions:

- Which segments within the shipping industry should be included?
- Does the specific position in the value chain affect the segments response to oil price shocks?
- Do share prices respond differently to positive and negative shocks?
- Which methods should be applied to maximize both the validity and reliability of our results?
- How do our findings compare to the previous results and why are they academically interesting?

## 1.2 Delimitations

To focus our study, we need to set some limitations for the research, which will be explained in the following section. A more comprehensive discussion will be elaborated in section 3.1.

Firstly, as many industries are undoubtedly associated in some part of the oil value chain, a connection does not necessarily imply a unison reaction to the price of the commodity. As industries are involved in different stages of the overall value chain, their reactions are also expected to differ. This should therefore be the case for different shipping industries.

Secondly, previous research has shown that the reactions from various markets and industries react differently to sudden changes in crude oil prices. As industries which are closely related to the extraction of crude oil have shown more significant effects, we will investigate the different reactions from the segments included.

Third, it would be interesting to see if there are any different market reactions to whether the shocks in crude oil prices are positive or negative. Thus, we can determine whether investors view positive shocks differently than negative shocks, and vice versa.

For the methodology, we will elaborate on the regression analysis and the event study with its following calculations. We have included a variety of both parametric and non-parametric test to ensure the validity and reliability of our research. It is worth mentioning that there are other sophisticated methods for researching the field. However, we firmly believe that the methods presented will be sufficient to answer our research question.

We argue that as previous research has analysed the effects of drastic oil price changes across greater industries, we wish to analyse the effects within the shipping industry to pinpoint the direct causal effect of such shocks for the industries in question. We also note that previous academic literature on the topic is rather pragmatic when discussing the shipping, or marine transport industry. Further, we believe that our research will supplement the existing academic literature by analysing the short-term effects of such events on specific industries.

Overall, the research is divided into two separate studies, where we wish to analyse the effects of both positive- and negative shocks related to the price of crude oil. This is a result of previous research on the topic, whilst we also believe that the fact that we have included various segments their reactions towards the different kind of shocks may vary. In addition, the results of a positive shock in the crude oil prices for an industry might not necessarily imply an opposite result of that of a negative shock.

## 2 Literature review

The topic covering fluctuations in various commodity prices and their effects on equity markets has been vastly debated throughout the financial theory. Even though commodities and equities are traded on different exchanges, there is a great deal of dependence between the two.

The effect on the overall market from changes in commodity prices are twofold; on the one hand, as one sector uses the commodity in its production, an increase (decrease) in the commodity price will push the cost of goods for the company up (down). On the other hand, companies who produce the commodity, will then benefit (detriment) from an increase (decrease) in the price of the commodity. We have chosen to look specifically at the daily effects on the return of shipping companies within the drilling, offshore support vessels (OSV)-, crude oil tanker-, and product tanker segments respectively, and their reactions towards various shocks in the oil price. As will be further explained and elaborated below, there is a widespread of academic literature on the topic of crude oil- and equity returns.

The development of the oil price is a popular field of study, where many researchers have analysed the effect it has had on individual equities, specific segments, and also national indices (Grammenos & Arkoulis, 2002; Aggarwal et al. 2012; Hamilton, 1983). A high proportion of the research covering the effects of oil price changes stems from the oil and gas industry (Sadorsky, 2001), and thus we have been unsuccessful in finding comprehensive comparable research on the various shipping segments.

There is little doubt about the industries' sensitivity towards large fluctuations in the oil price. Earlier post-war analyses showed that measures of monthly oil price shocks are good predictors of output (Mork, 1989). However, others have shown that over time, these changes in output are short-lived; counter-actions such as alterations in monetary policy pull the economic situation back to normality (Bernanke, Gerlter & Watson, 1997). Similarly, Lee & Ni (2002) studied the long run supply and demand effects of oil shocks on different industries. They found that the predominant effects of oil shocks are on the supply side for industries which are oil-intensive in production. Conversely, they found that industries that are less oil-intensive in production experienced the effects on the demand side.

Manning (1991) studied the interaction between the variation of crude oil prices and the share prices of oil companies. As a hypothesis, he wanted to analyse different reactions in the market price of three different types of portfolios of oil companies to the crude oil price (one with only fully integrated companies, one containing specialized Exploration and Production (E&P) companies, and a portfolio combination of the two). He argued that the effect of oil price news is greater for the E&P portfolio than for the portfolio consisting of fully-integrated firms. As a result of testing his first hypothesis, he found serial correlation in the weekly portfolio returns and lagged effects of the oil price changes, which he argued were indicators of market inefficiency. Further, his findings also showed that there exists an effect resulting from unanticipated oil price changes in the returns of the three oil stock portfolios over the period 1986 – 1988.

As many researchers have studied the effect of the oil price and macroeconomic factors, Park & Ratti (2008) estimated the effects of monthly oil price shocks and the real stock returns of U.S. and European countries over the period of 1986 - 2005. Their findings showed that oil price shocks have a statistically significant impact on real stock returns within the same month.

Interestingly, they found that oil price shocks account for 6% of the volatility in the stock market. This implied that increased oil price volatility lead to a statistically significant depressed real stock returns contemporaneously or within one month for most countries. Furthermore, they found that oil price shocks contributed more to the variability in real stock returns than the interest rate. Similar studies have also shown that oil prices and its volatility play an important role when trying to explain economic activity, whilst changes in economic activity has a little impact on oil prices (Sadorsky, 1999). In addition, their research showed that the dynamics in the oil price has changed, in that the oil price movements explain a larger fraction of the forecast error variance in real stock returns than other factors, such as the domestic interest rate.

Ciner (2012) analysed how oil price shocks affected stock price movements when accounting for the time variation. They focused on how persistent the shock is and to what extent the persistence affected the stocks. By applying the monthly data of the West Texas Intermediate (WTI) crude oil prices, S&P 500, Nasdaq Composite and 20 large companies from DJIA, they found that oil price shocks with persistency less the 12 months was negatively related to stock returns, this was however not applicable for oil stocks, which reacted positively to the change. When looking at shocks with persistency of 12 to 36 months, they found a positive response in the stock market, while shocks lasting longer than 36 months were negative. Similarly, Huang et al. (1996) investigated the relationship between daily oil futures returns on daily U.S. stock returns. The findings they presented showed that oil future returns lead to some individual oil company stock returns. However, they also found that oil future returns do not have much impact on broad-based market indices.

Lin et al. (2011) analysed the relationship between oil price shocks and economic activity in greater China. They investigated monthly data of changes in oil production and real import oil price, in addition to real stock index returns and real activity data explained by representative single voyage freight rates used to measure global oil demand. Their findings showed that all supply shocks have a significant positive impacts on the Hong Kong and Chinese stock markets, while the effect of oil price shocks in Greater China have been mixed. Regarding global demand shocks for oil, both Hong Kong and Taiwan are significantly affected in a positive matter, while China seems unaffected. This is explained by the Chinese stock market's independence from world stock markets and global economy. The period of the analysis appears to be influenced by the high Chinese growth for the period, which might have offset any increases (shocks) in the oil price. Only global supply shocks have a positive impact on China's stock return, whilst global demand shocks and oil-specific demand shocks appear insignificant.

Hammoudeh & Li (2005) applied data from 1986 to 2003 on 3-months NYMEX oil futures, the MSCI world index and four oil sensitive indices including U.S. Amex Oil Index, NYSE Transportation index, Mexico Stock Exchange Mexican Bolsa IPC Index (MEXBOL) and Norway's Oslo Stock Exchange All Index (OSEAX). They found that there is a positive relationship between the oil price and OSEAX and MEXBOL. Additionally, when using the arbitrage pricing theory framework to investigate the impact of oil futures and the MSCI on the oil-sensitive stock returns, they observed that the systematic risk relative to the world capital market returns are way more important in explaining the sensitivity compared to the oil price change.

Another interesting topic which has been covered is the development of the oil price in relation to the transportation sector, consisting of marine transportation, but also railroad, aviation, etc. Evidence has shown conflicting results, both when looking at oil price shocks, but also looking at the development of the oil price over time. Where it has been found the transportation sectors react negatively (positively) to oil price increases (decreases) (Gogineni 2010), other studies have found discrepancy when analysing across sectors. In their research consisting of 560 US firms over the period of 2000-2008, Narayan & Sharma (2011) found that oil prices affect firm returns differently, both in terms of sign and magnitude. In contrast to the results presented in Gogineni (2010), they found that the transporting sector experiences a rise in returns when oil prices rise. This was also the case for the energy sector, whilst the other 12 sectors experienced a fall in returns. Their results suggested that as different sectors have different market structures and thus are heterogeneous, the oil price is likely to affect firm returns in different sectors differently, implying that the effect of oil is heterogeneous across the market.

On the other hand, Nandha & Brooks (2009) found strong support for the role of the oil prices when explaining the transport sectors negative risk premium. For the countries falling within the "Developed", "Europe" and "G7" groupings, the oil factor was jointly significant at the 1% level negative risk premium. Interestingly, they find no such relationship for other country groupings such as "Asia Pacific", "Latin America" and "Developed". However, their results reflect some limitations, namely the fact that some countries regulate the transportation sector in one way or another.

When Grammenos & Marcoulis (1996) searched for a relationship between global macroeconomic risk factors and returns of international shipping stocks, they analysed the stock returns of 19 shipping companies within the tank, bulk, OSV and cargo segments listed in the U.S., Norway, Stockholm and London over a five year period. First, they found that the market beta was statistically significant in support of the CAPM. Like many prior researches, they concluded that the market-beta does not hold a great deal of explanatory power. However, they also found company specific factors to hold more explanatory power when only explanatory variables were applied in the model. Such factors were the average age of the fleet and the book-value of leverage, where the average age of the fleet was negatively correlated with the returns. They found that changes in oil price (among other factors such as laid-up tonnage) were negatively related to shipping stock returns for all markets. Interestingly, the authors applied a model where dynamics are incorporated, as Poon & Taylor (1991) and Wasserfallen (1989) argue that lead and lag values of each macroeconomic variable have a role to play, since the former reflect the slow impact of macroeconomic shocks while the latter reflect expectations.

Grammenos & Arkoulis (2002) investigated the relationship of macroeconomic risk factors and the returns of shipping stocks. They applied data for industrial production and inflation numbers for the "G7" countries in addition to price changes in Brent crude oil, currency fluctuations to the US Dollar and changes the laid-up tonnage in the tanker- and bulker segment, all from 1989 to 1998. Their research showed that changes in Brent oil prices were both negatively related and statistically significant when trying to explain the return of the shipping stocks. This was also the result for the laid-up tonnage. However, the exchange rate variable exhibits a positive relationship. Furthermore, no significant relationship was found for the global measures of neither inflation nor industrial production. However, an interesting result from their research was that the factors were consistent in the way they affected shipping stocks internationally, as the shipping stocks in Norway had the highest market-beta, whilst the lowest was observed in the U.S.

El-Masry et al. (2010) studied the exposure of shipping companies towards several macroeconomic factors such as the exchange rate, interest rates and oil prices using to the return of 143 companies in 16 different countries from 1997 and 2005. In contrast to previous research, their findings suggested that shipping firms in general are more affected by the exchange rate fluctuations than interest rates. They argued that shipping companies are well able to manage and suppress the effects of these risk factors effect on their stock return. Specifically, they observed that a high proportion of shipping companies benefited from an appreciation of the dollar as well as an increase in oil price. The positive relationship between shipping companies and the oil price could also be explained by an increase in the price of commodities, such as oil, as it acts as an indicator for the state of the world economy. Furthermore, the authors acknowledge that segregating the shipping industry into its respective sectors might enhance the empirical results and shed more light on their industry specific exposure.

Whereas El-Masry et al. (2010) found a positive relationship between oil price increase and return on the majority of their shipping companies, Drobetz et al. (2010) focused on the development of the container-, tanker- and bulker sector in 48 different countries. In their analysis, they could only find a statistically significant relationship between the development of the oil price and container rates. Their research further suggested the relationship could be explained by considering oil price increase as a proxy for increased economic activity, which arguably affects the transportation sector in a positive direction. Though their findings were statistically significant, it must be taken into consideration that the research was done in a rather bullish industry.

Poulakidas & Joutz (2009) explored the effect of oil price changes on tanker rates during the period between 1998 and 2006. Their investigation included weekly WTI oil spot prices, its equivalent 3 month futures, U.S. crude oil inventories and the Baltic Dirty Tanker Index (BDTI). Their research found Granger causality in the spot rates when applying the past knowledge of spot tanker rates, spot- and future contracts of the WTI and the crude oil inventories. Their findings suggested that when the price of 3-month futures contract of crude oil is trading above the spot price, there is an upward pressure on spot tanker rates. Similarly, a strong demand for oil implies a stronger demand for tankers. In addition, they were able to find co-integration between oil tanker rates and spot oil prices, which they suggest could be explained by the tanker demand working as the derivative of the demand for oil.

Aggarwal et al. (2012) analysed the impact of oil price shocks on the 71 transporting firms who make up the S&P transportation index. They analysed the effects on the stock returns of the transporting companies with respect to large changes in the spot price of WTI oil. These shocks were distinguished between positive and negative shocks, where a positive shock implied a daily increase in the oil price of minimum 5%, and conversely a reduction of -5% implied a negative shock[1]. In general, their findings clearly suggested that the returns on transportation firms are significantly affected by these shocks. The authors also found that the results from these shocks often differed for the firms within the marine sub-sector. In general for the transportation segment the firm returns and risk exposure to oil price shocks are asymmetrical; where returns are significantly influenced by oil price increases whilst risks are influenced by oil price declines.

As a conclusion of the previous literature analysing the effect of the oil price development with various stock returns, there seems to be conflicting results on the effects, which is vastly dependent on which industry that is analysed. We therefore argue that as the research has shown contrasting results throughout different industries, there are evidences implying that the degree and direction in which such shocks will affect different shipping companies will vary. Subsequently, it would therefore be reasonable to assume that oil price movements will yield different results also within the shipping industry, which is why we wish to analyse the effects by breaking down the shipping segments.

For our analysis, we wish to contribute to the existing literature by furthering our understanding on the different segments within the shipping industry. By expanding on the suggestions by El-Masry et al. (2010), we wish to contribute to the existing literature by analysing how such oil price shocks affect the daily returns of shipping companies within a specified range of shipping sectors. Furthermore, as base for our analysis we wish to apply the similar methodology and distinction between positive and negative shocks as introduced in Aggarwal et al. (2012).

[1] For the remainder of this paper, we apply the same definition as Aggarwal et al. (2012) where a "shock" is defined as a daily change in the oil price equivalent to ±5%

# 3 Data

In this section of our research, we will discuss the data selection and the criteria surrounding our selection. It is important to note that the data selection and methodology parts will complement each other on some areas.

## 3.1 Data selection

Our research question and hypotheses will guide the criteria for our data selection. As our main focus for this research is to analyse the effect of oil price shocks on selected shipping segments, we have chosen to collect data from the largest public shipping companies within each segment. After thorough considerations, we have determined our final dataset based on the following selection processes. A collection of companies which we have been both included and excluded from our research can be found in Appendix 1 and 2.

### 3.1.1 Selection process 1

1. The company will have to be publically listed
2. The company has to be listed on a major exchange
3. The company has to be listed during at least one of the estimation periods
4. All data will have to be available on Thomson One Reuters Datastream
5. The oil price shock has to be related to a change in the Brent crude oil spot price
6. The oil price shock has to be between 01.01.2006 and 31.12.2015

Firstly, the fact that the companies have to be publically traded makes us able to track daily movements in both stock prices and trading volume, a requirement needed to conduct the event study application explained in the methodology part.

Secondly, we have only included shipping companies within the segments which are listed on a major exchange. Furthermore, we have excluded companies on minor exchanges (such as Oslo Axess), this is due to the fact that by only including shares registered on the major exchanges we ensure that we have included the stocks with the largest trading volume and longer trading history.

As a third requirement, we have only chosen companies which have been listed on an exchange for a minimum of one of the estimation windows. The reason why we include companies which have not been listed during the entire period is the fact that we have experienced that a lot of the companies that we have considered, were not listed until after the early period of the estimation window. However, for each event, we will clarify which companies who are excluded from the analysis.

Fourthly, we have chosen to extract all relevant data from Thomson One Reuters Datastream. As one of the most comprehensive economic and financial time series databases, we apply the platform as it is regarded as a reliable source of data extraction. Similarly, we have extracted the closing price of the Brent crude oil spot price from the Thomson One Reuters Datastream platform. As all data is extracted from the same database, we further argue that by extracting all data from one source, we exclude any risk of invalid data composition which might arise when extracting data from multiple sources.

Fifth, in contrast to many of the previous researches involving the changes in oil prices' effect on asset returns, we have chosen to apply the Brent crude oil spot price as a benchmark for the development of the oil price. Furthermore, we have chosen the Brent crude oil as it has in later years been considered the overall benchmark for crude oil prices (U.S. Energy Information Administration, 2014). We apply the spot price instead of the futures prices, as most of the literature are constructed by applying the spot prices. Also, previous studies have shown that stock prices respond mainly to changes in oil spot prices. Lastly, as spot prices carry stronger signals for stock prices, and only a small part of the spot price changes might be anticipated by futures prices and that possibility is even smaller given our focus on large oil price shocks (Aggarwal et al. 2012). Further, Hammoudeh (2015) argues that the futures price is myopic and highly exposed to behaviour of zealous speculators, which result in incorrect signals regarding expected future oil spot prices.

The sixth requirement is that the oil price drops/increases have to be within the time-frame of our analysis, which we have set to be between 01.01.2006 and 31.12.2015. Initially, we wished to apply as long as possible research period. However, due to the fact that we require the company to be publically listed, many of the companies within our segments were not publically listed prior to the beginning of our research period. Rather than setting our research period at an earlier starting period, we have chosen to start our research at 01.01.2006 to ensure that there are approximately the same amounts of companies included in our analysis at each event. We have therefore chosen a 10-year time-span, which we argue will provide sufficient data as well as the possibility to cover shocks that come from a wide array of sources, which will be highlighted in section 5.1.2.1.

### 3.1.2 Selection Process 2

We introduce a further set of criteria for our data selection, as some of the deals did not have adequate quality or information required to analyse our hypotheses.

7. For the company to be classified into one segment, a minimum of 75% of the company's fleet needs to fall under the specific segment
8. The market capitalization of the company must be, on average, ~1 billion NOK
9. Stock prices need to be available for a minimum of 250 days in the estimation window to be included in the designated event[2]
10. The stock price has to be available for all days in the event window
11. The stock price has to be traded at least 2/3 of the days in the estimation window

As many shipping companies have vessels operating in different segments, the classification of a pure play company in each segment would eliminate too many companies from our research. Furthermore, by the limitations in the research of Aggarwal et al. (2012) and by the encouragement provided by El-Masry et al. (2010), we argue that shipping companies in different segments are most likely to react differently to a change in the oil price. We therefore need to do some segmentation as including companies with large investments in different segments might distort our results. As an easily quantifiable and objective determination of core business, we have simply analysed the company's fleet composition to expeditiously determine in which segment the company operates under. Therefore, as a sixth requirement, we set the cut-off at 75% of the company's fleet to fall in under a specific segment to be included.

The seventh requirement states that over the period of research, we exclude any of the smaller companies by restricting the inclusion to companies to those which historically have had a market capitalization around 1 billion NOK. This requirement is linked to the second selection requirement, which limits the available companies to those which are expected to both have

[2] For estimation period 3, the total number of estimation days is only 202 trading days. For a company to be included, it has to be listed for the entire estimation period.

adequate trading volume and trading frequency. This is a natural cut-off to exclude any minor companies which will be more influenced by smaller and infrequent trades, potential biases to our results.

The eighth requirement involves the fact that we apply a 250 day estimation window. However, due to the fact that the fourth estimation window only has 202 trading days is available, we have included this estimation window for the calculations in event 9. The application of this requirement is further explained in the methodology part.

The ninth requirement enables us to exclude any stocks which are not available during the event windows surrounding ±10 days, ±5 days, ±2 days and ±1 day the of the shock. As requirement eight, this will be further elaborated in the methodology part.

The final requirement is included to account for any problems related to thin trading. The presence of thin trading occurs when the asset in the sample is traded infrequently so that the relative return approaches zero. Furthermore, we believe that the illiquidity of such stocks might yield biased results. This occurs as the observation will give a less risky result, as the covariance with the market, represented through the beta of the market model, will be biased downwards. Even though research has been introduced to provide correct beta estimations through OLS on thin traded stocks (Scholes & Williams, 1977 & Dimson, 1979), Cowan & Sergeant (1996) found no evidence of any estimation improvements. Therefore, we have simply chosen to exclude the companies which are not traded in 1/3 or more of the estimation period. Furthermore, Karpoff's (1987) review of literature regarding the relationship between price changes and trading volume shows that there are empirical relations between volume and the magnitude of the price change. We therefore need to make sure the sample included in our analysis is traded in a certain volume, as low volumes decrease the quality of the data. This exclusion is simply conducted by excluding companies without movements in the stock price more than 2/3 of the estimation period.

# 4 Methodology

## 4.1 Introduction

For our analysis, we have chosen to divide the analysis into two parts. For the first part, we will analyse the shocks which are negative and below -5% per day. For the second part of our analysis, we will evaluate the effects of shocks which are positive and greater than 5% per day. The analysis will help us conclude on the hypotheses which will be presented in section 6.

## 4.2 Event study

There is no resolute method for measuring the effect of oil price shocks on equity returns. In order to measure if there is an effect from the shock, we have chosen to use the reaction of the changes in the stock prices of the companies surrounding the events. We have chosen to look at the stock price as it reflects the true value of the firm, given that the market is efficient. The stock price incorporates the relevant value which influences a stock price, and reflects any relevant information as well as the discounted value of expected future cash flows. We therefore argue that, should the value of the firm be affected by a change in the oil price, it should be reflected by a change in the stock price. The applications of event studies have been widely applied in previous research to examine any short-term effects a pre-specified event has on a companys value. For our analysis, we will base our research on the event study framework presented in Campbell et al. (1997).

An event study studies the abnormal return of companies before, during, and after a common type of event, where the goal is to analyse whether the event has any influence on the company's share price. Examples of comparable events include, amongst other, earnings-, and company announcements, CEO or Board removals, mergers and acquisitions, issuance of new debt or equity, change in equity, or in our case, a change in a key macroeconomic figure. The overall idea behind the event study is that the market processes the information surrounding an event in an efficient and unbiased manner. Thus, in general, it tests whether the efficient market hypothesis holds, where all available public information will be reflected in a stock price at any time. However, as we apply event windows that are longer than one day (the day of announcement, or shock), we implicitly assume semi-strong markets in our study to allow for any leaked- or lagged effects in the market.

When comparing the actual observed returns to the estimated expected returns, we will be able to identify in which way the short-term effect on the share price reacts to both a positive- and negative shocks in the crude oil prices. By dividing the shocks into positive and negative, we are also able to conclude whether the stock prices react differently given that the shock is either positive or negative. By calculating a company's abnormal return, we are therefore looking to measure the "surprise effect" of the positive and negative shocks.

### 4.2.1 Five-step event study process

Before conducting the study, we need to define the events of interest and also the periods over which the securities involved will be examined. We then determine the selection criteria for the inclusion of the securities in our study, which was introduced in section 3.1. To appraise the event's impact we require a measure of the abnormal return. The abnormal return is given by the actual *ex post* return of the security over the event window, and is defined as the return that would be expected if the event did not take place. For each security *i* in time *t*, we have

$$\varepsilon_{it}^{*} = R_{it} - E[R_{it} \mid X_t] \qquad (4.1)$$

where the normal returns are defined as the returns on the firm's stock if the event had not occurred. Conversely, we define the abnormal returns as the actual returns subtracted by the normal return.

Once a normal performance has been selected, we apply the parameters from the *estimation window*. By applying the coefficients retrieved from the estimation window, we calculate the expected returns in the *event window*, and test for any abnormality in the returns. The results are then organized, analysed and statistically tested in different ways. After performing these steps, we will be capable to determine whether there are any abnormal returns in the various shipping segments as a result of an oil price shock. In the following, we will further present and elaborate on the steps within the event study model.

The framework presented by Campbell et al. (1997) provides a detailed explanation of the general approach for an event study. However, we have chosen to apply the steps presented in the studies of Bowman (1983) and Henderson (1990). In their research, they present five steps which are relatively standardized, and we will further explain each of the steps in detail to adjust it to our oil price shock study.

1. Determine dates
2. Calculate the expected returns
3. Measure abnormal returns
4. Organize and accumulate the abnormal returns
5. Analyse and statistically test the abnormal returns

#### *4.2.2.1 Determine dates*

After defining the event, we must determine the dates when the event took place. The important issue regarding the event date is that it should be the date in which the news arrives in the market, and not necessarily when it occurred. For our analysis however, the event is immediately observable to the market and thus the market immediately observes the event.

To estimate the expected return, we include a period of daily share prices prior to the event is required. This period in an event study is referred to as the estimation window. An important assumption behind the estimation of the parameters in the estimation window is that the period should represent the true and normal return of a stock. Furthermore, this implies that the parameters which are collected would not be affected if the estimation window is increased to infinity. When assuming normality in the estimation window with the true return of a stock, the analysis will assume that we have no sampling errors in the coefficients of the market model applied for calculating expected returns, as the sampling error variance term asymptotically will approach zero.

Normally the length of an estimation window is set to be between 200 and 250 trading days, equivalent to 9-12 months prior to the event (Bartholdy et al. 2007). However, for our parameters to be as unbiased as possible, we have identified four estimation periods, within our research period presented in section 3.1 in which the oil price has not experienced a daily shock of ±5% to calculate the regression coefficients. The estimation windows applied to calculate the coefficients have stretched over the following time horizon:

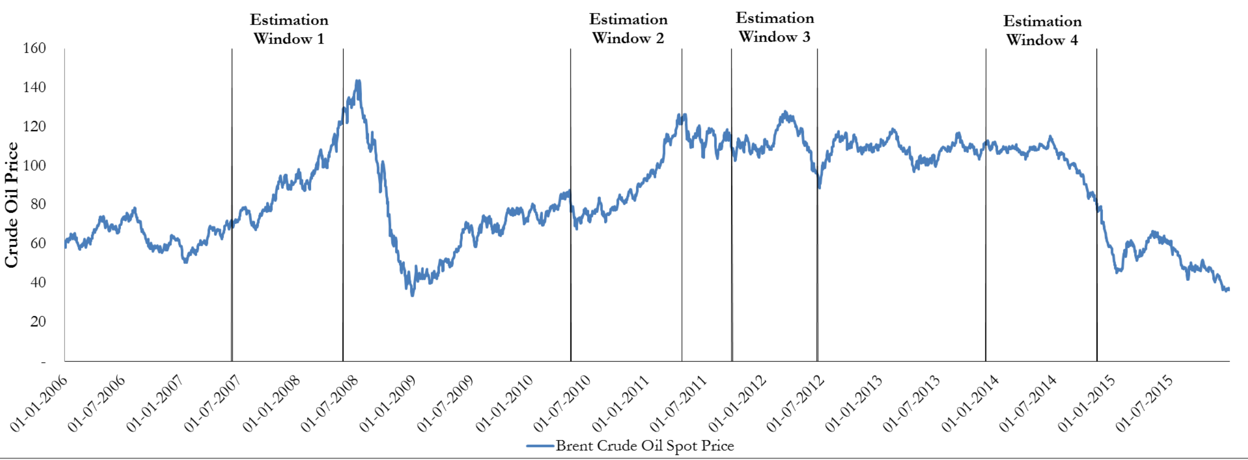
**Table 4.1**

| Estimation window | Start | End | Trading days |
|---|---|---|---|
| 1 | 08-06-2007 | 22-05-2008 | 250 |
| 2 | 06-05-2010 | 20-04-2011 | 250 |
| 3 | 23-09-2011 | 18-06-2012 | 202 |
| 4 | 28-11-2013 | 12-11-2014 | 250 |

The figure below illustrates the respective estimation windows.

**Figure 4.1**

**Brent Crude Oil Spot Price Development with estimation windows**




The first day in the estimation window is denoted $T_0$, whilst any daily notifications of time is denoted by t. The estimation window ranges from day $T_0$+t to $T_1$. The length of the estimation window is denoted as $L_1$.

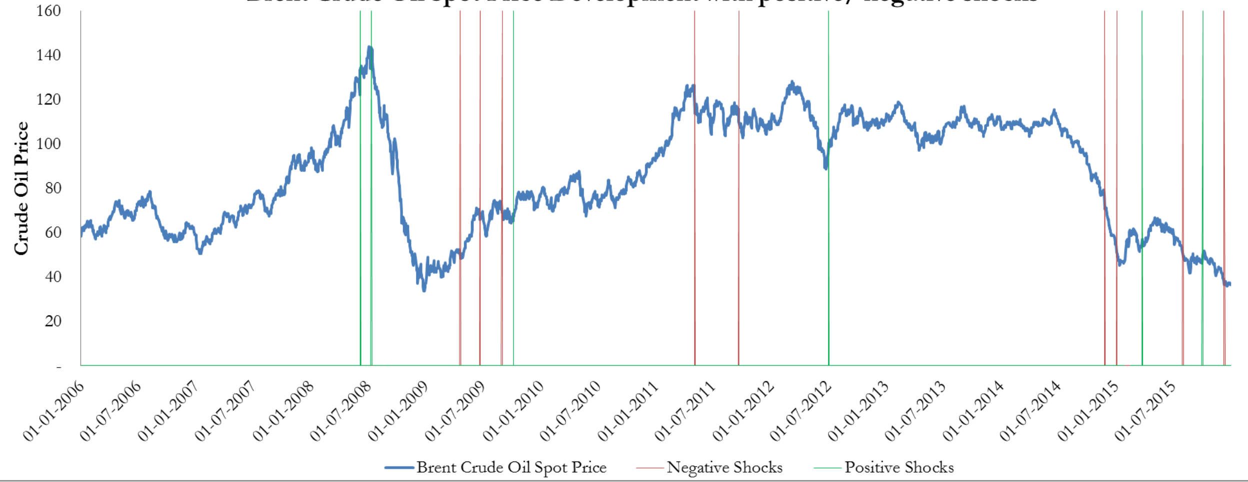
The event window is the time-span where any effects of the event is assumed to reveal the abnormal returns. The window surrounding the event is set to be a short period before and after the date of the shock. However, in our analysis, we will not apply many days prior to the event, as the shock is as visible for all market participants. Though, we have included a short period prior to the shock to account for any possibility of any rumours or preventive actions that have affected the market's reaction. On the other hand, the period after the event is used to make sure all relevant public information has been priced into the shock. Allowing for a period after the shock also gives the market time to adjust to the shock. Furthermore, this enables us to see whether there are any lagged effects of the shock. A delayed reaction from the market has been documented in previous research (Manning, 1991). Based on previous research, the normal range is set symmetrically between 10 and 1 days before the event (Campbell et al. 1997), whilst Aggarwal et al. (2012) applied a variety of ranges, from 11 days to the actual event date for their analysis. For our research, we will test the abnormal returns in the period ±10 days, ±5 days, ±2 days and ±1 surrounding the event. Similar to the restriction in the estimation window, we have excluded any events where any other shocks have reoccurred within the 21 day estimation window. The 15 events applied in our research are given in the table below:

**Table 4.2**

| Event number | Event date | Oil price change | Positive/ Negative |
|---|---|---|---|
| 1 | 06-06-2008 | 8,592% | Positive |
| 2 | 11-07-2008 | 5,643% | Positive |
| 3 | 20-04-2009 | -6,133% | Negative |
| 4 | 22-06-2009 | -6,701% | Negative |
| 5 | 31-08-2009 | -5,315% | Negative |
| 6 | 06-10-2009 | 5,035% | Positive |
| 7 | 05-05-2011 | -5,706% | Negative |
| 8 | 22-09-2011 | -5,050% | Negative |
| 9 | 03-07-2012 | 5,049% | Positive |
| 10 | 27-11-2014 | -8,747% | Negative |
| 11 | 05-01-2015 | -6,498% | Negative |
| 12 | 26-03-2015 | 5,157% | Positive |
| 13 | 03-08-2015 | -5,870% | Negative |
| 14 | 05-10-2015 | 6,159% | Positive |
| 15 | 11-12-2015 | -5,104% | Negative |

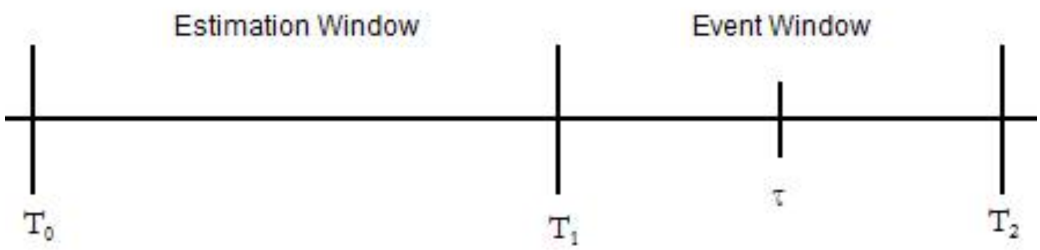
The following figure gives a good overview of the shocks we will include in our analysis, which is extracted from the development in the Brent crude oil price the last 10 years:

**Figure 4.2**
**Brent Crude Oil Spot Price Development with positive/ negative shocks**




The event window starts at $T_1$+t and will range to $T_2$, where the length of the event window is denominates as $L_2$. A graphic illustration of the different windows discussed above is given below:

**Figure 4.3**




### *4.2.2.2 Calculating expected returns*

When trying to estimate the stock return of a company, various models have previously attempted to estimate the true stock return. For our research, we have chosen to apply the well-known market model for the calculations of the expected returns. For this section, we will briefly discuss alternative models to the market model which are applicable for calculating the expected returns, and elaborate on the model we have chosen and its method, but also its assumptions.

In the financial theory, there are several prominent market models. The simplest model, the mean market return model applies historic returns when calculating the expected returns. Compared to both the market model, the mean market return model does not take into account any movements in the market nor the systematic risk component, and is thus excluded from our research. Another, and perhaps the most widely applied model, is the Capital Asset Pricing Model (CAPM). However, like all other estimation models, it has its limitations. For the CAPM, it assumes that all prediction errors are zero for all firms regardless of its size or market capitalization. This assumption implies that $\varepsilon_{it} \sim N(0, \sigma_{\varepsilon i}^2)$. In addition, the CAPM is based on assumptions concerning the behavior of investors. A third model is the market-adjusted return model.

The market-adjusted model measures the return on the market and expects that the equivalent returns are valid for the specific company. The model depends on the same theory as the market model. However, the market model is considered to be more precise, as it includes both an intercept through the alpha and a slope coefficient through the beta, which is specific for each firm. A last alternative is the more sophisticated multifactor model, which incorporates additional explanatory variables in the regression. These factors are included to capture more of the variations in the stock returns. However, empirical results have shown that these additional variables have little or no explanatory power and there are thus limited gains of applying the model (Campbell et al. 1997).

As mentioned above, we have chosen to apply the market model for our research. This is due to the fact that it is simple and argued to be as precise as any other estimation models when conducting an event study (Dyckman et al. 1984; Cable & Holland, 1999). In addition, this method is applied in the study of Aggarwal et al. (2012).

To apply the market model, we regress the return on the market on the return of a single stock. This implies that the market model is a time series regression model, where the return of an asset is estimated as a linear function of the returns over a certain period (Cuthbertson & Nitzsche, 2004). The time series regression follows the following static model, for security *i*, in time *t* :

$$y_{it} = \beta_o + \beta_i Z_{it} + \varepsilon_{it} \quad \text{for t} = 1,2, \ldots, \text{n} \qquad (4.2)$$

For the market model, where we regress the return on a selected market portfolio of the return on a single asset, we get the following equation:

$$R_{it} = \alpha_i + \beta_i * R_{Mt} + \varepsilon_{it} \quad \text{for t} = 1,2, \dots, \text{n} \ \& \ \varepsilon_{it} \sim N(0, \sigma^2_{\varepsilon i}) \qquad (4.3)$$

As the linear regression above seeks to explain the progression of one asset by another variable (the market portfolio), it follows that the estimations from the model will deviate from true observed values by some extent. There are several techniques for estimating the regression model, such as the Maximum Likelihood Model (MLM) and the Generalized Linear Model (GLM). However, we have chosen to apply the model with the "best fit", i.e. the regression line that minimizes the distance between the observations and the estimated regression line by minimizing the sum of squared residuals (SSR). This is estimated by the Ordinary Least Squares Assumption (OLS), and will be applied for the remainder of this analysis.

When estimating the parameters in the time series model presented above, we need to account for five key assumptions (Woolridge, 2009; Stock & Watson, 2011):

1. Linearity in parameters
2. No perfect collinearity
3. Zero conditional mean
4. Homoscedasticity
5. No autocorrelation

The first assumption simply states that the model should be linear in the parameters $\alpha_i$ and $\beta_i$, as the time series follows a model which is linear in its parameters.

The second assumption addresses the argument of no perfect collinearity in our data. As we only have one explanatory variable in our model, there is no perfect multicollinearity within the variables in the model. Furthermore, as explained in the data selection process, we have collected daily stock prices on the major exchanges to ensure that the data is neither constant or a perfect linear combination. However, it is worth mentioning that thin traded stocks may have observations where it is not traded at all, the daily return of the stock is zero. Further, if a stock is not traded on a regular basis, the observation becomes constant. For some of the stocks within the Norwegian OSV market show signs of low daily trading volumes. However, this assumption is taken care of by the criteria in section 3.1.2.

The third assumption for the OLS estimator to be unbiased assumes a zero conditional mean. This implies that, given the explanatory variables at all time, the expected value of the error term is always zero, i.e. the error term is uncorrelated with the explanatory variable:

$$E[\varepsilon_{it} \mid X_{it}] = 0 \tag{4.4}$$

For our model, this suggests that our error term is uncorrelated with the return on the market, at all time. This implies that changes which stem from sources outside of the model are exogenous. On one side, it is easy to envision the fact that the stocks would be influenced by shocks and systematic risk, which again create a correlation between the explanatory variable and the error term. However, we argue that our sample from the occurring events and the time horizon of our analysis are sufficiently protracted, implying that any violations would not result in a substantial effect on our results.

The fourth assumption assumes that the variance of the error term $\varepsilon$ is constant across time *t* for each of the stocks, i.e. the variance is homoscedastic. If this assumption is violated, and the variance of the error term differs across *t*, the model suffers from heteroscedasticity. However, should the data suffer from heteroscedasticity, this will not lead to biased estimators, but rather the standard deviations of the parameters from the regression will be biased.

The fifth assumption addresses the fact that we cannot have any autocorrelation between the error terms in the regression. This implies that the error term in time *t* should be uncorrelated with the error term in time *s*, where $t \neq s$. Put differently, we have

$$Corr(\varepsilon_t, \varepsilon_s) = 0 \quad \text{for } t \neq s \tag{4.5}$$

Even though we can have OLS estimators of the coefficients to be unbiased white noise, consistent and asymptotically normally distributed, the issue regarding autocorrelation might lead problems to arise. Furthermore, we cannot apply hypothesis testing to inspect if the underlying assumptions are violated. By applying either the t-test or F-test we run the risk of underestimating the variance of the residuals and thus implying that the test statistics might become unreliable and biased downwards (Gujarati, 2004: 458-459). In order to detect autocorrelation in our time series, we apply the Durbin-Watson d-statistic, which states the ratio of the sum of squared differences in successive residuals to the regression sum of squares (RSS). The definition of the statistic is (Gujarati, 2004: 467)

$$d = \frac{\sum_{t=2}^{t=n}(\hat{\varepsilon}_t - \hat{\varepsilon}_{t-1})^2}{\sum_{t=1}^{t=n}\hat{\varepsilon}_t^2} \tag{4.6}$$

As $\sum \hat{\varepsilon}_t^2$ and $\sum \hat{\varepsilon}_{t-1}^2$ differ in only one observation, the test can be written as:

$$d \approx 2(1 - \frac{\sum \hat{\varepsilon}_t \hat{\varepsilon}_{t-1}}{\sum \hat{\varepsilon}_t}) \tag{4.7}$$

The first-order coefficient of autocorrelation is defined as:

$$\hat{\rho} = \frac{\sum \hat{\varepsilon}_t \hat{\varepsilon}_{t-1}}{\hat{\varepsilon}_t^2} \tag{4.8}$$

We can then express the *d*-statistic to be an approximation by:

$$d \approx 2(1 - \hat{\rho}) \tag{4.9}$$

Where we know that the value of the correlation coefficient has to be $-1 \leq \hat{\rho} \leq 1$. It therefore follows that the Durbin-Watson *d*-statistic has to be $0 \leq d \leq 4$. Furthermore, if there is zero correlation between the two variables, we see from equation (4.9) that $d = 2$. Therefore, to test whether there is autocorrelation, we test whether the Durbin-Watson d-statistic is statistically different from 2. If this turns out to be the case, we can reject the null hypothesis of zero autocorrelation. However, there are no critical values available for the Durbin-Watson *d*-statistic. We therefore apply the table illustrating both the lower and upper bounds which can be applied in hypothesis testing. The test only depends on the number of observations *n* and the repressors *k*. We apply the following rules, from Table 12.6 in Gujarati, 2004:

| *Null hypothesis* | *Decision* | *If* |
|---|---|---|
| **No positive autocorrelation** | Reject | $0 < d < d_L$ |
| **No positive autocorrelation** | No decision | $d_L \leq d \leq d_U$ |
| **No negative autocorrelation** | Reject | $4 - d_L < d < 4$ |
| **No negative autocorrelation** | No decision | $4 - d_U \leq d \leq 4 - d_L$ |
| **No autocorrelation, positive or negative** | Do not reject | $d_U < d < 4 - d_U$ |

*Source: Basic Econometrics, Damodar N. Gujarati, 2004*

In Appendix 3 we have listed the d-statistics from the Durbin-Watson test, which are calculated from all four estimation periods. The results show that there are weak signs of both positive and negative autocorrelations. However, as $d = 2$ is merely a theoretical benchmark and is seldom the case in research. We thus argue that, as the calculated d-statistic is approximately 2 across both assets and estimation periods, our research will not be notably biased by any presence of autocorrelation.

#### *4.2.2.3 Measuring abnormal returns*

From the market model explained in equation (4.3), the expected return can be explained by the constant $(\alpha_i)$ and a slope coefficient $(\beta_i)$ multiplied by the return on the market portfolio$(R_{mt})$. We calculate the beta value for each firm, as the covariance between the company's returns and market return, given by;

$$\beta_i = \frac{Cov[R_{it}, R_{Mt}]}{\sigma_M^2} \quad (4.10)$$

We can rewrite equation (4.3) to solve for abnormal return:

$$R_{it} = \alpha_i + \beta_i R_{Mt} + \varepsilon_{it} \quad (4.3)$$

$$\varepsilon_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{Mt}) \quad (4.11)$$

Rewriting the error-term as the abnormal return for company *i* in time *t* we get $(\varepsilon_{it} = AR_{it})$. By modifying this into equation (4.12) we can easily see that:

$$AR_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{Mt}) \quad (4.12)$$

$$Abnormal\ Return_{it} = Actual\ Return_{it} - Expected\ Return_{it}$$

The formula thus gives us the estimation of the abnormal return being equal to the actual return subtracted by the expected return.

#### 4.2.2.4 Organizing and accumulating the abnormal returns

By adding all the individual ARs for each of the event windows, we can calculate the Cumulative Abnormal Returns (CAR) for each security (Campbell et al. 1997):

$$CAR_i(T_1 + 1, T_2) = \sum_{t=T_1+1}^{T_2} AR_{it} \quad (4.13)$$

We add all the ARs for each event, and calculate the average abnormal return by dividing by the number of observations in each event:

$$\overline{AR}_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it} \quad (4.14)$$

As a final calculation, we add all the $\overline{AR}_t$s to calculate the cumulative average abnormal return for all firms in each of the event windows:

$$\overline{CAR}(T_1 + 1, T_2) = \sum_{t=t_1+1}^{T_2} \overline{AR}_t \quad (4.15)$$

#### *4.2.2.5 Analysing and statistically testing the returns*

In order to analyse the returns, we need to test the returns from each event and statistically test their significance. Throughout the remainder of this event study, we will apply the following notation:

| | |
|---|---|
| $\boldsymbol{AR_t}$ | Abnormal return for a single stock at time *t* |
| $\boldsymbol{\overline{AR}_t}$ | Average abnormal returns across stocks in sector *i* at time *t* |
| $\boldsymbol{CAR_t}$ | Cumulative abnormal return for a single stock at time *t* |
| $\boldsymbol{\overline{CAR}_t}$ | Cumulative average abnormal return for all stocks in sector *i* at time *t* |
| **Estimation period** | Period in which the variables are calculated before each event |
| **Event window** | The window where the shock possibly effects the abnormal returns |
| **T** | Time from one observation to another |
| $\mathbf{L_1}$ | Length of estimation window |
| $\boldsymbol{t = T_0 + 1 \ to \ t = T_1}$ | Estimation period |
| $\mathbf{L_2}$ | Length of event window |
| $\boldsymbol{t = T_1 + 1 \ to \ t = T_2}$ | Event window |
| **N** | Number of observations |

There is no one-way solution for conducting and validating event studies. However, following the procedure presented in Campbell et al. (1997) and most research literature, the study follows a test for abnormal returns, including both parametric- and non-parametric tests. Both methods are introduced, as the study might have several factors which might disrupt the validity of our results. The parametric tests are the classical event study tests, whilst the non-parametric tests act as a complement to the parametric tests.

The two main factors which might influence the credibility of the results for our tests are the presence of abnormal distribution and also the presence of event clustering. Firstly, any abnormal distributions occur if there are any major outliers in the event window, resulting in the cumulative abnormal returns to be non-normal. Secondly, in the case of event clustering, by having several events occur in the same calendar date it may create correlation across our samples.

During the period of an event, it is reasonable to assume that the abnormal returns are abnormally distributed. Specifically, as we have previously mentioned, some of the companies within the OSV segment may be subject to thin-trading. As a result, these stocks may experience large shocks due to the fact that they are less liquid, and hence more volatile. Taking into account that any of the assets are abnormally distributed, we apply non-parametric tests. The non-parametric tests include the Rank test, introduced by Corrado (1989), and the Sign test, which was introduced by Brown & Warner (1980). Both tests have been further developed over the past; however, we argue that the tests presented in the two researches are sufficient to complement our parametric tests.

#### 4.2.2.5.1 Parametric tests

In general, the overall objective behind a parametric test is to evaluate whether the cumulated abnormal returns in the event window are significantly different from zero. By applying the parametric test, we can estimate the significance of the abnormal return of one stock during one event $(AR_t)$, whilst also testing the average abnormal return for all firms at one point in time $(\overline{AR}_t)$ . Similarly, we can test the cumulative abnormal return for a single firm during the event $(CAR_t)$, and then also the cumulative average abnormal return for all firms during one event $(\overline{CAR}_t)$.

The parametric tests require a student's t-test, and we therefore need to create a null-hypothesis and consequently, a contradicting alternate hypothesis (Stock & Watson, 2011):

$$H_0 : No\ abnormal\ return\ in\ the\ event\ window$$

$$H_A : Abnormal\ return\ in\ the\ event\ window$$

To test the hypotheses, we derive the distribution of the test statistic under the null-hypothesis from the assumption of no abnormal return. By rejecting the null-hypothesis on a determined critical level, we are able to distinguish whether there are abnormal returns in the event window. To calculate any abnormal returns, we apply Equation (4.12) where abnormal returns are defined as the difference between the actual return and the expected return given by the market model. Unless otherwise specified, we will apply a 95% confidence interval to evaluate the statistical significance of our results. This implies that, a significance level of 5% indicates that if the shock has no effect, we will obtain the observed difference or more in 5% of studies due to random sampling error.

The estimation of the variance of the abnormal returns consists of two parts. The first part stems from the fact that the variances in the sampling errors are estimated from a sample, and not the entire population. Secondly, we also have errors from the market model in the estimation window.

As mentioned in Section 4.2.2.2, we have regressed the coefficients in the market model from the period of 250 trading days for estimation periods 1, 2 and 4, whilst 202 trading days for period 3. Therefore, the sample in the estimation period represents the population and thus implying that the sampling errors to be zero.

From equations 3.12 and 3.3 the residuals from the market model are rewritten to detect any abnormal returns. Therefore, the variance of the residuals can be calculated by:

$$\hat{\sigma}_{\varepsilon_i}^2 = \frac{1}{L_1 - 2} \sum_{t=T_0+1}^{T_1} (AR_{it})^2 = \sigma^2(AR_{it}) \qquad (4.16)$$

The variance of the residuals describes the variance in the abnormal returns, which is equal to the sum of squared residuals (SSR), divided by the number of days in the estimation period subtracted by two degrees of freedom. In our parametric test, we then assume that these residuals are normally distributed with a zero mean and a variance of $V_i$ which is defined as:

$$V_i = I\sigma_\varepsilon^2 + X_i^*(X_i^T X_i)^{-1} X_i^{*T} \sigma_{\varepsilon_i}^2 \qquad (4.17)$$

Under the null-hypothesis, we can apply Equation (4.16) and (4.17) and the joint normality of the abnormal returns to draw inferences. For the event window sample abnormal returns we therefore have:

$$\hat{\varepsilon}_i^* \sim N(0, V_i) \tag{4.18}$$

For this research, we therefore need to calculate the variance $\sigma^2(AR_{it})$ in order to estimate $var(CAR_i)$, $var(\overline{AR}_t)$ and $var(CAR_{it})$. To evaluate the performance in the event window we calculate the cumulative abnormal return of each firm:

$$CAR_i(t_1 + 1, t_2) = \sum_{t=t_1+1}^{t_2} AR_{it} \tag{4.19}$$

And the corresponding variance:

$$\sigma_i^2 = (t_1 + 1, t_2) = L_2 \sigma_{\varepsilon_i}^2 \tag{4.20}$$

We therefore know that the cumulative abnormal return for company *i* is normally distributed with the following characteristics:

$$CAR_i(t_1 + 1, t_2) \sim N(0, \sigma_i^2(t_1 + 1, t_2)) \tag{4.21}$$

When the cumulative abnormal return is calculated for each firm in the event window, we can calculate the cross-sectional performance at time *t* in the event window. By calculating the average abnormal returns in the event window, we are able to analyse whether there are any specific days which overall outperform within the event window. The average abnormal return and the corresponding variance are calculated by applying the following formulas:

$$\overline{AR}_t = \frac{1}{N} \sum_{i=1}^{N} AR_{it} \tag{4.14}$$

$$\sigma_i^2(\overline{AR}_t) = \frac{1}{N^2}\sum_{i=1}^{N}\sigma_{\varepsilon_i}^2 \tag{4.22}$$

However, for our research, the most appealing parameter is the cumulative average abnormal return, more specifically, the average of the abnormal returns for all firms in each segment across all days in the event window. The formula for the return and variance are given by:

$$\overline{CAR}(t_1+1, t_2) = \sum_{t=t_1+1}^{t_2}\overline{AR}_t \tag{4.15}$$

$$\sigma_i^2\overline{CAR}(t_1+1, t_2) = \sum_{t=t_1+1}^{t_2}\sigma_i^2(\overline{AR}_t) = \sigma_i^2(\overline{AR}_t)L_2 \tag{4.23}$$

The distribution of the cumulative abnormal average return can be described as:

$$\overline{CAR}(t_1+1, t_2) \sim N(0, \sigma_i^2\overline{CAR}(t_1+1, t_2)) \tag{4.24}$$

As mentioned earlier in this section, we will test the significance of these returns against its standard deviations by applying the student's t-distribution. When calculating the t-statistic, we are able to find the critical levels that will allow us to either reject or fail to reject the null hypothesis of the return being different from zero in the event of an oil price shock. The t-statistic for the different types of returns is calculated by dividing the estimate of interest by the corresponding standard deviation. We therefore have:

$$\overline{AR}\text{: } t = \frac{\overline{AR}_t}{\sqrt{\sigma_i^2(\overline{AR}_t)}} \tag{4.25}$$

$$CAR\text{: } t = \frac{CAR_i(t_1+1, t_2)}{\sqrt{\sigma_i^2(t_1+1, t_2)}} \tag{4.26}$$

$$\overline{CAR}:\ t = \frac{\overline{CAR}(t_1 + 1, t_2)}{\sqrt{\sigma_i^2 \overline{CAR}(t_1 + 1, t_2)}} \tag{4.27}$$

#### 4.2.2.5.2 Non-parametric tests

In this section, we will derive two non-parametric tests, which we have included to complement the parametric tests performed in the previous section. These non-parametric tests contribute a rational result as we are able to effectively determine whether the abnormal returns are positive or negative. In contrast to the parametric test, these tests disregard the actual number of the returns (Kolari & Pynnonen, 2010). The two non-parametric applied are the Sign test, and the Corrado Rank test, which will be further elaborated below.

The Sign test requires the abnormal returns, i.e. the cumulative abnormal returns, to be independent across securities and that all expected proportion of positive abnormal returns under the null-hypothesis is 0.50. Put differently, the basis of the test is that under the null-hypothesis it is equally probable that the CAR will be positive or negative (Campbell et al., 1997). In addition, we apply the sign test as previous research has shown conflicting results when it comes to shipping companies and various indices and their reactions to changes in the oil price across different countries (Grammenos & Marcoulis, 1996; Hammoudeh et al., 2004; Lin et al., 2011).

Instead of applying individual ranks for each observation, the Sign test only tests whether the returns are positive or negative. As mentioned earlier, previous research has shown that many companies within the shipping industry have a negative exposure towards the oil price. Accordingly, we will also apply the Sign test for negative abnormal returns. To test the significance of the result, the equation below will test whether the abnormal returns are different from zero:

$$t_{sign} = \left[\frac{N^+}{N} - 0.5\right]\frac{\sqrt{N}}{0.5} \sim N(0,1) \tag{4.28}$$

In equation (4.12), we showed how we calculated the abnormal return ($AR_i$) for each company in the four segments. To carry out the Rank test, we first have to rank all the ($AR_i$), across the other observations for both the estimation period and the event window. However, for dealing with the situation where the AR's are zero, we have applied the mid-range rank. Further, we standardized the variables by converting them into values between 0 and 1. The main benefit of the Rank test is that it is simple to interpret, whilst also providing an estimate for concluding whether the event yields abnormal returns, or not. In addition, as the test takes into account any large outliers, it makes the test more robust than the t-statistic for the parametric tests. However, compared to the parametric t-test, the standardized values are relative and do not provide any logical interpretation as the parametric tests. The Rank test is conducted by applying the formula:

$$K_{it} = \frac{Rank(AR_{it})}{1 + L_1 + L_2} \tag{4.29}$$

where $K_{it}$ denotes the standardized rank value, whilst Rank ($AR_{it}$) denotes the ranking of each AR amount of all observations from the period *t* for firm *i*. Further, we calculate the variance by

$$\sigma_{\bar{K}}^2 = \frac{1}{L_1 + L_2} \sum_{t=T_0}^{T_2} (\bar{K}_t - 0.5)^2 \tag{4.30}$$

As we are analysing several days over the entire event period, we apply the Rank test by summing all the mean excess ranks for the event window through the following:

$$\bar{K}(T_1 + 1, T_2) = \frac{1}{L_2} \sum_{t=T_1+1}^{T_2} K_{it} \tag{4.31}$$

We are then able to conduct the Rank test by the formula:

$$t_{rank} = \sqrt{L_2} \left( \frac{\bar{K}(T_1 + 1, T_2) - 0.5}{\sqrt{\sigma_{\bar{K}}^2}} \right) \tag{4.32}$$

As previously stated, the non-parametric tests will be calculated to complement the parametric tests provided in section 4.2.2.5.1. However, it is worth mentioning that the Rank test encompasses the Sign test through the element of size in the estimate, but it is more sensitive to the event window length, thin trading, and also increases in return variance (Cowan, 1992). Therefore, we will apply both tests for our research.

# 5 Markets

The markets in which the shares of the different shipping companies and the oil products are traded differ on many levels. Commodities are based on physical products such as gas, cocoa, soybeans and of course oil, whereas a stock is simply an ownership of a specific company. Consequently, these products are traded on different exchanges. To clarify our research, we will in this part break down the differences within the oil products on the market, before elaborating further the equity industries in which are included in our research.

## 5.1 Crude Oil Market

In general, crude oil is a fossil fuel which exists in liquid form in underground pools or reservoirs. Further, as crude oil is an unrefined product, it is an essential ingredient in the production of various petroleum products. Though crude oil is often applied as a homogenous classification across all unrefined oil products, there are differences, ranging in both level of density and consistency. This is due to the fact that the oil is extracted from different geographical locations, and will thus naturally have its own very unique properties. A brief illustration of the different properties which make up the various crude oil types can be found in Appendix 4 (U.S. Energy Information Administration, 2014).

Even though there are many different crude oil types, there are three main different baskets from which crude oil are normally classified. These include the West Texas Intermediate (WTI), which refers to oil extracted from wells in the U.S. and further refined across the continent. Further, the OPEC basket consists of a collective of different crude oils from some of the world's crude oil producers. Lastly, the Brent Blend crude oil will be applied as the main benchmark for crude oil in this research, as it has been argued that it is the global benchmark for crude oil prices (Energy & Capital, 2012). The characteristics and historical development will be further elaborated in the section below.

### 5.1.2 Brent Crude Oil

The North Sea Continental shelf contains significant oil reserves and is the largest source of oil production in OECD Europe. The shelf consists of five countries, more specifically Denmark, Germany, Norway and the United Kingdom. Several production streams from the North Sea constitute the Brent international benchmark for oil prices. From its peak of production of approximately 6.3 million barrels per day (bpd) in 1996, the production has declined slowly, averaging around 3.5 million bpd in the recent years (U.S. Energy Information Administration, 2016; Norwegian Petroleum Directorate, 2013)

The major oil producing areas are the northern and southern part of the North Sea, plus the Norwegian Sea. Since the exploration of the Ekofisk field in 1971, there are now a total of 817 Norwegian oil and gas fields (including fields under development), and a total of 4,820 in the North Sea Continental Shelf (Norwegian Petroleum Directorate, 2013). In the following, we will further elaborate on the historical developments of the crude oil prices.

#### *5.1.2.1 Historical Development*

***1987 - 2005***

From the collected data, we observe that the price for one barrel of oil equalled $18.63 in May 1987. Until the new century, the price of one barrel of the Brent spot peaked at $41.45 in September 1990, whilst the lowest price was $9.1 in December of 1998, and the average price for the period was around $18 per barrel. One of the main reasons behind the oil price increase of the 1990s was the Iraqi invasion of Kuwait in 1990, where the market anticipated a decrease in world oil production.

During the turn of the century, the price of oil per barrel started a significant increase. From the beginning of the 21st century, the price of a barrel of oil hovered around ~$25. These levels were also observed until 2003, when the world crude oil demand grew by 3.4% (U.S. Energy Information Administration, 2008). In addition, a major factor influencing the increase of oil supply was due to the political instability within the world's major exporters of oil. Predominantly through the US invasion of Iraq, this caused a reduction in the world supply by 2.2 million bpd over the spring. Also influencing the supply of crude oil vastly, was the general strike in Venezuela which eliminated 2.1 million bpd during December 2002 and January 2003.

In the following year, the prices rose even further, averaging $40-50 per barrel for Brent crude oil. The increase in the price of oil was largely due to the rising oil demand in developing countries such as China and India, where the annual GDP growth rates were stable between 9% per year (The World Bank, 2016).

*2006 - 2010*

From the 1980s until 2005, the production of crude oil increased along with demand. However, after 2005 the price per barrel of oil saw a significant increase. With the prices varying around $50-60 per barrel in late 2005, it raised to more than $140 per barrel in 2008. From 2005 and onwards, the world's oil markets experienced a vast change in the price elasticity for the crude oil. Now, a rise in the price of crude oil only had a marginal impact in the production, whereas earlier, a rise in the oil prices was mostly followed by a noticeable increase in production. This is why many have called 2005 the tipping point for oil prices (Murray, 2012).

As a result of the lack of increases in production to meet the increased demand between 2005 and 2007, this period experienced a vast increase in the price of crude oil. In addition, several geopolitical tensions in oil producing regions such as Iraq, as well as the Israel and Lebanon conflict forced an overall decrease in production. Throughout this period, the price varied vastly between the minimum of low ~$40s for the period and mid ~$90s as the maximum observed price per barrel of oil.

In 2008 the price of Brent crude oil surpassed the $100 threshold, which withheld until the latter part of the year. Then, as an effect of the global financial crisis, the prices of oil plummeted from the high of $143.95 in July, to $33.73 during late December, equivalent to a 76.5% drop. Another major factor which led to a decrease in oil prices was the US's decision to lift the ban on offshore drilling within US Coastal waters, signalling an increase in production. The lifting of this ban alone was projected to free up reservoirs containing of approximately 18 billion barrels of oil (CNN, 2008). In addition, an increase in the US dollar towards many oil importing exchange rates also weakened the overall demand for oil during the period.

In the aftermath of the global financial crisis the price of one barrel of Brent crude oil traded at $40 in January, whilst trading at ~$80 per barrel in the end of December. Through the year of 2010 the price dropped somewhat, trading ~$70 per barrel. Reasons behind the slight drop in the latter part of this period were due to growing concerns over the European economy, but also a strong dollar and high world inventory levels. However, prices slowly increased at the end of 2010, pricing the crude oil to ~$90 per barrel.

***2011 - 2015***

After the first decade of the new millennium, the world experienced a wave of political turmoil in oil producing economies throughout the Arabian Peninsula. This drove the oil price above the $100-mark in February 2011. Even though OPEC and Saudi Arabia maintained a high production level, the Arabian Spring led to a further increase in oil prices. The high price of oil remained, pricing the Brent Crude at over $100 per barrel throughout the year. A major reason was the expectation of increased demand worldwide (Shore, 2011). During the spring, the exchange rate between the oil importing nations appreciated towards the dollar, resulting in an upward pressure of the oil price at ~$125 per barrel. However, the dollar appreciated in the latter parts of 2011, bringing the oil price back to ~$105.

In 2012, the world experienced a shortage of oil through further sanctions on Iran. However, the shortage was counterbalanced by a growing concern of a market oversupply and the worrying European sovereign debt crisis, leading the price per barrel to fluctuate around the $100-125 levels for the first half of the year. Midway through 2012, the oil price slumped after the US increased its production to the highest levels since the 1990s and furthered by the decision from European countries not to cut government spending to solve their debt crisis (Reuters, 2012). After the European bailouts during the 3rd quarter, the price of oil rose again to the levels experienced at the beginning of the year. The rise was also fuelled by increased worries over the ongoing civil war in Syria.

During the first half of 2013 the Brent crude oil spot price oscillated around the end-of-year levels of 2012, though the price dropped below the $100 level for a short period in April. However, during the summer, the price of oil increased as a result of increased instability in Egypt, Libya and Syria and also by the U.S. and EU tightening their sanctions on Iran (Bloomberg, 2013). This was furthered by better economic prospects in the U.S., China and an increased belief in the European economy (BLS, 2013; BBC, 2013; European Commission, 2013). This sparked a peak in the oil price, where the spot price of the Brent Crude Oil reached the $110-115 levels.

In January 2014, the Joint Plan of Action was implemented as a deal to freeze the Iranian nuclear program in exchange for decreased economic sanctions on Iran implying a daily increase in the supply in production of crude oil of approximately 3.1 million barrels (Organization of the Petroleum Exporting Countries, 2015). However, much of the pessimism around the market being oversupplied by Iranian crude production was offset by the increased economic outlook in the U.K. and U.S., leaving the price shifting between $100 and $110 (The World Bank, 2015). During the latter part of the first half of the year, the new political unrest in Crimea, in addition to the instability in the Middle East put an upward pressure on the oil price, but was offset by the expectations of lower growth in China (The World Bank, 2015). However, during the second half of 2014, the price fell below the $100 threshold. Even with continued instability, the low Chinese growth rate, the world production surpassed the consumption for the entire year (U.S. Energy Information Administration, 2015). This continued for the remainder of 2014, driving the Brent crude oil spot price to its lowest since 2009. No counter-action was followed by the major oil producers, who on the contrary, increased their production, leaving the price nearly halved by the end of the year.

The beginning of 2015 saw the spot price of Brent trading at around ~$50 per barrel, a drastic 50% reduction from a year earlier. Even with continued instability in many major oil exporting nations, the excess oil in the market due to production growing more than consumption had floored the prices of oil, where world production exceeded consumption by almost 2 million bpd. In addition, the US dollar appreciated against most of the oil producing currencies, putting even further downward pressure on crude oil prices (U.S. Energy Information Administration, 2015). In February, the US oil reserves reached its highest levels since 1982. Furthermore, the depressed growth rates of many non-OECD countries such as China and India saw crude oil prices reaching record low levels (U.S. Energy Information Administration (2015). Midway through the year, the price reached mid ~$60 levels, due to an expected decrease in shale oil production in the US, in addition to the war in Yemen, Iraq and Syria.

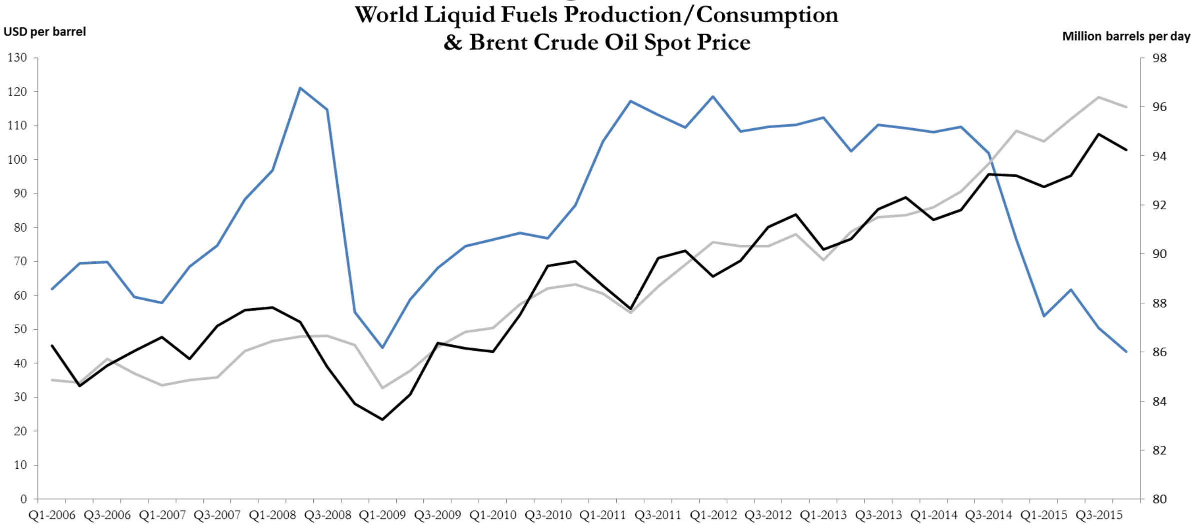
However, for the second half 2015, the dollar appreciated even further, putting an even further downward pressure on the oil price, which saw it stumble to low $50s during July, and $40s in

August. This forced the EIA to lower its expectations of future oil prices to an average of $54 per barrel for 2015, down $6/b from the previous month (U.S. Energy Information Administration, 2015), with the WTI volatility at 66.8% through the OVX Index (U.S. Energy Information Administration, 2016). At the end of the year, the Brent crude spot price stumbled further, trading at mid-$30 levels per barrel. This forced the EIA to lower its forecast for 2016 for the Brent crude oil to $56 per barrel (U.S. Energy Information Administration, 2016)

**Summary Oil Price Development**

We observe that the Brent crude oil spot price has varied vastly over the period of research. Furthermore, we detect a difference in causation in relation to the influence of the oil price. From the early parts of our research, much of the variation in the oil price has been impacted by geopolitical instability in the Middle East, driving the oil price up. Further, as an effect of the financial crisis during 2008 and 2009, there was a downward pressure from the suppressed economic situation in most of the Western and OECD countries. However, much of the decline was offset by the growth in major developing countries such as China and India. For the latter part of the research period, the variation is vastly explained by the excess production, driving up world inventories. As a consequence of the standoff between the producers in OPEC, non-OPEC and the American shale oil producers, where no significant production cuts were implemented, supply outweighed the demand and thus forcing an abrupt decline in the price of oil. An illustration of the crude oil price development can be found in the graph below.

**Figure 5.1**
**World Liquid Fuels Production/Consumption**
**& Brent Crude Oil Spot Price**




*Source: EIA / Datastream*

#### *5.1.2.2 Oil value chain*

The production of oil encompasses a range of different activities and processes which jointly contribute to the transformation of underlying petroleum resources into useable end-users. However, it is worth mentioning that the value chain presented only includes the steps in which the services of the shipping sectors included in our research are mentioned. In the following sub-sections, we will therefore briefly elaborate on the different phases and illustrate how they are related to the vessels in our analysis.

##### 5.1.2.2.1Exploration phase

The exploration activities involve the search for rock formations, generally through seismic surveys to assess the potential of offshore oil and gas fields. Fields which show promising geological structure are then identified for drilling operations. Depending on the water depth of the field, different drilling rigs will be employed to drill the wells. In general, seismic vessels perform the exploration phase, whilst the Anchor Handling Tug Supply vessels (AHTS) set anchors for the rigs, whereas the Platform Supply Vessels (PSV) supply the rigs with drilling mud, drilling risers and other liquids.

##### 5.1.2.2.2 Development phase

The development of the oil fields commences when an economically recoverable field is located. From here, the subsea infrastructures are installed on the seabed. Typically, such offshore oil fields can be developed through offshore platforms and floating production systems. The development phase will therefore require Diving Support Vessels (DSV) and Construction Support Vessels (CSV) to put the infrastructure in place. Other seaborne assets could also include pipe laying vessels/ barges, depending on the scope of work.

##### 5.1.2.2.3 Production phase

The production phase includes the extraction-, processing-, storage-, and transportation of oil. The main activities are performed by offshore platforms and the Floating Production, Storage and Offloading units (FPSO). However, there are also several types of OSVs included in the production phase, such as AHTS, PSVs, crew boats, utility vessels and subsea support vessels, as well as well intervention vessels.

#### 5.1.2.2.4 Transportation phase

Following the transportation of oil from the production site, the unrefined product needs to be transported to the appropriate processing facilities. From offshore facilities, the petroleum has to be transported, usually through either pipelines or through tanker vessels.

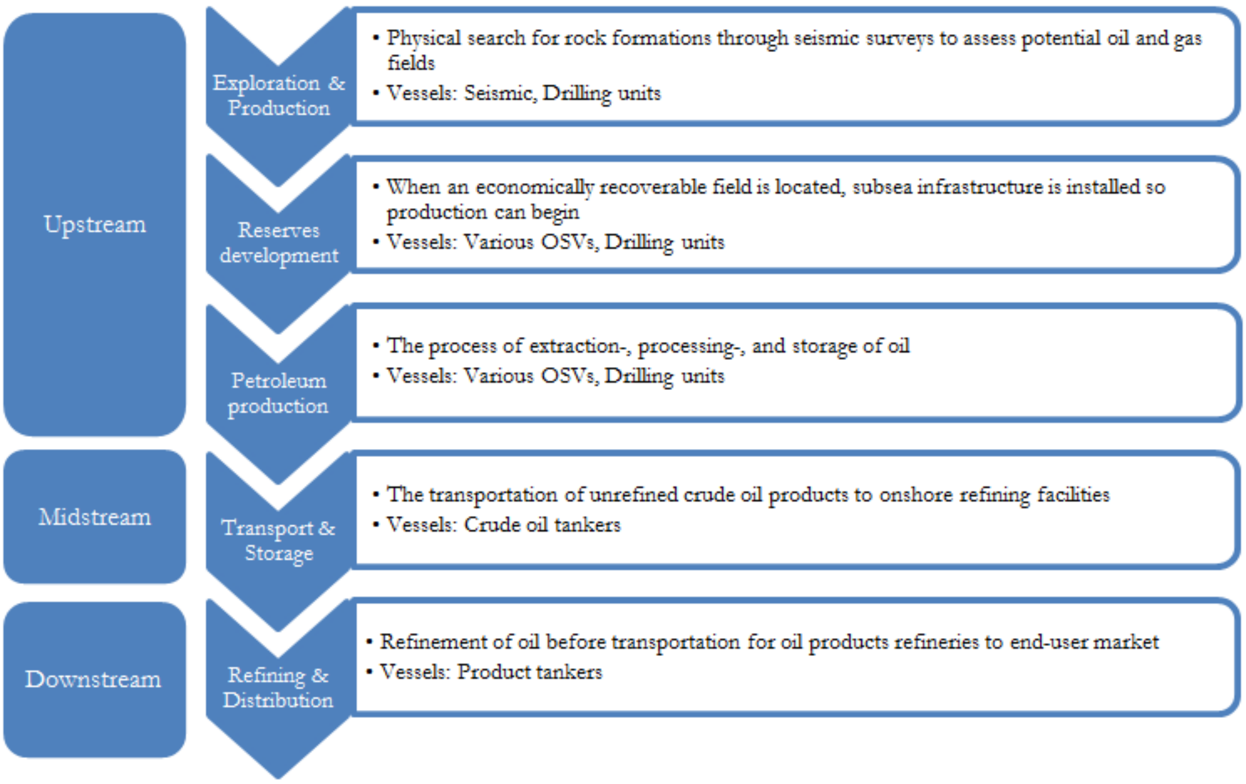
#### 5.1.2.2.5 Refining & distribution phase

After the unrefined crude oil product is refined into a cleaner product, such as gasoline and jet fuel. These products are often transported in clean coated tanks, which transport the cleaner products to points closer to the end-user or market.

#### 5.1.2.2.6 Summary of oil value chain

A brief summary of the value chain presented above is illustrated in Figure 5.2 below.

**Figure 5.2**




Source: Compiled by Authors/ Marine Money Offshore/ The World Bank Group: The Petroleum Sector Value Chain, 2009/ Bridging the Gap: 2015 Annual Global Working Capital Survey of the Oil & Gas sector, PwC

## 5.2 Shipping market

Through the activities provided in section 5.1.2.2 and the oil value chain presented in Figure 5.2, we will present the different shipping markets included in our analysis.

### 5.2.1 Offshore drilling vessels

The offshore drilling term is used to describe drilling activities on the continental shelf. The term includes the mechanical process where a wellbore is drilled into the seabed, for the extraction of petroleum products. As the rest of the shipping segments, the offshore drilling segment is categorized as a highly capital intensive industry, where the building cost of a sophisticated drillship can amount to ~US$1 billion.

For our research, we have focused on companies within the drilling segment whom predominantly own and manage vessels within the drillship sub-segment. However, as many of these companies also own and operate drilling units, we have chosen to only include companies whose fleet mainly consists of drilling ships. Other drilling units which fall under this segment are Fixed-platform rigs, Jack-ups, Submersible-, and Semisubmersible drilling rigs.

*Historical Development*

The first emergence of offshore drilling units stem from the US in the late $19^{th}$ century. Covering an area of approximately 750,000 $km^2$, the North Sea has become the world's most active offshore drilling region with around 170 active rigs in January 2015. Similarly, there were around 100 active drilling rigs in Gulf of Mexico, 69 in Brazil and 65 of the coast of West Africa in the equivalent period (Swartz, 2015).

The key feature of the drillships, which separates them from the drilling rigs, is their mobility through a self-propulsion. From the early days of the introduction of the offshore drillships, there have been vast developments in the characteristics of the vessels. To adapt to the world's increased oil demand, constructors have to drill in deeper waters, from 350ft in 1961 to 12,000ft in 2009 (Leffler et al. 2003).

### 5.2.2 Offshore support vessels

As many other shipping industries, the OSV industry is considered to be vastly volatile characterized by large peaks and downturns, immense competition, uncertain future cash flows and high investments (Stopford, 2009).

For this analysis, we have chosen to apply companies which have a predominately high proportion of AHTSs and PSVs in their fleet. However, it is also worth mentioning that the fleet of these companies also consists of various subsea and offshore construction vessels, such as smaller tugs, CSVs, Inspection Maintenance and Repair Vessels (IMR), DSVs and Remotely Operated Underwater Vehicles (ROV). For the remainder of this analysis, we will apply a general notation for the ships within this industry, namely OSV.

*Historical Development*

The need for OSVs arose from the start of the oil exploration activity in the Gulf of Mexico in the mid-1950s. Since then, the shipping segment has grown vastly, amounting to 18.255 units in 2007 (Stopford, 2009: Table 2.5). Today, the majority of such vessels operate in the Gulf of Mexico, North Sea, Asia Pacific Region, Middle East, West-Africa and Brazil (Aas et al., 2009).

In general, OSVs provide support to offshore drilling rigs; pipe-laying and oil producing assets such as production platforms and FPSOs utilized in E&P activities. The transportation can be divided into two parts, the deck-cargo which includes everything which is transported on the deck of the supply vessel, whilst the bulk-cargo is everything transported in the below deck tanks of the supply vessel. What differentiates the supply vessels from most other ships worldwide is that it is a multi-task vessel, and therefore has to be designed for many different purposes (Aas et al., 2009). As a consequence, the determination of the best design with regards to economy of scale (fleet level) and economy of scope (specialization) effects becomes more challenging (Wijnolst & Wergeland, 2008). Additionally, specialized single purpose vessels are generally built at a lower cost, which will allow them to provide more competitive rates given the same returns requirement.

### 5.2.3 Oil tanker vessels

Oil tankers are designed to carry bulk volumes of oil and oil products. The tanker freight market consists of two main segments, crude tankers who carry unrefined products and product tankers who carry the refined products. In addition to the freight market, the tanker industry also includes the new building market, where new ships are ordered and built, used ships are traded in the sale and purchase market, whilst ships which are considered old or useless are scrapped in the demolition market (Stopford, 2009). As most of the large oilfields around the world are located fairly remote to the end users, applying crude tankers to transport crude oil from extraction locations to the refineries and product tankers to transport the refined products to locations near the end markets are efficient and convenient ways of supplying the markets (Lun et al. 2013).

*Historical Development*

The tanker market has generally been cyclical and volatile as a result of the many conditions and factors affecting the supply and demand for tanker capacity. In the beginning of seaborne oil trade, the major oil companies were the ones owning and operation the vessels. From the 1950s, more independent tanker companies took part of oil transportation as oil trade from this point in time grew at more than 8% p.a. in terms of tonnage transported. The oil majors used the independent tanker companies through time charters to balance their demand for capacity and reduce risk for having a too large fleet. As the oil trade continued to grow in the 1970s and 80s, oil trade started to become highly volatile, making the oil companies reduces their fleet and focus on their core business. This resulted in oil transportation being a market operation instead of a well-planned industrial marked. Further, this increased competition, and in the late 1970s around 70% of the transportation was traded in a spot market. The 1980s were characterized by high volatility in oil trade due to the end of Europe and Japans transition from coal to oil, economic depressions and more fuel efficient technology (Stopford 2009). The tanker fleet has grown firmly since the millennium. All segments have more or less doubled in terms of deadweight tonnage capacity, except Long Range (LR) product tankers who have quadrupled in capacity. The fleet development is to a certain extent supported by growth in demand for oil and oil products (International Energy Network, 2007).

#### 5.2.3.1 Crude oil tankers

The crude tankers are usually separated into Ultra Large Crude Carriers (ULCC), Very Large Crude Carriers (VLCC), Suezmax-, Aframax- and Panamax carriers. The larger vessels in the crude segment, the ULCC-, VLCC- and Suezmax carriers usually loads in the Arabian Gulf, West Africa and the Red- and Black Sea, while Aframax carries crude from the North Sea, Mediterranean, Caribbean and South East Asia (Clarkson Research Services, 2015). The diversity in ship sizes are due to different demands for crude among the different end markets, location of oilfields, location of refineries, sizes of straits, port capacities and global economic development. Demand for crude oil is closely linked to the global economic growth and especially the evolution of developing countries and countries in transition to become more advanced.

#### 5.2.3.1 Product tankers

The purpose of product tankers is to transport refined oil products between refineries or from refineries to end-users, which distinguish whether tanker employed are carrying "dirty products" or "clean products". Dirty products include crude oil or refined products such as Fuel oil, Vacuum gas oil, Diesel oil or Bunker oil. Clean products are typically Gasoline, Jet Fuel, Naphtha and Clean Condensates. For tankers transporting dirty products will subsequently be able to carry the clean products. Though, it has to be thoroughly cleaned as there are strict requirements regarding the degree of distillation of the products shipped. Oil companies are generally demanding information of the previous cargo, making it easier to disclose the reason behind deviations in product quality. Due to the differences in cargo, the vessels are characterized by having coated tanks making the cleaning process easier and to prevent corrosion from the refined products (Danish Ship Finance, 2012).

The product tankers are further separated into categories by the length of the freight, where the larger vessels operate the longer freights. LR 2 and LR 1 vessels are usually loading in the Arabian Gulf and India, while Medium Range and Handy size vessels load in the US Gulf, Mediterranean, Black Sea and UK (Clarkson Research Services, 2015). The two most influential factors affecting tanker rates are supply of tanker vessels and the volume of seaborne trade in dirty and clean oil products, where the latter determines the demand for transportation of oil and oil products (Lun et al. 2013).

# 6 Hypothesis

Based on our severe enthusiasm for the maritime industry and its alteration towards oil price fluctuations, together with the guidance and inspiration of the preceding research, we present the following hypotheses which will directly guide our empirical research. The hypotheses are based on research which we believe will be most interesting when analysing the effects of oil price shocks. In addition, we find that previous literatures lack the measurement of equivalent effects across the various segments within the shipping industry. From the literature review, researchers seem to find inconsistent results when analysing the effect of oil price changes on asset- and index returns. For E&P companies, there seems to be an effect from unanticipated oil price changes in the asset returns of both U.S. and Canadian firms. Also, evidence has also found that sudden oil price drops affect the indices across Europe positively. However, the Norwegian market showed a positive response of real stock returns to an oil price increase (Park & Ratti, 2008).

Previous research has shown that the returns of oil and gas companies are highly pro cyclical with the development of the oil price (Sadorsky, 2001; Manning, 1991). From the oil value chain presented in section 5.1.2.2, we have shown that when oil companies expect a high return from their oil fields, they will charter more assets within the drilling and OSV sectors. Further, as the oil price is the main driver of the companies' profitability, we expect the returns of companies within the two segments to be positively related to the developments of the oil price. Similarly, when the oil prices are low, the main drivers of the oil companies' earnings are suppressed. As a result, we expect companies within the drilling and OSV segments to face higher competition due to lower activities which again is expected to put a downward pressure on the charter rates of the vessels, and thus lowering the returns of companies within the two segments.

On the other hand, when the demand for oil increases, there is an overall need for crude oil to be transported by crude oil tankers from storage facilities in oil producing locations to refineries closer to the end user. Furthermore, when the price of oil is low, the end user demand is expected to increase accordingly. Thus, to supply the product to the end user an increased demand of product tankers will follow. We believe tanker rates are predominantly driven by increased demand and therefore expect both these events to increase the returns of companies within these two tanker segments. Similarly, when the overall demand is low, we expect this to depress the equivalent returns.

For different transportation sectors worldwide, research has shown conflicting results, depending on which indices and sectors that are analysed. As an extension to the analysis provided by El-Masry et al. (2010), we therefore wish to analyse the effect by dividing the shipping industry into different segments. By extending our hypotheses on previous research which has found that positive and negative oil price shocks yield different results on asset prices which are analysed (Aggarwal et al., 2012), we divide the hypotheses into an analysis of positive oil price shocks, and negative oil price shocks.

## 6.1 Oil price exposure on industry

We would like to investigate the effect of the collection of shipping companies within the drilling-, OSV-, crude oil tanker-, and product tanker segments, in the first part of our hypotheses. Furthermore, these hypotheses should be analysed together, following our arguments of the missing research in the literature review. As the literature review displays, the previous research has diverse conclusions of companies' influence from oil price changes. However, there are commonalities, where the asset price returns are insignificant or limited. We therefore introduce the first part of our hypotheses:

Hypothesis 1.1: *Negative oil price shocks have no effect on shipping asset prices*

Hypothesis 1.2: *Positive oil price shocks have no effect on shipping asset prices*

According to Stopford (2009), there are five major factors influencing the demand for shipping transport. Two of the major factors stem from the transportation of commodities and cost of transportation. For our analysis, the development of crude oil prices influences both these factors. Furthermore, these factors affect the overall demand of vessels, and we therefore believe it has a vast explanatory power when it comes to predicting changes in the equity returns of shipping companies. However, several previous studies which have tried to quantify the effects of oil price changes on shipping companies' returns have shown contradictory results.

## 6.2 Oil price exposure on drilling industry

Through the review of previous literature in section 2, we have found it to be an insufficient research on the field of oil price changes and its effect on the drilling segment. However, as illustrated in section 5.1.2.2, there is little doubt about the connection between the two markets. Though not considered as a traditional shipping industry, we have included the drilling industry to further analyse the extent of which both negative and positive shocks will have on the companies. We further argue that, the industry is of vital part of the exploration and production of crude oil, and hence we are expecting to see results in line with research on the traditional oil and gas companies (Sadorsky, 2001; Boyer & Filion, 2007). Based on this, we have developed the following hypotheses:

Hypothesis 2.1: *Negative oil price shocks have no effect on asset prices within the drilling industry*

Hypothesis 2.2: *Positive oil price shocks have no effect on asset prices within the drilling industry*

## 6.3 Oil price exposure on OSV industry

The core activities of the OSV industry are presented in section 5.2.2 and the industry's core operations are similar to that of the marine transportation in Grammenos & Arkoulis (2012). However, from its roles with regards to the oil price in section 5.1.2.2, there is a clear relation between the two. As the vessels within the OSV industry deliver its services to offshore installations, there is a natural link between increased activities on offshore installations with higher oil prices. Furthermore, the increased activities on these installations imply higher activities for OSV vessels, and thus increased revenues. By extending on the findings in Kavussanos et al. (2002) and Kavussanos & Marcoulis (2005), where both Norwegian and U.S. OSV's are statistically significant variables for estimating the return on OSV shares, we analyse the following hypotheses:

Hypothesis 3.1: *Negative oil price shocks have no effect on asset prices within the OSV industry*

Hypothesis 3.2: *Positive oil price shocks have no effect on asset prices within the OSV industry*

## 6.4 Oil Price exposure on crude tanker industry

The crude oil tanker industry involves transporting vast quantities of unrefined crude oil products from the point of extraction to the designated refineries. Differentiating itself from the industries in section 5.2.1 and 5.2.2, the main driver for the industry is the supply of crude oil. Any change to the global supply of crude oil is shown to have a persistent effect on the tanker market levels, where positive crude oil supply shock increase the demand for crude oil transport services and also raise freight rates (Shi et al. 2013). In addition, Poulakidas & Joutz (2009) found that an increased demand for oil also forces a strong demand for tankers, and thus an increase in charter rates. However, we have been unsuccessful in finding studies which analyse the effects the differences of a positive and negative shock in the oil prices, and have therefore developed the following hypotheses for the crude oil tanker market:

Hypothesis 4.1: *Negative oil price shocks have no effect on asset prices within the Crude oil tanker industry*

Hypothesis 4.2: *Positive oil price shocks have no effect on asset prices within the Crude oil tanker industry*

## 6.5 Oil Price exposure on product tanker industry

An extension to the evaluation of crude oil tankers' response to crude oil price changes, we further our analysis by investigating the equivalent shocks on the product tanker market. We have been unsuccessful in finding any comprehensive research for the product segment, as the crude oil tankers have been the focus of most tanker-related research. However, according to BIMCO (2015), low crude oil prices show strengthened earnings for product tankers through an increased demand for oil. As a result, such a decrease in crude oil prices might also induce a lowering of bunker costs, whilst also leading to increased activities within the product tanker market. To analyse this, we will therefore test the following hypotheses:

Hypothesis 5.1: *Negative oil price shocks have no effect on asset prices within the Product tanker industry*

Hypothesis 5.2: *Positive oil price shocks have no effect on asset prices within the Product tanker industry*

# 7 Empirical results

In the proceeding section, we will present and analyse our results in relation to the hypotheses presented in the section above. We will initiate this section by analysing the effects of both positive and negative shocks in crude oil prices during the timespan of our investigation, before analysing the equivalent effects by isolating the individual segments.

## 7.1 Oil price exposure on shipping industry

For the first part of our analysis, we wish to investigate a shock in the oil price and the combined effects it has had on the basket of companies. This part of the analysis will act as an introduction as well as a basis for our further analysis into the respective segments. We further feel it is important to divide the analysis into whether the oil price shock is either positive or negative, as previous research has shown that the two differ in terms of overall effect on shipping companies' returns (Aggarwal et al. 2012). Further, we have assumed semi efficient markets, where the stock prices reflect all publicly available information and where the stock prices quickly absorb any new information. From this assumption we apply the stock price as a measurement for short-term value creation which we will measure through the event study method explained in the methodology part.

### 7.1.1 Hypothesis 1.1

***Introduction***

For our first hypothesis, we examine whether any daily negative shocks in the Brent crude oil spot price establish a ground for any short-term abnormal returns in the period before and after any of the events. We further argue that the effects of oil price changes will vary across the segments in our analysis, but will apply the hypothesis as a base for our analysis. Thus, we form our hypothesis in light of previous research:

Hypothesis 1.1: *Negative oil price shocks have no effect on shipping asset prices*

The methodology presented in section 4 will be applied, and we will examine the presence of abnormal returns in the event of negative oil price shocks by performing the event study with diverse event windows. To analyse the statistical significance of our findings, we will apply the parametric t-test to obtain a numerical result, where we retrieve a percentage of significant $\overline{CAR}$'s for the different event windows. To complement the parametric tests, we apply two different non-parametric tests. These two tests do not provide a numerical result, rather they standardize the returns as either above-, or below average to establish whether there is a presence of positive or negative returns. For the different tests, we have applied four separate event window intervals, which stretch ±10, ±5, ±2 and ±1 day around the day of the negative oil price shock.

***Results and analysis***

We will start by presenting the parametric tests, before complementing the results with the non-parametric tests as a robustness check.

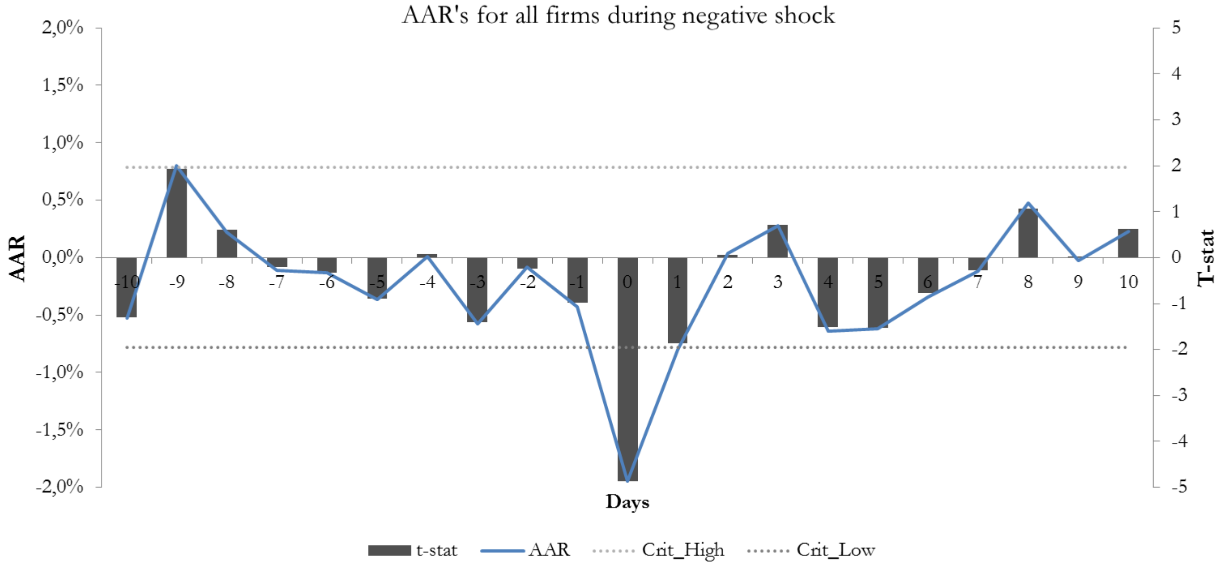
Parametric test

From the calculations of the abnormal returns across the 9 negative shock event windows across all the shipping companies the $\overline{CAR}$s ranges from -17.04% (event 10) to 6.07% (event 1) in the 21 day event window, with an average of -4.66% across all events. In addition, both extremes are statistically significant at the 1% level. The average $\overline{CAR}$s ranges from -4.66%, -5.12%, -3.2% and -3.17% during the 21-, 11-, 5-, and 3 day event windows respectively. In addition, seven of the nine $\overline{CAR}$'s during the negative shocks are statistically significant for the 3 day event window, whilst only five, seven and six shocks are statistically significant for the 5-, 11-, and 21 day event windows. Even though it seems as if a negative oil price shock causes an average negative return on the firms in the analysis, there are great variations. These findings seem so be in line with the inconclusive findings in previous research (Aggarwal et al.; 2012 & El-Masry et al. 2010; Olugbode & Pointon, 2010).

For the calculations of the $\overline{AR}$s of over the 21day event window across all assets, we observe at day 0 and +1 are the only which are statistically significant at the 5% level. The vast effect on day 0 indicates that the price effect on average *at* the day of the negative shock is significant, whilst we assume that the result on day +1 may contain lagged effects of the oil price shock. These findings indicate that the markets are quite efficient as there is, on average, less noise around the days surrounding the shock. Similarly, when analysing across all events, we observe that the $\overline{AR}$'s on the day of a negative shock imply a negative average abnormal return for all events, where only event 7 has a statistical significance less than 5%. Figure 7.1.1 below illustrates the average abnormal returns along with the 5% significance levels. As the standard deviation is constant of all observations (Equation 4.22), the t-statistics are highly correlated with the abnormal returns. In addition, we can observe that the returns after the shock (day +1 to +10) have larger variations than for the similar period prior to the shock (day -10 to -1). This might imply a larger variance in the equities following a shock in the oil price.

**Figure 7.1.1**

AAR's for all firms during negative shock




<u>Non-parametric tests</u>

The non-parametric tests are of assistance to us to reduce the problem regarding non-normal distributions; the Rank test is affected by the size of the abnormal returns. Meanwhile, as longer the event window stretches, they will appear more significant. Therefore, by applying the Sign test, we analyse the sign, whilst disregarding the relative size of any abnormal return.

The Rank test ranks the returns in the event window relative to the period, whilst also including the returns in the estimation window, where an event window average below 50% indicate negative abnormalities in the stock returns. A summary of the Rank tests can be found in Appendix 6.1, where we observe that for the negative shock the shortest event windows have a lower event window average, where the averages decrease from 47.5% in the ±10 day window, to 38.7% in the ±1 day window. However, it is worth mentioning that only event 8 and 10 are statistically significant for the ±1 day window.

Similar to the Rank test, the Sign test detects positive abnormal returns if the event window average is above 50% (more 1's than 0's), and negative abnormal returns if it is below 50% (less 1's than 0's). A summary of the observed Sign tests for all companies during a negative shock can be found in Appendix 6.1. On average, our findings when conducting the Sign test confirm the results in the Rank test, where there is evidence of negative abnormal returns during the negative shocks. However, in contrast to the Rank test, more observations show statistical significance in the ±1-day event window.

***Partial conclusion***

The findings in the parametric tests for a negative oil price shock showed that, on average, there are negative abnormal returns for the companies in our research group. However, there are some variations in the level of significances. Nonetheless, the results show a higher significance of negative abnormal return during the shorter event windows, where 6 of the 9 events have 1% significance level or lower. Our findings indicate the difficultness many of the previous research has emphasized, namely the assessment of generalising the negative oil price shocks' effect on shipping companies across segments. Based on the results presented, we are able to determine that a negative shock in crude oil price leads to negative abnormal returns across the shipping companies within our research.

### 7.1.2 Hypothesis 1.2

***Introduction***

The second hypothesis is similar to the previous. However, rather than studying the effect of a negative shock in the oil price, it addresses the effect of a positive shock in the oil price. As with the previous hypothesis, we argue that the effects of oil price changes will vary across the segments in our analysis, but will apply the hypothesis as a base for the following hypotheses.

Hypothesis 1.2: *Positive oil price shocks have no effect on shipping asset prices*

Over the period of our analysis, there were a total of six daily positive shocks in the Brent crude oil spot price which satisfied the criteria presented in section 3.1.1.

*Results and analysis*

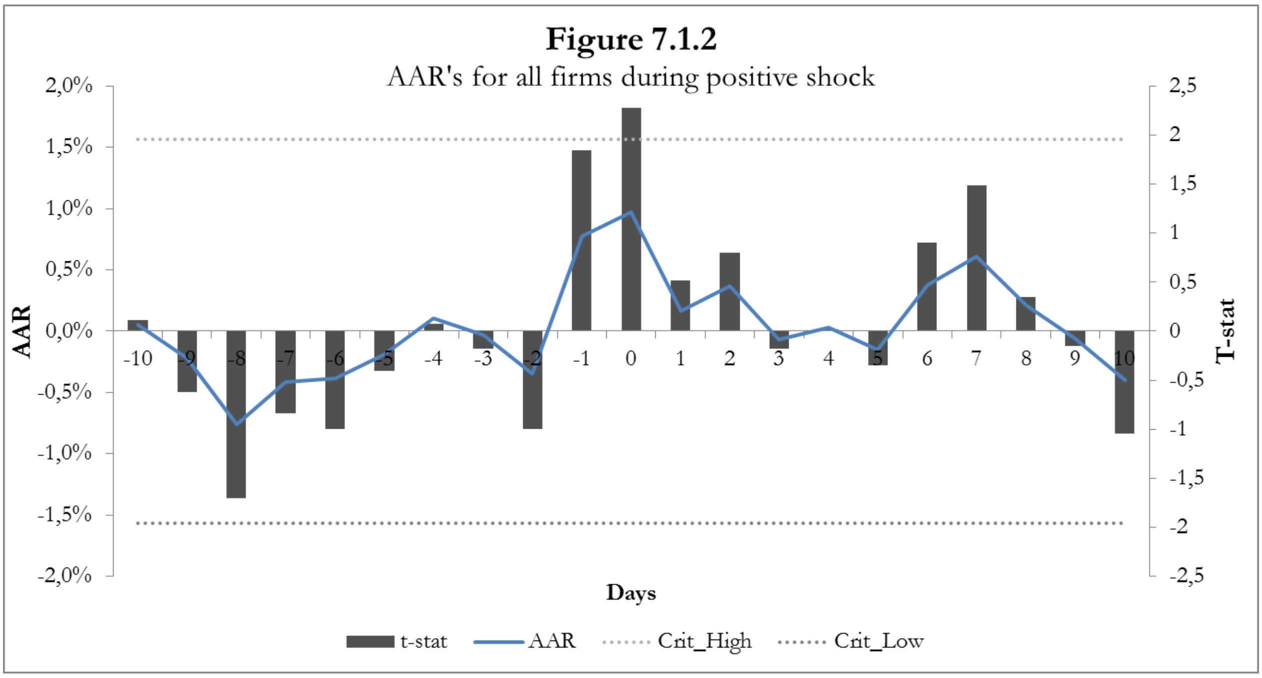
Similar to hypothesis 1.1, we will investigate whether there are any abnormal returns across the firms in the presence of a positive oil price shock. The analysis will also be performed by a parametric t-test, which we will complement with a non-parametric Rank-, and Sign test.

Parametric test

The results from the $\overline{CAR}$s of the shipping firms resulting from the ±10, ±5, ±2 and ±1 day event window yield the opposite of the results found in hypothesis 1.1. Here, on average, they are positive in all the four different event windows. For the positive shocks, the average value of the $\overline{CAR}$s are calculated to be 0.64%, 1.63%, 1.93% and 1.91% for the ±10, ±5, ±2 and ±1-day event windows, respectively. Moreover, the maximum value is found in the 5 day event window (event 14), and in general, as the event window gets smaller, the cumulative abnormal returns seem to become more consistently towards a positive return where only event 12 has a negative $\overline{CAR}$ for the window. However, similar to the findings in hypothesis 1.1, they are not exclusively positive, even though the findings seem to be more consistent in the narrower event window. In addition, four out of the six $\overline{CAR}$'s are statistically significant for the 3 day event window, whilst only two are statistically significant for the 5-, 11-, and 21 day event windows. An excerpt of the $\overline{CAR}$'s calculated for the shipping firms within our analysis can be found in Appendix 6.1.

Similar to the findings around the negative shock in the oil price, we observe that a positive shock in the oil price yields a significant average abnormal return for all firms, over all positive event windows at the day of the shock. Also, when analysing each event's $\overline{AR}$, they are all positive for the day of the shock. However, different from the negative shock is that here we observe that the shocks on average also impacts the day prior to the shock, i.e. at day -1, compared to day +1 for the negative shocks. In addition, the difference is that across all positive shocks, only the day of the shock yields a significant average abnormal return.

As expected there are, on average, significant abnormal returns across all companies on the day of the shock. However, for each individual event, only two of the six (event 2 and 14) are significant at the 5% level, whilst four are significant at the 10% level. Furthermore, the t-statistic in event 14 is very large, which has driven up the average in Figure 7.1.2. Therefore, we believe that the event might have a biased impact on the significance level and thus, creating a false sense of significance across all events. The $\overline{AR}$'s for each event can be found in Appendix 6.1.




Non-parametric tests

The Rank tests for all companies during positive shocks in the oil price seem to give an event window average which indicates positive abnormal returns across all firms in our analysis. However, similar to the results in hypothesis 1.1 as we shorten the length of the event window from 21 days to 3 days, there seems to be stronger evidence for a positive abnormal return across all firms. Furthermore, for the event window average, there are no observations which are statistically significant for the 21- and 11- day windows, whilst event 14 is the only event which shows a significance level of less than 5% for the two shorter event windows. This implies that, even though there is an extreme observation at the day of announcement, there are almost no evidences of abnormal returns on average across all days in the specified event windows. A summary of the non-parametric Rank tests for the positive shocks in the oil price can be found in Appendix 6.1.

Over the six events which yield a positive shock in the oil price, there seems to be presence of abnormality in the returns of all the companies. The results for our Sign test show a more consistency as the event window decreases. From an event window average of 51.05% in the 21-

day event window the average increases to 58.9% during the three-day window, where only event 9 has an event window average below 50%. However, the 21-day and 11-day event windows show no statistical significance, whilst four of the six events show a significant impact in the three-day window. These observations imply that there are evidences of positive returns in the shorter event windows. A summary of the non-parametric Sign tests for all firms can be found in Appendix 6.1.

*Partial conclusion*

The findings in our parametric tests seem to be equivalent to that of the negative shock; only the firms now show signs of positive abnormal returns as a result of a positive oil price shock. This is evident for the $\overline{\mathrm{CAR}}$'s, where five of the six event windows yield a positive abnormal return across all industries. A similar result can be found from the $\overline{AR}$'s, where we observe that the reaction over the industry in our research shows a significant positive average abnormal return around the day of the shock. The findings are though not as conclusive amongst the non-parametric tests, where the Rank tests show very limited evidence of a positive abnormal return, whilst the Sign test results are more in line with the findings from the parametric tests. Based on the results from a positive shock in crude oil prices, our findings show that positive shocks in crude oil prices cause a positive abnormal return for our shipping companies.

### 7.1.3 Conclusion shipping industry

The findings from our tests of both negative and positive shocks show a statistically significant result amongst the companies within our research. There are however some limitations from our tests, where the analyses over the 21- and 11-day event windows seem to show less conclusive results, compared to the event windows over 5- and 3 days. For example, as the spread between the maximum and minimum parameters seems to decrease as we limit the event window, there is both more consistency in the parameters whilst at the same time a lower level of significance, i.e. more statistically reliable results. These results can also be viewed in relation to the $\overline{AR}$'s which are, on average across all firms, positive for all observations for the day of the oil price shock.

The results show a positive correlation between the changes in the crude oil prices, and the subsequent development of share prices. The results though show, for each individual shock, that the effects are short-lived, as we extend the number of days in our event windows, the evidence becomes less visible. The findings seem to be in line for both the calculations from the $\overline{CAR}$ and $\overline{AR}$s, indicating a negative (positive) shock in crude oil prices lead to an immediate negative (positive) shock in the share prices of the companies within our research. For our composition of firms within the shipping industries presented in section 5, we are thus able to reject hypothesis 1.1 and 1.2.

## 7.2 Oil price exposure on drilling industry

There have been limited studies which analyse the effect of oil price on companies within the offshore drilling industry. However, Kaiser & Snyder (2013) and Kaiser (2014) found that the primary market indicators consist of utilization and day rates, where the demand in the offshore E&P market is associated with oil and gas prices. Furthermore, from the illustrations in Figure 5.2 we can view the drilling industry as being correlated to the findings in that of oil and gas companies. Furthermore, previous research has found the drilling sector to have the highest market beta, and thus higher average returns and systematic risk. It is also argued that the drilling sector is influenced, amongst other things, by the price of crude oil (Kavussanos et al. (2003). The overall demand for drilling units is highly dependent on the oil and gas companies' activity level, which again is highly dependent on the current market price of the crude oil (Sadorsky, 2001; Boyer & Filion, 2007). Moreover, as the expected lifetime of such drilling units are long, periods when the supply of rigs greatly exceeds demand, it will affect the industry vastly.

### 7.2.1 Hypothesis 2.1

***Introduction***

In the second part of our research, we will extend on the analysis on shipping companies in general by focusing on the companies within the drilling industry, and the effects of oil price shocks on the industry participants. However, as previous research has shown that companies within the upstream sector of the oil value chain is correlated with the crude oil prices, limited research has analysed the effects on the shipping industries assisting the sector, such as the drilling industry. We therefore provide the following hypothesis.

Hypothesis 2.1: *Negative oil price shocks have no effect on asset prices within the drilling industry*

We have analysed the equivalent events for negative shocks as in section 7.1.1, where we have removed all companies that do not fall within the drilling segment. In this way, we are able to isolate the effect these shocks have on the drilling segment.

***Results and analysis***

Parametric test

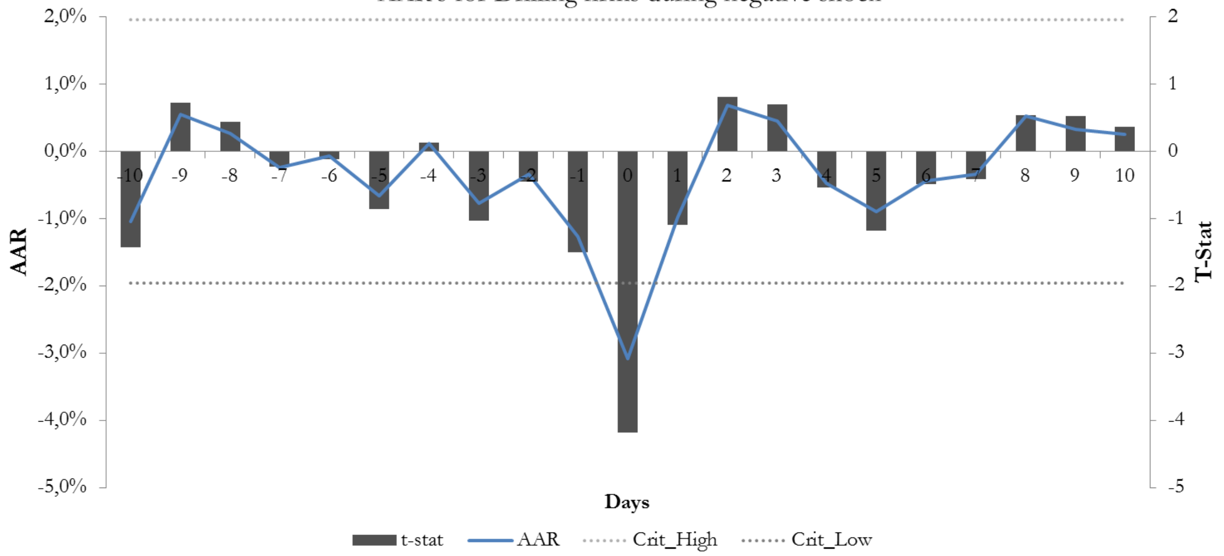
In our calculations of the $\overline{CAR}$s for the drilling industry, there are, across all events and event window lengths, varying results from a negative shock in the oil price. On average however, there seems to be a positive correlation between the oil price and drilling companies, where the average of the cumulative average returns for all nine events seem to show a return between -7.5% and -5% across all four event window dimensions. In addition, both the 11- and 5-day event windows show entirely negative returns as a result of a negative oil price shock. A quite surprising result though, is the fact that there is a slight positive $\overline{CAR}$ for the three day event window in event 3. Even so, as with the analysis of all firms in the section above, the results seem to be more consistent as we shorten the event windows.

Another observation which is evident from the negative oil price shock on drilling firms is the various results from the 21-day event window, where a negative shock in the oil price predominantly results in a negative abnormal return. However, this is not conclusive for all events, as some yield a positive abnormal return for the firms within the industry. In addition, only four of the nine events show any signs of statistical significance for the longest event window. What is interesting is that all events with a statistical significance yield a negative $\overline{CAR}$ over the period. Furthermore, this is the case for all of the shorter event windows as well. For our three day event window, only three events have a reported p-value above the 5% threshold. For these, only one observation (event 3) yields a $\overline{CAR} > 0$. However, this result has a p-value of 87.5%, which makes it far from statistically significant. The other two observations show a negative $\overline{CAR}$, but with around 10% significance level.

For the $\overline{AR}$s, we observe that there is a drastic and statistically significant decline in the share prices of drilling firms on the day of the negative shock. Furthermore, for each of the nine negative shocks during our period of research, the average abnormal returns were consistently negative, where only one such observation was insignificant at the 5% level. Even though the share prices seem to experience larger fluctuations around the day of the shock, there are no such observations that yield, on average, a statistical significance. What is somewhat surprising is the dire changes in the $\overline{AR}$'s which subsequently follow a shock. The $\overline{AR}$ for the resulting negative shock in crude oil prices for drilling firms can be found in Figure 7.2.1. In addition, the level of variability in the share price development after a shock seems to be similar to the variability prior. However, as these figures as based on averages of averages, we will further evaluate the developments of the share prices of all drilling companies after the shock.

**Figure 7.2.1**

AAR's for Drilling firms during negative shock




As the calculations of the $\overline{AR}$s' are based on averages, we will complement the research by analysing the spread of the drilling companies in the days after a negative shock. To isolate and illustrate the effects of the shares development after a shock, we have constructed a portfolio consisting of all drilling companies' development from the day prior to the shock and up to ten days after. In general, we observe that the spread development increases the longer we move away from the shock, implying a large gap between the minimum and maximum return following a shock. Though, on average and for most of the negative shocks, we observe a slight decline in the share prices on the day of the shock. However, a clear and common pattern across the firms is rather seldom. Whereas most drilling firms experience a sharp decline on the day of the shock, there is less conclusive evidence of the path which follows. The development of share prices after the shock can be found in Appendix 6.2

Non-parametric tests

When calculating the Rank test, we observe that the event window average is below 50% implying negative abnormal returns for drilling firms during a negative oil price shock. In general, there is consistency regarding the direction of drilling firms' performance following a negative shock. However, this is not the case from each event. During the 21 day event window event 5 indicates positive abnormal returns, whilst event 5 does not detect any signs of abnormality. On the other hand, for the 11 day-, 5 day-, and the 3 day event windows, all events indicate negative abnormal returns from the Rank test. In addition, during these three event windows, all observations indicate a negative abnormal return as no observations are above the 50% threshold, where the event window averages vary from 14.3% to 49.8%. Still, the significances of the Rank tests are limited as there are only one or two significant observations in each of the different event windows, across all negative shocks.

We observe similar results when calculating the Sign test. However, when the event window is shortened two distinctive differences compared to the Rank tests are evident; firstly, one event in the two shorter event windows indicate positive abnormal returns from the Sign test, though none of these observations were statistically significant. Secondly, in the two shortest windows, eight and seven of the observations are statistically significant. What is interesting is that the two insignificant observations in the 3-day event window are the ones which least imply a negative abnormal return. If we only include significant observations, the event day average drops to 22.8%. Further, the observations which yield a significant result in the 3-day event window always yield significant results in the 5 day event window, and equivalently for the 11 day window, with the exception of event 13.

***Partial conclusion***

The findings in the parametric tests show that there is a clear relationship following a negative shock in the crude oil prices and the stock price returns of firms within the drilling industry. Especially evident in the shorter event windows, the share prices of companies within the drilling segment seem to suffer equivalently the size of the shock. However, observations subsequent to a negative shock seem to bring the share prices back to the levels prior to the shock. Though there are some events where the $\overline{CAR}$s do not show a negative share price development across the industry, the results show limited significance. Across all other events, where the results are of statistical significance, the observed $\overline{CAR}$s range from -5.2% to -14.5%. These results show that the industry suffers from a negative shock in crude oil prices.

From the calculations of the $\overline{AR}$s we observe that, on average across all negative shocks, the average abnormal returns across all drilling companies are negative. Furthermore, all except event 7 show sign of a statistical significance at a 5% level or lower. In addition, evidence shows that the days immediately surrounding the event also show negative abnormal returns, on average for the industry. Though, the results become less evident as we observe over the longer periods, showing that the share prices of these firms recover somewhat promptly from a negative shock.

When analysing the developments which follow a negative shock, we can further observe that there are vast differences within drilling firms. Though there is a common reaction on the day of the negative shock, the immediate subsequent days show varying results, indicating that the market expeditiously prices the shock into the firm value. Even though the average across all events state that the days following a shock result in a negative abnormal return, it is shown that some companies recover quickly after a shock, resulting in positive abnormal returns in the period following a negative shock (Appendix 6.2).

In the non-parametric tests, there are results which indicate a negative abnormal return for drilling firms following a negative shock in the oil price. The results become even more evident when the event window is shortened to both the ±2 and ±1 day event window. However, a contrast between the Sign- and the Rank test is while there are signs of statistical significance for negative abnormal returns in the Sign test, this is not as evident for the Rank test. On the other hand, when only including results from both tests which are statistically significant, we observe clear signs of negative abnormality in the returns of drilling firms as a result of a negative oil price shock.

The results from the parametric- and non-parametric tests emphasize the fact that the vast majority of negative abnormal returns stem from the day of the shock. Even though this might not seem as the greatest surprise, as the drilling industry is an oil intensive industry, these findings can be interpreted by the fact that the drilling market efficiently incorporates a shock in a vastly important determinant of the industry. Moreover, as the majority of both the cumulative-, and average abnormal returns arise from the day of the shock, making the shorter event windows more significant and interesting than the longer event windows.

### 7.2.2 Hypothesis 2.2

***Introduction***

For this part of the research, we will continue our analysis of oil price shock on the drilling industry similar to the analysis in the section above. However, for this part we will analyse the effects in which the industry experiences as a result of a positive oil price shock.

Hypothesis 2.2: *Positive oil price shocks have no effect on asset prices within the drilling industry*

We have analysed the equivalent events for positive shocks as in section 7.1.2, where we have removed all companies that do not fall within the drilling segment. In this way, we are able to isolate the effect these positive shocks have on the offshore drilling segment.

***Results and analysis***

Parametric test

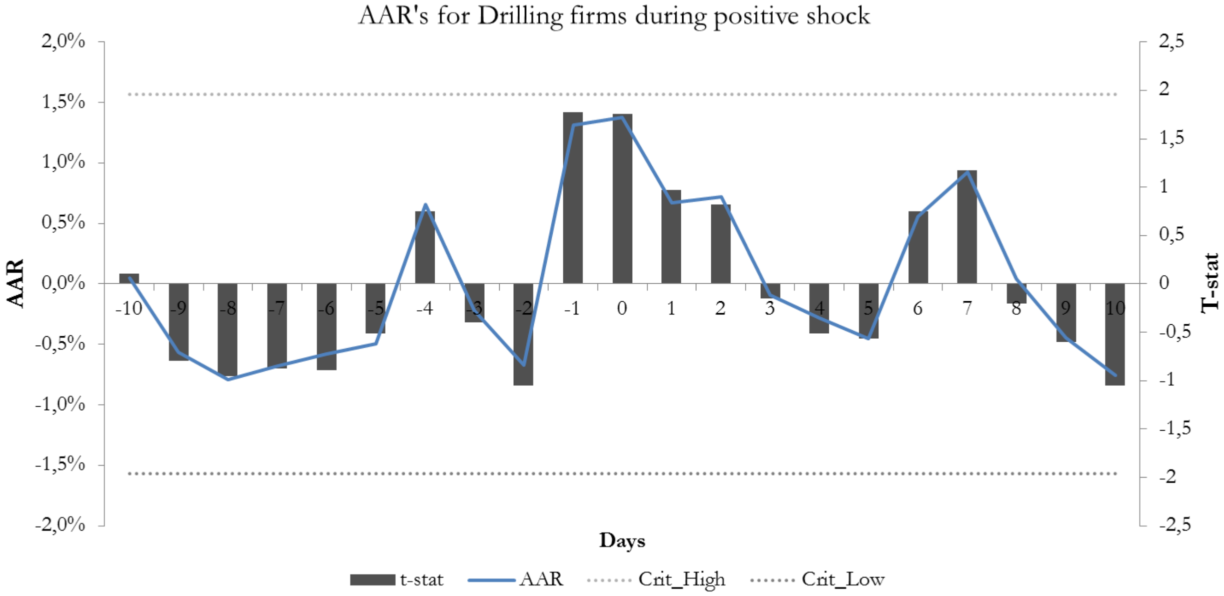
The $\overline{CAR}$s calculated following the six positive shocks display a similar, but opposite, result as in section 7.2.1. Over the six events, there seems to be a positive relationship between the drilling industry and positive shocks in crude oil prices. However, there are fluctuations between the maximum and minimum calculated $\overline{CAR}$s across all events. These results vary from -15.1% and 6.1%, -9.6% and 10.7%, -3.8% and 12.%, and 0.5% and 9.3% for the ±10 day, ±5 day, ±2 day and ±1 day event window respectively. What is evident is similar to the findings for the negative shocks on the industry, namely the fact that the results become more consistent the narrower the event window.

In the 21 day event window, we observe that the $\overline{CARs}$ have large fluctuations, even though averages across all events are greater than zero. However, as the event window is abbreviated, the calculations show more consistent results implying that in the 3 day event window, all cumulative average abnormal returns are positive for drilling firms, across all events. On the other hand, whilst the results show a more consistent trend in and around a shock, the statistical significance is somewhat limited. In the 21 day event window, only event 2 shows signs of statistical significance at a 5% level. Quite surprisingly, the calculations show a negative $\overline{CAR}$ during the window. Further, only three out of the six events have a statistical significance for each of the three shorter event windows, where only the $\overline{CAR}$ for the 11 day event window in event 2 shows a negative and statistically significant cumulative average abnormal return, whilst the remaining show a $\overline{CAR} > 0$.

For the $\overline{AR}$s calculated for the drilling companies in the event of a positive shock in crude oil prices, we observe that the results are coinciding with the results for the cumulative average abnormal returns above. We also note that, on the days surrounding the positive shock, the returns are positive. However, this is not always the case. For both event 1 & 12, the average abnormal return is negative across the industry, though both lack a level of statistical insignificance. In the remaining six events which yield a positive return, only three of the observations show a statistical significance. However, the averages for the industry in general and across all positive shocks show that the industry benefits from a positive shock in crude oil prices. An average of the calculations of the $\overline{AR}$s can be found in the figure below.

**Figure 7.2.2**

AAR's for Drilling firms during positive shock



Though the results from the two parametric tests above show signs of the industry benefiting from a positive shock in crude oil prices, some of our observations lack a statistical significance at the 5% level. We will further investigate the developments of these firms in the days after the shock. The findings from each firm's development vary, and thus indicating a difficultness of generalizing the entire industry. An example is whereas Songa Offshore experienced an increase above 30% over the five days after event 14, whilst BW Offshore on the other hand experienced a decrease of nearly 20% over the five days after event 2. Following the shock, the spread between the indexed development of each firm increases, whilst also varying across events. However, except for event 1, we observe that the industry average closely follows the development of the oil price following a positive shock. This might indicate that, following a shock, investors have promptly priced the shock into the company and the further developments of the stocks depend on other factors than the oil price. The development of share prices after the shock can be found in Appendix 6.2.

Non-parametric tests

The calculations for the Rank tests for drilling firms following a positive shock seem to, on average, offer a positive abnormal return on the industry's asset prices. We observe that the event window average show signs of positive abnormal returns across all windows and all shocks. Equivalent to the findings for the negative shocks, as the event window is shortened; the results seem to yield a more persistent pattern. On the other hand, all except for the 3-day event window has one or more observation where the event window average is below 50%, indicating a negative abnormal return. However, only one event window average over all windows and events for positive shocks are characterized as statistically significant at the 5% level.

For the Sign test, we also observe that the averages calculated show positive abnormal returns over all events. However, for each of the event windows there is at least one event which does not show signs of positive abnormal return, even though the averages are above 50%. As with the Rank test, the pattern shows an increasing positive abnormal return as the event window is shortened. Similarly, the number of significant observations increases from zero during the 21-day event window, two for both the 11- and 5-day event windows, whilst the 3-day event window show a significance for four of the six events. Further, only the 11-and 5-day event windows in event 2 yield a statistical significance for a negative event window average, whilst the rest of the observations which show statistical significance yield a positive event window average.

*Partial conclusion*

Through the results from the parametric tests, we observe that the consequence of a positive shock in the crude oil price leads to a positive increase in the share price of companies within the drilling industry. For the $\overline{CAR}$s, we witness some variations in the returns, when we let the event window stretch over 21 days. Though, the results become more conclusive as we narrow the length of the event windows. In addition, the results show exclusively positive abnormal returns for the $\pm 1$ day event window.

For the $\overline{AR}$s calculated, the results show a large variation in the development of the share prices, on average. We observe that from day -1 to +2, the industry experiences an increase in the return across the industry. The calculations show that the industry benefits from a positive shock in the crude oil prices. These observations apply for most of the individual event windows. However, even though the calculations show that the returns increase in the days surrounding the event, there are limited observations which are statistically significant at the 5% level.

From the developments immediately after the shock, we observed that the industry on average showed an effect on the day prior to the shock and also the subsequent two trading days. Further, firms within the portfolio varied in their reactions resulting from a positive shock. The positive crude oil price shock leads to positive abnormal return in the following days. However, the effect from the shock diminishes as we move further away from the day of the shock.

From the non-parametric tests, there are evidences of positive abnormal returns for drilling stocks as a result of a positive shock in the oil price. From the Sign test, four of the six events show a statistical significance in the 3-day event window, whilst none of the event window averages from the equivalent period show any significance from the Rank test. Even though the calculations from the event window average seem to suggest the presence of positive abnormal returns, the limited number of significant results makes it difficult to conclude on the fact that a positive oil price shock indeed has an effect on drilling stock returns.

Both the parametric and non-parametric tests show that there are signs that the drilling industry benefits from a positive shock in the oil price. The calculations provided showed positive abnormal returns for all firms around the immediate days surrounding the event. However, compared to the similar negative shock, the numbers of significant results has decreased. Further, when evaluating the post-shock period, the results indicate that the pricing of the shock in the market was more stagnant.

### 7.2.3 Conclusion drilling industry

For the drilling industry, we observe that the negative shocks in the crude oil prices lead to a statistical significant negative abnormal return amongst the industry. However, even though the results indicate positive abnormal returns as a result of a positive shock, the results lack statistical significance at the 5% level. We further observe that, for both types of shocks, that the period surrounding the shocks show large fluctuations in the returns across the industry. As a result, our findings lead us to reject the null-hypothesis regarding negative shocks, whilst we fail to reject the equivalent null-hypothesis regarding the positive shocks.

## 7.3 Oil price exposure on OSV industry

The OSV industry is critical to the worldwide offshore oil and gas operations, and contributes to the economic and ecological impacts experienced by the local communities supporting the offshore oil and gas industries. The main activity within the OSV industry is to provide goods and services to offshore activities, as OSVs provide a vital linkage between offshore E&P activities and shore-based facilities (Kaiser & Snyder, 2013). Albeit the lack of research on the OSV industry and the linkage towards the developments of crude oil prices, there have been studies arguing that risk, and thus the expected return for the OSV industry are of similar characteristics as the drilling industry (Kavussanos et al., 2003).

As an industry, the OSV market illustrates the motivation behind this research, where the reaction of OSV companies from a shock in crude oil prices is twofold. Firstly, as a maritime transporter, an increase (decrease) in the price of oil would imply higher (lower) costs of transportation. Secondly, as the main determinant of increased (decreased) activity is closely related to an increase (decrease) in the price of crude oil. For this part of our analysis, we expect the latter to have the predominant effect. As a result of their close characteristic link to the drilling industry, we therefore expect similar findings as in the section above.

### 7.3.1 Hypothesis 3.1

*Introduction*

Even though the activities within the logistics chain are to a great extent controlled and coordinated by the level of E&P's, they are also dependent on other external factors. Such activities include port operations and as a logistics supplier, whilst also stand-by services (Olesen, 2015). We therefore argue that the crude oil price is of vast important to the industry, and to further our understanding of the industry, we would like to extend on the previous literature by analysing the effects of negative shocks to the crude oil prices.

Hypothesis 3.1: *Negative oil price shocks have no effect on asset prices within the OSV industry*

As in section 7.2.1, we have only included companies within the industry of interest, to isolate the effects the negative shock on the OSV industry.

***Results and analysis***

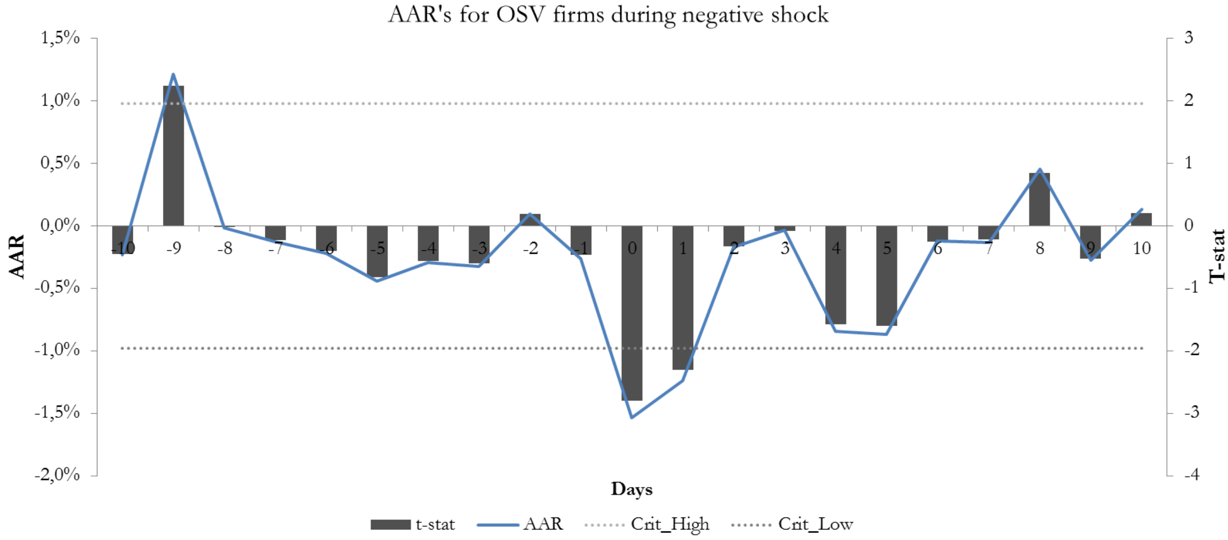
Parametric test

The $\overline{CAR}$s calculated from the OSV industry following a negative shock in the crude oil price yield, on average, a negative cumulative abnormal return over all event windows. Throughout the four different event windows, we observe that the average cumulative abnormal returns for our OSV shares are calculated to be -5.24%, -5.11%, -3.12% and -3.04% for the 21-, 11-, 5-, and 3 day windows respectively. Moreover, only a few calculations indicate a positive cumulative abnormal. These include event 1 for the $\pm 10$ day window, event 11 for the $\pm 5$ day window, event 1 & 15 for the $\pm 2$ day window and event 1 for the $\pm 1$ day window. Similar to the findings for the drilling firms, we observe that as each event window is shortened, the difference between the maximum and minimum $\overline{CAR}$s observed converge towards the average. The observations thus converge towards a consistent pattern across the industry. However, a disappointing result which contradicts our initial expectations is the fact that the negative shock does not exclusively result in a negative cumulative abnormal returns for the OSV companies in our analysis.

For the statistical significance of our results, we observe that there are three, five, four and six significant observations for the $\pm 10$, $\pm 5$, $\pm 2$ and $\pm 1$ day window respectively. Furthermore, throughout the event windows, all significant observations imply a negative cumulative abnormal return, i.e. all results which imply a positive $\overline{CAR}$s are statistically insignificant. We also note that, as our analysis of the similar shocks for the drilling industry, the number of significant observations increases as the event window is shortened.

For the calculation of the $\overline{AR}$s, we observe that, on average across all events, there are signs of a statistically significant negative average abnormal return amongst the OSV companies. In addition, except for event 15, all other events yield an average abnormal return on the day of the shock. However, for event 15, we observe that the returns following the shock show vast fluctuations in direction. From Figure 7.3.1 we further note that the negative returns are statistically significant, on average, for the day of the shock, in addition to day 1. The industry further experiences, on average, negative abnormal returns in the subsequent seven days following a negative shock. For each individual event we observe that the results in six of the eight events which show a negative average abnormal return are significant on the day of the event, whilst event 15 which shows a positive abnormal return is statistically insignificant.

**Figure 7.3.1**
AAR's for OSV firms during negative shock




The negative average abnormal returns across all events have shown that the effect on the industry is enduring. As a result we will complement the calculations by looking at the developments of the share prices for the companies in question, and their reactions after each event. The figures related to this analysis can be found in Appendix 6.3. The developments which follow a negative shock seem to be in line with the results from the $\overline{CAR}$ and the $\overline{AR}$, where a negative shock in the oil price pulls the share price returns within the industry down. As the period after the shocks include more normality in the returns of the crude oil prices, we observe that the industry for the most follows the direction of the crude oil prices. However, the spread between the companies is increasing, as we move further away from the day of the negative shock.

<u>Non-parametric tests</u>

From the non-parametric Rank test, we observe that the event window averages across the different event windows suggest negative abnormal returns. The averages also suggest that the observations from the Rank test imply that as we shorten the event window. We observe that the event window averages decreases from 47.14% in the ±10 day event window, to 38.78% in the ±1 day event window. However, even though the averages are below the 50% threshold for all event windows, there are individual observations in which they are above 50%, i.e. indicating a positive abnormal return. For the 21-, 11-, 5-, and 3-day event windows there are one, zero, two and one observations which imply a positive abnormal return. It is however worth mentioning that none of these observations are considered to be statistically significant at the 5% level.

The averages and trends from the Rank test are analogous to the findings when conducting the Sign test. Across all event windows, the averages indicate negative abnormal returns, where the observations seem to converge towards a coherent result, where all averages are below the 50% threshold. However, the results from the Sign test seem to indicate negative abnormal returns in two ways; firstly, in the ±1 day event window, all observations result in a negative abnormal return. Secondly, the results yield a much higher level of significance, where all events except for event 1 and 15 show a statistical significant negative abnormal return. The tables from the two non-parametric tests can be found in Appendix 6.3.

*Partial conclusion*

From the parametric tests of the effects from a negative shock in the crude oil prices, we observe that it leads to a negative abnormal return across the industry. Though these findings are not a surprise and mostly confirm our initial expectations, the results and significance for the longer event windows seem to be less conclusive. As the event windows are shortened, the observations vary from -21.6% to 4.1% in the 21-day event window, whilst only varying between -8.6% and 1.3% for the 3-day event window. Furthermore, the averages across events becoming more consistent, and we also observe an increase in the statistical significance for the shorter event windows.

The calculated $\overline{AR}$s give, on average, an indication a statistically significant drop in OSV share prices as a result of a negative shock in crude oil prices. Furthermore, from Figure 7.3.1 we further observe that the shock also has an effect on the subsequent trading day. Across eight of the nine events, we find that OSV firms have a negative average abnormal return. From the eight events which show a negative abnormal return, seven are statistically significant at the 5% level, where the remaining events yield insignificant results.

Following the aftermath of a negative oil price shock, we note that the averages amongst the firms follow the development of the oil price. In addition, the result of a negative shock leads the industry to experience a significant negative return for the day after the shock. However, as we move further away from the shock, both the spread between the individual stocks increases, whilst the average diverges somewhat more from the crude oil price development. These findings are in line with the findings for the $\overline{CAR}$s and $\overline{AR}$s where we observed that the effects of a negative shock were more evident in the shorter event windows.

For both the Rank- and the Sign test we observe that the event window averages indicate a negative abnormal return across all event windows. However, though the averages indicate a negative abnormal return across all events for both tests, the number of significant observations differs. Whereas the Rank test only has one, three, three and two significant observations across the event windows, there are four six, five and seven significant observations for the equivalent windows from the Sign test. A possible explanation is that the Rank test is affected by the size of the abnormal return, whilst the Sign test considers whether the sign of the return is positive or negative, and not the relative size of the return.

After analysing the effects of negative oil price shocks on the OSV industry through various parametric- and non-parametric tests, we observe that the shock leads to a negative development for the industry. Though a few results vary for the OSV industry, the majority of the observations show a consequential and statistical significant drop in share prices. Furthermore, our findings show that the market absorbs the shock into the value of the companies somewhat slower than for the equivalent calculations from the drilling industry. In addition, these results become more evident as the event windows are shortened. As our event windows are symmetric around the events, it is difficult to observe the lagged effects when applying the parametric $\overline{CAR}$ and $\overline{AR}$ tests as they include the same amount of days prior to the shock. However, from their developments after the shock, we observe that the shocks do have an effect on the industry following a negative shock in crude oil prices.

### 7.3.2 Hypothesis 3.2

***Introduction***

In the second part of our analysis, we will analyse the effects of the corresponding positive shocks in crude oil prices, and how these shocks affect the OSV companies' share prices. As their main areas of operations are categorized as a transporting firm, one might argue that their reactions would follow a similar trend as the transporting firms found in Aggarwal et al. (2012). However, as their core objectives are to assist oil production operations, their operations fall within two stools and thus should be analysed as a separate transporting industry.

Hypothesis 3.2: *Positive oil price shocks have no effect on asset prices within the OSV industry*

For our sixth hypothesis, we will therefore analyse the effects of positive oil price shocks on the OSV industry.

***Results and analysis***

Parametric test

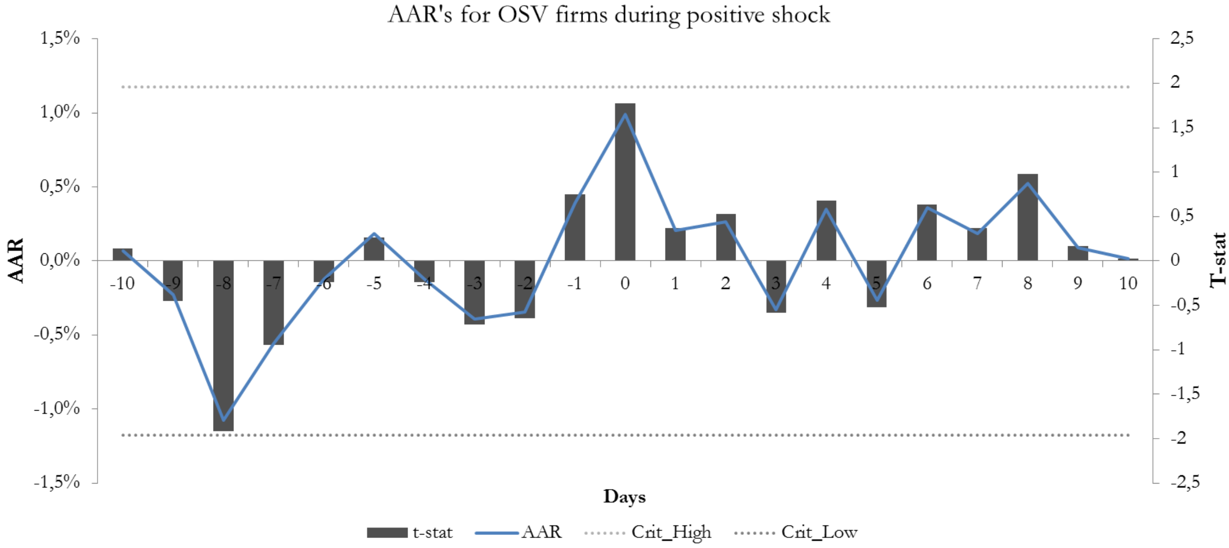
The $\overline{CAR}$'s calculated for the corresponding positive oil price shocks result in an average return across all events of 0.19%, 1.63%, 1.5% and 1.58% for the $\pm10$, $\pm5$, $\pm2$ and $\pm1$ day event window respectively. Similar to the findings from negative shocks on the drilling industry and the negative shocks for the OSV industry, the results become more coherent as the event window is minimized. For the three longer event windows we observe that, even though the averages indicate $\overline{CAR} > 0$, there are observations that imply a negative cumulative abnormal return across the industry. Following, the more extreme negatives are found in the longer window. Furthermore, it is worth mentioning that for the $\pm5$ and $\pm2$ event window, the only observation with a $\overline{CAR} < 0$ stems from event 2. On the other hand, all observations yield exclusively positive $\overline{CAR}$s for the 3 day event window.

Though the observations seem to coincide more as the event window is shortened, the analysis lacks significant observations. From the calculations, we observe that there is only one significant observation across all events for each window. For the 21 day, the only significant observation stems from event 1, whilst the remaining significant observations are all found in event 15. Compared to the findings from the negative oil price shock, the results are disappointing. Furthermore, the results are not in line with the findings in Aggarwal et al. (2012), where oil price increases leads to a negative change in firm returns.

For the average abnormal returns across events, we observe from Figure 7.3.2 that there are signs of a positive relationship across all six events. For each event, we also find that the average across the industry is positive. Though we observe that on the day of the shock, OSV companies experience ~1% increase in their share price. This continues somewhat through the next nine days, the days leading up to the event yield negative abnormal returns across the industry. However, in line with the findings under the $\overline{CAR}$s, there seems to be a lack of statistical significance and thus difficult to come up with a tangible conclusion as to whether there is a concrete impact on the industry from the oil price shock. The results in Appendix 6.3 show that only event 2 & 14 yield a statistical significance at the 5% level.

**Figure 7.3.2**

AAR's for OSV firms during positive shock



From Figure 7.3.2, we observe that the industry experiences an increase in share price returns in the days following a positive shock. A pitfall which arises from the calculations above is that the averages across both events and companies might not paint the most comprehensive picture, and we will therefore further look at the development of the share prices during the days after an oil price shock. Except for the first event, where the oil price experiences a large increase, the OSV market seems to remain quite stable, we observe that for the remaining events (event 2, 6, 9, 12 & 14) the industry's development seems to follow the oil price in a greater extent. These results seem to be in line with the findings from the $\overline{AR}$s, where the industry seems to benefit in the following days of a positive shock. The developments of the share prices following a positive shock can be found in Appendix 6.3.

Non-parametric tests

Across all observations, the Rank tests show that positive shock in the oil price results in an event window average above the 50% threshold for OSV companies. Coherent with the results in the parametric tests, the results seem to be more conclusive evidence as we shorten the event window. For the 21- and 11 day event windows, there are two and three event windows which imply a negative return, whilst for the 5- and 3 day event windows there are zero and one event implying a negative return. However, even though the observations become more consistent as the window is shortened, none of the event windows contain statistically significant abnormal returns. Therefore, by accounting for non-normal distributions, we cannot conclude on the fact that abnormal returns are present in the different event windows.

When calculating the Sign test, the results are similar to those calculated in the Rank test; namely an event window average implying positive abnormality in the returns for OSV companies as a result of a positive oil price shock. However, a difference between the two parametric tests is found for the statistical significance. As no observations gave a statistical significant calculation in the Rank test, we find that there are a greater number of significant observations in the Sign test for the shorter event window. Here, four of the six events show a statistical significance for the 3-day event window, where all indicate a positive abnormal return. Furthermore, the observations which are of significance are the ones which show the greatest positive abnormal returns.

*Partial conclusion*

As a result of the parametric tests presented in section 4.2.2.5.1, companies within the OSV segment seem to benefit from a positive shock in the oil price. Through the $\overline{CAR}$s, we observe that across all events, companies in the OSV industry benefits from an increase in the price of crude oil. This can be viewed by the positive abnormality in the returns from the rest. Secondly, as the event window is shortened around the day of the shock, the observations yield more consistency and also a higher level of statistical significance. However, when the event window is increased, the spread between the various events increases and the positive effects the increase has on the industry becomes less clear to interpret.

Even though there are evidences of a positive average abnormal return around the day of the shock, we observe that none of the observations within the 21-day event window yield a significant result. Furthermore, for each $\overline{AR}$ calculated, there are only two events which yield a statistical significance on the day of the shock. Though each event show that the firms within the industry benefits from a positive shock in crude oil prices, the lack of significance makes it difficult to generalize positive shocks across the industry.

When analysing the effects following a shock, we discard the presence of statistical significance, to further analyse each share's development. After each shock, five out of the six events seem to show a relatively similar development amongst the OSV industry and the crude oil price, which are in line with the days following the shock for the $\overline{AR}$s calculated. These results show that there are, on average, a positive relationship between positive oil price shocks and the share prices within the industry following a shock.

In our non-parametric tests, we find evidence of positive abnormal returns in the Rank test for all event windows. Further, these evidences are increased for the two shortest event windows, where only one observation for the 3-day event window shows a slightly negative abnormal return. A pitfall from the calculations in the Rank test is that our results struggle to meet the required significance level to draw a conclusion. For the Sign test, the event window averages yield similar results as the Rank test. However, a major difference between the two tests is the fact that the results in the Sign test have a higher level of statistical significance, where all observations except for one yielded a positive abnormal return in the two shortest event windows.

### 7.3.3 Conclusion OSV industry

In our analysis of the OSV industry, we observe that the negative shock in crude oil prices result in a negative development across the industry. The results though do not yield exclusively conclusive results for all event window lengths, as the results become clearer as the windows are shortened. On the other hand, the results show that the industry benefits from a positive shock in crude oil prices, though the results, on average, lack statistical significance. Further, the market seems to quickly incorporate the shocks into the share price, visible from the mixed results from the longer windows, whilst the shorter windows seem to show more conclusive results from the industry. This is also evident as we analyse the individual share price developments after a shock. As a result of our findings in section 7.3.1, we are able to reject the null-hypothesis for the negative shocks to crude oil prices on the OSV industry. However, the findings in section 7.3.2 make us fail to reject the null-hypothesis for the equivalent positive shocks in the crude oil prices.

## 7.4 Oil price exposure on crude oil tanker industry

There exists an extensive amount of previous literature trying to explain the relationship between oil price and the pattern of tanker rates. In their article investigation the correlation between oil futures- and spot-markets and tanker rates, Alizadeh & Namikos (2004) managed to find a significant relationship between tanker rates and the West Texas Intermediate oil price in the U.S. They argued that as the spread between the WTI oil price and the Brent crude oil increased, i.e. Brent crude oil becomes relatively cheap compared to WTI, there was an increased demand for crude oil import to the US.

In their analysis, Poulakidas & Joutz (2009) found that the demand for oil, unlike most other products, is inelastic. From an owner of crude tankers perspective this can imply that when the price of oil increases, the demand for oil and further the demand for oil transportation is relatively unaffected and vice versa. They also observed that when the spread between spot and 3-mounth future oil prices increased, it puts an upward pressure on tanker rates. This reaction was explained by the relationship linking the idea of increased demand for oil to an increased demand for tankers. Further, they found a negative relationship between crude oil inventories and spot tanker rates. Going forward we will investigate how the share price of firms in the crude oil tanker sector responds to different shocks in the crude oil price.

### 7.4.1 Hypothesis 4.1

***Introduction***

Commencing with the analysis of negative oil price shocks impact on the return of crude tanker companies, we expect to find some abnormalities as we know that crude tanker companies both on a firm- and market perspective are affected by fluctuations in oil price. We are therefore interested in the investors' reaction as a result of a negative shock in the oil price. For this part of the research, we will therefore evaluate the following hypothesis:

Hypothesis 4.1: *Negative oil price shocks have no effect on asset prices within the Crude oil tanker industry*

As mentioned in section 6.4 the industry is predominantly driven by an increase in either demand or supply, or both. However, we believe that by insulating the tanker market and its reaction to drastic changes in the crude oil prices, we will be able to assess whether the industry is affected by these changes.

***Results and analysis***

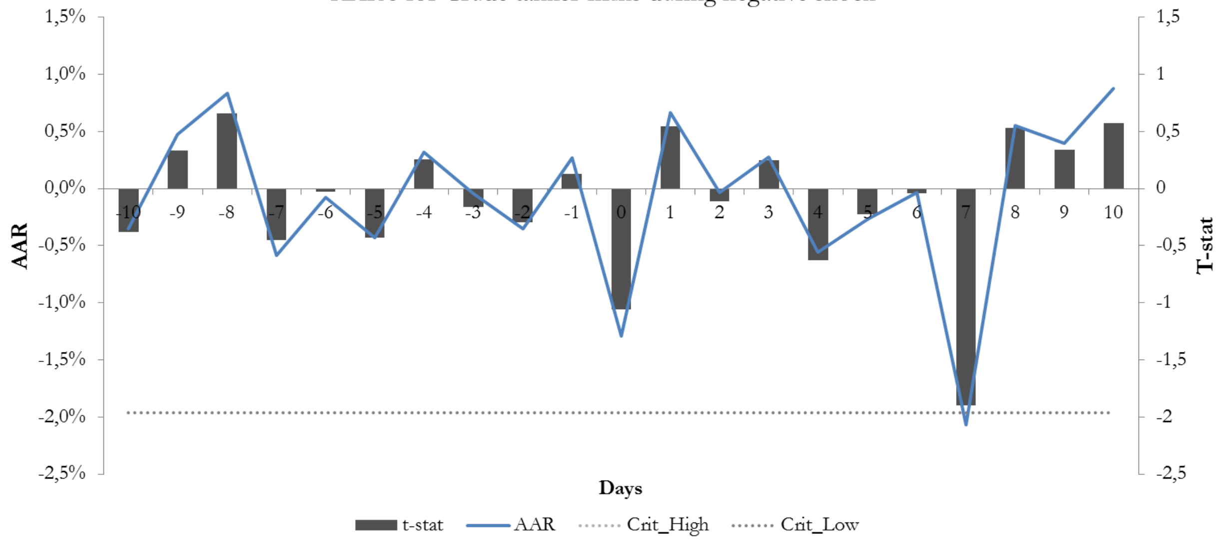
Parametric tests

For the cumulative abnormal returns we discover that crude tanker firms on average yield a small and negative $\overline{CAR}$ for all event windows. However, although the average of all calculated $\overline{CAR}$s yielded a negative return over all events, there are vast differences within the individual events and event windows. The differences resulting from a negative shock in crude oil prices can be illustrated by the 21-day event window, where event 8 saw a cumulative abnormal return of -27.2%, the equivalent event window in event 11 resulted in a 17.8% return. Quite surprisingly, both these results are statistically significant at the 5% level. For the 11-day event window, the results are similar, where the most extreme observations have a vast spread (-13.6% and 28.7%), where both observations are significant at the 1% level.

Further, in the 5-day event window we see more consistency among the $\overline{CAR}$'s, as all observations are negative with an average of -4.98%, with a maximum and minimum of -0.90% and -16.43% for event 3 and 10 respectively. This is though not the case for the shortest event window, where four of the nine events yield a positive $\overline{CAR}$. Similar to the two longer event windows, the positive and negative extremes (-6.2% and 9.1%) are statistically significant at the 5% level for the $\pm 2$ day event window. This is also the case for the $\pm 1$ day window, where the two significant results amount to -6.25% and 9.16%. In general, we observe that the negative shock in the crude oil price yield large variations within the different events. The only visible pattern is that when the 21 day event window has a positive $\overline{CAR}$, most of the corresponding shorter event windows also yield a positive cumulative abnormal return for the industry.

From the average of the $\overline{AR}$s we observe that the day of the shock results in a slight negative return. However, the results from the $\overline{AR}$s reflect the absence of a clear pattern as we also observed in the calculations of the $\overline{CAR}$s. In seven of the nine events, the average abnormal returns are negative, where only two of these observations are statistically significant at the 5% level. On the other hand, the two events which yield a slightly positive average abnormal return are not considered to be statistically significant. The major drop on day 7 stems from event 8, where the average abnormal return was -9.3%. We do not find any similar results for day 7 across the other events, and therefore treat the observation as an extraordinary circumstance. The analysis of the $\overline{AR}$s for the crude oil tanker industry can be found in the figure below.

**Figure 7.4.1**
AAR's for Crude tanker firms during negative shock




As the two tests above fail to give a clear pattern across the industry, we will further our analysis to analyse each individual stock's behaviour from the day prior to the shock and the following ten days. We observe that the developments of the share prices are quite similar to the oil price immediately after the shock for events 3, 4, 5, 8 & 15. However, as seen in the equivalent analysis for the prior industries, the differences between the firms and the oil price seems to increase as we move further from the day of the shock.

<u>Non-parametric tests</u>

Continuing with the Rank test, which indicates a negative abnormal return if the event window average is below 50%, we find that for the ±10-, ±5-, ±2 and ±1event windows, the averages are slightly below the 50% threshold. For the respective event windows, the averages are calculated to be 49.37%, 48.53%, 46.52% and 45.71%. As we move closer to the day of the event the negative averages seem to decrease, indicating a negative abnormal return. However, across all events and event windows, there are observations which show signs of both positive- and negative returns. Furthermore, the number of significant results is a scarcity, where there are 1, 2, 2 and 0 significant observations for the 21-, 11-, 5-, and 3 day event windows respectively.

For the Sign test, we a find similar pattern as for the Rank test, where the average of all event windows is decreasing as we shorten the event window. This is also evident from the individual event windows, where there are major differences in the observed event window averages.

However, a vast difference from the Rank test, we observe here that the statistical significance is increasing, from three significant observations in the ±10 day event window, to seven, six and nine for the ±5, ±2 and ±1 day event window. Nonetheless, though all results are significant for the 3 day event window, five of the observations indicate a negative abnormal return, whilst the remaining four significant results indicate a positive abnormal return.

*Partial conclusion*

Going through our results for negative oil price shocks impact on crude oil tankers, there are indications of a positive relationship as we have an overweight of negativity in the $\overline{CAR}$'s overall. We observe the same pattern here as for previous findings in that the results become more consistent as we move closer to the day of the shock in oil price. Having that said, we do have some inconsistencies, especially some that stems from event number 11 where we observe that both the 21-, 5- and 3-day window to be positive and significant at a 5% level. When taking a closer look at this event we observe that it occurs on 5 January 2015, which occurs during of a long lasting drop in oil price, due to factors such as oversupply of oil the market (Baffes et al., 2015). As the crude oil price dropped from mid-2014 the demand for large tankers increased as commodity traders and import countries employed crude tankers as temporary storage facilities, and large countries like India and China build up their petroleum reserves (Clarkson Research Services, 2015).

In contrast to the $\overline{CAR}$ calculations, the $\overline{AR}$ results show how the crude oil tanker responds to a shock the same day as the shock whereas the $\overline{CAR}$`s look at windows surrounding the event. For negative events we can clearly see that investors get a bearish view on the crude tanker sector on the day the oil price drops. We interpret these findings to be a result of highly efficient stock markets, as investors respond immediately to the shock in oil price. However, a disappointing factor is the lack of significant results across our nine events.

Regarding our non-parametric results we find them to be emphasising our parametric results in that they in general imply negativity in the event windows, though this is not exclusively the case. Further, the Rank test showed no significant results in thee ±1 day event window, with two significant results for the ±2 and ±5 day windows, and one for the ±10 day window. Even though the level of significance increased for the calculations of the Sign test implying that all observations in the shortest event window were significant at the 5% level, nearly half of these results indicated a positive abnormal return, whilst the reaming indicated a negative abnormal return.

Considering these findings in the context of our expectations, we find it somewhat surprising that investors in the crude oil tanker sector consider a drop in crude oil price as something affecting these assets negatively. As crude prices decreases we expected that there would be an increase in demand. One explanation, which is in line the findings in Drobetz et al. (2010), might be the view of oil price development acting as a proxy for global economic activity, which in this case implies that as the oil price drops the demand for seaborne trade declines and further earnings of crude tanker companies.

If we assume that a substantial part of the negative oil price shocks were due to lower demand for oil we can relate our results to Poulakidas & Joutz (2009). They argued that the movements in tanker rates were driven by the demand for oil and can therefore explain why the crude tanker returns are negative during negative oil price shocks.

### 7.4.2 Hypothesis 4.2

***Introduction***

In the second part of the analysis of the crude oil tanker segment we will investigate the short term effects of positive shocks in the crude oil price. A positive shock in the oil price can have several effects on the return of crude tanker companies. On a firm specific level, bunker is a substantial part of vessels operational costs. Therefore, following a positive shock in oil prices we can expect higher bunker cost, which again will affect the profitability of the fleet. Considering the market as a whole an increase in oil prices might lower the demand for crude oil, but as previous literature has found, the demand for oil to be inelastic we expect this effect to be somewhat insignificant (Poulakidas & Joutz, 2009). On the other hand, an increase in crude oil prices might enable oil companies to initiate production at facilities that initially weren't profitable. This again may further increase the supply, and thus the need for transportation from exploration point to storage facilities or refineries. By investigating how investors react to these events we might be able clarify these effects, and we have formed the following hypothesis to cover how the returns of crude tanker companies react to positive shock:

Hypothesis 4.2: *Positive oil price shocks have no effect on asset prices within the Crude oil tanker industry*

This part of the analysis is an extension to hypothesis 4.1, where we analyse the effect of a positive oil price shock on the aforementioned industry.

**Results and analysis**

Parametric tests

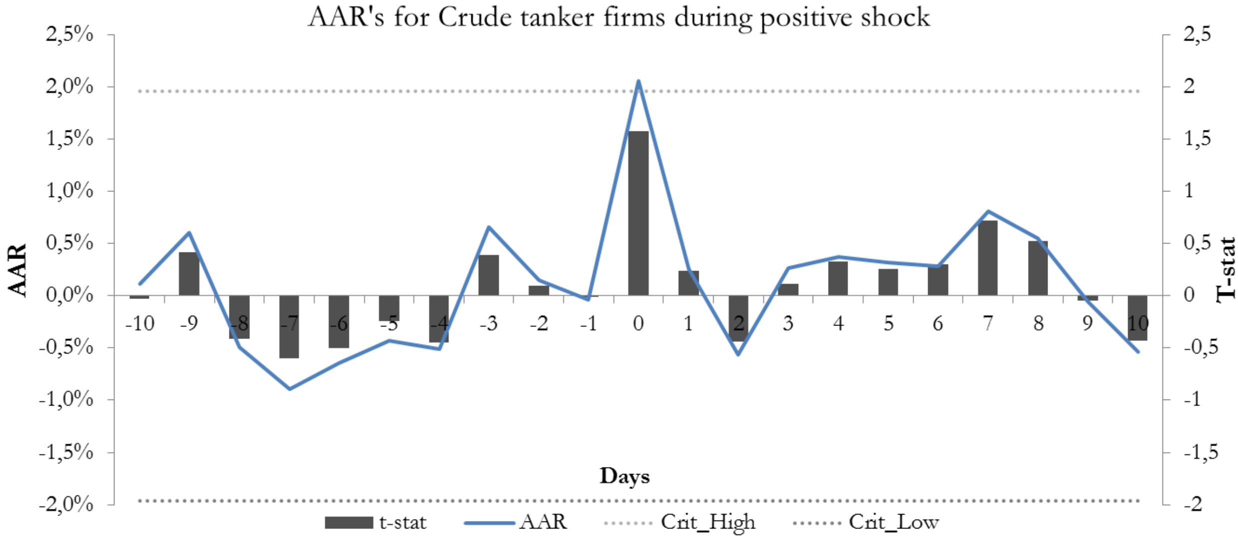
In the performed parametric test, the event study results from the calculated $\overline{CAR}$s display the average across all crude tanker firms; we observe that a positive shock in the crude oil prices leads to a positive return for all event windows. The average seems to be quite consistent across the different events, where we have 2.2%, 2.5%, 3.4% and 2.2% for the ±10, ±5, ±2 and ±1 day event windows respectively. In the 21-day event window, there are two events which show a negative $\overline{CAR}$, whilst for the remaining three event windows there is only one event which yield a negative cumulative abnormal return. We further discover that as we analyse the shorter event windows, the pattern seems to become clearer. This implies that, even though the averages across events yields $\overline{CAR} > 0$, a generalization for the industry across all events is difficult.

The calculation of the $\overline{CAR}$s seem to indicate that as we move closer around the day of the positive shock in the crude oil prices, the industry's reaction becomes somewhat more coherent. However, for us to be able to draw a conclusion whether a positive shock in the oil price in fact leads to an abnormal return for the crude tanker industry, the calculations must be of statistical significance. From the tables in Appendix 6.4 we observe that the results lack the presence of significance across most observations. For ±10 day event window we observe that none of the observations are significant at either the 5- or 10% level, which is also the case for the ±5 day event windows. Furthermore, only event 14 is considered to be significant at the 5% level for the two shortest event windows.

Continuing by analysing the average abnormal returns, $\overline{AR}$s, we observe from the figure below that on average crude companies have positive abnormal returns on the day of the event. Furthermore, we find that all events yield a positive $\overline{AR}$ on the day of the event. We also observe that there seems to be little variations in the stock returns on the days prior and after the shock, which might indicate that there is a limited longer term effect on the industry stemming from a positive oil price shock. For each event, we further observe that all $\overline{AR}$s are greater than zero. However, the presence of statistically significant observations is a scarcity, where only find event 2 and 14 to be considered significant at the 5% level. Considering the period stretches across 21 days, it is difficult to find any clear pattern, though our calculations seem to show that the market is highly efficient in incorporating the oil price shock into the crude oil tanker firms.

**Figure 7.4.2**

AAR's for Crude tanker firms during positive shock




When analysing the developments following a positive shock, there are mixed results for the industry. For event 2, 6 and 14, we observe that the industry follows the shock in the crude oil immediately surrounding the shock, where the further development seems to be regardless of the development of the crude oil prices. For events 1, 9 and 12 there seems to be no reaction to the oil price shock from the industry. These results seem to be some events which show signs of a positive reaction from the crude oil industry as a result of a positive shock in the oil price, which is equivalent to the findings in the two parametric tests. However, also in line with the parametric tests, there is no unanimous reaction across events for firms within the crude oil tanker industry.

<u>Non-parametric tests</u>

From the Rank test, we see that the event window average across all events increases as we shorten the event window, where they are calculated to be 52.4%, 53.9%,55.4% and 59.5% for the 21-, 11-, 5-, and 3-day event windows respectively. For the 21-day event window, all observations suggest positive abnormal returns for the period, whilst for the 11- day event window the event window average indicts negative abnormal returns. During event nine, both the 5- and 3-day event window indicates a negative abnormal return. However, a major disappointment for the Rank test is the absence of results with any statistical significance. Across all events, only event 14 yields a significance of minimum 10%, for the three shortest event windows, whilst no events show any significance for the 21-day event window.

The results from the Sign test from the equivalent periods and industry, the results are somewhat different. In common with the Rank test, there are observations which indicate a negative abnormal return, across all event windows. The majority yield a positive abnormal return, as the pattern is similar to that of the Rank test, where the averages are calculated to be between 52.0% and 63.6% from the longest to the shortest event windows. However, the levels of significant results are more present under the Sign test. For the ±10 and ±2 day windows, only two observations are statistically significant, though all indicate positive abnormal returns. On the other hand, the ±5 and ±1 day windows indicate that five events show a positive abnormal return, though not all are significant.

*Partial conclusion*

Our findings derived from the parametric $\overline{CAR}$ tests indicate that the returns of crude oil tanker companies on average are abnormal in a positive direction for the majority of our observations. However, there are exceptions which negative abnormal returns, though these are highly insignificant and appear arbitrary. Further we observe that as we narrow the event window, the results become more consistent, with only one negative deviation in each of the two shortest windows, we thus find the shorter event windows more interesting. Hence, the abnormalities are close to being absent in the windows wider than 5 days and the corresponding p-values are insignificant. We also find it difficult to observe any clear pattern for the crude tanker assets from the second day after the event and beyond. This might emphasis that the market is quite efficient when it comes to pricing the change in oil prices into crude oil tanker firms.

As we observed in Figure 7.4.2 the $\overline{AR}$s calculated emphasis the above in the way that they show clear signs of abnormalities at the day of the shock, where all individual events showed a positive relationships between crude oil prices and share prices of tanker firms. However, our observations show limited results which are significant at the 5% level. It is thus difficult to draw a firm conclusion from the average abnormal return observations surrounding the event day due low significance and arbitrary observations.

From both our parametric tests, the results show an observable pattern from the positive shocks in crude oil prices to the share prices of crude oil tanker firms. In the developments following a shock, three of the six events show a similar pattern, whilst the remaining three events show limited sign of a relationship. Furthermore, any signs of a pattern in the calculations above diminish rapidly as we move further away from the shock.

Our two complementing non-parametric tests are able to strengthen our view in that they on average indicate positive abnormal return for all four windows in addition to increase while narrowing the window around the day of the event. From both tests, we are able to observe results similar to that of the parametric tests. However, though the results from the Rank tests indicate positive abnormal returns, the significance level is limited. Further, the findings in the Sign tests are similar, in addition to there being more statistically significant results.

Similarly to the negative shocks, we can use same argument for positive shocks where we observed a positive relationship between crude oil tanker companies and crude oil price, which is consistent with the findings of El-Masry et al. (2010). In their research, they found a high proportion of the 143 shipping companies they analysed benefitted from an increased oil price as they argued that the industry is highly geared towards international trade.

### 7.4.3 Conclusion crude oil tanker industry

The analysis we have conducted for the crude oil tanker industry has given us valuable and surprising information regarding how investors react to positive and negative shocks in the crude oil price. However, even though there seems to be a relationship between the development of crude oil prices and crude oil tanker returns, the lack of significant results coerces us to fail to reject both hypotheses presented in this section 7.4.

## 7.5 Oil price exposure on product tanker industry

To extend on the analysis of the tanker industries' reaction towards a shock in the oil price, the last part of our research will comprehend the final stage of the marine transportation of oil. Though closely connected to the crude oil tanker segment, the products trade is considered to be very different from the crude oil trade (Stopford, 2009). However, Asche et al. (2003) showed that there is a long-run relationship between the prices of such refined products, and the price of crude oil. Furthermore, they found that the crude oil is considered to be an exogenous variable when determining the prices of the refined produces, implying that its development has an explanatory effect on the prices of refined products. Our expectations for the product tanker industry, is that the firms' share prices will follow the direction of the shock.

### 7.5.1 Hypothesis 5.1

***Introduction***

As product tankers operate one step further down in the oil chain and have many similarities as crude tankers, the market introduces some new factors making the segment quite different. The segment differs from crude tanker in the way that their cargo usually is traded in much smaller parcels in addition to being a product of what is transported by crude oil tankers (Stopford, 2009). In their research on the impact of crude oil price on tanker market, Shi et al. (2013) found that the supply of crude oil has a significant effect on the entire tanker market. Using a structural vector autoregressive model they also examined the relationship between crude oil prices and tanker rates. Their results were ambiguous depending on whether the shock in oil price was driven by increased supply or not, and degree of the supply shock. We conduct our analysis to look at the short term effects on share prices before and after shocks in oil prices, hence the following;

Hypothesis 5.1: *Negative oil price shocks have no effect on asset prices within the Product tanker industry*

We will apply the similar event dates as for the analysis above, only including the product tanker firms within our analysis.

***Results and analysis***

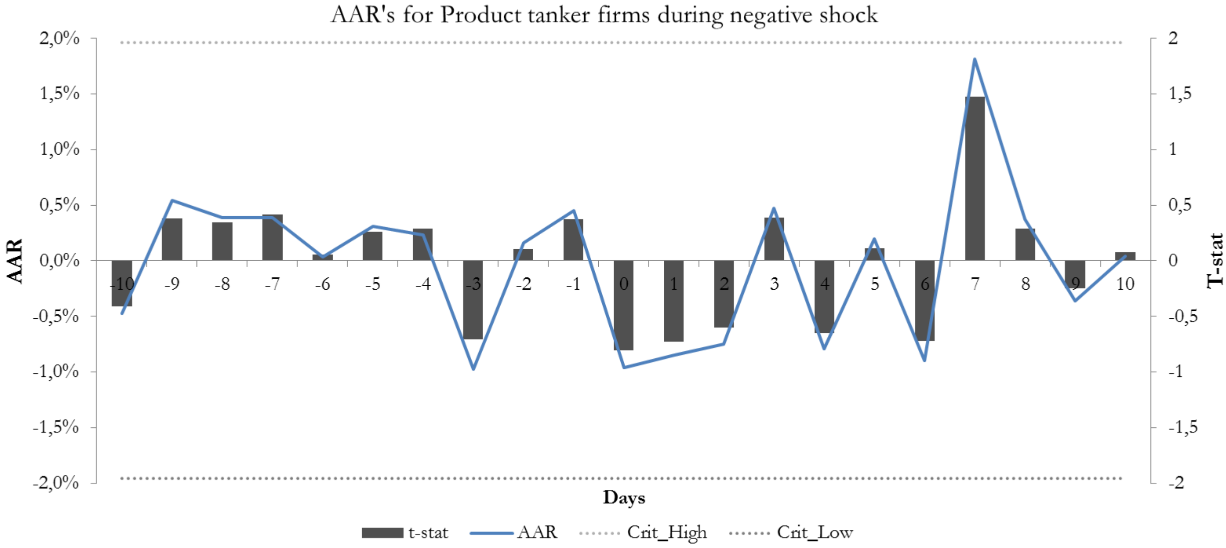
Parametric test

To get an overview of our findings we will present the average $\overline{CAR}$ which includes all events. For the 21-day window our tests resulted in an average $\overline{CAR}$ at -0.64% with spread from a maximum of 16.9% in event 3 to -8.9% in event 10. Moving on to the 11-day window we observe that the average $\overline{CAR}$ becomes slightly more negative, yielding -2.4% as the spread from highest to lowest becomes narrower and lower. The maximum dropped down to 7.5% in event 11 while the minimum was -10.4% in event 13. Narrowing the window further towards the day of the event we find that the 5-day window yields an average of -1.9% comprised by an even slimmer spread in the separate observations. Maximum and minimum for the 5-day window are 3.4% and -6.1% occurring in event 11 and event 4 respectively. For the 3-day window average $\overline{CAR}$ is -1.3%, while maximum and minimum are at 4.45% and -4.46%. For all events the majority of the observations are negative, and for the 3- and 5-day windows seven out of the total of nine events yield a negative $\overline{CAR}$.

Although we have a clear predominance of negative $\overline{CAR}$s, the corresponding significant levels do not able us to generalize the negative shocks over the entire industry. Quite surprisingly, there are only two observations with a statistical significance, the $\pm$10 day event window in event 3 and the $\pm$2 day event window in event 4. Furthermore, the significant $\overline{CAR}$ in event 3 indicates positive abnormal returns, whilst the corresponding $\overline{CAR}$ for event 4 indicates a negative abnormal return. All of the remaining observations calculated are considered to be statistically insignificant.

From the calculations of the $\overline{AR}$s, the results indicate some negative movements on the day of the shock, and also a few days after. Furthermore, the stock returns following the shock seem to contain more volatility than what was the case prior to the shock. For each event, seven of the nine shocks yield a negative $\overline{AR}$ for the industry, leaving only two events to yield a positive return. However, across all events, the only significant observation can be found in event 3. In addition, we see a sudden positive escalation at day 7. However, this is mainly due to a positive abnormal return in events 3, 8 and 11. As this is exclusive for only three of the nine events and there are not equivalent shocks in oil prices during the period, we assume that these outliers stem from another factor than the crude oil price.

**Figure 7.5.1**
AAR's for Product tanker firms during negative shock




From the developments following a shock, we observe that the averages across events 3, 4, 7, 8 and 15 show indications of a relationship between the oil price shock and the industry. On the other hand, the remaining events (events 5, 10, 11 and 13), any indications of a relationship seem a scarcity. However, evident in each of the events, the oil price drops more than the portfolio of product tankers. Furthermore, any signals of effects from a positive oil price shock seem to become less conclusive as we move away from the day of the shock. The amplitude between the various returns also seems to increase for the shock. The development of share prices after the shock can be found in Appendix 6.5.

<u>Non-parametric tests</u>

In the Rank test for the product firms during a negative shock, we observe that the event window averages across all events indicate a negative abnormal return for the period. Further, for the ±10 day event window, the event window average is 49.5%, indicating a slight negative abnormal return. The average seems to decrease as we shorten the event window, where the average for the ±1 day event window yields an event window average of 44% and below the 50% threshold across all events. However, even though the results seem to yield a negative abnormal return, the amount of significant results are limited, as only event 4 shows any significance in the ±5 and ±2 event windows. The Rank tests calculated can be found in appendix 6.5.

For the Sign test results, we observe that the two longer event windows have an event window average above 50%, indicating a positive abnormal return for the period. However, for the ±2 and ±1 day event windows, the averages indicate a negative abnormal return. Though, for all lengths of event windows, we observe at least one event in which the Sign test indicates a positive abnormal return. Furthermore, we find four observations which are of statistical significance for the ±10 and ±5 day event windows, whilst there are five and six significant observations for the ±2 and ±1 day event windows. However, among all these significant observations, they all vary between observations which yield a positive and negative abnormal return.

*Partial conclusion*

Overall we see a reasonable indication of a downward sloping trend for product tanker companies in the short term before and after a negative drop in the oil price. Our findings for the $\overline{CAR}$s suggest abnormal negativity across the majority of events close to the negative shock. However, this positive relationship can arguably be related to the finding of El-Masry et al (2010) who found a positive relationship between oil price and returns of a large variety of shipping companies. They suggested that the relationship could be due to oil, as a major commodity, acts as an indicator for the state of the world economy and global trade. This is also pointed out in Drobetz et al. (2010) whom imply that as the oil price drops investors are expecting a slowdown in global seaborne trade.

Additionally, we do find the same deviation as we did for crude oil tankers companies in event 11 which occurred 5 January 2015 where all $\overline{CAR}$ values are highly positive. We find this result quite natural due to increased supply of crude oil (U.S. Energy Administration, 2015) combined with an increase in the global refining capacity (Clarkson Research Services, 2015), both which are of crucial importance from the seaborne oil products trade volume.

The correspond $\overline{AR}$ results from the day of the shock, in addition to increased volatility in the share price returns' following the shock. Furthermore, the results show that the industry experiences a negative average abnormal return for seven of the nine events. A pitfall from the

$\overline{AR}$ tests is that only event 3 yields a statistically significant result. Though the calculations indicate a negative reaction across the industry, the lack of significant results makes a conclusive resolution on the matter of oil price shocks and the product tanker market difficult.

The findings from the non-parametric test show that the industry, on average, suffers from a sudden negative shock in crude oil prices. For the Rank test, only the ±1 day event window shows exclusively negative abnormal returns in the event window. However, none of these observations are of statistical significance. Conversely, the parameters from the Sign tests do not show exclusively negative returns across the industry. Though the event window averages differ between positive and negative returns, the numbers of significant results are more visible for the Sign test.

After analysing the results from both the parametric- and non-parametric tests, the results do give an indication of a decrease in product tankers share price as a result of an oil price drop. However, as these calculations only show a slight decrease on the day of the event, and limited reactions in the following days, the industry is not noteworthy affected by the crude oil price drop. This is further supported by the lack of statistical significance for the different tests performed in this section.

### 7.5.2 Hypothesis 5.2

The final step of our analysis addresses the effect a positive oil price shock has on the equity returns on companies within the product tanker industry. Product tankers are affected by several oil related factors. On a firm perspective the companies have a majority of the operating costs are derived from fuel expenses which is highly correlated with the crude oil price. The supply and demand for refined oil products are the main driver product tanker employment, and as crude oil is the main input for refined products its price is arguable of importance for the price of refined products and further the demand (Asche et al., 2003). For this hypothesis, we will examine how investors interpret positive shocks in crude oil prices, thus we form our next hypothesis as following:

> Hypothesis 5.2: *Positive oil price shocks have no effect on asset prices within the Product tanker industry*

In our final hypothesis, we wish to analyse the effect of an equivalent positive shock in the crude oil prices, on the product tanker industry.

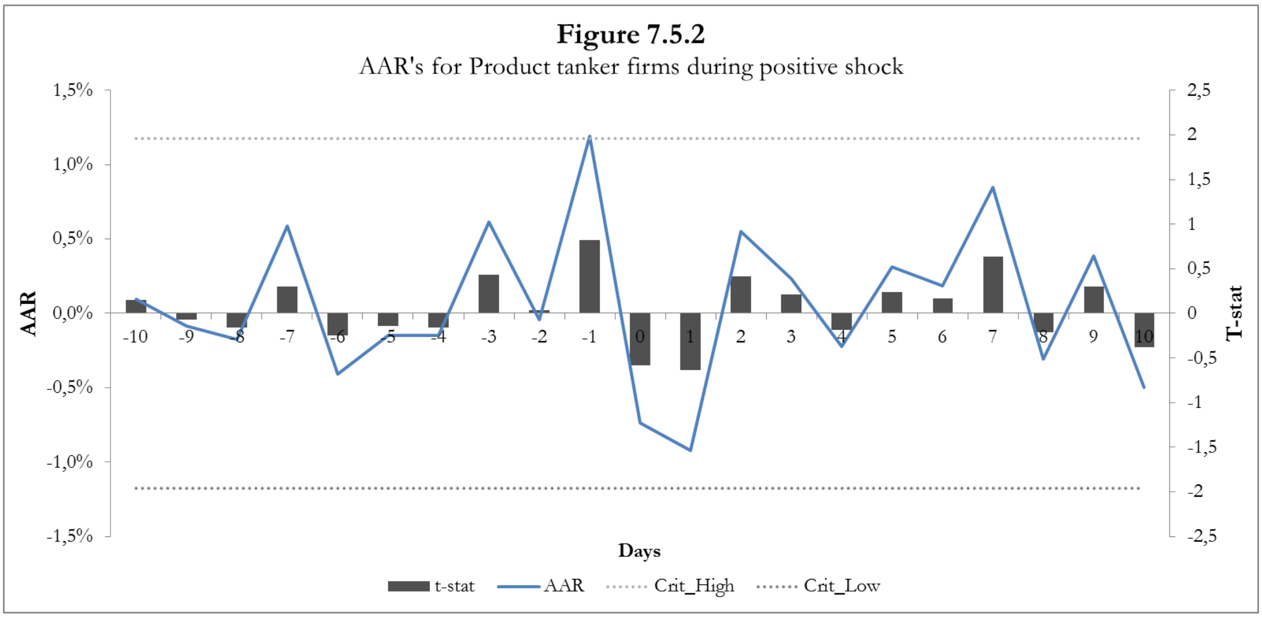
***Results and analysis***

<u>Parametric tests</u>

The cumulative average abnormal return for the product tanker firms during a positive shock, show a variation of results. During the 21-, 11-, and 5-day event windows, the average across the industry indicates positive abnormal returns, whilst a slight negative return is calculated for the 3 day event window. Furthermore, we observe that across each individual event window lengths, there are vast differences. The observed $\overline{CAR}$s across the 21-day event window vary between -4.4% and 6.0%, between -0.8% and 3.1% for the 11-day window, -4.7% and 3.9% for the 5-day window, and -5.1% and 3.8% for the 3-day event window. Though these results do not show a clear pattern across the industry, we observe that the $\pm$10-, $\pm$5- and $\pm$2 day event windows yield four events showing positive abnormal returns, whilst the $\pm$1 day event window yields three events showing a positive return. In addition, within each event, the different event windows yield conflicting results of the calculated cumulative average abnormal returns.

Similar to the variation of sign of the abnormal return, there are no observations yielding a significant abnormal return for any of the different event window lengths, nor for any of the events. From the vast differences in the calculated $\overline{CAR}$s, the lack of significance does not come as a surprise.

The calculations of the average abnormal returns across the product tanker industry, we observe similar results as the $\overline{CAR}$s, where there is no clear pattern over the six events. However, on average, there seems to be a negative average abnormal return on the day of a positive oil price shock, as five of the six events yield a negative return on the day of the shock. This is quite a surprising result, as there seemed to be a negative average abnormal return following a negative oil price shock, which we calculated in section 7.5.1. However, as with the results from the $\overline{CAR}$s above, none of the observations on the day of the shock are statistically significant at the 5% level. The average of the $\overline{AR}$s for the product tanker industry can be found in the figure below.




Further we will try to paint a clearer picture of the reactions by analysing the developments following a positive shock. From the developments of the share prices of the product tanker industry after a positive oil price shock, there seems to be little, if any, signs of a relationship between the two variables. For all events except for event 14, we observe that the industry seems to be totally unaffected by the positive oil price shocks, most often even reacting similarly as the negative shock in crude oil prices. There are signs of some reaction in event 14, but it is rather minimal. Furthermore, for most of the events, the spread between the different companies is large, even for the days immediately after the shocks.

<u>Non-parametric test</u>

In contrast to the parametric tests above, the Rank test averages of all positive shocks seem to result in a positive abnormal return for the product tanker firms, in contrast to the findings in the parametric tests. Furthermore, in contrast to all the results presented for all tests in this section, the spread between the event window averages seem to increase as the event window is narrowed. In addition, across all the Rank tests, the only significant observation is for the ±5 day event window in event 14.

From the Sign tests, the event window averages across all events seem to indicate presence of positive abnormal returns. However, opposite to the Rank test, as we shorten the event window, the average decreases. Though, at the same time as the average converges towards 50%, the underlying results seem to be more extreme, where the observed event window averages are calculated to be in the range of 40%-70%. In contrast to the Rank test, the Sign tests yield more significant results for the calculated event window averages. However, the significant results do not show a clear pattern, as they vary from results indicating both positive and negative abnormal returns.

*Partial conclusion*

Going through our findings it is difficult to draw a firm conclusion on the market's interpretation on positive shocks in the crude oil prices, and the firms' share prices. From the $\overline{CAR}$ tests, we were unable to see any clear pattern regarding whether investors react positively or negatively to a shock. The extent of positive and negative return was approximately equally distributed, all with absence of any level of significance.

Whereas the $\overline{AR}$s are positive but insignificant at the 5% level at day 1 prior to the event, the average return on the event day and one day after the event are negative but insignificant at the 5% level. Furthermore, the findings yield somewhat the same as observed for the $\overline{CAR}$s, with a variety of positive and negative returns. However, our findings are in line with the findings of Huang et al. (1996), who observed a lack of correlation between oil futures, and thus the expectation of the future of oil, and stocks for tanker firms.

Furthermore, there are hardly any indications of positive abnormalities from the non-parametric tests, or even any relationship at all. The Rank test showed only one observation over one window which was of statistical significance. Even though there was a larger presence of significant results amongst the Sign tests, they varied between the results indicating both negative- and positive returns for the product tanker industry.

### 7.5.3 Conclusion product tanker industry

At last we will draw a conclusion of how investors behave in regards to positive and negative shocks in the crude oil price. Firstly, we found a slight positive reaction from the market during negative shocks in the oil price and returns in the product tanker share prices. Secondly, there is no visible relationship between the positive shocks in the crude oil price on product tanker companies. As a result, even though we do find a slight reaction from the market during negative shocks, due to the lack of significance during both tests, we were unable to reject any of the two hypotheses presented in this section.

# 8 Concluding discussion

## 8.1 Conclusion

In the following section, we will give a brief summary of the results found in section 7. We have conducted an investigation in an attempt to measure the effects from both positive and negative shocks in the crude oil prices on the list of included companies found in Appendix 1. In addition, we have extended on the existing literature by conducting the research by segregating the aforementioned firms into their respective segments. From the dataset between the period of 2006 to 2015 we have analysed the returns of 15 OSV-, 15 drilling-, 5 crude tanker- and 8 product tanker companies. The analysis is performed by applying the event study, which estimates the normal returns in four different estimation periods through the market model, to determine whether there are any abnormalities in the returns across the 15 event windows.

In our analysis of negative shocks, we find strong evidences of market value destruction amongst the firms within the drilling- and OSV segments, whilst evidences of market value destruction amongst the crude oil tanker segment. Furthermore, when applying the 3-day event windows, the results show an increasingly significant pattern. These results are also evident from the non-parametric Rank and Sign tests. For the firms within the product tanker segment, the results yield a less conclusive result, where we are unable to find similar patterns as for the three sectors mentioned above. However, a vast lack of significance across our results indicates that no conclusion can be drawn from the product tanker industry. This is also the case when analysing the results from the non-parametric tests.

From the equivalent analysis of positive shocks across the industries, the results are similar to the findings for the negative shocks, where drilling- and OSV firms seem to benefit from a positive shock in crude oil prices. Similarly, crude oil tankers seem to also benefit from a positive shock in crude oil prices, though the results are not as apparent as for the two previously mentioned segments. Further, these outcomes become further evident as we shorten the event window. This is also the case for the non-parametric tests. However, though the findings suggest a market value creation from both the parametric and non-parametric tests, the positive shocks yield a more limited number of significant results across all three industries. Furthermore, there is no clear pattern from the product tanker segment, and thus no observable significant results, as under the negative shocks.

The results from the drilling- and OSV industries seem to react coherently from both kinds of shocks. These results can be viewed in relation to the global surge in crude oil prices from 2014, where the oil and gas companies' vast cuts across E&P spending saw both day- and utilization rates surge to record low levels. As previous research has exclusively shown that oil and gas companies are severely affected by oil price changes, the close link between the oil and gas and drilling- and OSV companies, seem to suggest that the effects experienced by oil and gas companies can be directly transferable to the two industries.

From the latter part of the oil value chain, the two tanker industries' seem to vary more in the results, or at least show a less clear pattern. The results from our tests indicate that no significant collective reaction is observed across the two shocks. However, as demand for crude oil and thus refined oil products remain at record high levels throughout our analysis; our results suggest that the tanker segments could be more related to the supply and demand factors in the oil market, rather than the observed price.

Furthermore, when the prices of crude oil remain low, markets such as crude oil tankers may embark into contango, where investors are willing to pay tanker owners a premium to receive the oil at a later point in time (Hammoudeh, 2015). Even with low prices of crude oil, this situation will lead to an increased utilization, and thus day rates. No similar situation arises for drilling- or OSV firms, where the activity level is more dependent on oil and gas companies' E&P spending.

We therefore believe that the differences between the segments lie in their different affiliation towards the crude oil determinants, such as the price, as well as the supply and demand. However, for our analysis, we have solely focused on the prices, which only show significant effect on the companies within the drilling- and OSV segments.

Our main findings and contributions to the existing literature are as follows. First, we find that oil prices affect firm returns differently depending on the sector to which firms belong to, which is in line with the findings of previous research (Gogineni, 2010; Grammenos & Marcoulis, 1996;

El-Masry et al., 2010; Grammenos & Arkoulis, 2002). Our findings suggest that firms belonging to the drilling- and OSV segments experience a rise in returns when oil prices rise, whereas a negative shock in the oil price leads to a share price decrease. Secondly, regarding the results of the crude- and product tanker segments; our findings suggest that both markets moves in the same direction as the oil price shock, except for product tankers during positive shocks were the findings were highly ambiguous. These results can be related to the findings in Poulakidas & Joutz (2009), more specifically that the demand for oil in itself is considered to be inelastic.

As we go through our concluding discussion, it is obvious that we imply that oil prices have a heterogeneous effect on firm returns, in line with Narayan & Sharma (2011). We therefore believe we have addressed the issue concerning the four segments' reactions towards shocks in the prices of crude oil in a comprehensive manner.

## 8.2 Further research

Through our thorough investigation of the impacts of positive and negative shocks in crude oil prices on shipping companies within the industries mentioned above, we believe we have determined each segment's dependence on drastic daily changes in crude oil prices. Nevertheless, due to the limitations presented in section 1.2 and 3.1 we were not able to cover every aspect, and will in this section discuss our thoughts of further research.

A drawback in our research is the sample size provided in each segment. Due to the strict selection criteria in order to isolate the effect on the respective industries, we were bound to exclude several companies. A smaller sample size might result in our findings not necessarily being representative for the entire population in each industry. By relaxing the criteria that defines the segment in which a company is assigned, it would be interesting to see if the results from our research would still be valid.

Furthermore, other research methods could be applied to verify the results. Firstly, other models for calculating abnormal returns which were mentioned in section 4 such as the CAPM and multiple factor models as presented in Aggarwal et al. (2012) and El-Masry et al. (2010). Secondly, other methodologies for measuring the short term effects of crude oil price shocks can be applied. The results from these models and methods could then be applied to verify the trends and results from our research.

As a main determinant of the operational performance of shipping companies, the event study methodology can be applied to analyse the effect of crude oil price shocks have on charter rates across industries. A further suggestion would be to get access to databases containing historical spot rates for the different segments for then to see if the changes in oil price are explain the behaviour of the rates. However, this would require access to extensive data resources.

Due to the fact that our research show more conclusive results around the shorter event windows, we would encourage any further research to analyse the effects through smaller and also asymmetric event windows, as in Aggarwal et al. (2012). In addition, a comparison from research which analyses the effects of longer shocks in crude oil prices, such as weekly or monthly shocks can be applied to verify the results from our research.

As we limit our analysis to only observe how the different segments react to shocks in the Brent crude oil price, we do not take into consideration the underlying sources of the respective shock i.e. supply and demand shocks. In a similar study, one might be able to get a clearer view on why these sectors react differently to the different sources behind the shocks. An analysis of the underlying reason behind the oil price shock might paint a clearer picture to why the different events yield different results. This would be especially applicable for the two tanker industries.

Lastly we would suggest looking at the effect of the financial crisis starting in late 2007. As this was characterised by high volatility and investor flight to less risky markets, it could be interesting to see how these sectors behaves compared to other sectors as demand for oil is found to be inelastic.

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# 10 Appendices

## Appendix 1

The list below contains the companies we have included in our research for each respective sector.

| | | Included in Estimation Period # (Yes/No) | | | |
|---|---|---|---|---|---|
| **Industry** | **Company** | **1** | **2** | **3** | **4** |
| Drilling | ARCHER | N | N | Y | Y |
| Drilling | ATWOOD OCEANICS | Y | Y | Y | Y |
| Drilling | AWILCO DRILLING | N | N | Y | Y |
| Drilling | BW OFFSHORE | Y | Y | Y | Y |
| Drilling | DIAMOND OFFS.DRL. | Y | Y | Y | Y |
| Drilling | ENSCO CLASS A | Y | Y | Y | Y |
| Drilling | FRED OLSEN ENERGY | Y | Y | Y | Y |
| Drilling | NOBLE ENERGY | Y | Y | Y | Y |
| Drilling | ODFJELL DRILLING | N | N | N | Y |
| Drilling | PETROLIA | Y | Y | Y | Y |
| Drilling | ROWAN COMPANIES CL.A | Y | Y | Y | Y |
| Drilling | SEADRILL | Y | Y | Y | Y |
| Drilling | SEVAN DRILLING | N | N | Y | Y |
| Drilling | SONGA OFFSHORE | Y | Y | Y | Y |
| Drilling | TRANSOCEAN | Y | Y | Y | Y |
| OSV | DEEP SEA SUPPLY | Y | Y | Y | Y |
| OSV | DOF | Y | Y | Y | Y |
| OSV | EIDESVIK OFFSHORE | Y | Y | Y | Y |
| OSV | EMAS OFFSHORE | N | Y | Y | Y |
| OSV | FARSTAD SHIPPING | Y | Y | Y | Y |
| OSV | GC RIEBER SHIPPING | Y | Y | Y | Y |
| OSV | GULFMARK OFFSHORE 'A' | Y | Y | Y | Y |
| OSV | HAVILA SHIPPING | Y | Y | Y | Y |
| OSV | HORNBECK OFFS.SVS. | Y | Y | Y | Y |
| OSV | SEACOR HDG. | Y | Y | Y | Y |
| OSV | SIEM OFFSHORE | Y | Y | Y | Y |
| OSV | SOLSTAD OFFSHORE | Y | Y | Y | Y |
| OSV | SUBSEA 7 | Y | Y | Y | Y |
| OSV | TIDEWATER | Y | Y | Y | Y |
| OSV | VIKING SUPPLY SHIPS | Y | Y | Y | Y |

| | | | | | |
|---|---|---|---|---|---|
| Crude | DHT HOLDINGS | Y | Y | Y | Y |
| Crude | EURONAV | Y | Y | Y | Y |
| Crude | FRONTLINE | Y | Y | Y | Y |
| Crude | NORDIC AMER.TANKERS | Y | Y | Y | Y |
| Crude | TEEKAY TANKERS 'A' | N | Y | Y | Y |
| Product | TORM A | Y | Y | Y | Y |
| Product | AMERICAN SHIPPING CO. | Y | Y | Y | Y |
| Product | ARDMORE SHIPPING | N | N | N | Y |
| Product | CAPITAL PRODUCT PARTNEF | Y | Y | Y | Y |
| Product | CONCORDIA MARITIME 'B' | Y | Y | Y | Y |
| Product | D'AMICO INTL.SHIP. | Y | Y | Y | Y |
| Product | NAVIOS MARITIME ACQ. | N | Y | Y | Y |
| Product | SCORPIO TANKERS | N | Y | Y | Y |

## Appendix 2

The list below contains the companies which we have considered including in our analysis but chosen to exclude as they fail to satisfy one or more of our selection criteria.

| Industry | Company | Low Trade | Not Listed | No core business |
|---|---|---|---|---|
| Mixed | AET | | | X |
| Mixed | Bahri | | | X |
| Mixed | China Ocean Shipping (COSCO) | | | X |
| Mixed | China Shipping Development Corp | | | X |
| Mixed | Crowley Maritime | | | X |
| Mixed | Dockwise Ldt. | | X | |
| Mixed | First Olsen Ltd. | | X | X |
| Mixed | Formosa Plastics Marine Corp | | | X |
| Mixed | Histria Shipmanagement | | X | X |
| Mixed | K-Line | | | X |
| Mixed | Maersk | | | X |
| Mixed | Mercator | | | X |
| Mixed | Minerva Marine | | | X |
| Mixed | MISC Berhad | | | X |
| Mixed | Mitsui O.S.K Lines | | | X |
| Mixed | Nanjing Tankers | | X | X |
| Mixed | Neda Maritime Agency Co | | X | X |
| Mixed | NYK Lines | | | X |
| Mixed | Ocean Tankers | | | X |
| Mixed | Oman Shipping Co | | | X |
| Mixed | Overseas Shipholding Group | | | X |
| Mixed | Pakistan Merchant Navy | | | X |
| Mixed | Savcomflot | | X | X |
| Mixed | Shipping Corp of India | | X | X |
| Mixed | SK Shipping | | | X |
| Mixed | Thenamaris | | | X |
| Mixed | Tsakos Energy Navigation | | | X |
| Mixed | Vroon Shipping | | | X |

| | | | | |
|---|---|---|---|---|
| OSV | Buksèr og Berging | | X | |
| OSV | Island Offshore | | X | |
| OSV | Nordic American Offshore | X | | |
| OSV | Rem Offshore | X | | |
| OSV | Simon Møkster Shipping | | X | |
| OSV | Østensjø Rederi | | X | |
| Tanker | Gener8 Maritime | X | | |
| Tanker | Navios Mrit. Mdstm.Ptns | X | | |
| Tanker | Tanker Investments ltd. | X | | |
| Tanker | Atlas Maritime | | X | X |
| Tanker | Dynacom | | X | |
| Tanker | IRISL Group | | X | |
| Tanker | Latvian Shipping Company | X | | |
| Tanker | Maran Tanker Management | | X | |
| Tanker | National Iranian Tanker Company | | X | |
| Tanker | Pyxis Tanker Inc. | X | | |
| Tanker | Sovcomflot | | X | |
| Tanker | Top Ships Inc. | X | | |

## Appendix 3

The tables below show our calculation of Durbin-Watson's d-statistics, which are used to detect autocorrelation in the residuals. The values will always lie between 0 and 4 where a value equal 2 indicates no autocorrelation. Values below 2 indicate serial positive correlation and values above 2 indicates negative serial correlation.

| | Durban-Watson d-statistic | | | |
|---|---|---|---|---|
| **Drilling Companies** | Period 1 | Period 2 | Period 3 | Period 4 |
| BW OFFSHORE | 2,071 | 2,076 | 2,169 | 2,059 |
| SEADRILL | 2,213 | 2,324 | 1,953 | 2,277 |
| FRED OLSEN ENERGY | 2,085 | 2,377 | 2,347 | 1,811 |
| ODFJELL DRILLING | | | | 2,064 |
| AWILCO DRILLING | | | 2,471 | 1,889 |
| SONGA OFFSHORE | 2,350 | 2,402 | 2,009 | 2,043 |
| PETROLIA | 1,814 | 1,975 | 2,378 | 2,133 |
| SEVAN DRILLING | | | 1,762 | 1,880 |
| ARCHER | | 2,068 | 2,059 | 1,887 |
| TRANSOCEAN | 2,305 | 2,301 | 2,074 | 2,175 |
| ENSCO CLASS A | 2,416 | 2,341 | 1,952 | 2,070 |
| ATWOOD OCEANICS | 2,376 | 2,292 | 2,119 | 2,093 |
| NOBLE ENERGY | 2,337 | 2,280 | 2,229 | 2,116 |
| ROWAN COMPANIES CL.A | 2,561 | 2,370 | 2,214 | 2,268 |
| DIAMOND OFFS.DRL. | 2,204 | 2,155 | 2,189 | 1,921 |

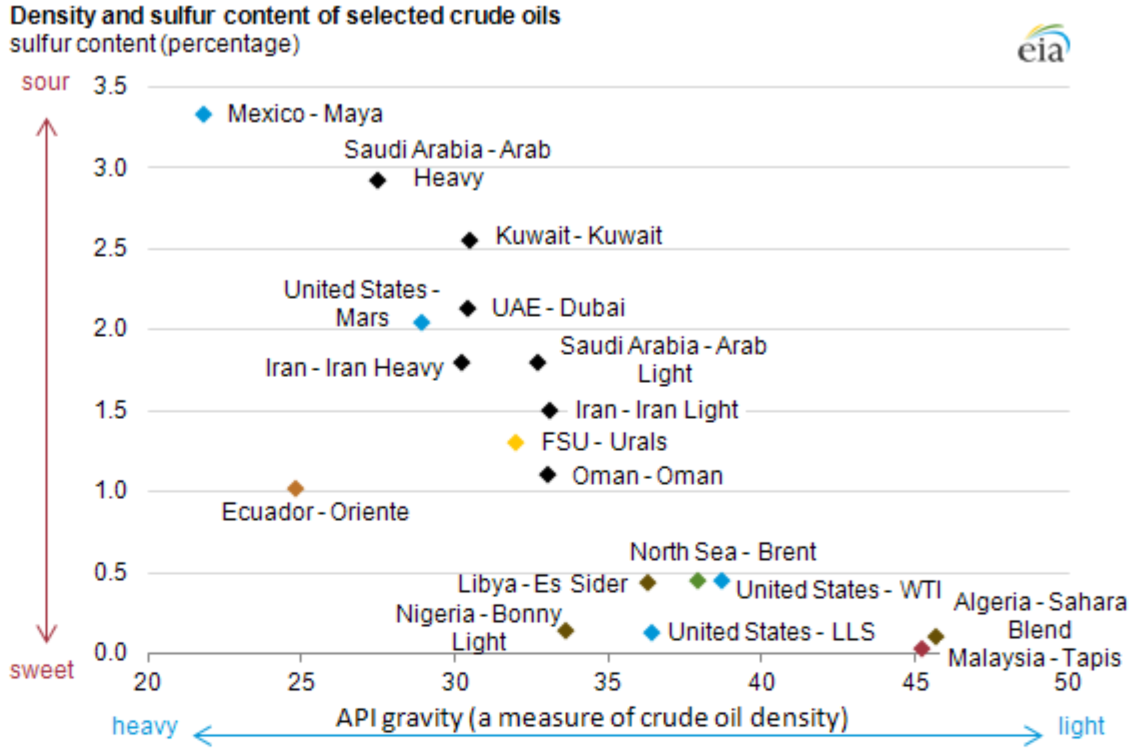
| | Durban-Watson d-statistic | | | |
|---|---|---|---|---|
| **OSV Companies** | Period 1 | Period 2 | Period 3 | Period 4 |
| DOF | 2,232 | 2,518 | 1,936 | 2,399 |
| EIDESVIK OFFSHORE | 2,221 | 2,147 | 2,022 | 2,514 |
| EMAS OFFSHORE | 2,311 | 2,578 | 2,396 | 2,118 |
| FARSTAD SHIPPING | 2,389 | 2,366 | 2,464 | 2,551 |
| HAVILA SHIPPING | 1,980 | 2,275 | 2,378 | 2,359 |
| SIEM OFFSHORE | 2,039 | 2,167 | 2,172 | 2,035 |
| SOLSTAD OFFSHORE | 2,351 | 2,364 | 2,420 | 2,457 |
| VIKING SUPPLY SHIPS | 1,863 | 2,093 | 1,837 | 2,356 |
| DEEP SEA SUPPLY | 1,995 | 2,095 | 2,103 | 2,247 |
| SUBSEA 7 | 2,213 | 2,247 | 2,279 | 1,921 |
| GC RIEBER SHIPPING | 2,088 | 2,318 | 2,217 | 2,376 |
| TIDEWATER | 2,187 | 2,292 | 1,805 | 2,390 |
| HORNBECK OFFS.SVS. | 2,192 | 2,003 | 1,993 | 2,108 |
| SEACOR HDG. | 1,978 | 2,099 | 2,423 | 2,272 |
| GULFMARK OFFSHORE 'A' | 2,515 | 2,039 | 2,153 | 2,027 |

| | Durban-Watson d-statistic | | | |
|---|---|---|---|---|
| **Crude Tanker Companies** | Period 1 | Period 2 | Period 3 | Period 4 |
| FRONTLINE | 2,011 | 2,006 | 1,935 | 1,806 |
| NORDIC AMER.TANKERS | 2,219 | 2,092 | 2,008 | 1,920 |
| TEEKAY TANKERS 'A' | 1,700 | 2,170 | 2,124 | 2,025 |
| DHT HOLDINGS | 2,433 | 2,352 | 2,186 | 2,019 |
| EURONAV | 2,177 | 2,000 | 1,831 | 1,791 |

| | Durban-Watson d-statistic | | | |
|---|---|---|---|---|
| **Product Tanker Companies** | Period 1 | Period 2 | Period 3 | Period 4 |
| TORM A | 2,202 | 1,942 | 2,208 | 1,784 |
| AMERICAN SHIPPING CO. | 2,154 | 2,503 | 1,657 | 1,672 |
| SCORPIO TANKERS | | 2,127 | 2,414 | 2,085 |
| CAPITAL PRODUCT PARTNERS | 2,010 | 2,273 | 1,834 | 2,085 |
| NAVIOS MARITIME ACQ. | | 1,554 | 2,389 | 2,122 |
| ARDMORE SHIPPING | | | | 2,016 |
| CONCORDIA MARITIME 'B' | 2,160 | 2,660 | 2,186 | 2,253 |
| D'AMICO INTL.SHIP. | 2,087 | 2,439 | 2,118 | 1,852 |

## Appendix 4

**Source:** U.S. Energy Information Administration (2012), based on Energy Intelligence Group—International Crude Oil Market Handbook.



## Appendix 5

The list below contains our alpha and beta calculations for all companies included in our analysis. The list is sorted after sector; drilling, OSV, crude tanker and product tanker. The blank fields occur when the respective companies are not listed on an exchange during at the estimation window.

| | Estimation window 1 | | Estimation window 2 | | Estimation window 3 | | Estimation window 4 | |
|---|---|---|---|---|---|---|---|---|
| Company | Alpha | Beta | Alpha | Beta | Alpha | Beta | Alpha | Beta |
| BW OFFSHORE | -0,00160 | 0,88281 | 0,00144 | 0,90245 | -0,00246 | 1,13049 | 0,00020 | 0,76414 |
| SEADRILL | 0,00215 | 1,18419 | 0,00064 | 1,00110 | 0,00036 | 0,85640 | -0,00223 | 0,78713 |
| FRED OLSEN ENERGY | 0,00101 | 0,73130 | 0,00009 | 0,91755 | 0,00023 | 1,47614 | -0,00412 | 0,64227 |
| ODFJELL DRILLING | | | | | | | -0,00270 | 0,22119 |
| AWILCO DRILLING | | | | | 0,00341 | 0,56277 | -0,00112 | 0,55278 |
| SONGA OFFSHORE | 0,00185 | 0,78870 | 0,00019 | 1,61595 | -0,00242 | 1,75363 | -0,00205 | 0,96146 |
| PETROLIA | -0,00057 | 0,78426 | -0,00257 | 1,18370 | 0,00146 | 0,69376 | 0,00167 | 0,42413 |
| SEVAN DRILLING | | | | | 0,00191 | 1,23517 | -0,00658 | 1,47713 |
| ARCHER | | | -0,00070 | 1,06547 | -0,00550 | 1,97968 | 0,00083 | 2,09394 |
| TRANSOCEAN | 0,00198 | 0,53024 | 0,00015 | 0,58701 | -0,00136 | 0,60640 | -0,00235 | 0,00206 |
| ENSCO CLASS A | 0,00121 | 0,48185 | 0,00084 | 0,41059 | -0,00076 | 0,78779 | -0,00168 | 0,12044 |
| ATWOOD OCEANICS | 0,00248 | 0,75909 | 0,00083 | 0,66581 | -0,00020 | 0,74644 | -0,00151 | 0,07759 |
| NOBLE ENERGY | 0,00225 | 0,49240 | 0,00070 | 0,65249 | -0,00004 | 0,79353 | -0,00099 | 0,16248 |
| ROWAN COMPANIES CL.A | 0,00112 | 0,69601 | 0,00125 | 0,75204 | -0,00107 | 0,80509 | -0,00145 | 0,09605 |
| DIAMOND OFFS.DRL. | 0,00200 | 0,59979 | -0,00010 | 0,37984 | -0,00043 | 0,58873 | -0,00180 | -0,08109 |
| DOF | 0,00003 | 0,81394 | 0,00095 | 0,29571 | 0,00053 | 0,55372 | -0,00206 | 0,60377 |
| EIDESVIK OFFSHORE | -0,00070 | 0,40736 | 0,00015 | 0,21661 | 0,00036 | 0,30139 | -0,00105 | 0,12984 |
| EMAS OFFSHORE | -0,00044 | 0,33834 | -0,00120 | 0,44146 | -0,00084 | -0,20392 | -0,00142 | 0,04353 |
| FARSTAD SHIPPING | -0,00026 | 0,28646 | 0,00075 | 0,31499 | 0,00044 | 0,40405 | -0,00246 | 0,83861 |
| HAVILA SHIPPING | -0,00014 | 0,46366 | -0,00020 | 0,31359 | 0,00083 | 0,77694 | -0,00124 | 0,34804 |
| SIEM OFFSHORE | 0,00147 | 0,80065 | 0,00014 | 0,75978 | 0,00037 | 0,59226 | -0,00260 | 0,55641 |
| SOLSTAD OFFSHORE | -0,00021 | 0,42025 | 0,00011 | 0,59701 | 0,00024 | 0,61708 | -0,00164 | 0,81337 |
| VIKING SUPPLY SHIPS | -0,00055 | 0,45634 | 0,00039 | 0,37324 | -0,00313 | 0,08811 | 0,00125 | 0,64881 |
| DEEP SEA SUPPLY | -0,00019 | 1,01913 | 0,00073 | 0,79387 | 0,00117 | 1,26172 | -0,00169 | 0,74544 |
| SUBSEA 7 | 0,00085 | 1,08415 | 0,00038 | 1,46912 | -0,00023 | 1,50601 | -0,00164 | 0,72312 |
| GC RIEBER SHIPPING | 0,00127 | -0,00335 | -0,00014 | -0,26265 | 0,00149 | -0,52016 | -0,00022 | -0,01405 |
| TIDEWATER | 0,00042 | 0,54071 | 0,00035 | 0,42991 | -0,00119 | 0,60994 | -0,00141 | -0,00971 |
| HORNBECK OFFS.SVS. | 0,00135 | 0,57655 | 0,00115 | 0,61084 | 0,00050 | 0,75172 | -0,00184 | 0,25935 |
| SEACOR HDG. | 0,00002 | 0,27492 | 0,00065 | 0,46496 | -0,00032 | 0,44848 | -0,00080 | 0,09480 |
| GULFMARK OFFSHORE 'A' | 0,00147 | 0,65640 | 0,00080 | 0,71118 | -0,00155 | 0,88263 | -0,00164 | -0,01178 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| FRONTLINE | 0,00145 | 0,82483 | -0,00237 | 0,59300 | 0,00006 | 2,13941 | -0,00167 | 1,14417 |
| NORDIC AMER.TANKERS | 0,00057 | 0,46371 | -0,00149 | 0,47660 | -0,00143 | 0,70865 | 0,00042 | 0,27797 |
| TEEKAY TANKERS 'A' | 0,00152 | 0,72777 | -0,00124 | 0,95852 | -0,00162 | 0,84134 | 0,00191 | 0,06972 |
| DHT HOLDINGS | -0,00062 | 0,93871 | -0,00027 | 0,64990 | -0,00498 | 0,60140 | 0,00071 | 0,24338 |
| EURONAV | 0,00054 | 0,31800 | -0,00146 | 0,63919 | 0,00109 | 0,94679 | 0,00206 | 0,85502 |
| TORM A | -0,00013 | 0,84614 | -0,00221 | 0,92197 | -0,00490 | 0,92057 | -0,00524 | 0,51176 |
| AMERICAN SHIPPING CO. | -0,00098 | 0,04723 | 0,00111 | 0,14159 | 0,00501 | -0,11780 | 0,00145 | 1,20294 |
| SCORPIO TANKERS | | | -0,00019 | 0,52375 | -0,00057 | 1,19187 | -0,00111 | 1,49903 |
| CAPITAL PRODUCT PARTNERS | -0,00028 | 0,45385 | 0,00068 | 0,74040 | 0,00043 | 0,50937 | -0,00026 | 1,32410 |
| NAVIOS MARITIME ACQ. | | | -0,00333 | 0,09938 | -0,00164 | 0,44349 | -0,00112 | 1,50449 |
| ARDMORE SHIPPING | | | | | | | -0,00071 | 1,18631 |
| CONCORDIA MARITIME 'B' | -0,00273 | 0,32280 | -0,00062 | 0,47368 | -0,00114 | 0,41602 | -0,00028 | 0,35425 |
| D'AMICO INTL.SHIP. | -0,00086 | 0,64102 | -0,00113 | 0,40832 | -0,00233 | 0,70306 | -0,00175 | 0,90443 |

## Appendix 6.1

### Results from parametric $\overline{CAR}$ – and $\overline{AR}$ tests, development in stock returns and non-parametric Rank- and Sign test for all firms of all shocks

The tables and figures below show our results from the parametric cumulative average abnormal return ($\overline{CAR}$) test, the parametric average abnormal return ($\overline{AR}$) test, the non-parametric Rank test and the non-parametric Sign test for each of the 15 shocks for all firms. First we show for negative shocks and then for positive shocks. ($\overline{CAR}$ and $\overline{AR}$ is denoted by CAAR and AAR in the tables/figures below)

#### *CAAR results for negative shocks of all firms*

| **EVENT 3** | (-10,10) | (-5,5) | (-2,2) | (-1,1) | **EVENT 4** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|---|---|---|---|---|
| CAAR | 6,07% | -0,28% | 0,59% | 0,79% | CAAR | -6,60% | -7,34% | -5,03% | -4,95% |
| Std. Dev | 1,70% | 1,23% | 0,83% | 0,64% | Std. Dev | 1,70% | 1,23% | 0,83% | 0,64% |
| t-test | 3,578 | -0,230 | 0,716 | 1,225 | t-test | -3,892 | -5,982 | -6,081 | -7,724 |
| p-value | 0,11% | 81,95% | 47,88% | 22,90% | p-value | 0,04% | 0,00% | 0,00% | 0,00% |
| N | 34 | 34 | 34 | 34 | N | 34 | 34 | 34 | 34 |

| **EVENT 5** | (-10,10) | (-5,5) | (-2,2) | (-1,1) | **EVENT 7** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|---|---|---|---|---|
| CAAR | -1,94% | -3,35% | -3,93% | -2,75% | CAAR | -3,59% | -3,25% | -1,03% | -1,65% |
| Std. Dev | 1,70% | 1,23% | 0,83% | 0,64% | Std. Dev | 1,84% | 1,33% | 0,90% | 0,69% |
| t-test | -1,145 | -2,726 | -4,751 | -4,287 | t-test | -1,956 | -2,444 | -1,150 | -2,372 |
| p-value | 26,02% | 1,01% | 0,00% | 0,01% | p-value | 5,79% | 1,93% | 25,74% | 2,29% |
| N | 34 | 34 | 34 | 34 | N | 38 | 38 | 38 | 38 |

| EVENT 8 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -9,40% | -7,90% | -5,70% | -4,44% |
| Std. Dev | 1,84% | 1,33% | 0,90% | 0,69% |
| t-test | -5,119 | -5,949 | -6,367 | -6,405 |
| p-value | 0,00% | 0,00% | 0,00% | 0,00% |
| N | 38 | 38 | 38 | 38 |

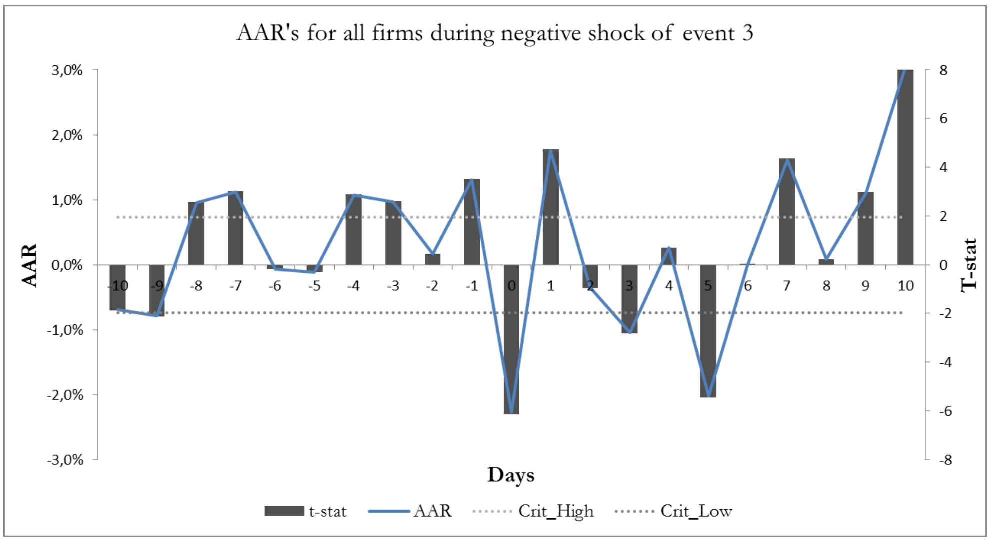
| EVENT 10 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -17,05% | -9,29% | -9,40% | -8,07% |
| Std. Dev | 2,01% | 1,45% | 0,98% | 0,76% |
| t-test | -8,489 | -6,393 | -9,596 | -10,631 |
| p-value | 0,00% | 0,00% | 0,00% | 0,00% |
| N | 43 | 43 | 43 | 43 |

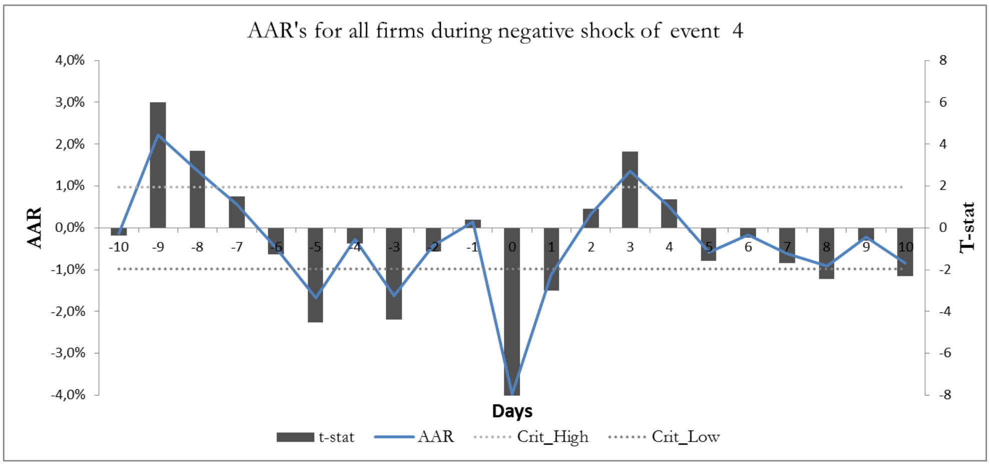
| EVENT 11 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 2,11% | 0,89% | 0,53% | -0,04% |
| Std. Dev | 2,01% | 1,45% | 0,98% | 0,76% |
| t-test | 1,050 | 0,609 | 0,541 | -0,048 |
| p-value | 29,94% | 54,57% | 59,14% | 96,17% |
| N | 43 | 43 | 43 | 43 |

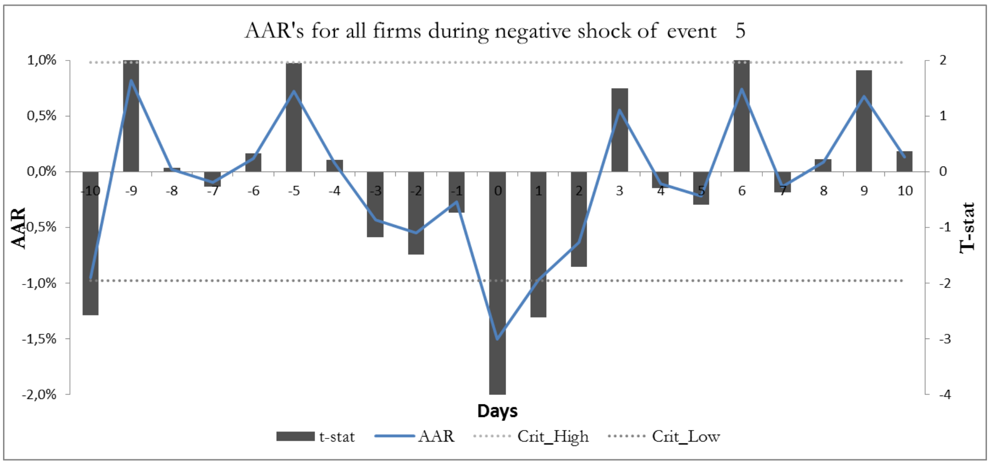
| EVENT 13 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -4,99% | -3,74% | -4,31% | -4,26% |
| Std. Dev | 2,01% | 1,45% | 0,98% | 0,76% |
| t-test | -2,487 | -2,571 | -4,396 | -5,618 |
| p-value | 1,68% | 1,37% | 0,01% | 0,00% |
| N | 43 | 43 | 43 | 43 |

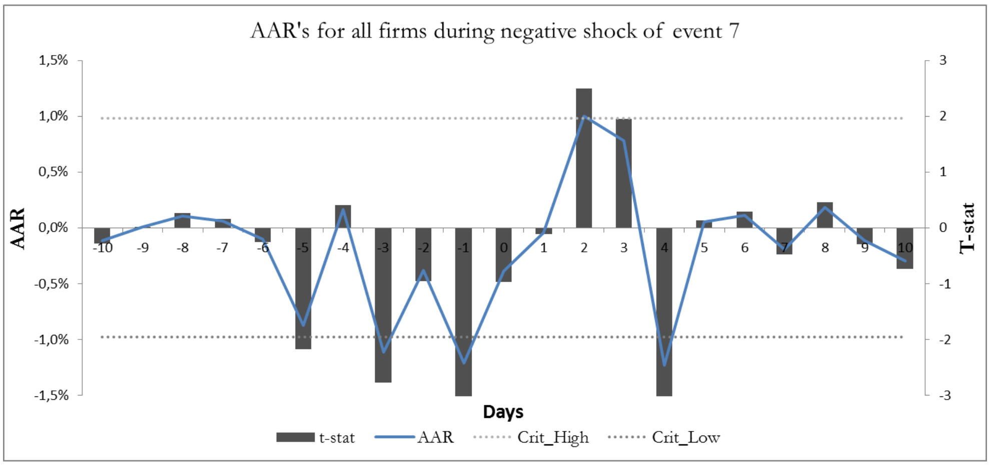
| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -6,56% | -11,85% | -0,69% | -3,22% |
| Std. Dev | 2,01% | 1,45% | 0,98% | 0,76% |
| t-test | -3,269 | -8,152 | -0,703 | -4,240 |
| p-value | 0,21% | 0,00% | 48,60% | 0,01% |
| N | 43 | 43 | 43 | 43 |

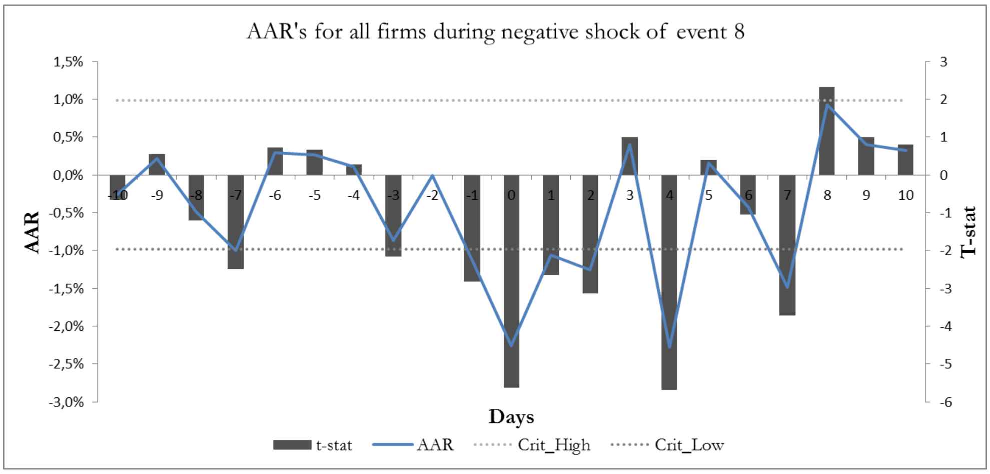
## $\overline{AR}$ *results for negative shocks of all firms*

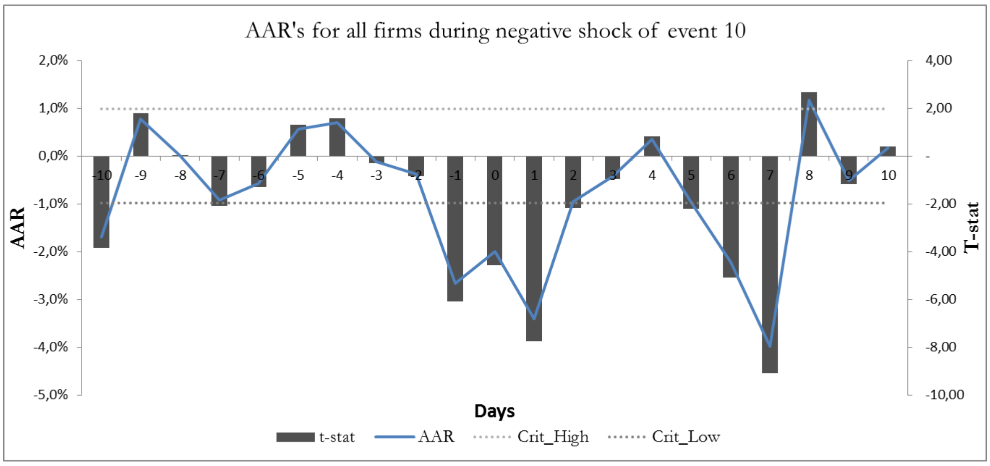


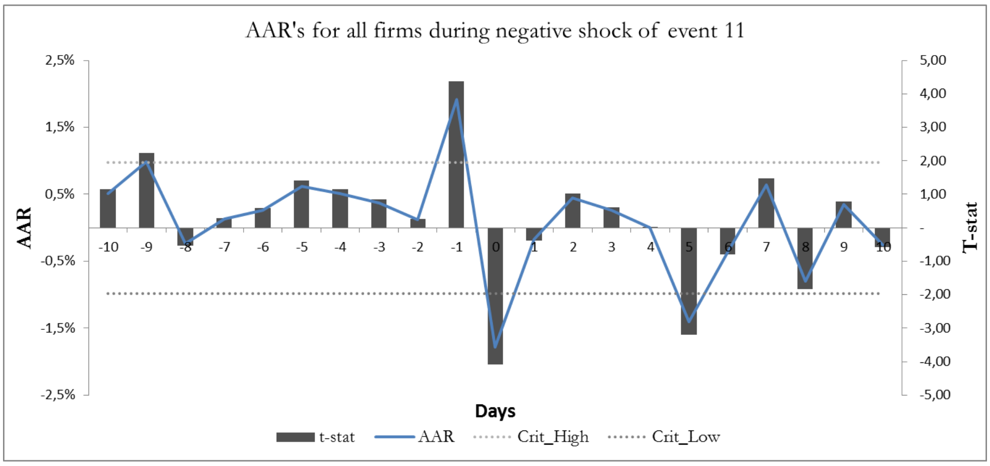

AAR's for all firms during negative shock of event 4
4,0%
3,0%
2,0%
1,0%
0,0%
-1,0%
-2,0%
-3,0%
-4,0%
AAR
8
6
4
2
0
-2
-4
-6
-8
T-stat
-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
Days
t-stat
AAR
Crit_High
Crit_Low

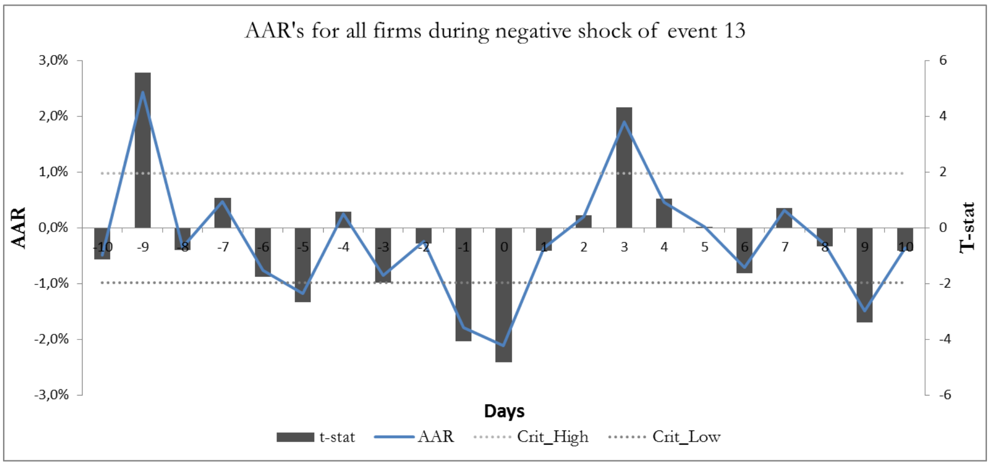

AAR's for all firms during negative shock of event 5
1,0%
0,5%
0,0%
-0,5%
-1,0%
-1,5%
-2,0%
AAR
2
1
0
-1
-2
-3
-4
T-stat
-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
Days
t-stat
AAR
Crit_High
Crit_Low

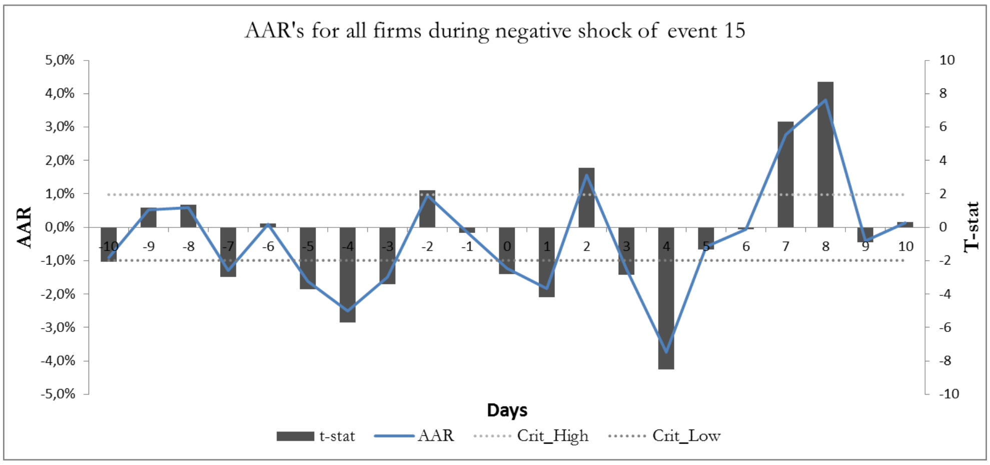

AAR's for all firms during negative shock of event 7
1,5%
1,0%
0,5%
0,0%
-0,5%
-1,0%
-1,5%
AAR
3
2
1
0
-1
-2
-3
T-stat
-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
Days
t-stat
AAR
Crit_High
Crit_Low


AAR's for all firms during negative shock of event 8
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low


AAR's for all firms during negative shock of event 10
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low


AAR's for all firms during negative shock of event 11
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low




## *Rank test results for negative shocks of all firms*

| **EVENT 3** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,516 | 0,495 | 0,503 | 0,527 |
| Std. Dev | 9,24% | 9,24% | 9,24% | 9,24% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,796 | -0,167 | 0,066 | 0,506 |
| p-value | 43,52% | 87,07% | 95,00% | 64,75% |

| **EVENT 4** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,457 | 0,422 | 0,391 | 0,329 |
| Std. Dev | 9,34% | 9,34% | 9,34% | 9,34% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -2,092 | -2,782 | -2,617 | -3,166 |
| p-value | 4,88% | 1,78% | 4,73% | 5,06% |

| **EVENT 5** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,489 | 0,463 | 0,401 | 0,361 |
| Std. Dev | 9,42% | 9,42% | 9,42% | 9,42% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -0,543 | -1,309 | -2,345 | -2,551 |
| p-value | 59,25% | 21,71% | 6,60% | 8,38% |

| **EVENT 7** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,484 | 0,463 | 0,475 | 0,443 |
| Std. Dev | 8,22% | 8,22% | 8,22% | 8,22% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -0,890 | -1,510 | -0,670 | -1,204 |
| p-value | 38,36% | 15,92% | 53,24% | 31,48% |

| **EVENT 8** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,456 | 0,435 | 0,390 | 0,352 |
| Std. Dev | 8,06% | 8,06% | 8,06% | 8,06% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -2,489 | -2,693 | -3,061 | -3,188 |
| p-value | 2,13% | 2,09% | 2,81% | 4,98% |

| **EVENT 10** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,430 | 0,442 | 0,346 | 0,281 |
| Std. Dev | 8,30% | 8,30% | 8,30% | 8,30% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -3,866 | -2,330 | -4,137 | -4,573 |
| p-value | 0,09% | 3,99% | 0,90% | 1,96% |

| EVENT 11 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,496 | 0,478 | 0,479 | 0,453 |
| Std. Dev | 8,36% | 8,36% | 8,36% | 8,36% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -0,227 | -0,865 | -0,566 | -0,980 |
| p-value | 82,25% | 40,54% | 59,61% | 39,92% |

| EVENT 13 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,475 | 0,478 | 0,416 | 0,360 |
| Std. Dev | 8,26% | 8,26% | 8,26% | 8,26% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,363 | -0,897 | -2,280 | -2,942 |
| p-value | 18,73% | 38,91% | 7,15% | 6,04% |

| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,475 | 0,418 | 0,486 | 0,385 |
| Std. Dev | 8,25% | 8,25% | 8,25% | 8,25% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,387 | -3,313 | -0,390 | -2,423 |
| p-value | 17,99% | 0,69% | 71,23% | 9,39% |

## *Sign test results for negative shocks of all firms*

| EVENT 3 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,475 | 0,468 | 0,494 | 0,529 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,830 | -1,047 | -0,191 | 0,952 |
| p-value | 40,73% | 29,62% | 84,88% | 34,19% |

| EVENT 4 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,420 | 0,374 | 0,324 | 0,275 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -2,628 | -4,099 | -5,724 | -7,300 |
| p-value | 0,91% | 0,01% | 0,00% | 0,00% |

| EVENT 5 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,455 | 0,420 | 0,353 | 0,294 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -1,476 | -2,616 | -4,770 | -6,665 |
| p-value | 14,12% | 0,94% | 0,00% | 0,00% |

| EVENT 7 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,466 | 0,443 | 0,426 | 0,377 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -1,114 | -1,873 | -2,390 | -3,976 |
| p-value | 26,63% | 6,22% | 1,76% | 0,01% |

| EVENT 8 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,426 | 0,395 | 0,353 | 0,325 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -2,434 | -3,434 | -4,780 | -5,679 |
| p-value | 1,56% | 0,07% | 0,00% | 0,00% |

| EVENT 10 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,423 | 0,436 | 0,330 | 0,271 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -2,534 | -2,103 | -5,506 | -7,403 |
| p-value | 1,18% | 3,64% | 0,00% | 0,00% |

| EVENT 11 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,536 | 0,516 | 0,530 | 0,465 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 1,185 | 0,517 | 0,981 | -1,129 |
| p-value | 23,71% | 60,54% | 32,77% | 25,98% |

| EVENT 13 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,472 | 0,465 | 0,400 | 0,310 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,930 | -1,138 | -3,243 | -6,148 |
| p-value | 35,33% | 25,62% | 0,13% | 0,00% |

| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,485 | 0,412 | 0,465 | 0,349 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,492 | -2,862 | -1,131 | -4,894 |
| p-value | 62,30% | 0,45% | 25,89% | 0,00% |

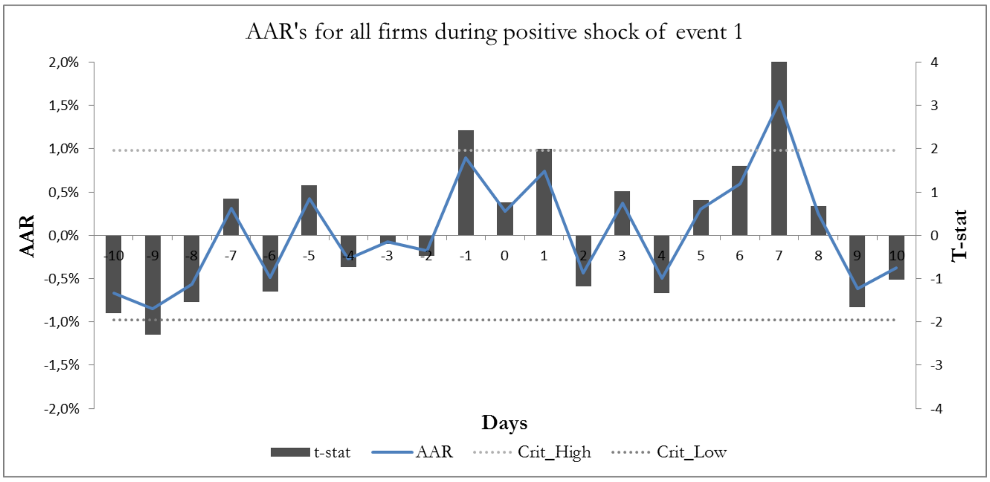
## *CAAR results for positive shocks of all firms*

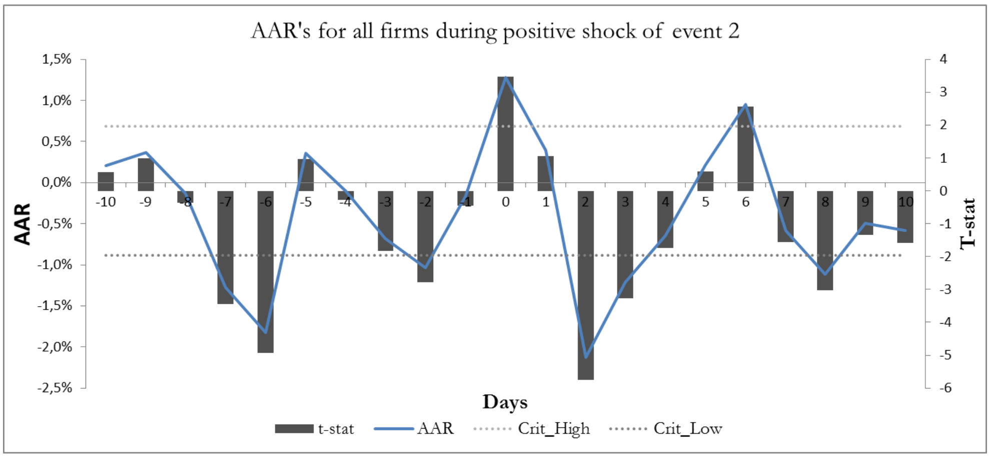
| **EVENT 1** | (-10,10) | (-5,5) | (-2,2) | (-1,1) | **EVENT 2** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|---|---|---|---|---|
| CAAR | 0,72% | 1,57% | 1,31% | 1,92% | CAAR | -8,21% | -3,72% | -1,66% | 1,51% |
| Std. Dev | 1,70% | 1,23% | 0,83% | 0,64% | Std. Dev | 1,70% | 1,23% | 0,83% | 0,64% |
| t-test | 0,424 | 1,279 | 1,579 | 2,996 | t-test | -4,842 | -3,032 | -2,001 | 2,352 |
| p-value | 67,43% | 20,97% | 12,37% | 0,51% | p-value | 0,00% | 0,46% | 5,34% | 2,46% |
| N | 34 | 34 | 34 | 34 | N | 34 | 34 | 34 | 34 |

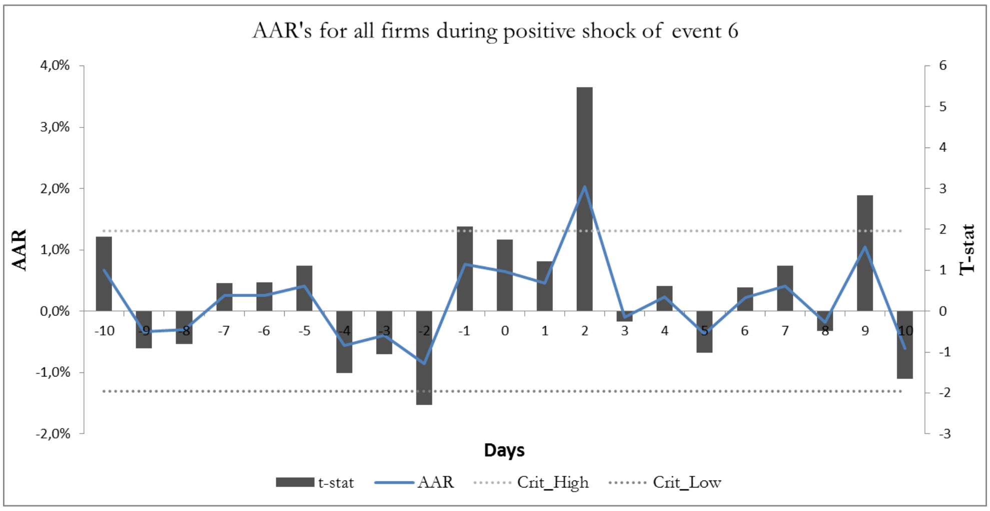
| **EVENT 6** | (-10,10) | (-5,5) | (-2,2) | (-1,1) | **EVENT 9** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|---|---|---|---|---|
| CAAR | 3,72% | 2,28% | 3,05% | 1,87% | CAAR | 2,14% | 2,22% | 1,14% | 0,71% |
| Std. Dev | 1,70% | 1,23% | 0,83% | 0,64% | Std. Dev | 3,03% | 2,20% | 1,48% | 1,15% |
| t-test | 2,190 | 1,855 | 3,684 | 2,924 | t-test | 0,705 | 1,009 | 0,770 | 0,620 |
| p-value | 3,55% | 7,23% | 0,08% | 0,61% | p-value | 48,46% | 31,88% | 44,59% | 53,86% |
| N | 34 | 34 | 34 | 34 | N | 41 | 41 | 41 | 41 |

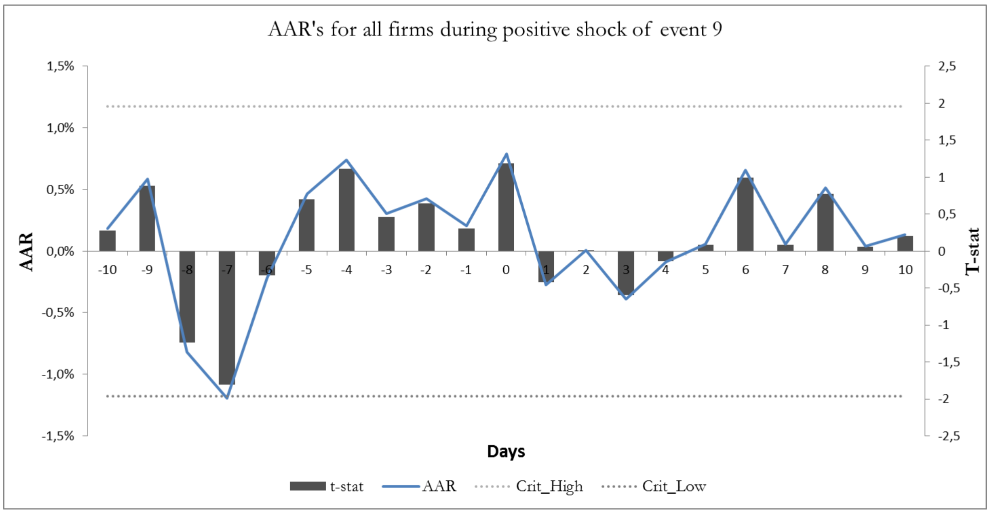
| **EVENT 12** | (-10,10) | (-5,5) | (-2,2) | (-1,1) | **EVENT 14** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|---|---|---|---|---|
| CAAR | 3,04% | 0,84% | -0,41% | -0,68% | CAAR | 2,45% | 6,59% | 8,16% | 6,15% |
| Std. Dev | 2,01% | 1,45% | 0,98% | 0,76% | Std. Dev | 2,01% | 1,45% | 0,98% | 0,76% |
| t-test | 1,515 | 0,578 | -0,415 | -0,897 | t-test | 1,218 | 4,535 | 8,331 | 8,100 |
| p-value | 13,72% | 56,62% | 68,01% | 37,47% | p-value | 22,98% | 0,00% | 0,00% | 0,00% |
| N | 43 | 43 | 43 | 43 | N | 43 | 43 | 43 | 43 |

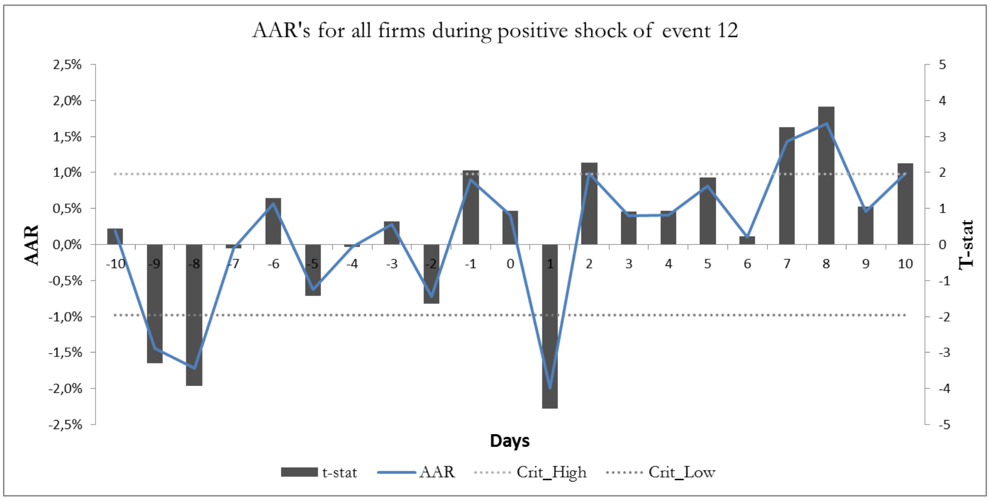
## *$\overline{AR}$ results for positive shocks for all firms*

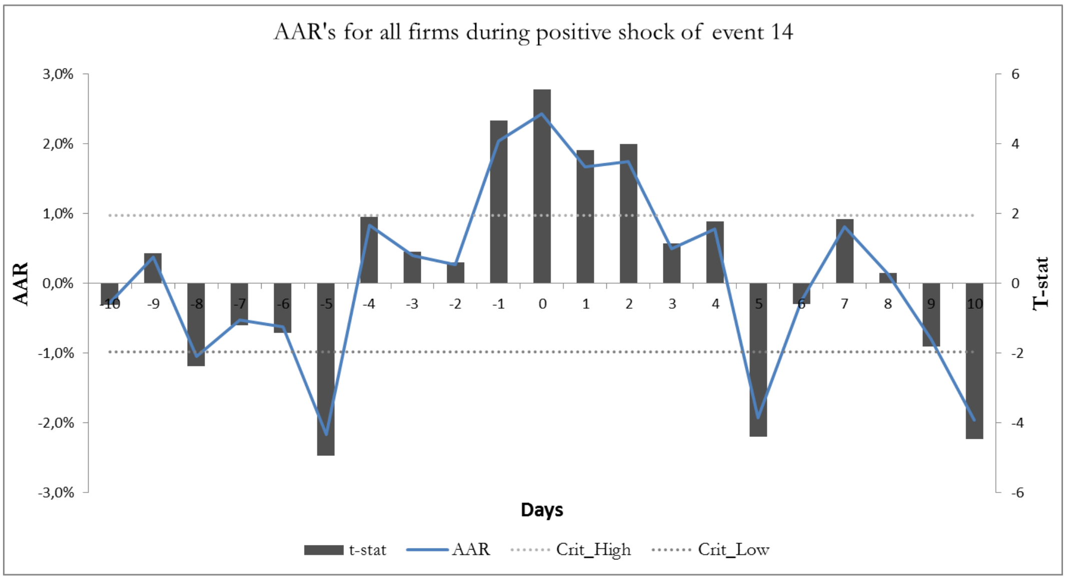



AAR's for all firms during positive shock of event 2
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low


AAR's for all firms during positive shock of event 6
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low


AAR's for all firms during positive shock of event 9
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low




## Rank test results for positive shocks of all firms

| EVENT 1 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,505 | 0,516 | 0,522 | 0,573 |
| Std. Dev | 9,39% | 9,39% | 9,39% | 9,39% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,237 | 0,569 | 0,533 | 1,353 |
| p-value | 81,46% | 58,10% | 61,66% | 26,91% |

| EVENT 2 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,472 | 0,477 | 0,482 | 0,592 |
| Std. Dev | 9,30% | 9,30% | 9,30% | 9,30% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,374 | -0,824 | -0,438 | 1,708 |
| p-value | 18,38% | 42,75% | 67,97% | 18,61% |

| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,522 | 0,530 | 0,565 | 0,583 |
| Std. Dev | 9,42% | 9,42% | 9,42% | 9,42% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 1,058 | 1,068 | 1,549 | 1,525 |
| p-value | 30,21% | 30,84% | 18,20% | 22,46% |

| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,524 | 0,533 | 0,537 | 0,539 |
| Std. Dev | 9,51% | 9,51% | 9,51% | 9,51% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 1,160 | 1,158 | 0,872 | 0,716 |
| p-value | 25,90% | 27,15% | 42,30% | 52,59% |

| EVENT 12 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,522 | 0,522 | 0,508 | 0,510 |
| Std. Dev | 8,35% | 8,35% | 8,35% | 8,35% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 1,215 | 0,884 | 0,223 | 0,207 |
| p-value | 23,77% | 39,56% | 83,24% | 84,89% |

| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,504 | 0,542 | 0,620 | 0,656 |
| Std. Dev | 8,26% | 8,26% | 8,26% | 8,26% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,214 | 1,681 | 3,254 | 3,270 |
| p-value | 83,28% | 12,09% | 2,26% | 4,68% |

### *Sign test results for positive shocks of all firms*

| EVENT 1 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,508 | 0,516 | 0,506 | 0,569 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,277 | 0,523 | 0,191 | 2,222 |
| p-value | 78,22% | 60,12% | 84,88% | 2,72% |

| EVENT 2 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,486 | 0,503 | 0,506 | 0,657 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,461 | 0,087 | 0,191 | 5,078 |
| p-value | 64,51% | 93,06% | 84,88% | 0,00% |

| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,499 | 0,497 | 0,535 | 0,588 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,046 | -0,087 | 1,145 | 2,856 |
| p-value | 96,33% | 93,06% | 25,34% | 0,46% |

| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,516 | 0,530 | 0,507 | 0,496 |
| Days in total | 213 | 208 | 205 | 204 |
| t-stat | 0,458 | 0,863 | 0,210 | -0,116 |
| p-value | 64,77% | 38,89% | 83,42% | 90,77% |

| EVENT 12 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,551 | 0,548 | 0,544 | 0,543 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 1,695 | 1,552 | 1,433 | 1,380 |
| p-value | 9,11% | 12,19% | 15,30% | 16,87% |

| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,503 | 0,539 | 0,637 | 0,682 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,091 | 1,276 | 4,450 | 5,897 |
| p-value | 92,74% | 20,31% | 0,00% | 0,00% |

## Appendix 6.2

### Results from parametric $\overline{CAR}$ – and $\overline{AR}$ tests, development in stock returns and non-parametric Rank- and Sign test for drilling firms of each shocks

The tables and figures below show our results from the parametric cumulative average abnormal return ($\overline{CAR}$) test, the parametric average abnormal return ($\overline{AR}$) test, development in stock returns, the non-parametric Rank test and the non-parametric Sign test for each of the 15 shocks for drilling firms. First we show for negative shocks and then for positive shocks. ($\overline{CAR}$ and $\overline{AR}$ is denoted by CAAR and AAR in the tables/figures below)

### *CAAR results for negative shocks of drilling firms*

| EVENT 3 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 1,50% | -0,08% | -0,90% | 0,18% |
| Std. Dev | 2,95% | 2,14% | 1,44% | 1,12% |
| t-test | 0,510 | -0,038 | -0,621 | 0,162 |
| p-value | 62,05% | 97,02% | 54,70% | 87,46% |
| N | 11 | 11 | 11 | 11 |

| EVENT 4 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -11,22% | -8,28% | -5,72% | -6,02% |
| Std. Dev | 2,95% | 2,14% | 1,44% | 1,12% |
| t-test | -3,800 | -3,872 | -3,968 | -5,391 |
| p-value | 0,29% | 0,26% | 0,22% | 0,02% |
| N | 11 | 11 | 11 | 11 |

| EVENT 5 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 3,92% | -2,11% | -2,98% | -2,58% |
| Std. Dev | 2,95% | 2,14% | 1,44% | 1,12% |
| t-test | 1,326 | -0,985 | -2,066 | -2,315 |
| p-value | 21,17% | 34,58% | 6,32% | 4,09% |
| N | 11 | 11 | 11 | 11 |

| EVENT 7 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -6,68% | -7,61% | -2,77% | -2,41% |
| Std. Dev | 3,63% | 2,63% | 1,77% | 1,37% |
| t-test | -1,838 | -2,893 | -1,559 | -1,756 |
| p-value | 9,31% | 1,46% | 14,72% | 10,69% |
| N | 11 | 11 | 11 | 11 |

| EVENT 8 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -8,31% | -9,09% | -6,28% | -6,52% |
| Std. Dev | 3,63% | 2,63% | 1,77% | 1,37% |
| t-test | -2,286 | -3,455 | -3,542 | -4,746 |
| p-value | 4,31% | 0,54% | 0,46% | 0,06% |
| N | 11 | 11 | 11 | 11 |

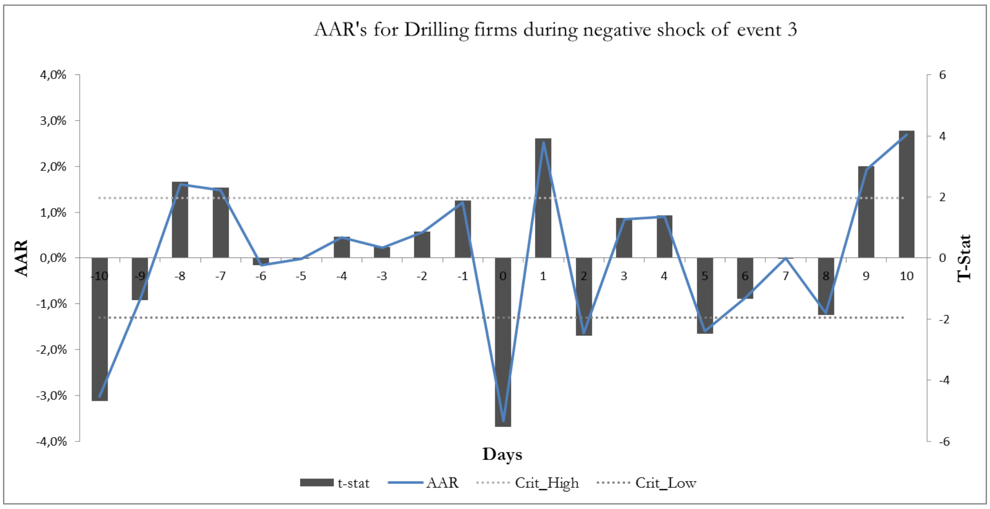
| EVENT 10 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -26,09% | -17,77% | -16,43% | -14,46% |
| Std. Dev | 3,82% | 2,76% | 1,86% | 1,44% |
| t-test | -6,832 | -6,430 | -8,819 | -10,018 |
| p-value | 0,00% | 0,00% | 0,00% | 0,00% |
| N | 15 | 15 | 15 | 15 |

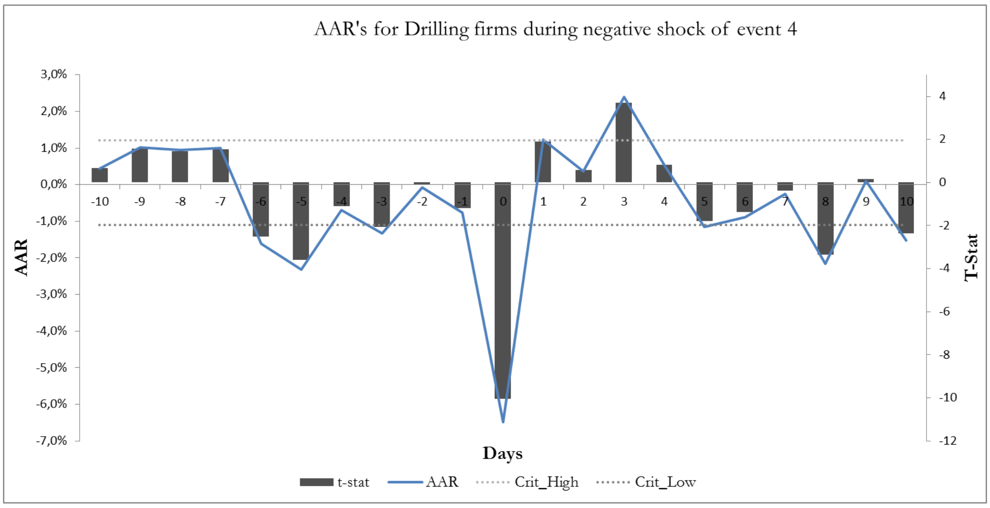
| EVENT 11 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -4,40% | -4,79% | -2,09% | -2,66% |
| Std. Dev | 3,82% | 2,76% | 1,86% | 1,44% |
| t-test | -1,151 | -1,734 | -1,121 | -1,844 |
| p-value | 26,76% | 10,34% | 27,99% | 8,50% |
| N | 15 | 15 | 15 | 15 |

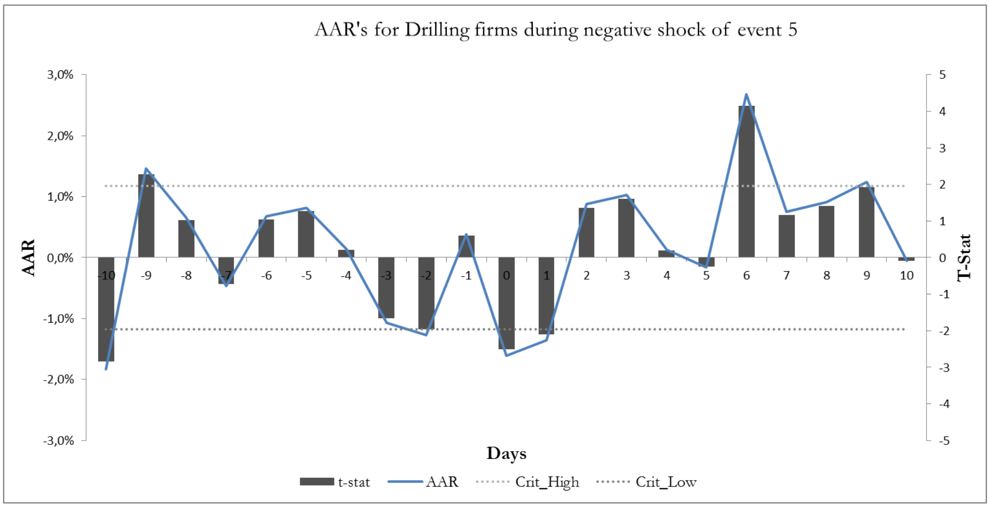
| EVENT 13 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -6,31% | -0,68% | -6,37% | -8,18% |
| Std. Dev | 3,82% | 2,76% | 1,86% | 1,44% |
| t-test | -1,652 | -0,247 | -3,421 | -5,668 |
| p-value | 11,93% | 80,86% | 0,38% | 0,00% |
| N | 15 | 15 | 15 | 15 |

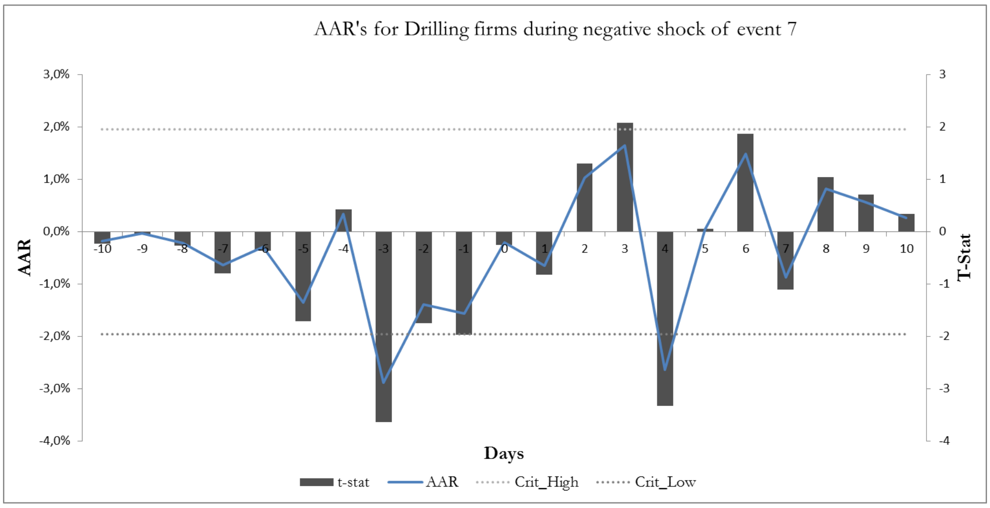
| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -9,25% | -14,52% | -1,30% | -5,23% |
| Std. Dev | 3,82% | 2,76% | 1,86% | 1,44% |
| t-test | -2,422 | -5,253 | -0,698 | -3,627 |
| p-value | 2,85% | 0,01% | 49,56% | 0,25% |
| N | 15 | 15 | 15 | 15 |

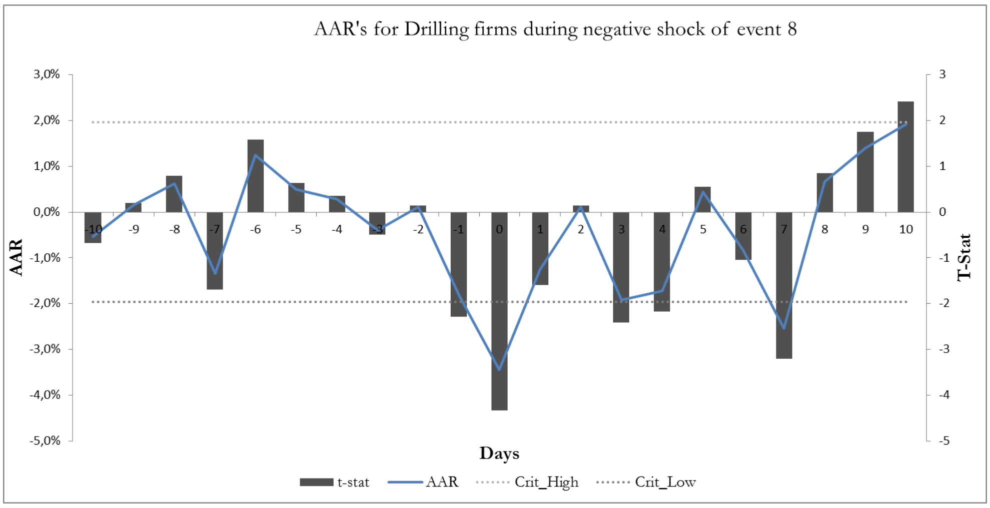
## *$\overline{AR}$ results for negative shocks of drilling firms*

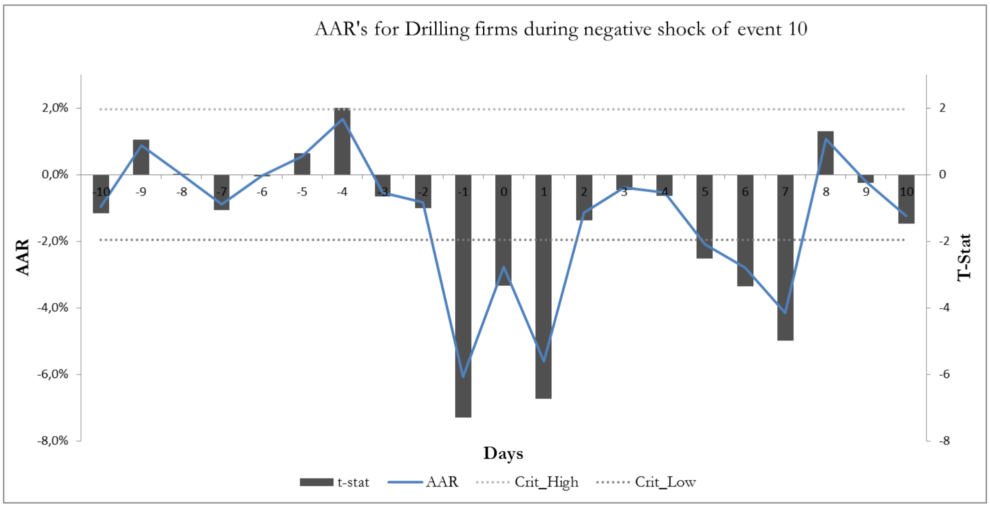


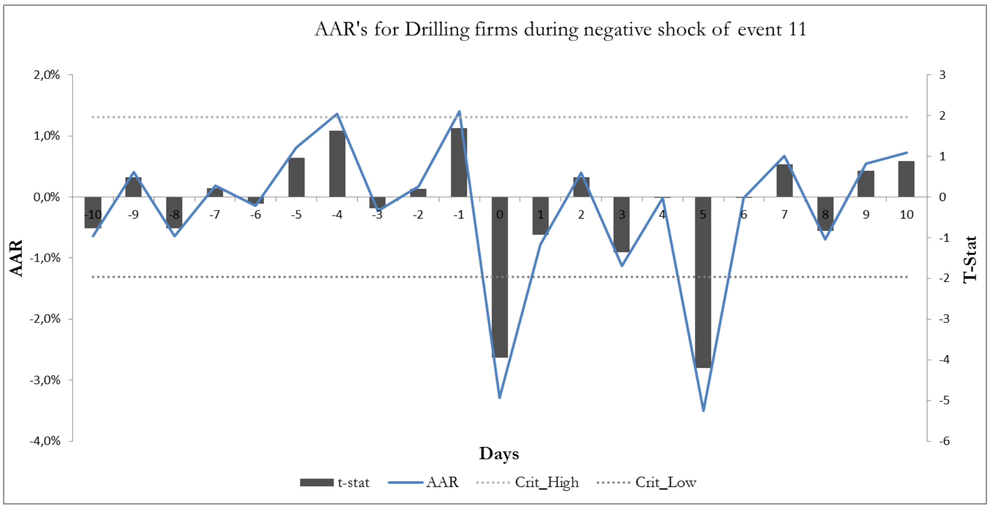

AAR's for Drilling firms during negative shock of event 4
AAR
T-Stat
Days
t-stat
AAR
Crit_High
Crit_Low

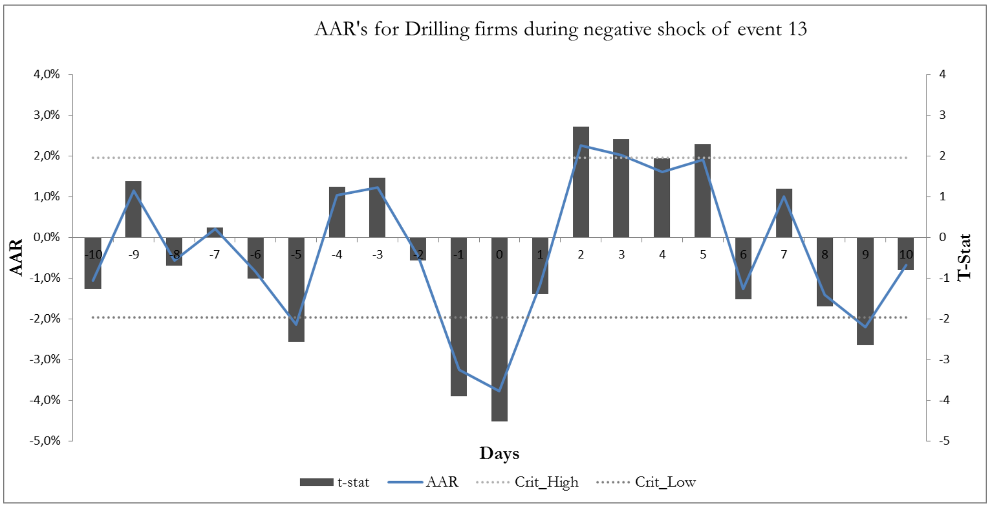

AAR's for Drilling firms during negative shock of event 5
AAR
T-Stat
Days
t-stat
AAR
Crit_High
Crit_Low

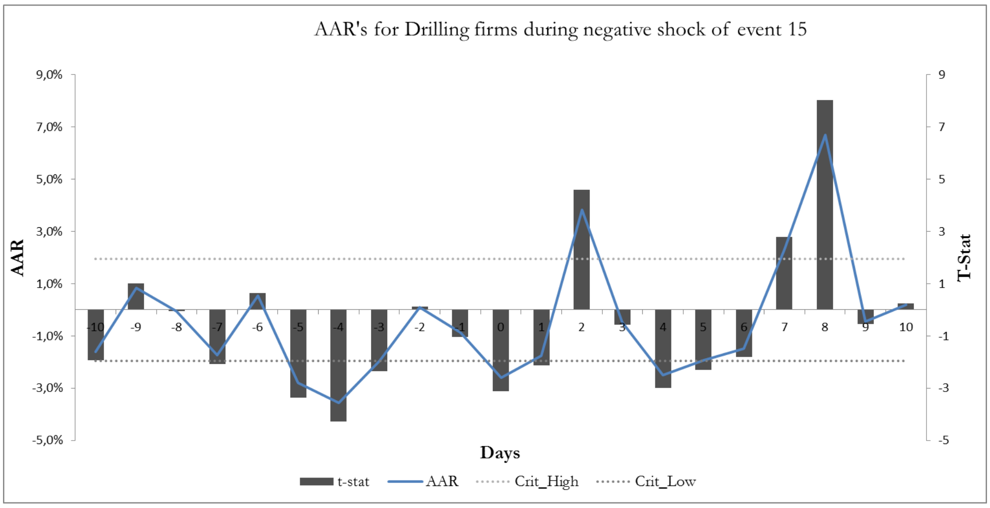

AAR's for Drilling firms during negative shock of event 7
AAR
T-Stat
Days
t-stat
AAR
Crit_High
Crit_Low


AAR's for Drilling firms during negative shock of event 8
AAR
T-Stat
Days
3,0%
2,0%
1,0%
0,0%
-1,0%
-2,0%
-3,0%
-4,0%
-5,0%
3
2
1
0
-1
-2
-3
-4
-5
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
t-stat
AAR
Crit_High
Crit_Low

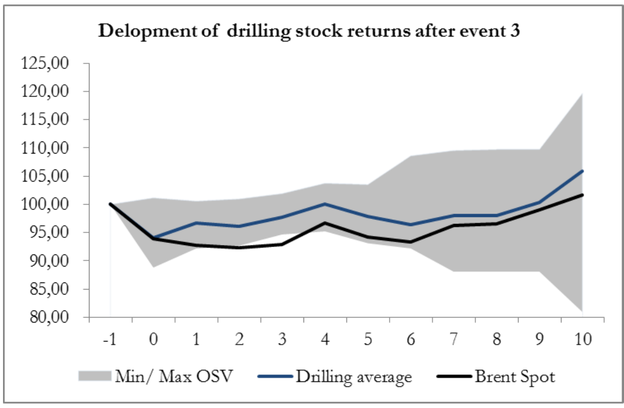

AAR's for Drilling firms during negative shock of event 10
AAR
T-Stat
Days
2,0%
0,0%
-2,0%
-4,0%
-6,0%
-8,0%
2
0
-2
-4
-6
-8
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
t-stat
AAR
Crit_High
Crit_Low

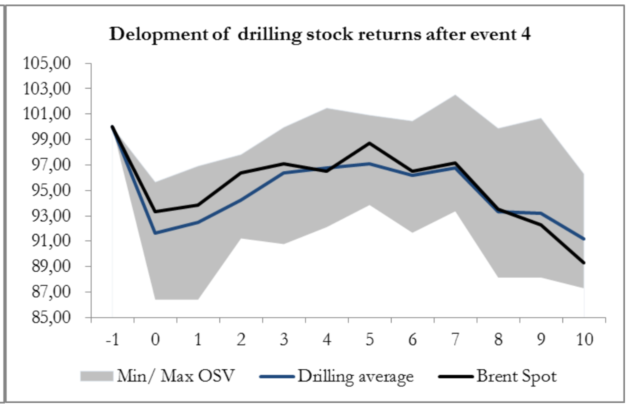

AAR's for Drilling firms during negative shock of event 11
AAR
T-Stat
Days
2,0%
1,0%
0,0%
-1,0%
-2,0%
-3,0%
-4,0%
3
2
1
0
-1
-2
-3
-4
-5
-6
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
t-stat
AAR
Crit_High
Crit_Low

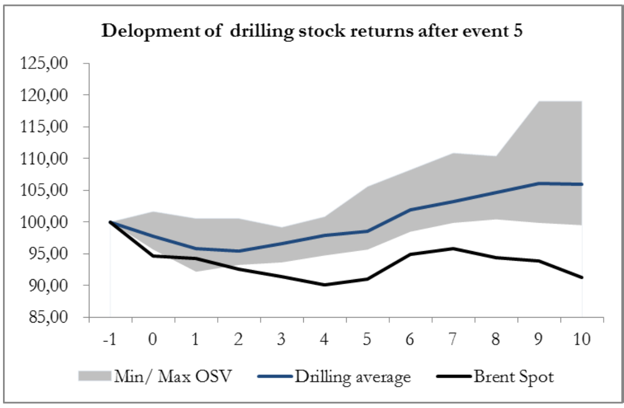


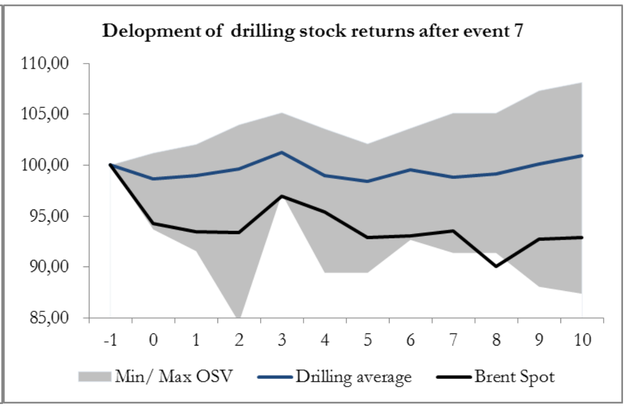



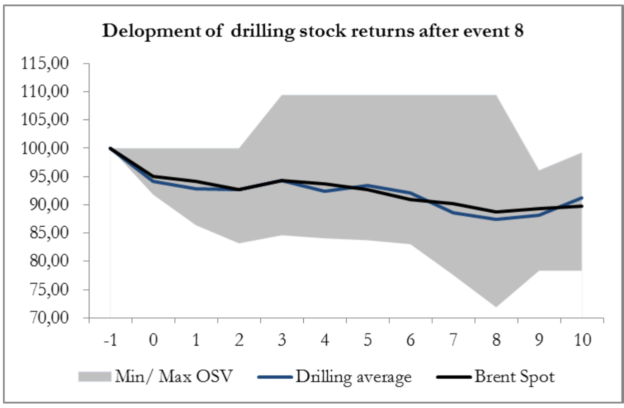

## *Development in stock returns for negative shocks of drilling firms*

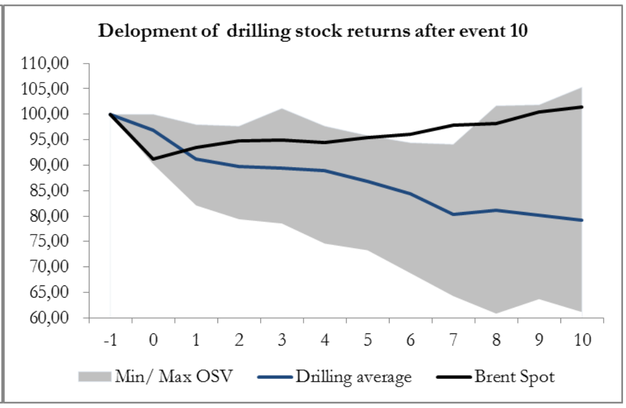


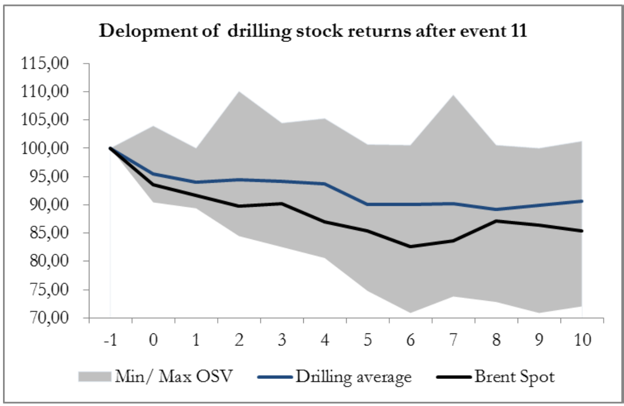



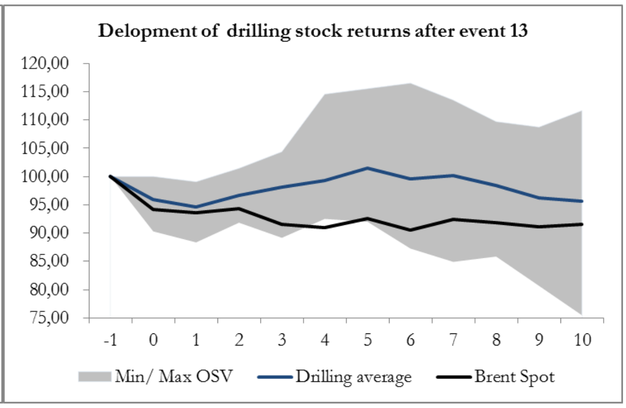

Delopment of drilling stock returns after event 5
125,00
120,00
115,00
110,00
105,00
100,00
95,00
90,00
85,00
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max OSV
Drilling average
Brent Spot

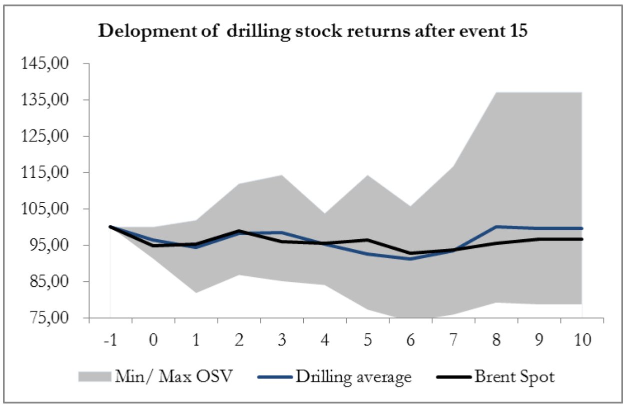

Delopment of drilling stock returns after event 7
110,00
105,00
100,00
95,00
90,00
85,00
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max OSV
Drilling average
Brent Spot


Delopment of drilling stock returns after event 8
115,00
110,00
105,00
100,00
95,00
90,00
85,00
80,00
75,00
70,00
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max OSV
Drilling average
Brent Spot


Delopment of drilling stock returns after event 10
110,00
105,00
100,00
95,00
90,00
85,00
80,00
75,00
70,00
65,00
60,00
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max OSV
Drilling average
Brent Spot


Delopment of drilling stock returns after event 11
115,00
110,00
105,00
100,00
95,00
90,00
85,00
80,00
75,00
70,00
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max OSV
Drilling average
Brent Spot


Delopment of drilling stock returns after event 13
120,00
115,00
110,00
105,00
100,00
95,00
90,00
85,00
80,00
75,00
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max OSV
Drilling average
Brent Spot


Delopment of drilling stock returns after event 15
145,00
135,00
125,00
115,00
105,00
95,00
85,00
75,00
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max OSV
Drilling average
Brent Spot

### *Rank test results for negative shocks of drilling firms*

| **EVENT 3** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,500 | 0,497 | 0,455 | 0,498 |
| Std. Dev | 15,317% | 15,317% | 15,317% | 15,317% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -0,012 | -0,059 | -0,661 | -0,018 |
| p-value | 99,024% | 95,436% | 53,807% | 98,704% |

| **EVENT 4** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,446 | 0,423 | 0,405 | 0,333 |
| Std. Dev | 15,498% | 15,498% | 15,498% | 15,498% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,604 | -1,648 | -1,371 | -1,865 |
| p-value | 12,368% | 12,765% | 22,857% | 15,901% |

| **EVENT 5** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,512 | 0,460 | 0,409 | 0,345 |
| Std. Dev | 15,605% | 15,605% | 15,605% | 15,605% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,346 | -0,847 | -1,306 | -1,721 |
| p-value | 73,254% | 41,491% | 24,855% | 18,368% |

| **EVENT 7** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,467 | 0,419 | 0,432 | 0,400 |
| Std. Dev | 13,280% | 13,280% | 13,280% | 13,280% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,153 | -2,025 | -1,153 | -1,306 |
| p-value | 26,195% | 6,788% | 30,120% | 28,257% |

| **EVENT 8** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,467 | 0,416 | 0,379 | 0,272 |
| Std. Dev | 13,060% | 13,060% | 13,060% | 13,060% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,163 | -2,144 | -2,078 | -3,026 |
| p-value | 25,800% | 5,519% | 9,226% | 5,649% |

| **EVENT 10** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,399 | 0,384 | 0,242 | 0,143 |
| Std. Dev | 12,452% | 12,452% | 12,452% | 12,452% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -3,712 | -3,077 | -4,638 | -4,962 |
| p-value | 0,129% | 1,052% | 0,564% | 1,572% |

| **EVENT 11** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,471 | 0,439 | 0,466 | 0,435 |
| Std. Dev | 12,597% | 12,597% | 12,597% | 12,597% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,069 | -1,600 | -0,598 | -0,898 |
| p-value | 29,716% | 13,789% | 57,576% | 43,557% |

| **EVENT 13** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,458 | 0,460 | 0,361 | 0,215 |
| Std. Dev | 12,345% | 12,345% | 12,345% | 12,345% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,566 | -1,079 | -2,512 | -4,004 |
| p-value | 13,234% | 30,353% | 5,370% | 2,793% |

| **EVENT 15** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,446 | 0,376 | 0,481 | 0,368 |
| Std. Dev | 12,403% | 12,403% | 12,403% | 12,403% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -2,011 | -3,303 | -0,334 | -1,847 |
| p-value | 5,738% | 0,704% | 75,189% | 16,188% |

### *Sign test results for negative shocks of drilling firms*

| **EVENT 3** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,450 | 0,479 | 0,436 | 0,515 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -1,639 | -0,674 | -2,064 | 0,490 |
| p-value | 10,236% | 50,093% | 4,000% | 62,419% |

| **EVENT 4** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,411 | 0,372 | 0,327 | 0,273 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -2,922 | -4,178 | -5,602 | -7,357 |
| p-value | 0,377% | 0,004% | 0,000% | 0,000% |

| **EVENT 5** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,498 | 0,438 | 0,382 | 0,273 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,071 | -2,022 | -3,833 | -7,357 |
| p-value | 94,324% | 4,419% | 0,016% | 0,000% |

| **EVENT 7** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,442 | 0,397 | 0,345 | 0,242 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -1,924 | -3,370 | -5,013 | -8,338 |
| p-value | 5,538% | 0,086% | 0,000% | 0,000% |

| EVENT 8 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,446 | 0,372 | 0,345 | 0,212 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -1,782 | -4,178 | -5,013 | -9,319 |
| p-value | 7,593% | 0,004% | 0,000% | 0,000% |

| EVENT 10 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,378 | 0,358 | 0,213 | 0,156 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -4,024 | -4,646 | -9,298 | -11,151 |
| p-value | 0,007% | 0,001% | 0,000% | 0,000% |

| EVENT 11 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,486 | 0,467 | 0,507 | 0,444 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,470 | -1,087 | 0,216 | -1,798 |
| p-value | 63,849% | 27,789% | 82,898% | 7,325% |

| EVENT 13 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,448 | 0,448 | 0,347 | 0,133 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -1,725 | -1,680 | -4,973 | -11,870 |
| p-value | 8,574% | 9,406% | 0,000% | 0,000% |

| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,435 | 0,339 | 0,427 | 0,311 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -2,143 | -5,239 | -2,379 | -6,115 |
| p-value | 3,303% | 0,000% | 1,810% | 0,000% |

## *CAAR results for positive shocks of drilling firms*

| EVENT 1 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -1,62% | 3,21% | 1,41% | 3,20% |
| Std. Dev | 2,95% | 2,14% | 1,44% | 1,12% |
| t-test | -0,549 | 1,501 | 0,975 | 2,870 |
| p-value | 59,39% | 16,16% | 35,04% | 1,52% |
| N | 11 | 11 | 11 | 11 |

| EVENT 2 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -15,17% | -9,67% | -3,85% | 2,04% |
| Std. Dev | 2,95% | 2,14% | 1,44% | 1,12% |
| t-test | -5,137 | -4,523 | -2,670 | 1,824 |
| p-value | 0,03% | 0,09% | 2,18% | 9,55% |
| N | 11 | 11 | 11 | 11 |

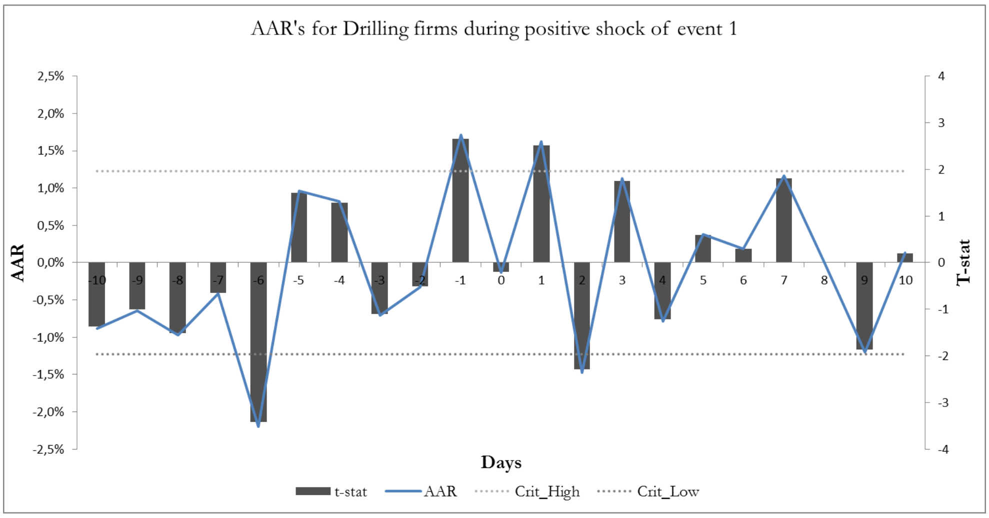
| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 4,92% | 5,57% | 6,62% | 3,39% |
| Std. Dev | 2,95% | 2,14% | 1,44% | 1,12% |
| t-test | 1,667 | 2,605 | 4,597 | 3,035 |
| p-value | 12,37% | 2,45% | 0,08% | 1,14% |
| N | 11 | 11 | 11 | 11 |

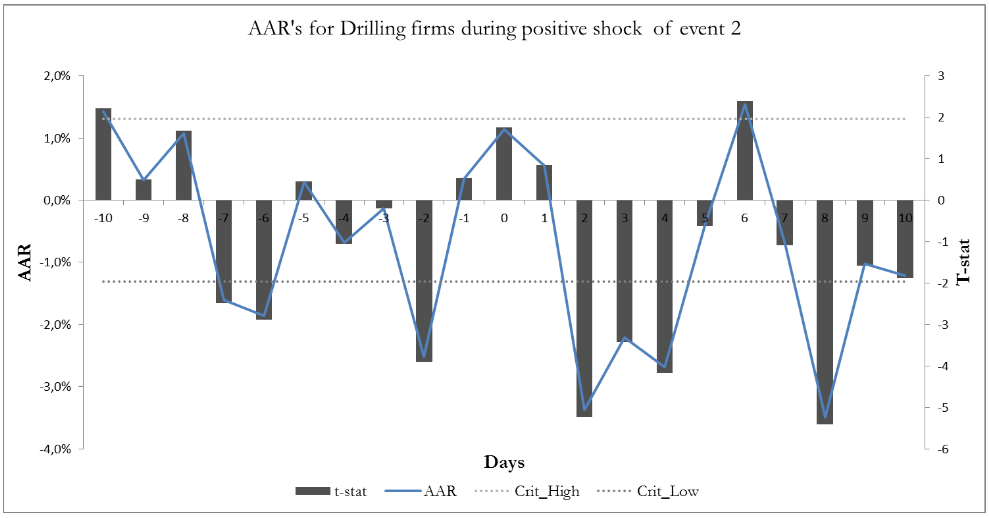
| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 5,34% | 4,56% | 2,94% | 1,70% |
| Std. Dev | 4,29% | 3,11% | 2,09% | 1,62% |
| t-test | 1,244 | 1,466 | 1,406 | 1,045 |
| p-value | 23,40% | 16,47% | 18,17% | 31,37% |
| N | 14 | 14 | 14 | 14 |

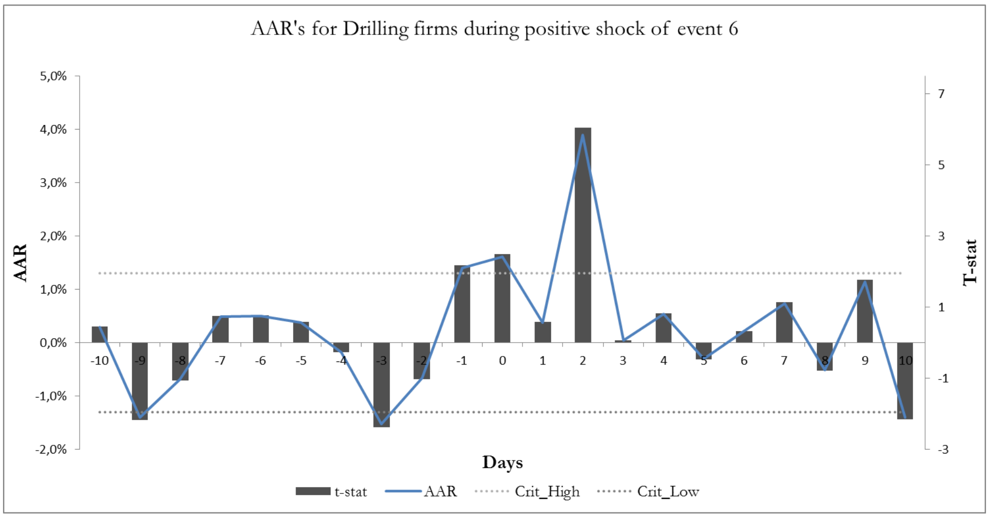
| EVENT 12 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 1,99% | 0,71% | 0,23% | 0,54% |
| Std. Dev | 3,82% | 2,76% | 1,86% | 1,44% |
| t-test | 0,522 | 0,257 | 0,124 | 0,376 |
| p-value | 60,92% | 80,06% | 90,27% | 71,19% |
| N | 15 | 15 | 15 | 15 |

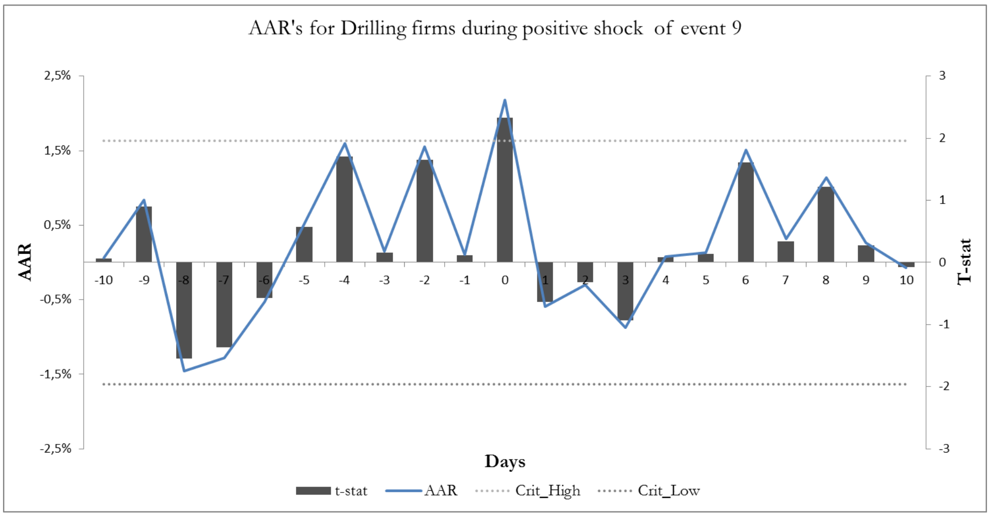
| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 6,16% | 10,76% | 13,12% | 9,31% |
| Std. Dev | 3,82% | 2,76% | 1,86% | 1,44% |
| t-test | 1,614 | 3,893 | 7,044 | 6,454 |
| p-value | 12,75% | 0,14% | 0,00% | 0,00% |
| N | 15 | 15 | 15 | 15 |

## $\overline{AR}$ results for positive shocks of drilling firms

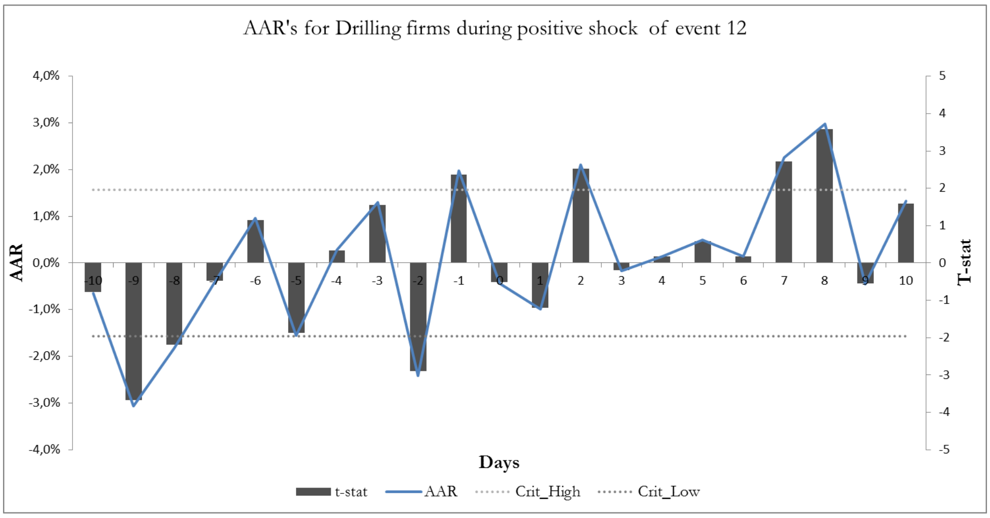


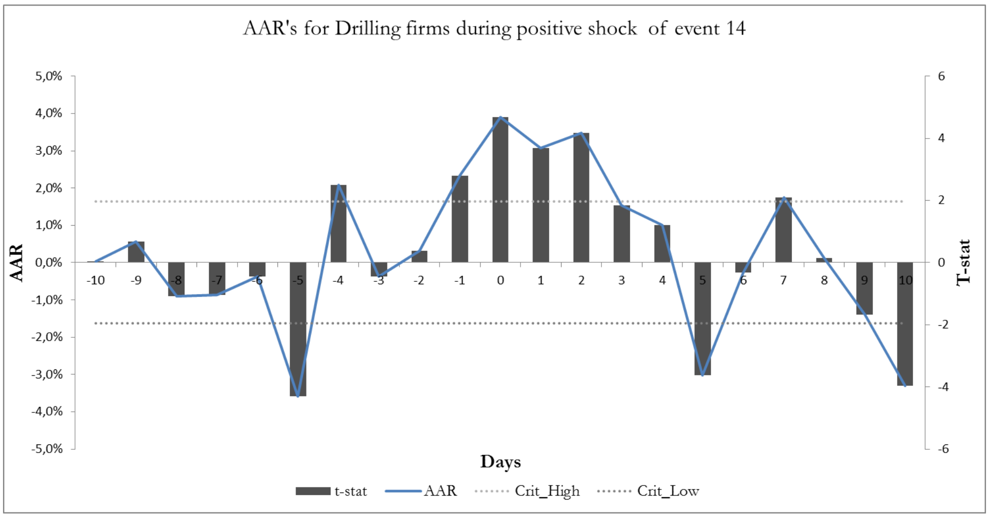





AAR's for Drilling firms during positive shock of event 9
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

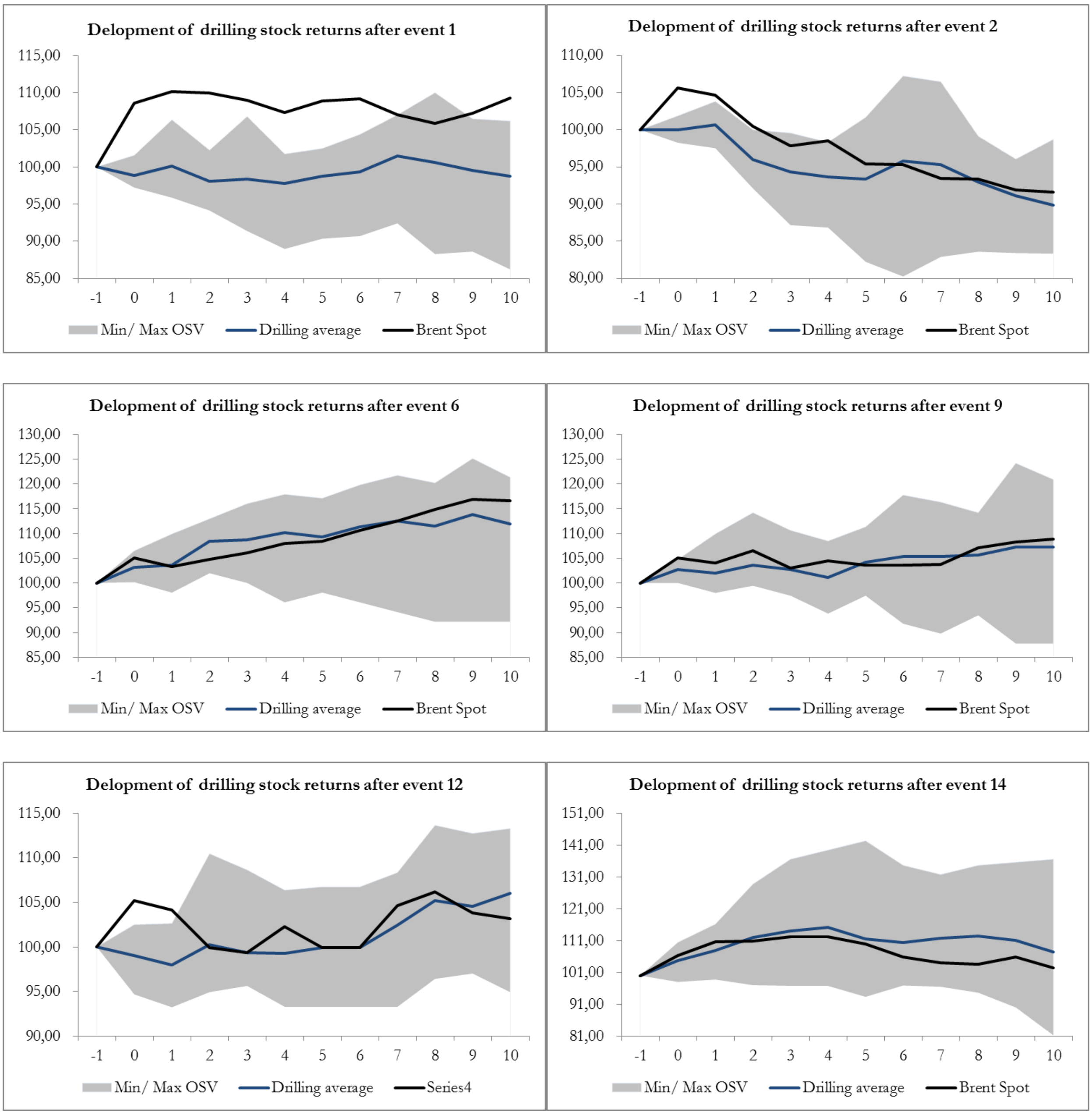



AAR's for Drilling firms during positive shock of event 12
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

AAR's for Drilling firms during positive shock of event 14
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

## *Development in stock returns for positive shocks of drilling firms*




## *Rank test results for positive shocks of drilling firms*

| **EVENT 1** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,489 | 0,524 | 0,502 | 0,610 |
| Std. Dev | 15,54% | 15,54% | 15,54% | 15,54% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -0,317 | 0,515 | 0,025 | 1,229 |
| p-value | 75,42% | 61,68% | 98,10% | 30,66% |

| **EVENT 2** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,440 | 0,418 | 0,437 | 0,616 |
| Std. Dev | 15,40% | 15,40% | 15,40% | 15,40% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,780 | -1,758 | -0,913 | 1,304 |
| p-value | 8,95% | 10,65% | 40,33% | 28,34% |

| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,521 | 0,559 | 0,651 | 0,652 |
| Std. Dev | 15,60% | 15,60% | 15,60% | 15,60% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,611 | 1,262 | 2,161 | 1,682 |
| p-value | 54,78% | 23,30% | 8,30% | 19,11% |

| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,540 | 0,557 | 0,577 | 0,577 |
| Std. Dev | 12,64% | 12,64% | 12,64% | 12,64% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 1,449 | 1,502 | 1,365 | 1,061 |
| p-value | 16,20% | 16,13% | 23,04% | 36,64% |

| EVENT 12 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,514 | 0,522 | 0,507 | 0,536 |
| Std. Dev | 12,51% | 12,51% | 12,51% | 12,51% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,511 | 0,573 | 0,120 | 0,493 |
| p-value | 61,49% | 57,82% | 90,91% | 65,57% |

| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,517 | 0,568 | 0,672 | 0,725 |
| Std. Dev | 12,34% | 12,34% | 12,34% | 12,34% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,624 | 1,817 | 3,115 | 3,161 |
| p-value | 53,92% | 9,65% | 2,64% | 5,08% |

## *Sign test results for positive shocks of drilling firms*

| EVENT 1 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,498 | 0,512 | 0,455 | 0,606 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,071 | 0,404 | -1,474 | 3,433 |
| p-value | 94,32% | 68,63% | 14,16% | 0,07% |

| EVENT 2 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,450 | 0,438 | 0,455 | 0,697 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -1,639 | -2,022 | -1,474 | 6,376 |
| p-value | 10,24% | 4,42% | 14,16% | 0,00% |

| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,485 | 0,545 | 0,636 | 0,697 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,499 | 1,483 | 4,423 | 6,376 |
| p-value | 61,83% | 13,93% | 0,00% | 0,00% |

| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,551 | 0,552 | 0,529 | 0,476 |
| Days in total | 213 | 208 | 205 | 204 |
| t-stat | 1,489 | 1,498 | 0,818 | -0,680 |
| p-value | 13,79% | 13,55% | 41,42% | 49,72% |

| EVENT 12 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,505 | 0,515 | 0,520 | 0,556 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,157 | 0,494 | 0,649 | 1,798 |
| p-value | 87,55% | 62,16% | 51,71% | 7,33% |

| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,517 | 0,570 | 0,653 | 0,711 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,575 | 2,273 | 4,973 | 6,834 |
| p-value | 56,59% | 2,38% | 0,00% | 0,00% |

## Appendix 6.3

### Results from parametric $\overline{CAR}$ – and $\overline{AR}$ tests, development in stock returns and non-parametric Rank- and Sign test for OSV firms of each shocks

The tables and figures below show our results from the parametric cumulative average abnormal return ($\overline{CAR}$) test, the parametric average abnormal return ($\overline{AR}$) test, development in stock returns, the non-parametric Rank test and the non-parametric Sign test for each of the 15 shocks for OSV firms. First we show for negative shocks and then for positive shocks. ($\overline{CAR}$ and $\overline{AR}$ is denoted by CAAR and AAR in the tables/figures below).

*CAAR results for negative shocks of OSV firms*

| **EVENT 3** | (-10,10) | (-5,5) | (-2,2) | (-1,1) | **EVENT 4** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|---|---|---|---|---|
| CAAR | 4,16% | -0,28% | 1,07% | 1,35% | CAAR | -4,17% | -7,34% | -5,80% | -5,84% |
| Std. Dev | 2,58% | 1,87% | 1,26% | 0,97% | Std. Dev | 2,58% | 1,87% | 1,26% | 0,97% |
| t-test | 1,613 | -0,151 | 0,848 | 1,385 | t-test | -1,616 | -3,936 | -4,611 | -5,990 |
| p-value | 12,91% | 88,19% | 41,09% | 18,77% | p-value | 12,83% | 0,15% | 0,04% | 0,00% |
| N | 14 | 14 | 14 | 14 | N | 14 | 14 | 14 | 14 |

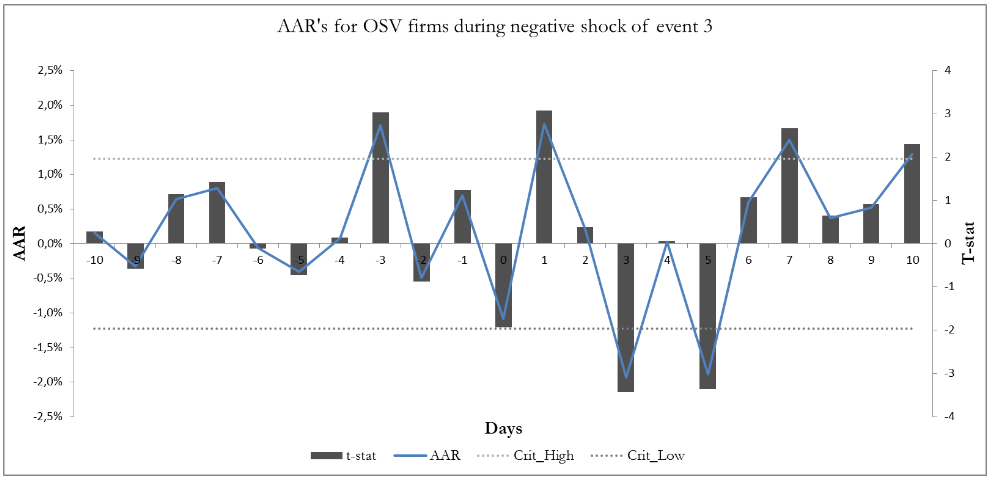
| **EVENT 5** | (-10,10) | (-5,5) | (-2,2) | (-1,1) | **EVENT 7** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|---|---|---|---|---|
| CAAR | -3,43% | -3,35% | -2,62% | -2,21% | CAAR | -3,43% | -3,25% | -1,11% | -1,80% |
| Std. Dev | 2,58% | 1,87% | 1,26% | 0,97% | Std. Dev | 2,62% | 1,90% | 1,28% | 0,99% |
| t-test | -1,330 | -1,793 | -2,085 | -2,268 | t-test | -1,305 | -1,710 | -0,866 | -1,817 |
| p-value | 20,49% | 9,45% | 5,59% | 3,97% | p-value | 21,15% | 10,80% | 40,03% | 8,92% |
| N | 14 | 14 | 14 | 14 | N | 15 | 15 | 15 | 15 |

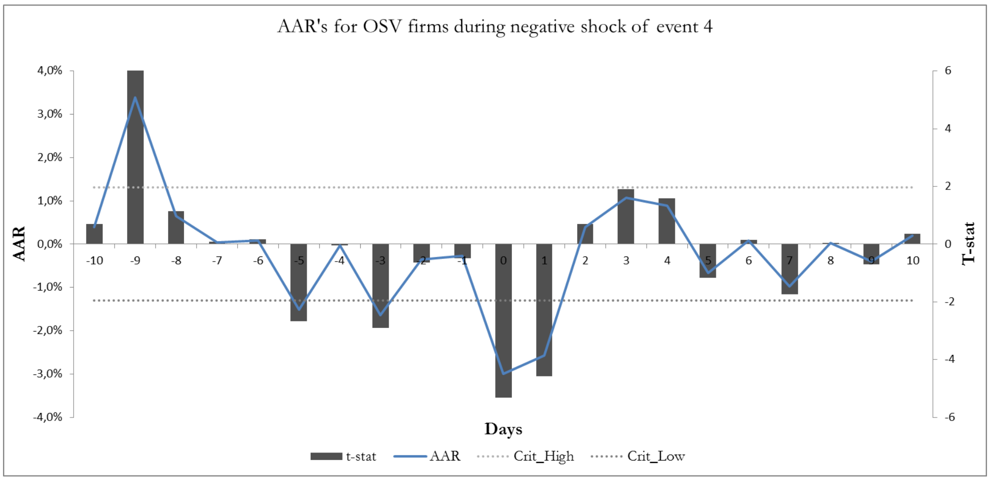
| **EVENT 8** | (-10,10) | (-5,5) | (-2,2) | (-1,1) | **EVENT 10** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|---|---|---|---|---|
| CAAR | -5,81% | -7,90% | -4,91% | -4,65% | CAAR | -21,63% | -9,29% | -11,02% | -8,58% |
| Std. Dev | 2,62% | 1,90% | 1,28% | 0,99% | Std. Dev | 2,41% | 1,74% | 1,18% | 0,91% |
| t-test | -2,215 | -4,161 | -3,837 | -4,691 | t-test | -8,974 | -5,326 | -9,373 | -9,423 |
| p-value | 4,26% | 0,08% | 0,16% | 0,03% | p-value | 0,00% | 0,01% | 0,00% | 0,00% |
| N | 15 | 15 | 15 | 15 | N | 15 | 15 | 15 | 15 |

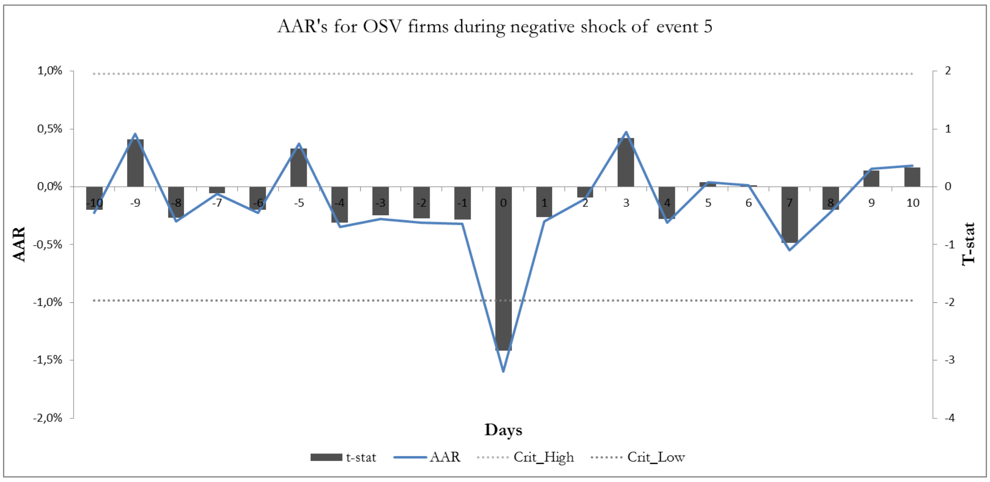
| **EVENT 11** | (-10,10) | (-5,5) | (-2,2) | (-1,1) | **EVENT 13** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|---|---|---|---|---|
| CAAR | -3,10% | 0,89% | -3,31% | -2,87% | CAAR | -2,05% | -3,74% | -2,49% | -2,44% |
| Std. Dev | 2,41% | 1,74% | 1,18% | 0,91% | Std. Dev | 2,41% | 1,74% | 1,18% | 0,91% |
| t-test | -1,287 | 0,507 | -2,818 | -3,153 | t-test | -0,849 | -2,142 | -2,119 | -2,683 |
| p-value | 21,75% | 61,93% | 1,30% | 0,66% | p-value | 40,90% | 4,90% | 5,11% | 1,70% |
| N | 15 | 15 | 15 | 15 | N | 15 | 15 | 15 | 15 |

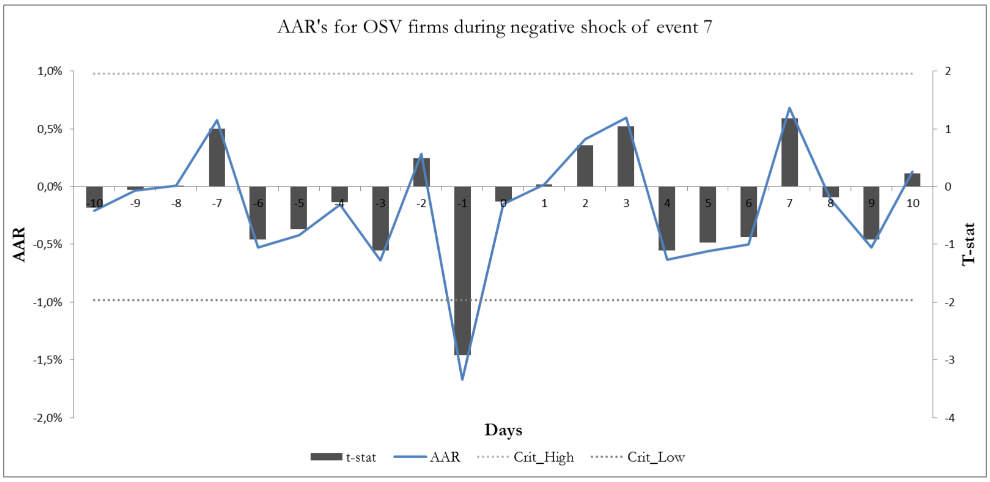
| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -7,72% | -11,85% | 2,18% | -0,31% |
| Std. Dev | 2,41% | 1,74% | 1,18% | 0,91% |
| t-test | -3,205 | -6,791 | 1,853 | -0,343 |
| p-value | 0,59% | 0,00% | 8,37% | 73,65% |
| N | 15 | 15 | 15 | 15 |

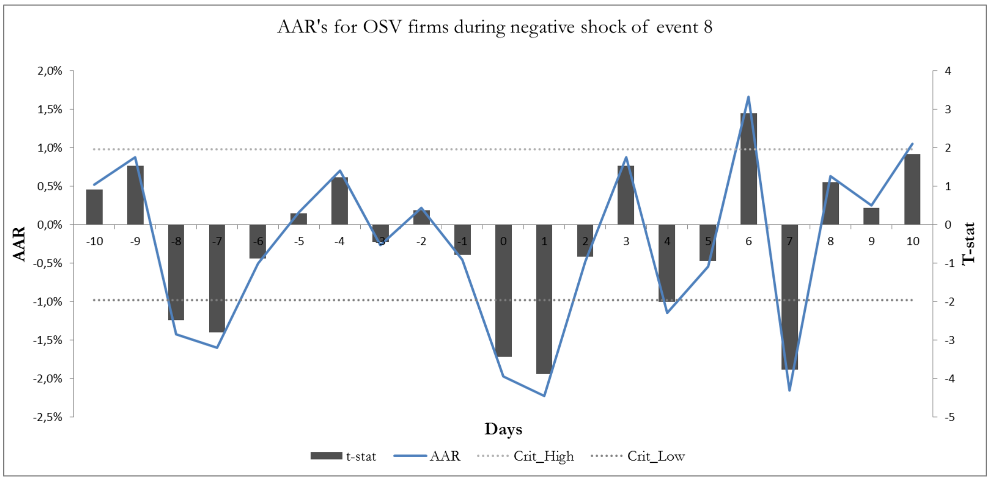
## *$\overline{AR}$ results for negative shocks of OSV firms*

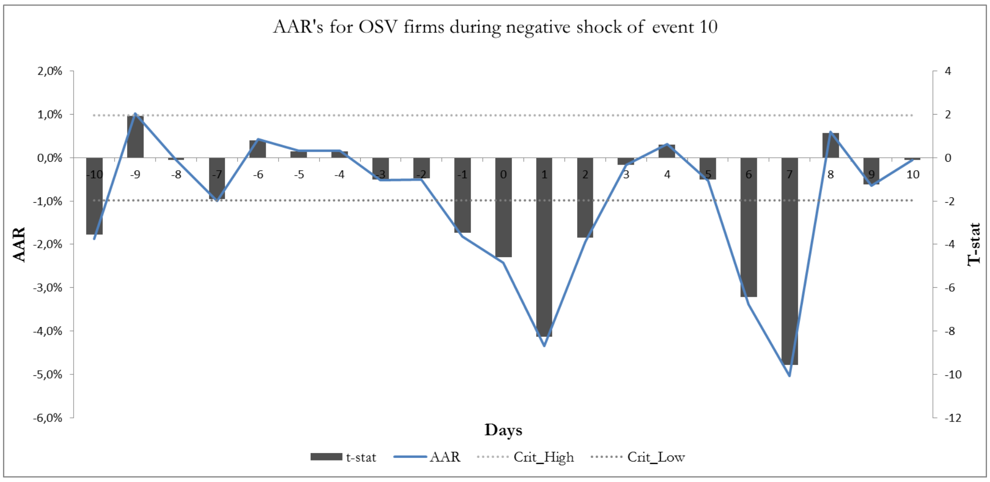


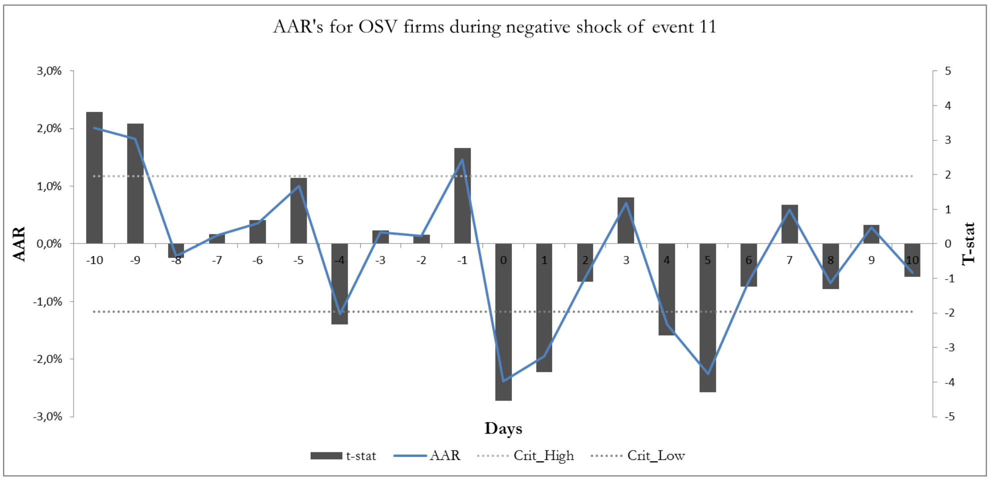



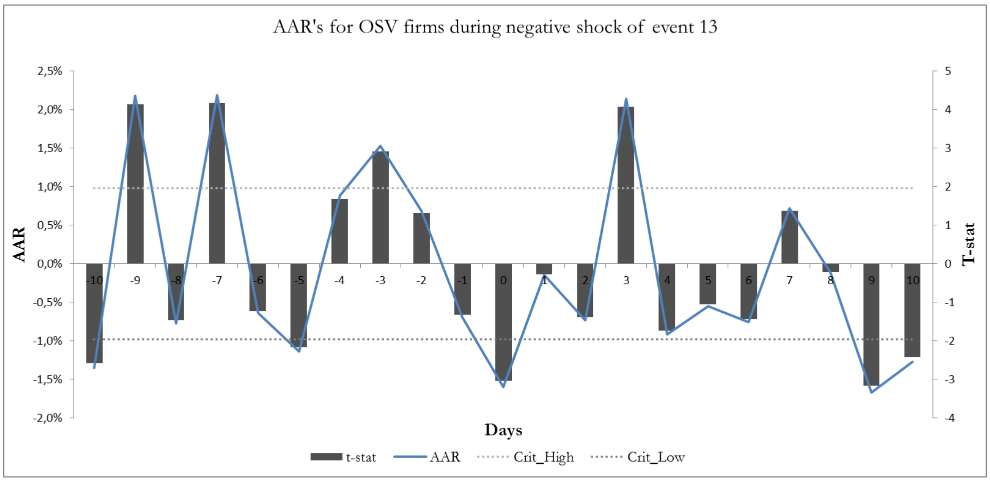

AAR's for OSV firms during negative shock of event 5
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

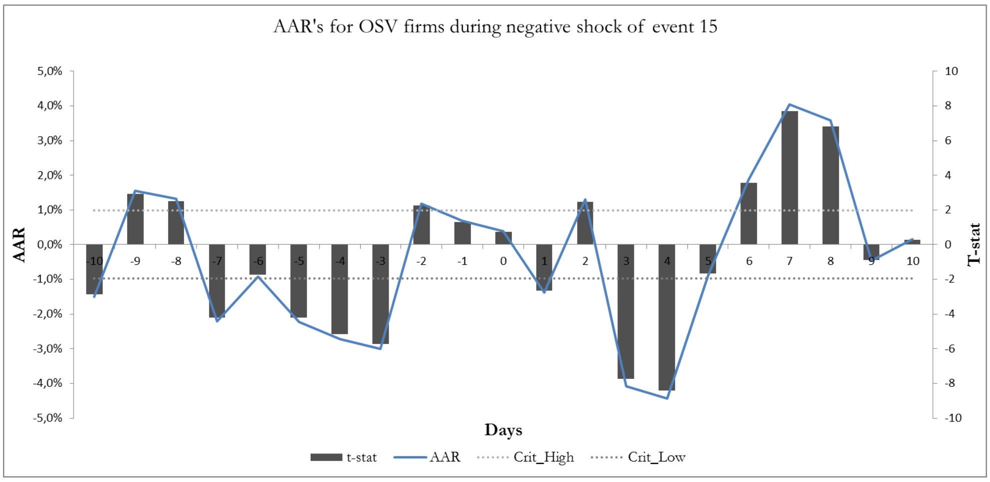

AAR's for OSV firms during negative shock of event 7
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low


AAR's for OSV firms during negative shock of event 8
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

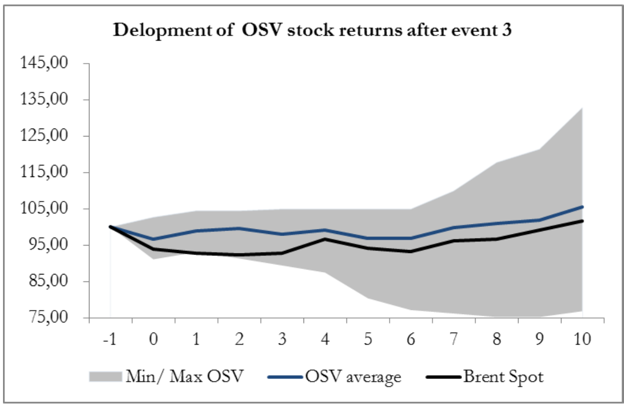

AAR's for OSV firms during negative shock of event 10
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

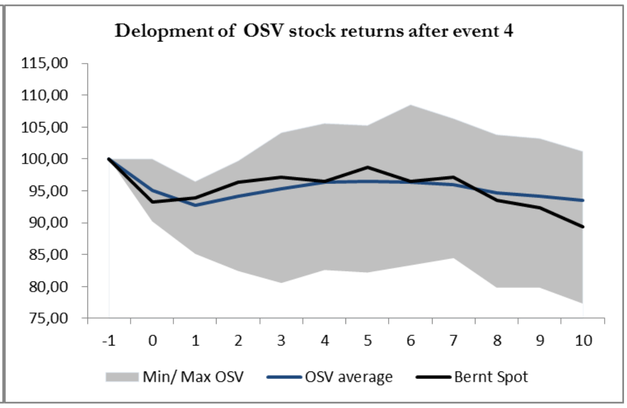

AAR's for OSV firms during negative shock of event 11
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

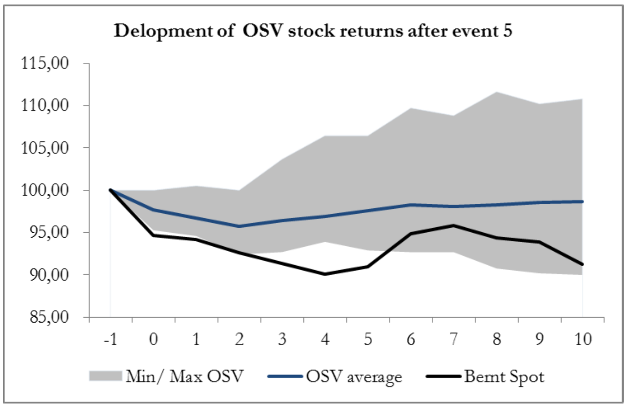

AAR's for OSV firms during negative shock of event 13
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

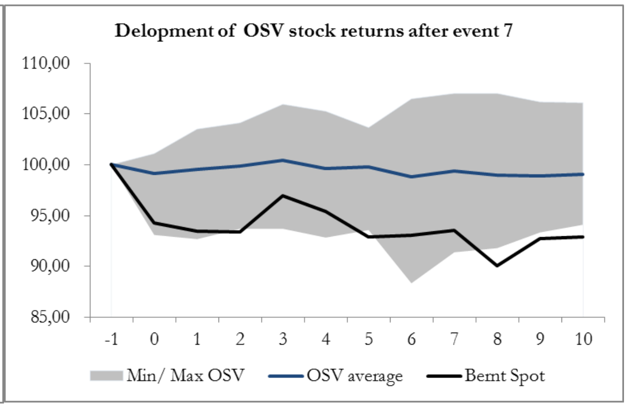


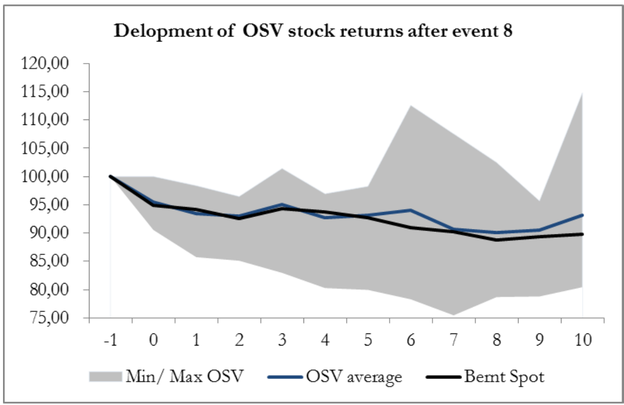

## *Development in stock returns for negative shocks of OSV firms*

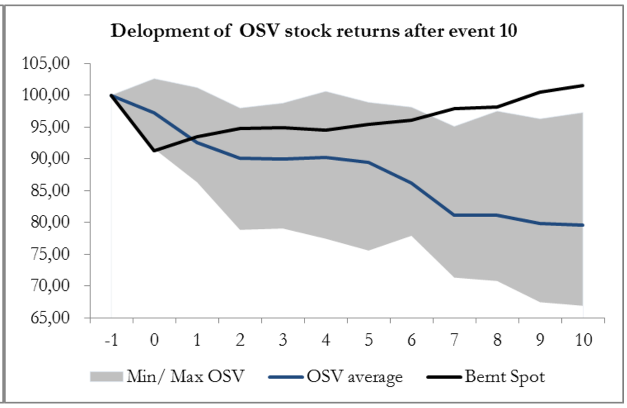


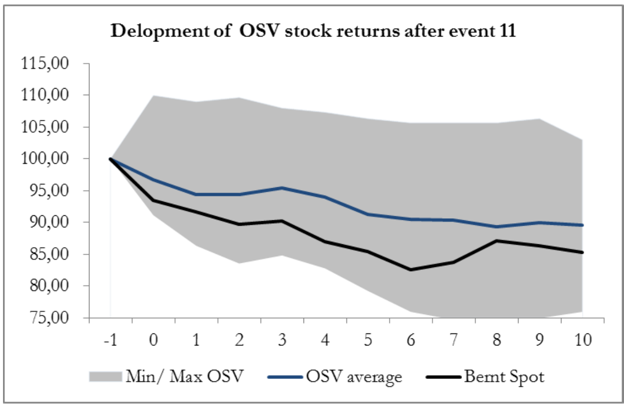



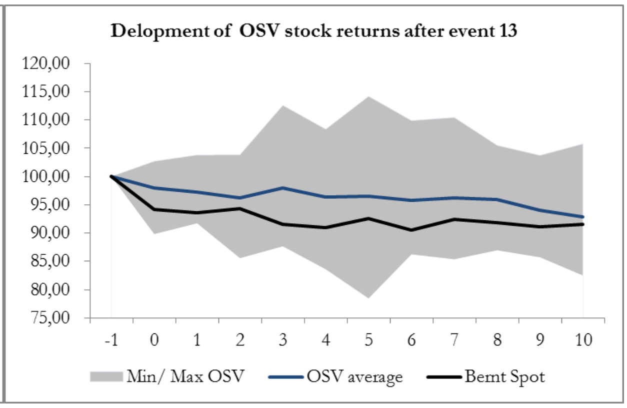



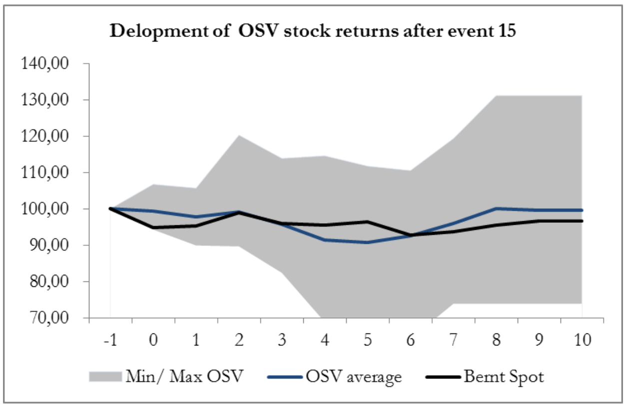






## *Rank test results for negative shocks of OSV firms*

| **EVENT 3** | (-10,10) | (-5,5) | (-2,2) | (-1,1) | **EVENT 4** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|---|---|---|---|---|
| Event window average | 0,513 | 0,493 | 0,513 | 0,554 | Event window average | 0,472 | 0,427 | 0,385 | 0,301 |
| Std. Dev | 9,71% | 9,71% | 9,71% | 9,71% | Std. Dev | 9,74% | 9,74% | 9,74% | 9,74% |
| Days in event | 21 | 11 | 5 | 3 | Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,615 | -0,231 | 0,306 | 0,956 | t-stat | -1,327 | -2,494 | -2,641 | -3,530 |
| p-value | 54,52% | 82,17% | 77,19% | 40,98% | p-value | 19,87% | 2,98% | 4,59% | 3,86% |

| EVENT 5 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,480 | 0,470 | 0,414 | 0,379 |
| Std. Dev | 9,89% | 9,89% | 9,89% | 9,89% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -0,914 | -1,007 | -1,952 | -2,114 |
| p-value | 37,13% | 33,56% | 10,84% | 12,49% |

| EVENT 7 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,485 | 0,471 | 0,474 | 0,434 |
| Std. Dev | 9,28% | 9,28% | 9,28% | 9,28% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -0,746 | -1,024 | -0,618 | -1,236 |
| p-value | 46,42% | 32,79% | 56,39% | 30,43% |

| EVENT 8 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,474 | 0,460 | 0,393 | 0,353 |
| Std. Dev | 9,08% | 9,08% | 9,08% | 9,08% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,336 | -1,460 | -2,629 | -2,804 |
| p-value | 19,59% | 17,22% | 4,66% | 6,76% |

| EVENT 10 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,403 | 0,410 | 0,302 | 0,225 |
| Std. Dev | 9,24% | 9,24% | 9,24% | 9,24% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -4,820 | -3,244 | -4,805 | -5,154 |
| p-value | 0,01% | 0,78% | 0,49% | 1,42% |

| EVENT 11 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,474 | 0,419 | 0,415 | 0,373 |
| Std. Dev | 9,32% | 9,32% | 9,32% | 9,32% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,291 | -2,887 | -2,028 | -2,354 |
| p-value | 21,09% | 1,48% | 9,84% | 9,99% |

| EVENT 13 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,471 | 0,500 | 0,452 | 0,430 |
| Std. Dev | 9,20% | 9,20% | 9,20% | 9,20% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,425 | -0,014 | -1,163 | -1,318 |
| p-value | 16,88% | 98,94% | 29,75% | 27,91% |

| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,471 | 0,399 | 0,537 | 0,441 |
| Std. Dev | 9,12% | 9,12% | 9,12% | 9,12% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,463 | -3,671 | 0,896 | -1,123 |
| p-value | 15,84% | 0,37% | 41,12% | 34,33% |

## *Sign test results for negative shocks of OSV firms*

| EVENT 3 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,418 | 0,403 | 0,429 | 0,476 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -2,688 | -3,177 | -2,317 | -0,771 |
| p-value | 0,76% | 0,17% | 2,13% | 44,15% |

| EVENT 4 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,418 | 0,344 | 0,286 | 0,238 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -2,688 | -5,083 | -6,950 | -8,479 |
| p-value | 0,76% | 0,00% | 0,00% | 0,00% |

| EVENT 5 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,384 | 0,377 | 0,343 | 0,310 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -3,808 | -4,024 | -5,097 | -6,166 |
| p-value | 0,02% | 0,01% | 0,00% | 0,00% |

| EVENT 7 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,460 | 0,467 | 0,440 | 0,378 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -1,307 | -1,087 | -1,946 | -3,957 |
| p-value | 19,25% | 27,79% | 5,27% | 0,01% |

| EVENT 8 | (-10,10) | -5,5 | -2,2 | -1,1 |
|---|---|---|---|---|
| Event window average | 0,444 | 0,424 | 0,333 | 0,333 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -1,829 | -2,471 | -5,406 | -5,395 |
| p-value | 6,85% | 1,41% | 0,00% | 0,00% |

| EVENT 10 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,432 | 0,430 | 0,307 | 0,244 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -2,247 | -2,273 | -6,271 | -8,273 |
| p-value | 2,54% | 2,38% | 0,00% | 0,00% |

| EVENT 11 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,556 | 0,461 | 0,493 | 0,378 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 1,829 | -1,285 | -0,216 | -3,957 |
| p-value | 6,85% | 19,99% | 82,90% | 0,01% |

| EVENT 13 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,489 | 0,509 | 0,453 | 0,400 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,366 | 0,297 | -1,514 | -3,237 |
| p-value | 71,48% | 76,71% | 13,13% | 0,14% |

| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,505 | 0,400 | 0,560 | 0,444 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,157 | -3,262 | 1,946 | -1,798 |
| p-value | 87,55% | 0,13% | 5,27% | 7,33% |

## *CAAR results for positive shocks of OSV firms*

| EVENT 1 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -0,22% | 1,57% | 1,32% | 2,07% |
| Std. Dev | 2,58% | 1,87% | 1,26% | 0,97% |
| t-test | -0,086 | 0,841 | 1,051 | 2,125 |
| p-value | 93,23% | 41,44% | 31,11% | 5,19% |
| N | 14 | 14 | 14 | 14 |

| EVENT 2 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -6,39% | -3,72% | -0,45% | 2,03% |
| Std. Dev | 2,58% | 1,87% | 1,26% | 0,97% |
| t-test | -2,479 | -1,994 | -0,355 | 2,082 |
| p-value | 2,65% | 6,60% | 72,82% | 5,61% |
| N | 14 | 14 | 14 | 14 |

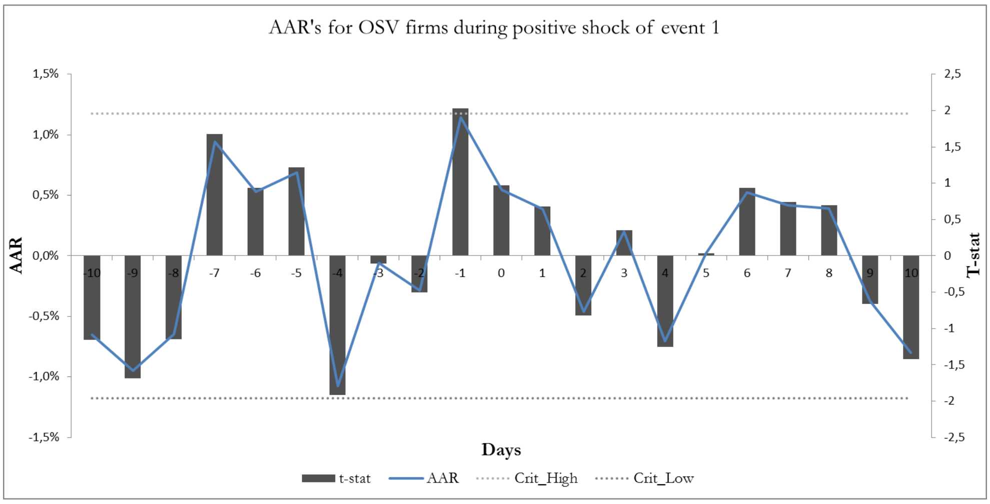
| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 3,56% | 2,28% | 0,84% | 0,03% |
| Std. Dev | 2,58% | 1,87% | 1,26% | 0,97% |
| t-test | 1,382 | 1,220 | 0,671 | 0,030 |
| p-value | 18,86% | 24,25% | 51,30% | 97,64% |
| N | 14 | 14 | 14 | 14 |

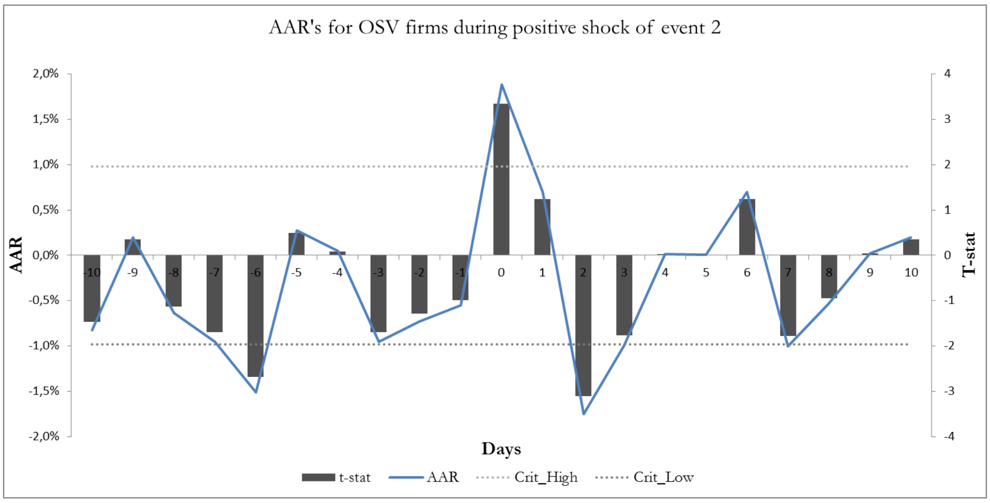
| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -0,09% | 2,22% | 0,65% | 0,36% |
| Std. Dev | 3,05% | 2,21% | 1,49% | 1,15% |
| t-test | -0,031 | 1,004 | 0,438 | 0,315 |
| p-value | 97,56% | 33,12% | 66,74% | 75,71% |
| N | 15 | 15 | 15 | 15 |

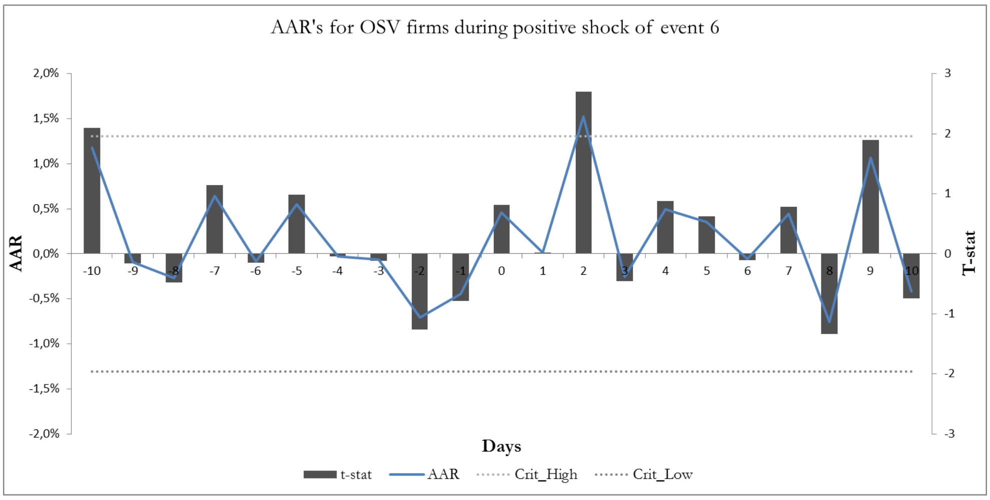
| EVENT 12 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 3,53% | 0,84% | 0,83% | 0,12% |
| Std. Dev | 2,41% | 1,74% | 1,18% | 0,91% |
| t-test | 1,463 | 0,482 | 0,709 | 0,135 |
| p-value | 16,40% | 63,70% | 48,92% | 89,47% |
| N | 15 | 15 | 15 | 15 |

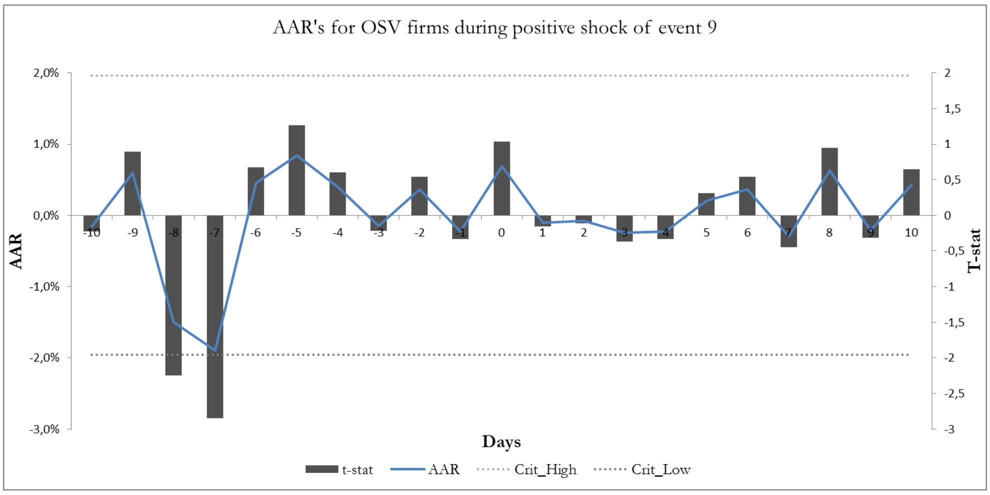
| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 0,77% | 6,59% | 5,82% | 4,89% |
| Std. Dev | 2,41% | 1,74% | 1,18% | 0,91% |
| t-test | 0,318 | 3,778 | 4,948 | 5,368 |
| p-value | 75,51% | 0,18% | 0,02% | 0,01% |
| N | 15 | 15 | 15 | 15 |

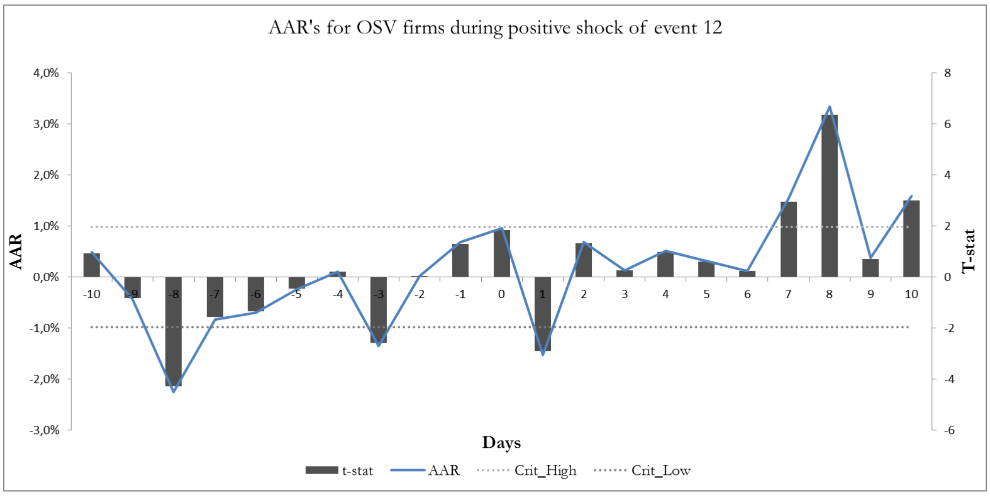
## *$\overline{AR}$ results for positive shocks of OSV firms*

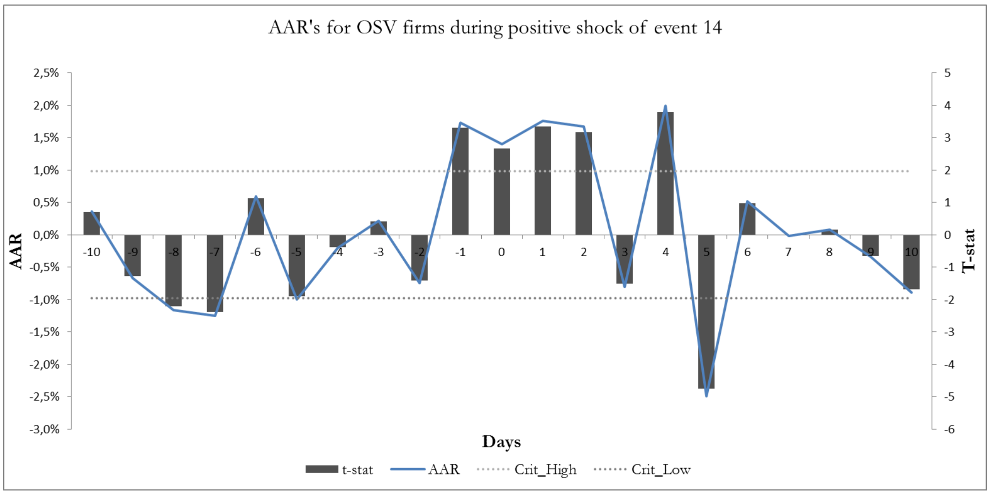



AAR's for OSV firms during positive shock of event 2
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

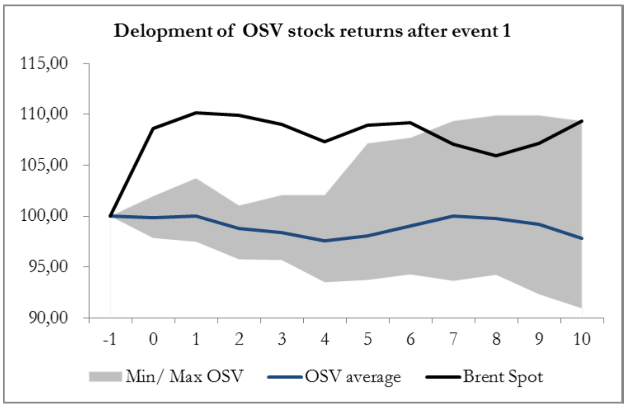

AAR's for OSV firms during positive shock of event 6
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

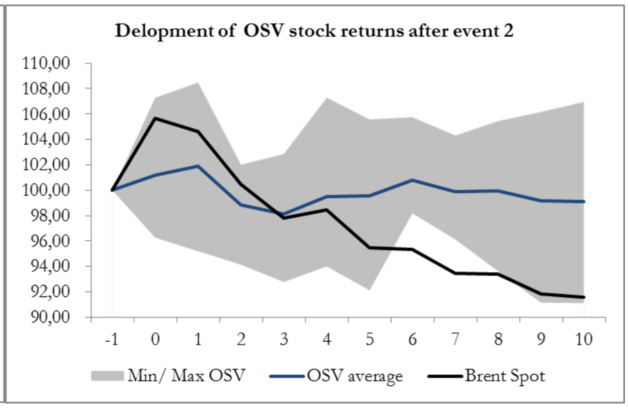

AAR's for OSV firms during positive shock of event 9
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

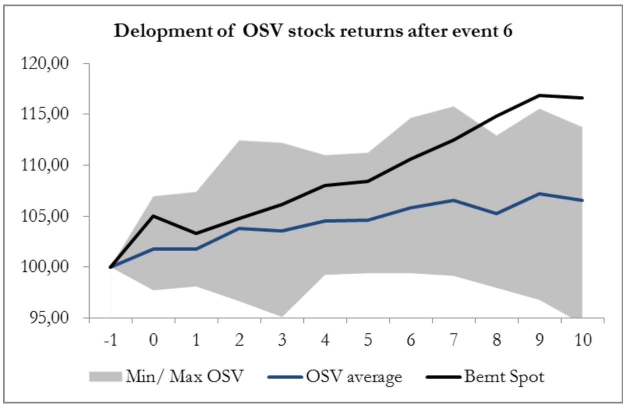


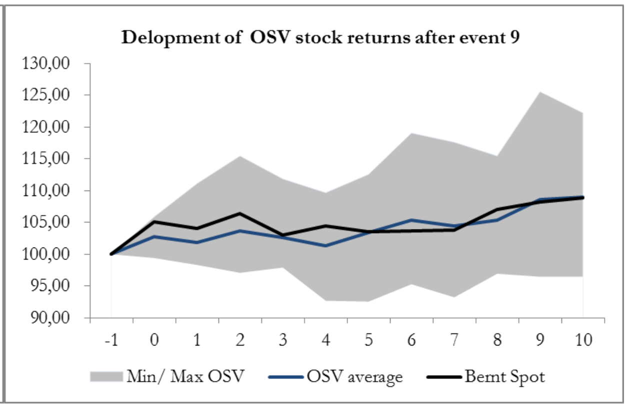



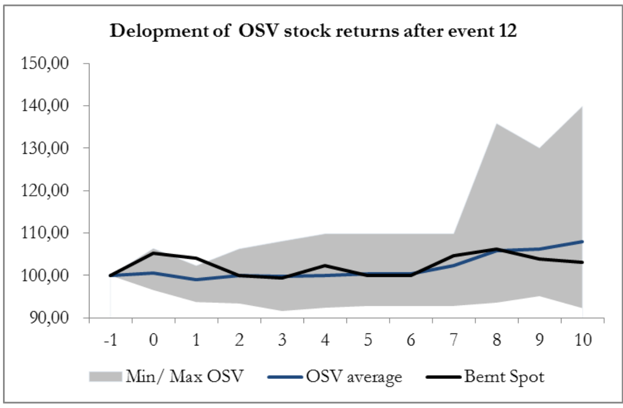

## *Development in stock returns for negative shocks of OSV firms*

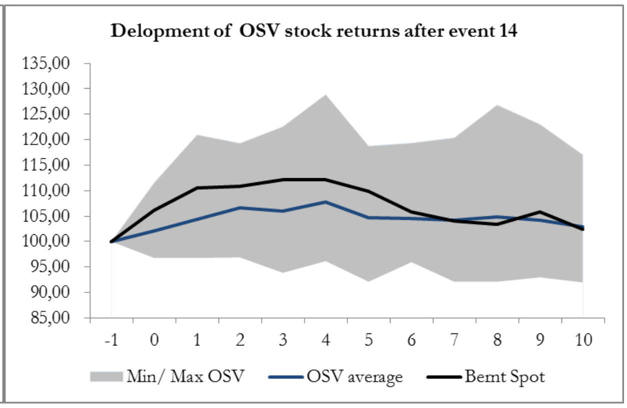





## *Rank test results for positive shocks of OSV firms*

| **EVENT 1** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,503 | 0,504 | 0,533 | 0,595 |
| Std. Dev | 9,85% | 9,85% | 9,85% | 9,85% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,126 | 0,133 | 0,753 | 1,666 |
| p-value | 90,12% | 89,63% | 48,53% | 19,42% |

| **EVENT 2** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,476 | 0,489 | 0,513 | 0,614 |
| Std. Dev | 9,77% | 9,77% | 9,77% | 9,77% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,128 | -0,367 | 0,293 | 2,019 |
| p-value | 27,21% | 72,06% | 78,12% | 13,67% |

| **EVENT 6** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,528 | 0,530 | 0,522 | 0,533 |
| Std. Dev | 9,87% | 9,87% | 9,87% | 9,87% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 1,288 | 1,013 | 0,508 | 0,571 |
| p-value | 21,18% | 33,27% | 63,30% | 60,77% |

| **EVENT 9** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,517 | 0,527 | 0,527 | 0,531 |
| Std. Dev | 10,59% | 10,59% | 10,59% | 10,59% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,753 | 0,832 | 0,574 | 0,505 |
| p-value | 45,97% | 42,30% | 59,10% | 64,86% |

| **EVENT 12** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,511 | 0,492 | 0,517 | 0,494 |
| Std. Dev | 9,31% | 9,31% | 9,31% | 9,31% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,541 | -0,291 | 0,404 | -0,105 |
| p-value | 59,42% | 77,65% | 70,30% | 92,31% |

| **EVENT 14** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,478 | 0,484 | 0,532 | 0,568 |
| Std. Dev | 9,20% | 9,20% | 9,20% | 9,20% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,074 | -0,588 | 0,772 | 1,281 |
| p-value | 29,52% | 56,85% | 47,51% | 29,03% |

### *Sign test results for positive shocks of OSV firms*

| EVENT 1 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,476 | 0,474 | 0,514 | 0,571 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,784 | -0,847 | 0,463 | 2,312 |
| p-value | 43,38% | 39,76% | 64,35% | 2,15% |

| EVENT 2 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,463 | 0,481 | 0,529 | 0,667 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -1,232 | -0,635 | 0,927 | 5,395 |
| p-value | 21,91% | 52,57% | 35,49% | 0,00% |

| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,500 | 0,487 | 0,486 | 0,524 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,000 | -0,424 | -0,463 | 0,771 |
| p-value | 100,00% | 67,22% | 64,35% | 44,15% |

| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,505 | 0,533 | 0,520 | 0,489 |
| Days in total | 213 | 208 | 205 | 204 |
| t-stat | 0,139 | 0,961 | 0,573 | -0,317 |
| p-value | 88,96% | 33,74% | 56,75% | 75,13% |

| EVENT 12 | (-10,10) | -5,5 | -2,2 | -1,1 |
|---|---|---|---|---|
| Event window average | 0,587 | 0,552 | 0,587 | 0,578 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 2,874 | 1,680 | 2,811 | 2,518 |
| p-value | 0,44% | 9,41% | 0,53% | 1,24% |

| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,495 | 0,479 | 0,560 | 0,600 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,157 | -0,692 | 1,946 | 3,237 |
| p-value | 87,55% | 48,96% | 5,27% | 0,14% |

## Appendix 6.4

### Results from parametric $\overline{CAR}$ – and $\overline{AR}$ tests, development in stock returns and non-parametric Rank- and Sign test for crude tanker firms of each shocks

The tables and figures below show our results from the parametric cumulative average abnormal return ($\overline{CAR}$) test, the parametric average abnormal return ($\overline{AR}$) test, development in stock returns, the non-parametric Rank test and the non-parametric Sign test for each of the 15 shocks for crude tanker firms. First we show for negative shocks and then for positive shocks. ($\overline{CAR}$ and $\overline{AR}$ is denoted by CAAR and AAR in the tables/figures below).

### *CAAR results for negative shocks of crude tanker firms*

| EVENT 3 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 11,74% | -4,51% | -0,90% | 3,56% |
| Std. Dev | 5,52% | 4,00% | 2,70% | 2,09% |
| t-test | 2,126 | -1,129 | -0,332 | 1,707 |
| p-value | 8,69% | 31,00% | 75,31% | 14,86% |
| N | 5 | 5 | 5 | 5 |

| EVENT 4 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -3,26% | -3,39% | -5,72% | -1,99% |
| Std. Dev | 5,52% | 4,00% | 2,70% | 2,09% |
| t-test | -0,591 | -0,849 | -2,122 | -0,954 |
| p-value | 58,03% | 43,47% | 8,73% | 38,39% |
| N | 5 | 5 | 5 | 5 |

| EVENT 5 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -12,73% | -10,87% | -2,98% | -6,25% |
| Std. Dev | 5,52% | 4,00% | 2,70% | 2,09% |
| t-test | -2,304 | -2,719 | -1,105 | -2,993 |
| p-value | 6,94% | 4,18% | 31,96% | 3,03% |
| N | 5 | 5 | 5 | 5 |

| EVENT 7 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 1,63% | 1,96% | -2,77% | 0,95% |
| Std. Dev | 4,24% | 3,07% | 2,07% | 1,60% |
| t-test | 0,385 | 0,639 | -1,337 | 0,595 |
| p-value | 71,58% | 55,10% | 23,87% | 57,80% |
| N | 5 | 5 | 5 | 5 |

| EVENT 8 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -27,23% | -13,59% | -6,28% | -2,83% |
| Std. Dev | 4,24% | 3,07% | 2,07% | 1,60% |
| t-test | -6,425 | -4,433 | -3,038 | -1,769 |
| p-value | 0,14% | 0,68% | 2,88% | 13,71% |
| N | 5 | 5 | 5 | 5 |

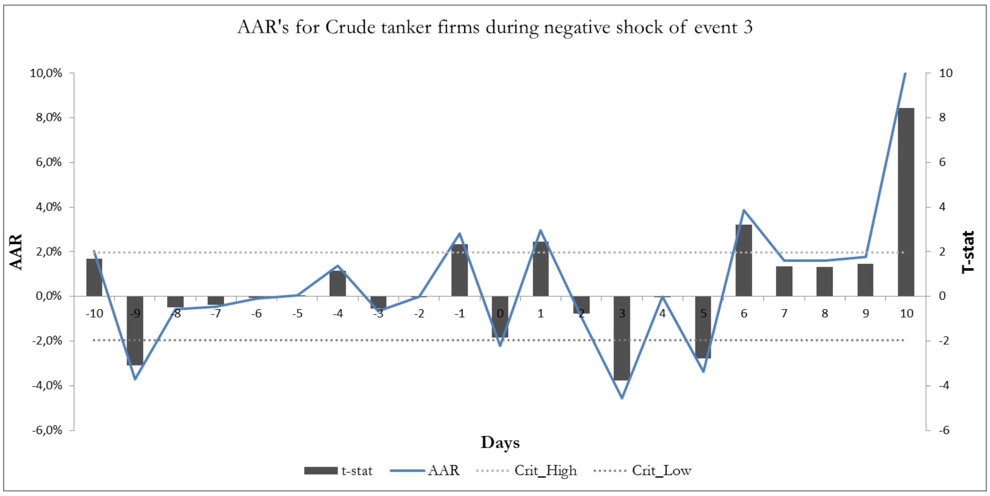
| EVENT 10 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 10,87% | 7,70% | -16,43% | 2,04% |
| Std. Dev | 6,44% | 4,66% | 3,14% | 2,43% |
| t-test | 1,688 | 1,652 | -5,233 | 0,838 |
| p-value | 15,21% | 15,94% | 0,34% | 44,00% |
| N | 5 | 5 | 5 | 5 |

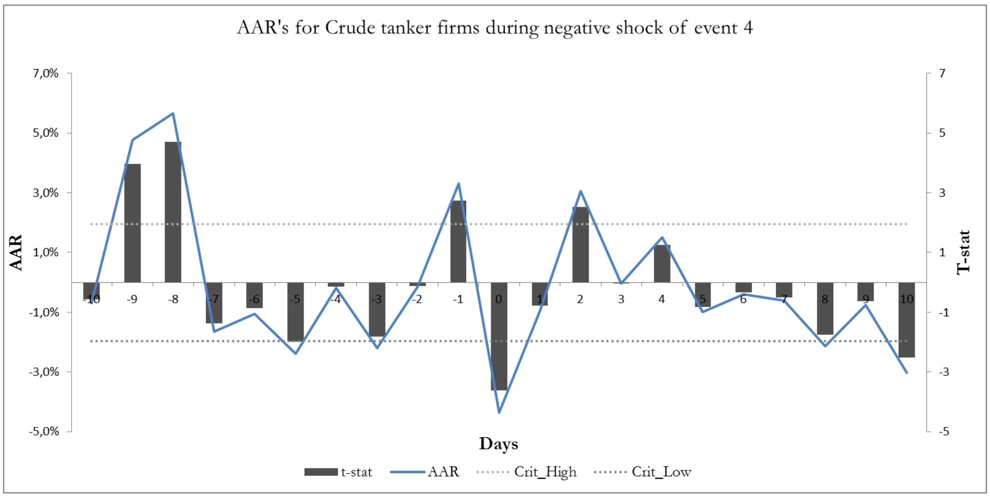
| EVENT 11 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 17,85% | 28,71% | -2,09% | 9,16% |
| Std. Dev | 6,44% | 4,66% | 3,14% | 2,43% |
| t-test | 2,774 | 6,163 | -0,665 | 3,766 |
| p-value | 3,92% | 0,16% | 53,54% | 1,31% |
| N | 5 | 5 | 5 | 5 |

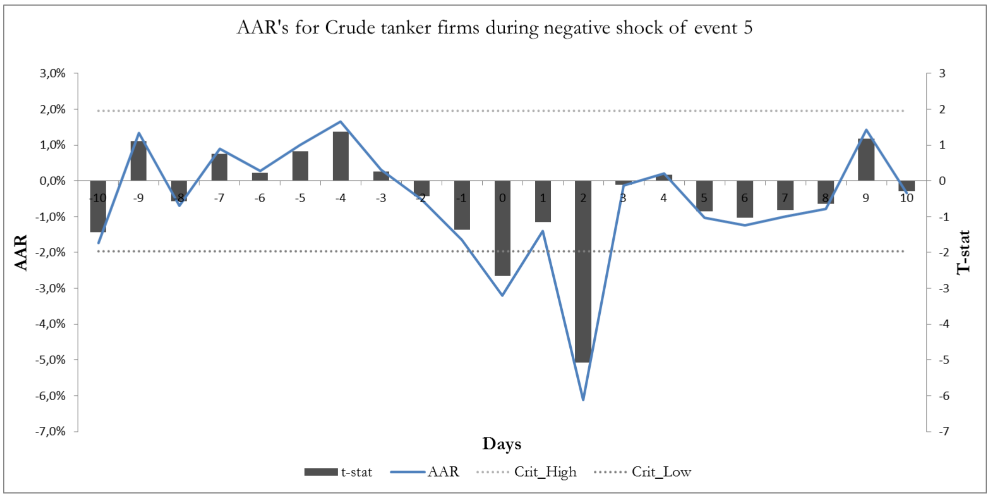
| EVENT 13 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -7,12% | -11,69% | -6,37% | -3,36% |
| Std. Dev | 6,44% | 4,66% | 3,14% | 2,43% |
| t-test | -1,107 | -2,510 | -2,030 | -1,381 |
| p-value | 31,88% | 5,38% | 9,81% | 22,58% |
| N | 5 | 5 | 5 | 5 |

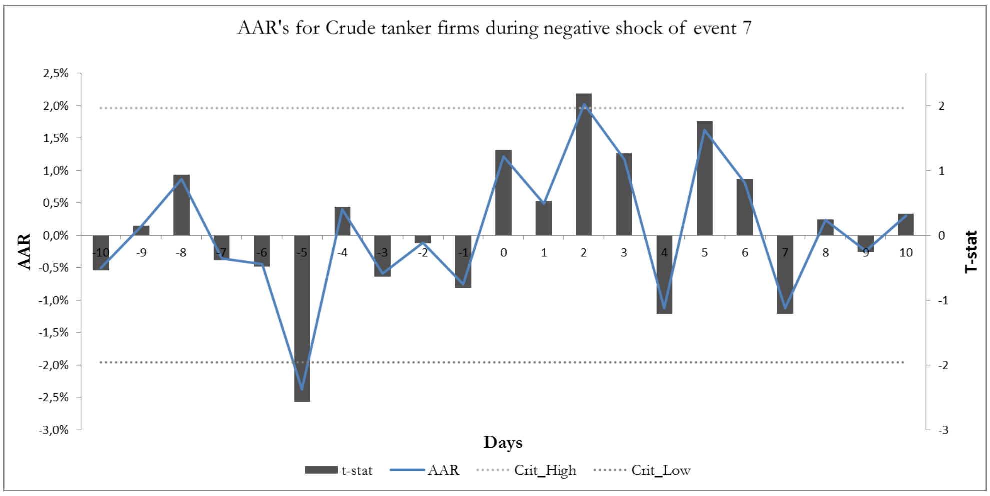
| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 1,54% | -1,36% | -1,30% | -3,89% |
| Std. Dev | 6,44% | 4,66% | 3,14% | 2,43% |
| t-test | 0,239 | -0,291 | -0,414 | -1,600 |
| p-value | 82,06% | 78,27% | 69,58% | 17,05% |
| N | 5 | 5 | 5 | 5 |

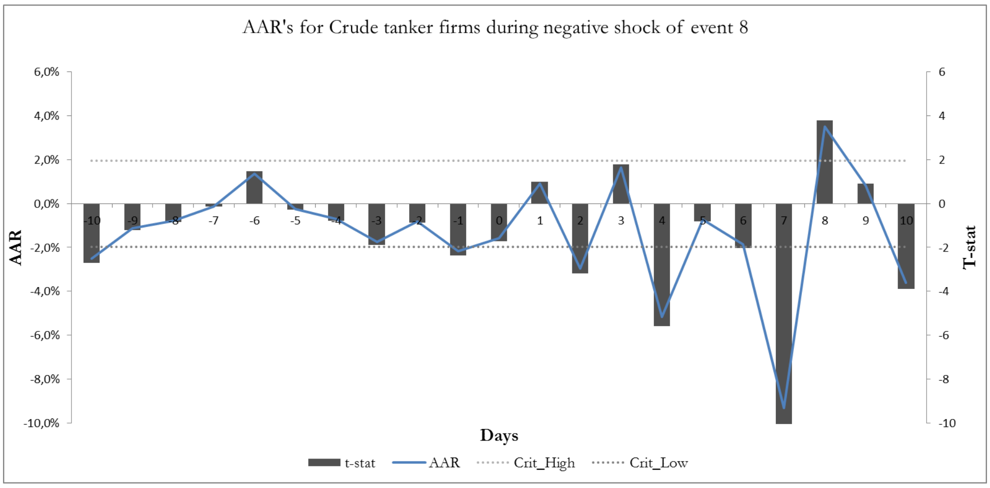
### *$\overline{AR}$ results for negative shocks of crude tanker firms*

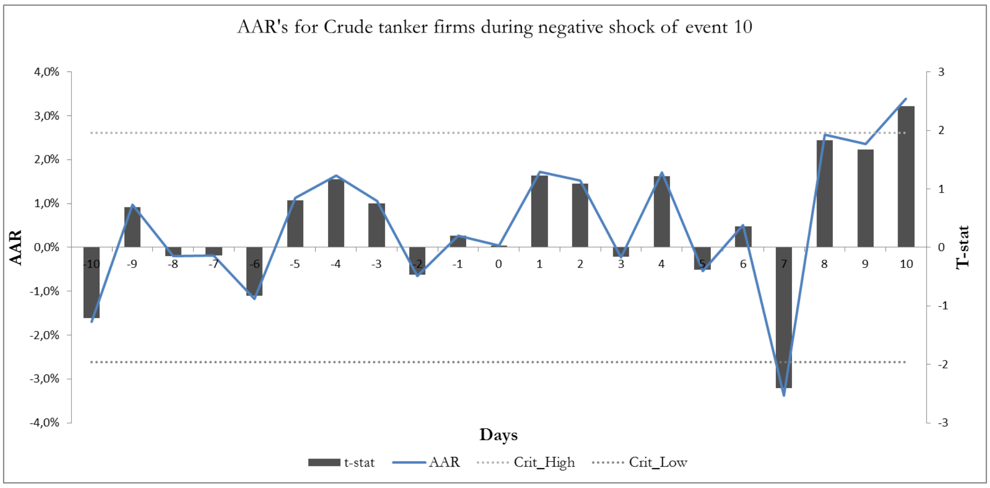


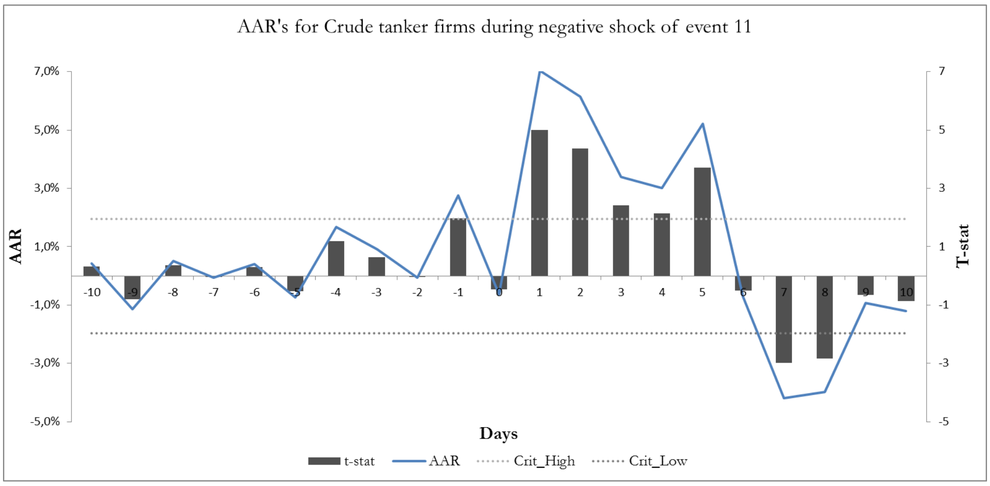

AAR's for Crude tanker firms during negative shock of event 4
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

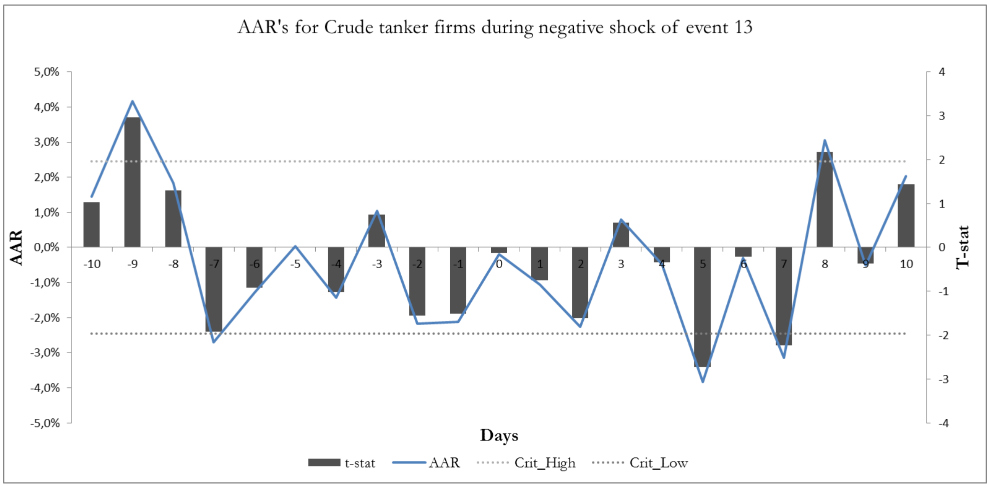

AAR's for Crude tanker firms during negative shock of event 5
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

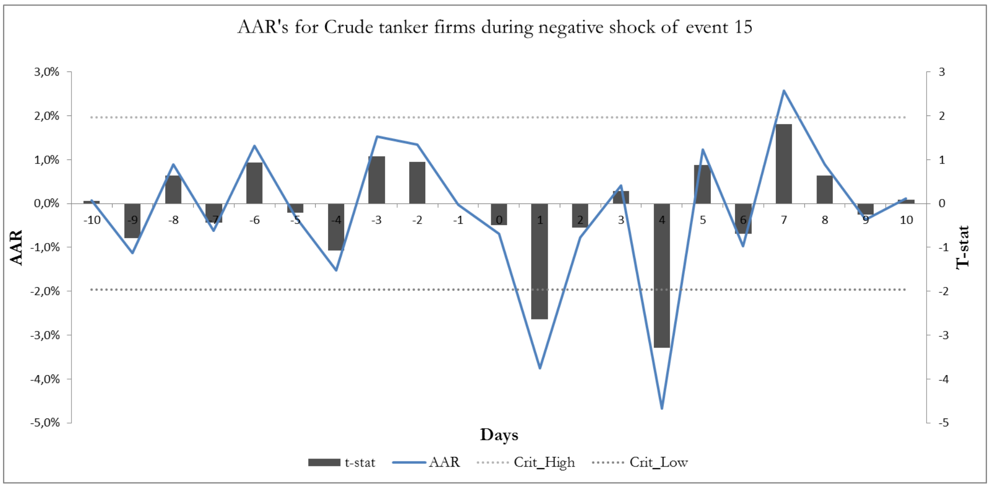

AAR's for Crude tanker firms during negative shock of event 7
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low


AAR's for Crude tanker firms during negative shock of event 8
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

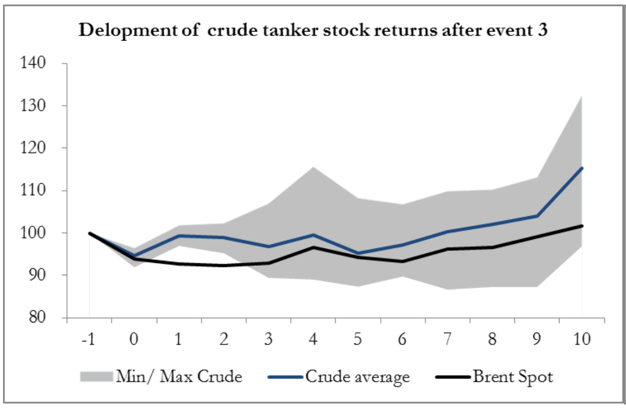

AAR's for Crude tanker firms during negative shock of event 10
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

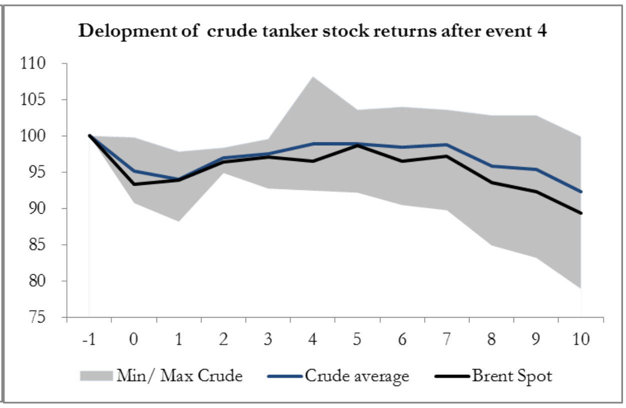

AAR's for Crude tanker firms during negative shock of event 11
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

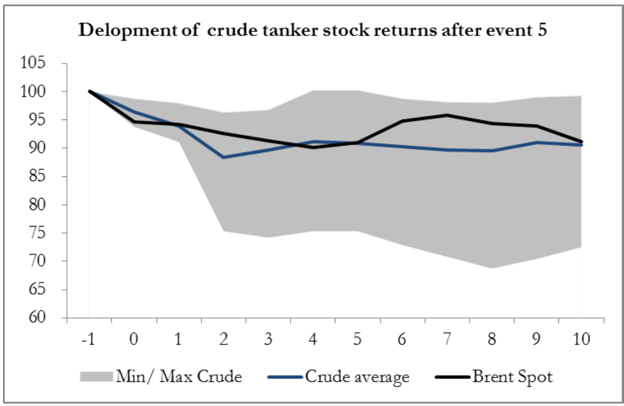


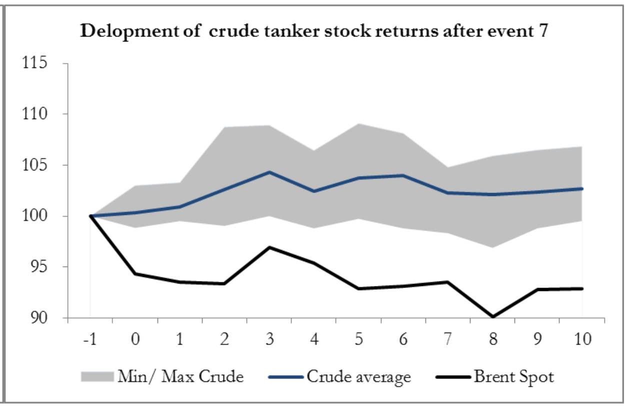



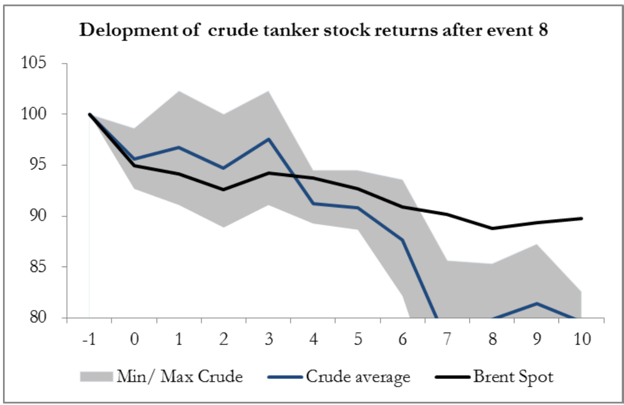

## *Development in stock returns for negative shocks of crude tanker firms*

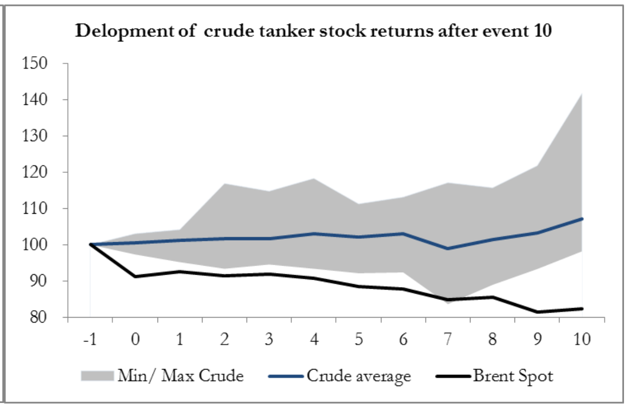


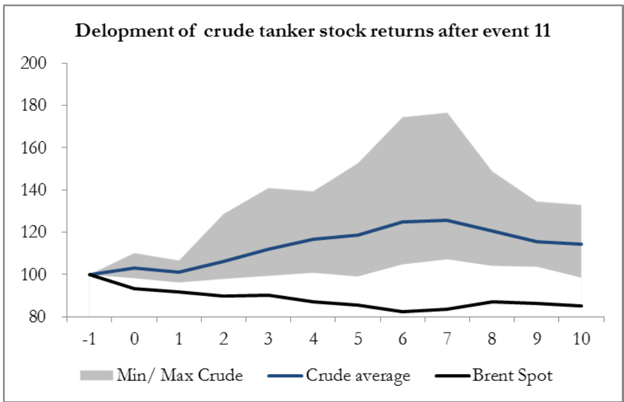



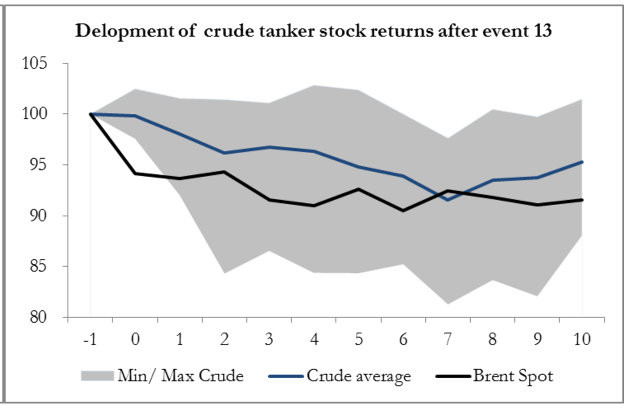

Delopment of crude tanker stock returns after event 5
105
100
95
90
85
80
75
70
65
60
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max Crude
Crude average
Brent Spot

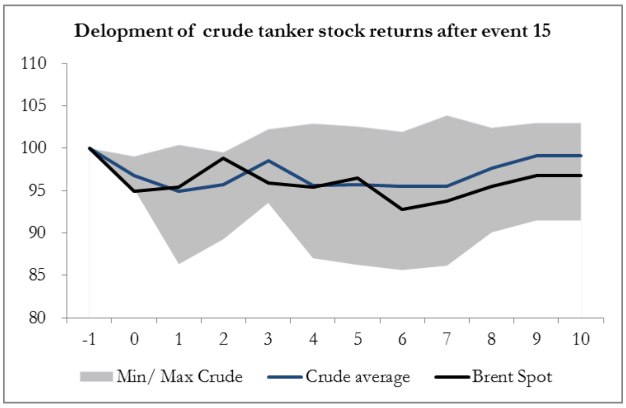

Delopment of crude tanker stock returns after event 7
115
110
105
100
95
90
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max Crude
Crude average
Brent Spot


Delopment of crude tanker stock returns after event 8
105
100
95
90
85
80
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max Crude
Crude average
Brent Spot


Delopment of crude tanker stock returns after event 10
150
140
130
120
110
100
90
80
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max Crude
Crude average
Brent Spot


Delopment of crude tanker stock returns after event 11
200
180
160
140
120
100
80
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max Crude
Crude average
Brent Spot


Delopment of crude tanker stock returns after event 13
105
100
95
90
85
80
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max Crude
Crude average
Brent Spot


Delopment of crude tanker stock returns after event 15
110
105
100
95
90
85
80
-1 0 1 2 3 4 5 6 7 8 9 10
Min/ Max Crude
Crude average
Brent Spot

## *Rank test results for negative shocks of crude tanker firms*

| EVENT 3 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,534 | 0,446 | 0,531 | 0,600 |
| Std. Dev | 17,34% | 17,34% | 17,34% | 17,34% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,895 | -1,028 | 0,403 | 1,004 |
| p-value | 38,10% | 32,61% | 70,36% | 38,94% |

| EVENT 4 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,431 | 0,433 | 0,466 | 0,343 |
| Std. Dev | 17,47% | 17,47% | 17,47% | 17,47% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,809 | -1,277 | -0,440 | -1,553 |
| p-value | 8,48% | 22,78% | 67,82% | 21,83% |

| EVENT 5 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,463 | 0,425 | 0,261 | 0,221 |
| Std. Dev | 17,70% | 17,70% | 17,70% | 17,70% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -0,956 | -1,410 | -3,016 | -2,734 |
| p-value | 34,99% | 18,61% | 2,96% | 7,17% |

| EVENT 7 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,503 | 0,502 | 0,528 | 0,529 |
| Std. Dev | 16,77% | 16,77% | 16,77% | 16,77% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,080 | 0,032 | 0,369 | 0,296 |
| p-value | 93,71% | 97,53% | 72,75% | 78,64% |

| EVENT 8 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,382 | 0,366 | 0,356 | 0,419 |
| Std. Dev | 16,20% | 16,20% | 16,20% | 16,20% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -3,330 | -2,748 | -1,981 | -0,867 |
| p-value | 0,32% | 1,90% | 10,44% | 44,95% |

| EVENT 10 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,562 | 0,599 | 0,564 | 0,613 |
| Std. Dev | 17,18% | 17,18% | 17,18% | 17,18% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 1,666 | 1,908 | 0,831 | 1,137 |
| p-value | 11,06% | 8,29% | 44,39% | 33,82% |

| EVENT 11 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,569 | 0,679 | 0,703 | 0,676 |
| Std. Dev | 17,10% | 17,10% | 17,10% | 17,10% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 1,854 | 3,465 | 2,650 | 1,780 |
| p-value | 7,78% | 0,53% | 4,54% | 17,31% |

| EVENT 13 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,466 | 0,401 | 0,329 | 0,367 |
| Std. Dev | 17,10% | 17,10% | 17,10% | 17,10% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -0,922 | -1,915 | -2,236 | -1,345 |
| p-value | 36,69% | 8,19% | 7,56% | 27,12% |

| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,533 | 0,518 | 0,449 | 0,346 |
| Std. Dev | 17,11% | 17,11% | 17,11% | 17,11% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,891 | 0,354 | -0,671 | -1,558 |
| p-value | 38,28% | 73,02% | 53,21% | 21,71% |

## *Sign test results for negative shocks of crude tanker firms*

| EVENT 3 | (-10,10) | -5,5 | -2,2 | -1,1 |
|---|---|---|---|---|
| Event window average | 0,488 | 0,364 | 0,500 | 0,583 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,392 | -4,448 | 0,000 | 2,698 |
| p-value | 69,54% | 0,00% | 100,00% | 0,74% |

| EVENT 4 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,357 | 0,409 | 0,450 | 0,250 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -4,703 | -2,965 | -1,622 | -8,093 |
| p-value | 0,00% | 0,33% | 10,61% | 0,00% |

| EVENT 5 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,464 | 0,364 | 0,100 | 0,000 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -1,176 | -4,448 | -12,974 | -16,186 |
| p-value | 24,07% | 0,00% | 0,00% | 0,00% |

| EVENT 7 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,505 | 0,455 | 0,480 | 0,600 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,157 | -1,483 | -0,649 | 3,237 |
| p-value | 87,55% | 13,93% | 51,71% | 0,14% |

| EVENT 8 | (-10,10) | -5,5 | -2,2 | -1,1 |
|---|---|---|---|---|
| Event window average | 0,343 | 0,309 | 0,320 | 0,400 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -5,174 | -6,227 | -5,838 | -3,237 |
| p-value | 0,00% | 0,00% | 0,00% | 0,14% |

| EVENT 10 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,552 | 0,618 | 0,600 | 0,600 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 1,725 | 3,855 | 3,243 | 3,237 |
| p-value | 8,57% | 0,01% | 0,13% | 0,14% |

| EVENT 11 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,552 | 0,727 | 0,720 | 0,800 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 1,725 | 7,413 | 7,136 | 9,712 |
| p-value | 8,57% | 0,00% | 0,00% | 0,00% |

| EVENT 13 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,419 | 0,309 | 0,240 | 0,267 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -2,665 | -6,227 | -8,433 | -7,554 |
| p-value | 0,82% | 0,00% | 0,00% | 0,00% |

| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,514 | 0,545 | 0,400 | 0,267 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,470 | 1,483 | -3,243 | -7,554 |
| p-value | 63,85% | 13,93% | 0,13% | 0,00% |

## *CAAR results for positive shocks of crude tanker firms*

| EVENT 1 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 3,81% | 1,45% | 1,41% | 1,79% |
| Std. Dev | 5,52% | 4,00% | 2,70% | 2,09% |
| t-test | 0,690 | 0,362 | 0,521 | 0,858 |
| p-value | 52,09% | 73,22% | 62,43% | 43,01% |
| N | 5 | 5 | 5 | 5 |

| EVENT 2 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -0,20% | 2,73% | -3,85% | 4,29% |
| Std. Dev | 5,52% | 4,00% | 2,70% | 2,09% |
| t-test | -0,036 | 0,684 | -1,428 | 2,056 |
| p-value | 97,24% | 52,46% | 21,28% | 9,49% |
| N | 5 | 5 | 5 | 5 |

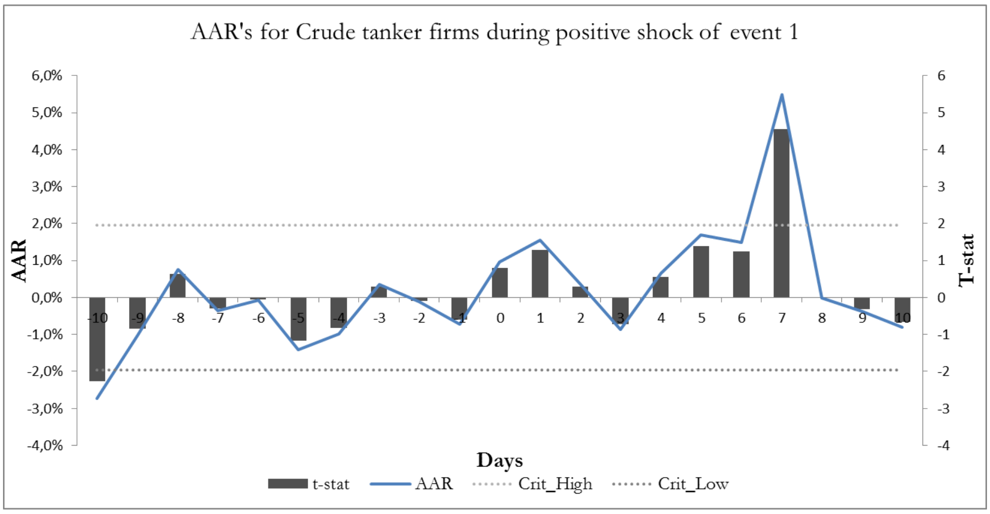
| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 1,95% | -1,53% | 6,62% | 1,66% |
| Std. Dev | 5,52% | 4,00% | 2,70% | 2,09% |
| t-test | 0,352 | -0,383 | 2,458 | 0,795 |
| p-value | 73,91% | 71,74% | 5,74% | 46,29% |
| N | 5 | 5 | 5 | 5 |

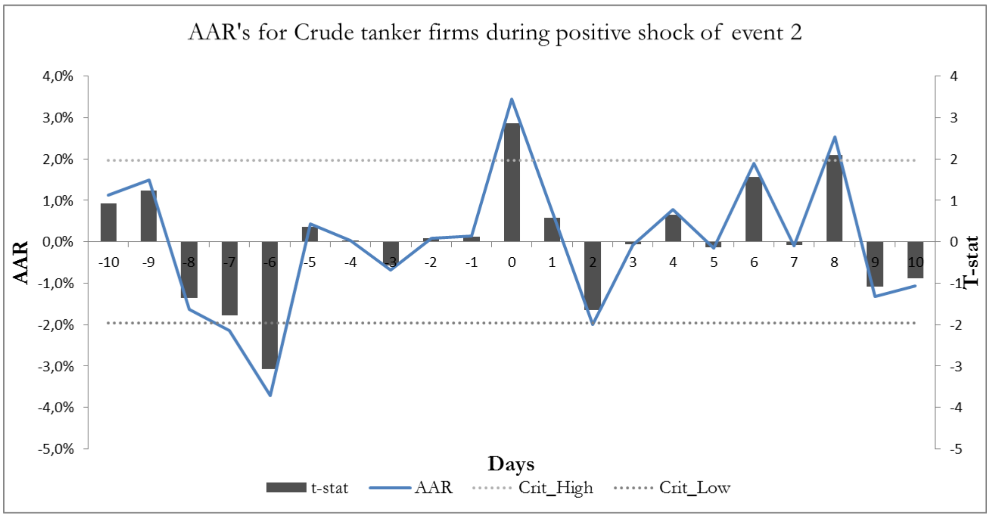
| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -1,51% | 0,09% | 2,94% | -0,74% |
| Std. Dev | 10,17% | 7,36% | 4,96% | 3,85% |
| t-test | -0,148 | 0,012 | 0,593 | -0,192 |
| p-value | 88,81% | 99,12% | 57,89% | 85,53% |
| N | 5 | 5 | 5 | 5 |

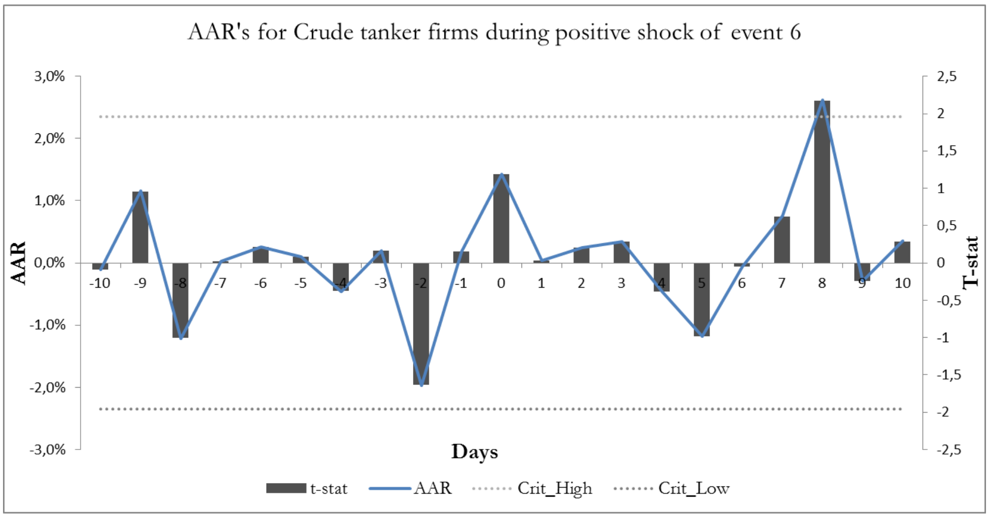
| EVENT 12 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 6,36% | 3,68% | 0,23% | 0,32% |
| Std. Dev | 6,44% | 4,66% | 3,14% | 2,43% |
| t-test | 0,988 | 0,791 | 0,074 | 0,133 |
| p-value | 36,85% | 46,48% | 94,40% | 89,92% |
| N | 5 | 5 | 5 | 5 |

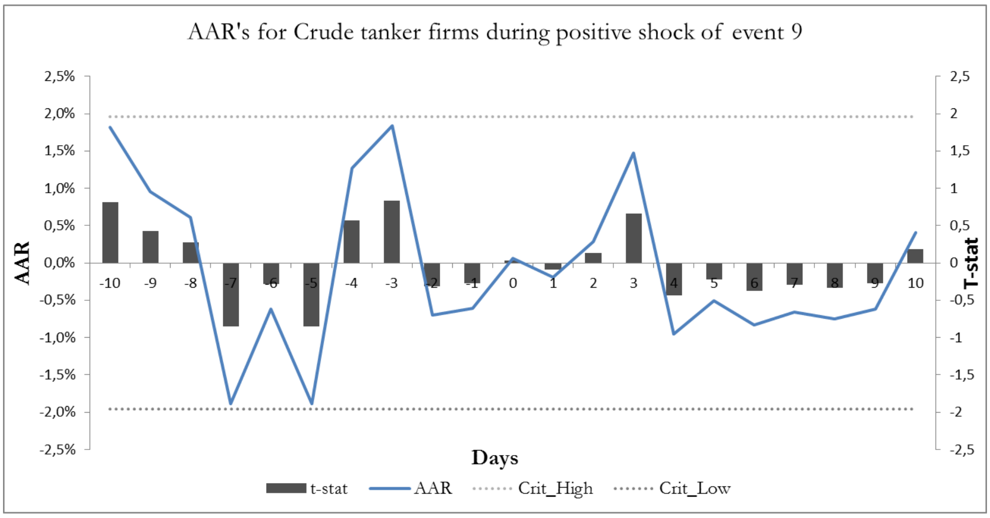
| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 3,10% | 8,74% | 13,12% | 6,30% |
| Std. Dev | 6,44% | 4,66% | 3,14% | 2,43% |
| t-test | 0,482 | 1,877 | 4,179 | 2,590 |
| p-value | 65,02% | 11,93% | 0,87% | 4,89% |
| N | 5 | 5 | 5 | 5 |

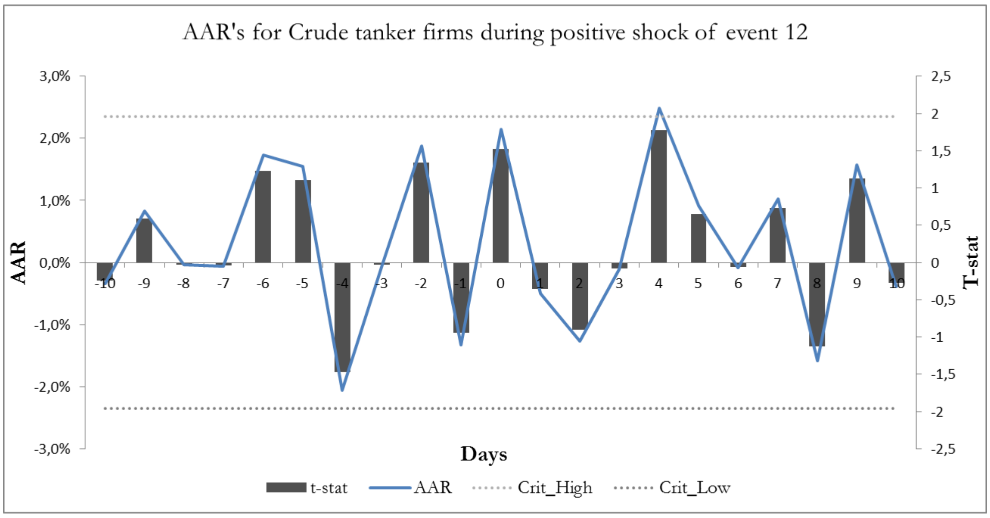
## $\overline{AR}$ results for positive shocks of crude tanker firms

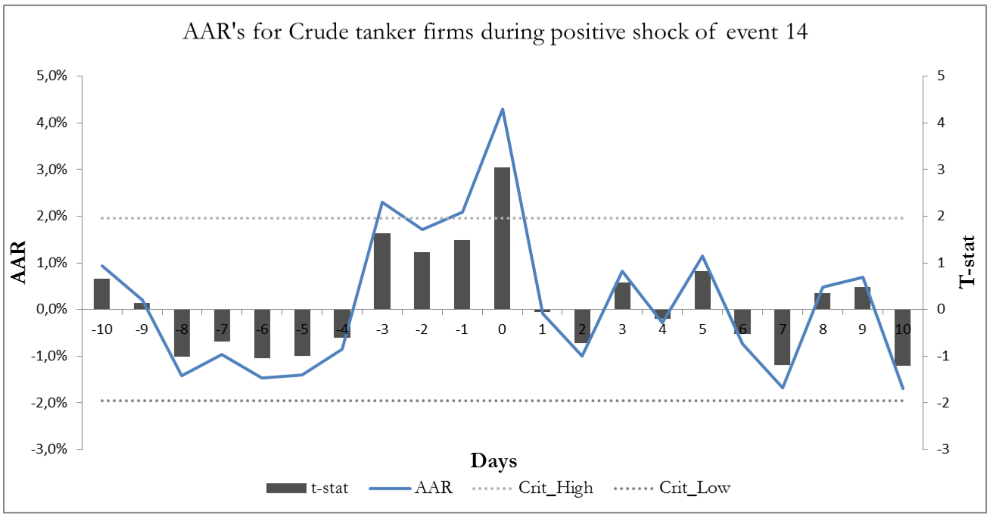


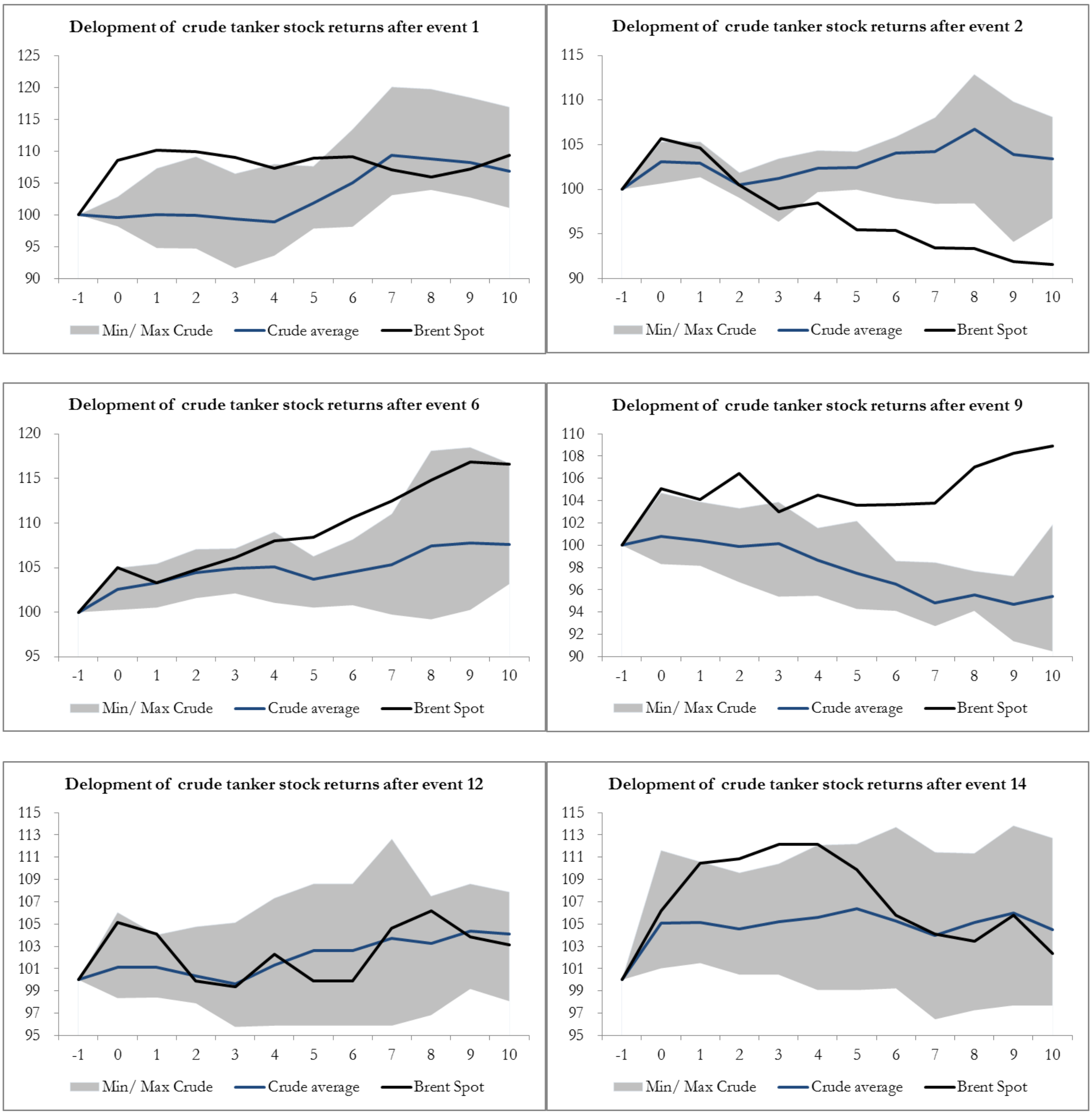




AAR's for Crude tanker firms during positive shock of event 9
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low


AAR's for Crude tanker firms during positive shock of event 12
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low


AAR's for Crude tanker firms during positive shock of event 14
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

## *Development in stock returns for positive shocks of crude tanker firms*




## *Rank test results for positive shocks of crude tanker firms*

| EVENT 1 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,511 | 0,521 | 0,558 | 0,578 |
| Std. Dev | 17,69% | 17,69% | 17,69% | 17,69% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,273 | 0,396 | 0,739 | 0,765 |
| p-value | 78,73% | 69,94% | 49,31% | 49,99% |

| EVENT 2 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,521 | 0,547 | 0,544 | 0,679 |
| Std. Dev | 17,42% | 17,42% | 17,42% | 17,42% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,548 | 0,902 | 0,569 | 1,782 |
| p-value | 58,94% | 38,63% | 59,41% | 17,27% |

| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,514 | 0,481 | 0,501 | 0,581 |
| Std. Dev | 17,85% | 17,85% | 17,85% | 17,85% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,361 | -0,359 | 0,014 | 0,785 |
| p-value | 72,20% | 72,67% | 98,95% | 48,99% |

| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,505 | 0,514 | 0,496 | 0,494 |
| Std. Dev | 17,81% | 17,81% | 17,81% | 17,81% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,126 | 0,253 | -0,054 | -0,058 |
| p-value | 90,09% | 80,48% | 95,90% | 95,77% |

| EVENT 12 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,562 | 0,562 | 0,523 | 0,504 |
| Std. Dev | 17,34% | 17,34% | 17,34% | 17,34% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 1,645 | 1,189 | 0,294 | 0,037 |
| p-value | 11,49% | 25,95% | 78,06% | 97,30% |

| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,534 | 0,609 | 0,688 | 0,737 |
| Std. Dev | 17,25% | 17,25% | 17,25% | 17,25% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,903 | 2,095 | 2,437 | 2,376 |
| p-value | 37,70% | 6,01% | 5,89% | 9,80% |

## *Sign test results for positive shocks of crude tanker firms*

| EVENT 1 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,524 | 0,568 | 0,600 | 0,667 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,784 | 2,224 | 3,243 | 5,395 |
| p-value | 43,38% | 2,70% | 0,13% | 0,00% |

| EVENT 2 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,571 | 0,591 | 0,550 | 0,750 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 2,352 | 2,965 | 1,622 | 8,093 |
| p-value | 1,94% | 0,33% | 10,61% | 0,00% |

| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,524 | 0,432 | 0,500 | 0,667 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,784 | -2,224 | 0,000 | 5,395 |
| p-value | 43,38% | 2,70% | 100,00% | 0,00% |

| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,448 | 0,491 | 0,480 | 0,533 |
| Days in total | 213 | 208 | 205 | 204 |
| t-stat | -1,529 | -0,262 | -0,573 | 0,952 |
| p-value | 12,78% | 79,34% | 56,75% | 34,21% |

| EVENT 12 | (-10,10) | -5,5 | -2,2 | -1,1 |
|---|---|---|---|---|
| Event window average | 0,581 | 0,582 | 0,480 | 0,400 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 2,665 | 2,669 | -0,649 | -3,237 |
| p-value | 0,82% | 0,81% | 51,71% | 0,14% |

| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,476 | 0,564 | 0,680 | 0,800 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,784 | 2,076 | 5,838 | 9,712 |
| p-value | 43,38% | 3,89% | 0,00% | 0,00% |

## Appendix 6.5

### Results from parametric $\overline{CAR}$ – and $\overline{AR}$ tests, development in stock returns and non-parametric Rank- and Sign test for product tanker firms of each shocks

The tables and figures below show our results from the parametric cumulative average abnormal return ($\overline{CAR}$) test, the parametric average abnormal return ($\overline{AR}$) test, development in stock returns, the non-parametric Rank test and the non-parametric Sign test for each of the 15 shocks for product tanker firms. First we show for negative shocks and then for positive shocks. ($\overline{CAR}$ and $\overline{AR}$ is denoted by CAAR and AAR in the tables/figures below).

***CAAR results for negative shocks of product tanker firms***

| EVENT 3 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 16,93% | 5,62% | 0,93% | -1,69% |
| Std. Dev | 4,81% | 3,48% | 2,35% | 1,82% |
| t-test | 3,520 | 1,616 | 0,396 | -0,928 |
| p-value | 1,69% | 16,70% | 70,88% | 39,60% |
| N | 5 | 5 | 5 | 5 |

| EVENT 4 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -5,91% | -7,56% | -6,14% | -2,49% |
| Std. Dev | 4,81% | 3,48% | 2,35% | 1,82% |
| t-test | -1,230 | -2,172 | -2,617 | -1,373 |
| p-value | 27,35% | 8,20% | 4,73% | 22,82% |
| N | 5 | 5 | 5 | 5 |

| EVENT 5 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -2,04% | -1,95% | -2,54% | -1,82% |
| Std. Dev | 4,81% | 3,48% | 2,35% | 1,82% |
| t-test | -0,424 | -0,562 | -1,084 | -1,000 |
| p-value | 68,89% | 59,86% | 32,76% | 36,32% |
| N | 5 | 5 | 5 | 5 |

| EVENT 7 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -2,82% | -0,82% | -0,91% | -1,96% |
| Std. Dev | 5,81% | 4,20% | 2,83% | 2,20% |
| t-test | -0,485 | -0,196 | -0,321 | -0,893 |
| p-value | 64,25% | 85,00% | 75,77% | 40,17% |
| N | 7 | 7 | 7 | 7 |

| EVENT 8 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -6,05% | -7,94% | -5,84% | -1,88% |
| Std. Dev | 5,81% | 4,20% | 2,83% | 2,20% |
| t-test | -1,042 | -1,890 | -2,060 | -0,858 |
| p-value | 33,19% | 10,07% | 7,84% | 41,92% |
| N | 7 | 7 | 7 | 7 |

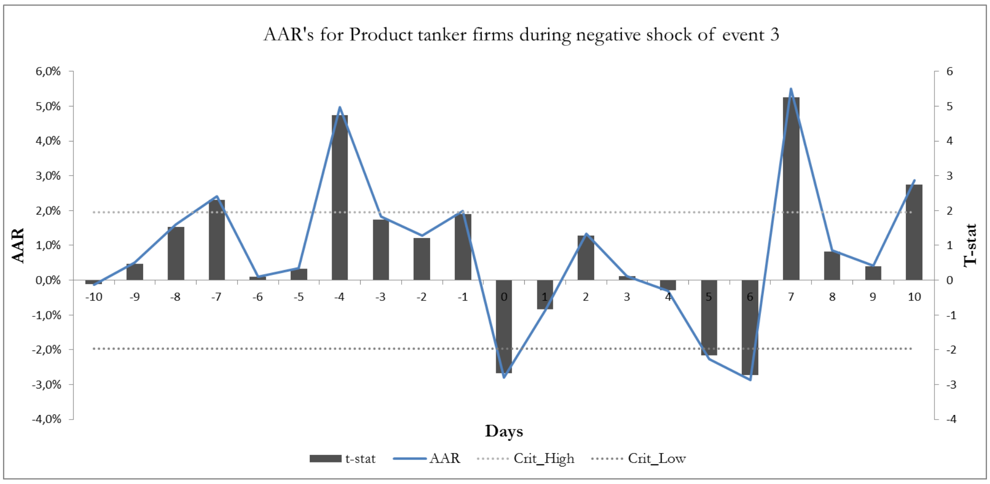
| EVENT 10 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -8,94% | 0,35% | -0,88% | -1,43% |
| Std. Dev | 6,51% | 4,71% | 3,17% | 2,46% |
| t-test | -1,374 | 0,074 | -0,276 | -0,582 |
| p-value | 20,68% | 94,30% | 78,94% | 57,64% |
| N | 8 | 8 | 8 | 8 |

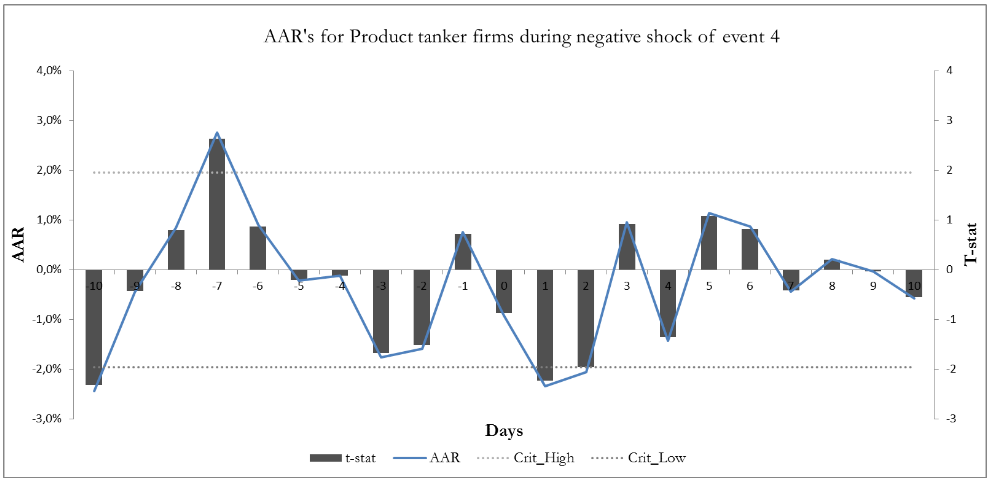
| EVENT 11 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 14,24% | 7,57% | 3,45% | 4,45% |
| Std. Dev | 6,51% | 4,71% | 3,17% | 2,46% |
| t-test | 2,189 | 1,607 | 1,088 | 1,812 |
| p-value | 6,01% | 14,68% | 30,82% | 10,76% |
| N | 8 | 8 | 8 | 8 |

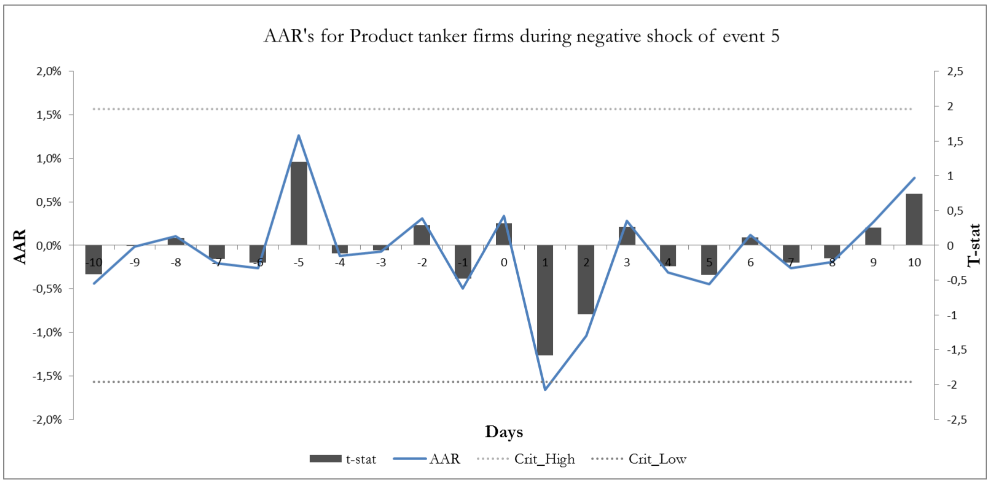
| EVENT 13 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -6,72% | -10,48% | -1,65% | -0,90% |
| Std. Dev | 6,51% | 4,71% | 3,17% | 2,46% |
| t-test | -1,033 | -2,225 | -0,521 | -0,365 |
| p-value | 33,19% | 5,68% | 61,68% | 72,48% |
| N | 8 | 8 | 8 | 8 |

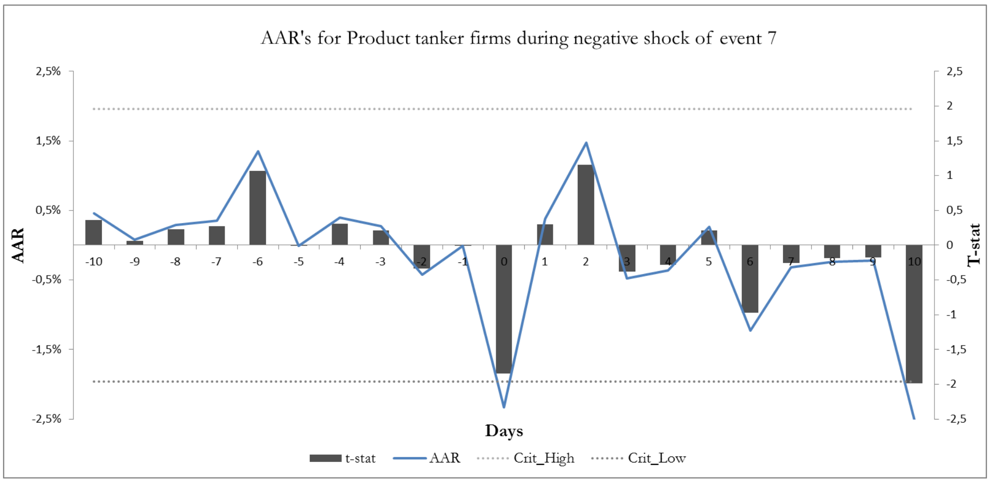
| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -4,42% | -7,22% | -3,89% | -4,46% |
| Std. Dev | 6,51% | 4,71% | 3,17% | 2,46% |
| t-test | -0,679 | -1,533 | -1,225 | -1,815 |
| p-value | 51,62% | 16,39% | 25,53% | 10,71% |
| N | 8 | 8 | 8 | 8 |

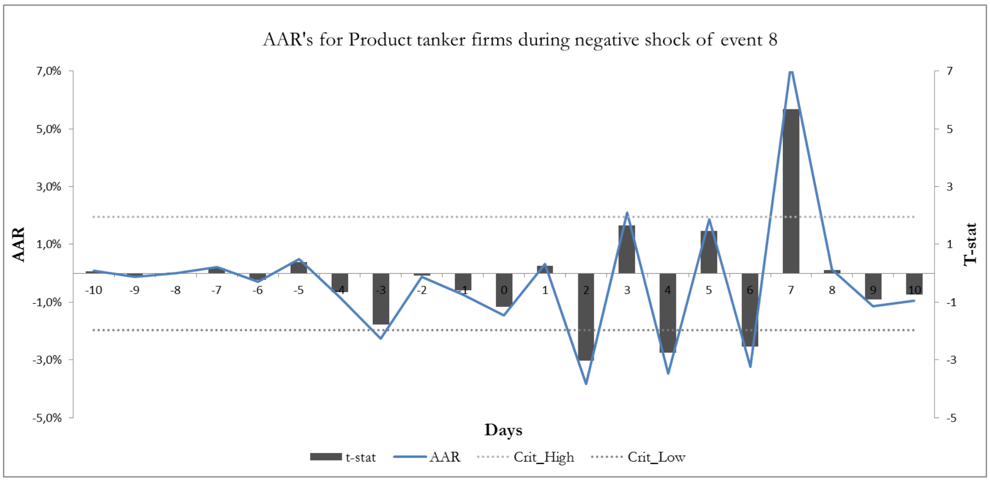
## $\overline{AR}$ *results for negative shocks of product tanker firms*

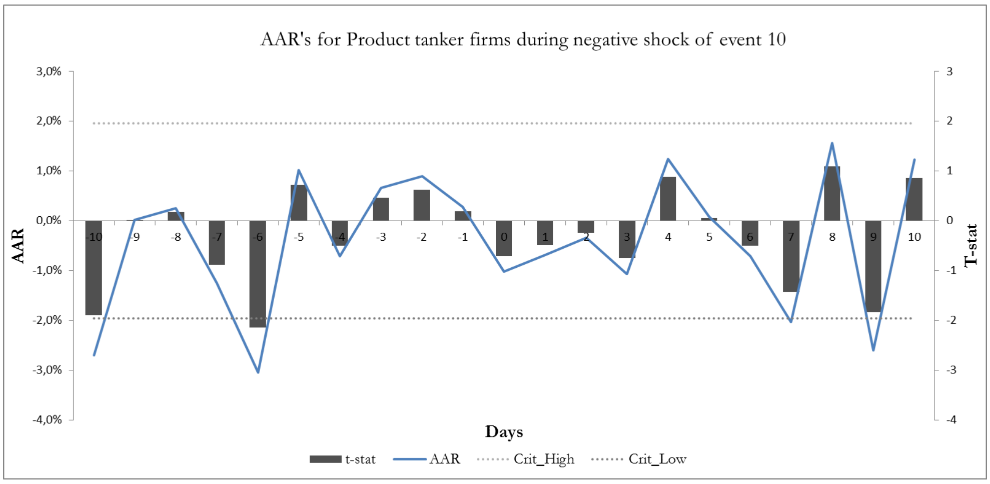


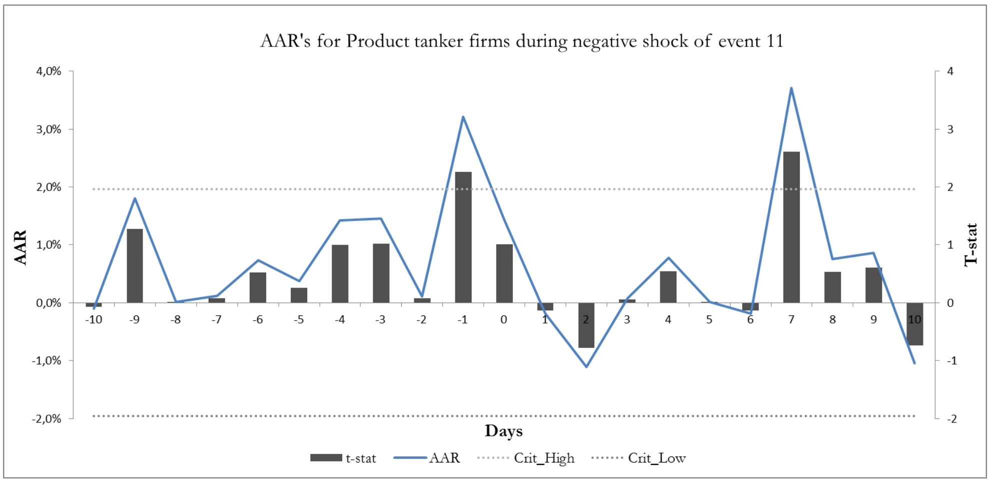



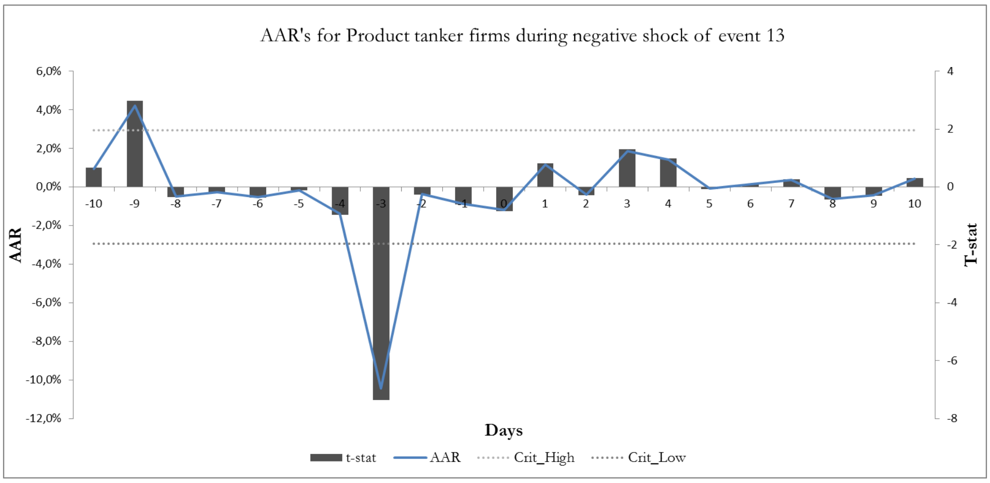

AAR's for Product tanker firms during negative shock of event 5
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

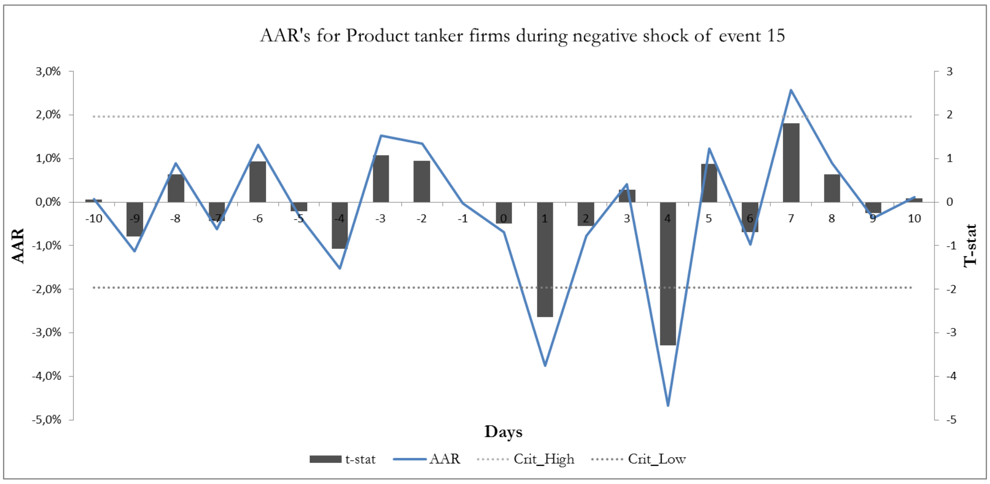

AAR's for Product tanker firms during negative shock of event 7
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low


AAR's for Product tanker firms during negative shock of event 8
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

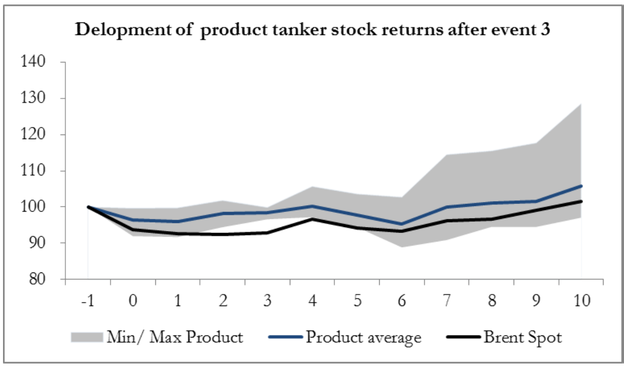

AAR's for Product tanker firms during negative shock of event 10
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

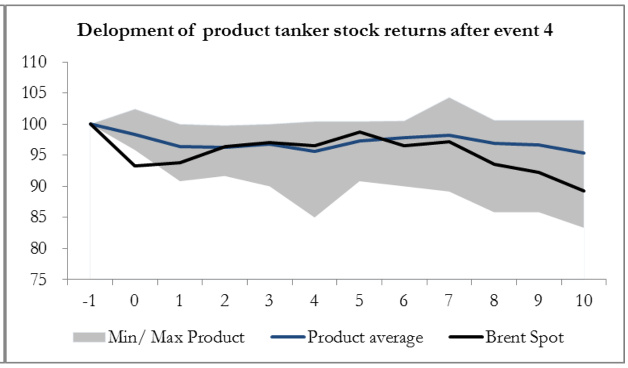

AAR's for Product tanker firms during negative shock of event 11
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

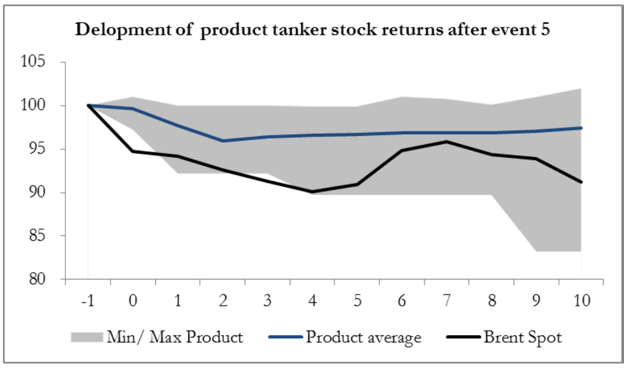

AAR's for Product tanker firms during negative shock of event 13
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

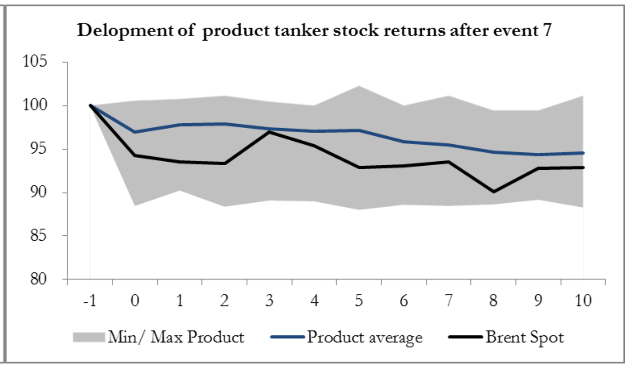


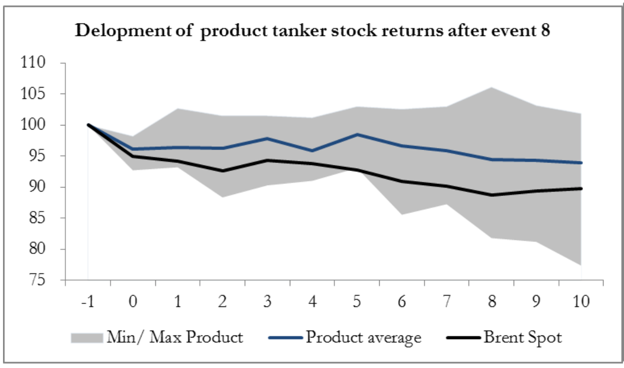

## *Development in stock returns for negative shocks of product tanker firms*

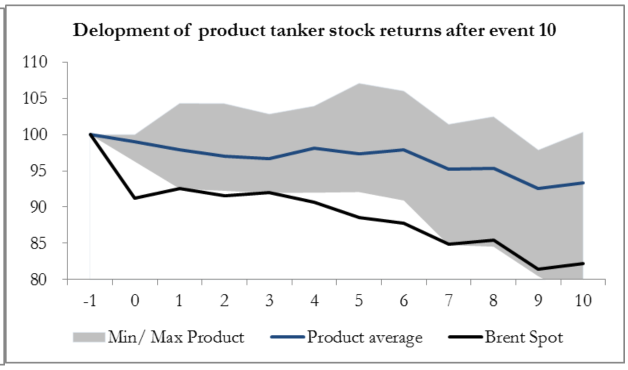


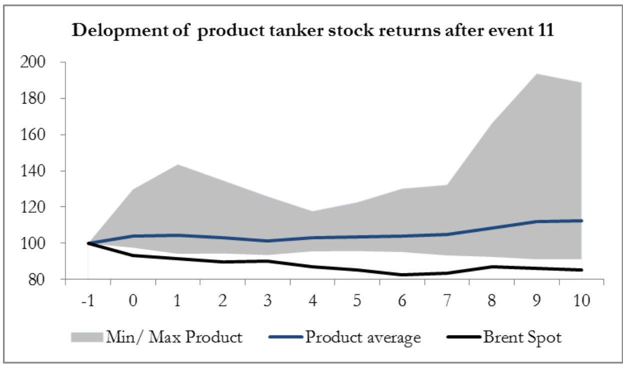



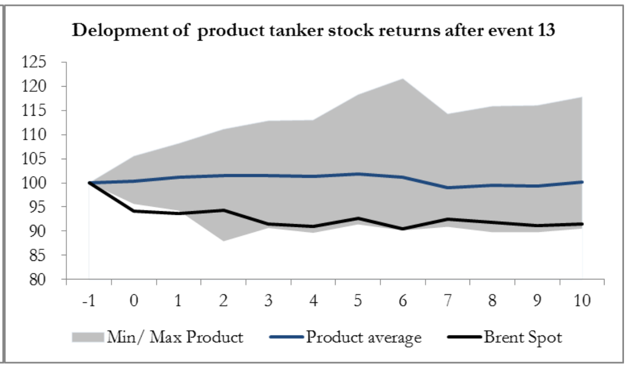



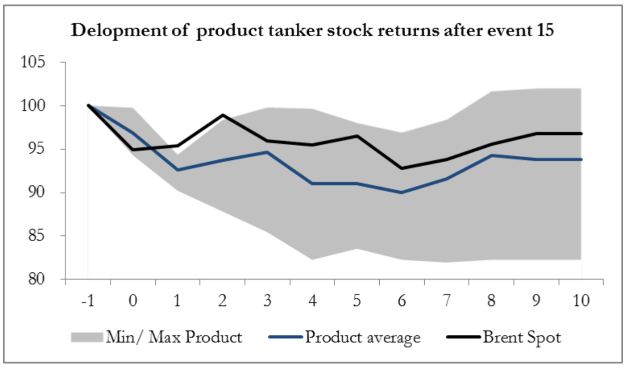






## *Rank test results for negative shocks of product tanker firms*

| **EVENT 3** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,546 | 0,536 | 0,556 | 0,457 |
| Std. Dev | 13,52% | 13,52% | 13,52% | 13,52% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 1,572 | 0,891 | 0,924 | -0,556 |
| p-value | 13,08% | 39,22% | 39,77% | 61,70% |

| **EVENT 4** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,464 | 0,396 | 0,316 | 0,387 |
| Std. Dev | 13,56% | 13,56% | 13,56% | 13,56% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,233 | -2,552 | -3,040 | -1,440 |
| p-value | 23,13% | 2,69% | 2,87% | 24,55% |

| **EVENT 5** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,483 | 0,479 | 0,462 | 0,459 |
| Std. Dev | 13,78% | 13,78% | 13,78% | 13,78% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -0,569 | -0,500 | -0,623 | -0,511 |
| p-value | 57,52% | 62,68% | 56,08% | 64,44% |

| **EVENT 7** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,496 | 0,484 | 0,509 | 0,468 |
| Std. Dev | 11,15% | 11,15% | 11,15% | 11,15% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -0,161 | -0,465 | 0,179 | -0,490 |
| p-value | 87,33% | 65,13% | 86,49% | 65,79% |

| **EVENT 8** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,455 | 0,459 | 0,423 | 0,426 |
| Std. Dev | 10,85% | 10,85% | 10,85% | 10,85% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,886 | -1,251 | -1,578 | -1,174 |
| p-value | 7,33% | 23,70% | 17,54% | 32,52% |

| **EVENT 10** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,456 | 0,511 | 0,491 | 0,436 |
| Std. Dev | 11,90% | 11,90% | 11,90% | 11,90% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -1,703 | 0,300 | -0,173 | -0,938 |
| p-value | 10,32% | 76,95% | 86,97% | 41,73% |

| **EVENT 11** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,539 | 0,537 | 0,481 | 0,496 |
| Std. Dev | 12,01% | 12,01% | 12,01% | 12,01% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 1,481 | 1,028 | -0,347 | -0,062 |
| p-value | 15,35% | 32,60% | 74,24% | 95,46% |

| **EVENT 13** | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,522 | 0,518 | 0,504 | 0,495 |
| Std. Dev | 11,92% | 11,92% | 11,92% | 11,92% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,854 | 0,493 | 0,074 | -0,067 |
| p-value | 40,29% | 63,19% | 94,38% | 95,10% |

| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,502 | 0,467 | 0,421 | 0,335 |
| Std. Dev | 12,00% | 12,00% | 12,00% | 12,00% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,062 | -0,918 | -1,475 | -2,382 |
| p-value | 95,09% | 37,82% | 20,03% | 9,75% |

## *Sign test results for negative shocks of product tanker firms*

| EVENT 3 | (-10,10) | -5,5 | -2,2 | -1,1 |
|---|---|---|---|---|
| Event window average | 0,676 | 0,709 | 0,800 | 0,667 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 5,801 | 6,820 | 9,730 | 5,395 |
| p-value | 0,00% | 0,00% | 0,00% | 0,00% |

| EVENT 4 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,495 | 0,436 | 0,320 | 0,400 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,157 | -2,076 | -5,838 | -3,237 |
| p-value | 87,55% | 3,89% | 0,00% | 0,14% |

| EVENT 5 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,552 | 0,545 | 0,520 | 0,533 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 1,725 | 1,483 | 0,649 | 1,079 |
| p-value | 8,57% | 13,93% | 51,71% | 28,15% |

| EVENT 7 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,490 | 0,455 | 0,486 | 0,429 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -0,336 | -1,483 | -0,463 | -2,312 |
| p-value | 73,72% | 13,93% | 64,35% | 2,15% |

| EVENT 8 | (-10,10) | -5,5 | -2,2 | -1,1 |
|---|---|---|---|---|
| Event window average | 0,415 | 0,429 | 0,429 | 0,429 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -2,800 | -2,330 | -2,317 | -2,312 |
| p-value | 0,55% | 2,06% | 2,13% | 2,15% |

| EVENT 10 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,411 | 0,477 | 0,425 | 0,333 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | -2,940 | -0,741 | -2,433 | -5,395 |
| p-value | 0,36% | 45,91% | 1,57% | 0,00% |

| EVENT 11 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,583 | 0,580 | 0,525 | 0,458 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 2,744 | 2,595 | 0,811 | -1,349 |
| p-value | 0,65% | 1,00% | 41,82% | 17,85% |

| EVENT 13 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,518 | 0,511 | 0,500 | 0,500 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,588 | 0,371 | 0,000 | 0,000 |
| p-value | 55,71% | 71,12% | 100,00% | 100,00% |

| EVENT 15 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,524 | 0,489 | 0,400 | 0,292 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,784 | -0,371 | -3,243 | -6,744 |
| p-value | 43,38% | 71,12% | 0,13% | 0,00% |

## *CAAR results for positive shocks of product tanker firms*

| EVENT 1 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 6,03% | 1,37% | 0,47% | -1,22% |
| Std. Dev | 4,81% | 3,48% | 2,35% | 1,82% |
| t-test | 1,255 | 0,392 | 0,201 | -0,670 |
| p-value | 26,51% | 71,10% | 84,89% | 53,27% |
| N | 5 | 5 | 5 | 5 |

| EVENT 2 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -4,41% | -0,49% | -3,46% | -3,34% |
| Std. Dev | 4,81% | 3,48% | 2,35% | 1,82% |
| t-test | -0,918 | -0,141 | -1,476 | -1,839 |
| p-value | 40,07% | 89,37% | 20,00% | 12,53% |
| N | 5 | 5 | 5 | 5 |

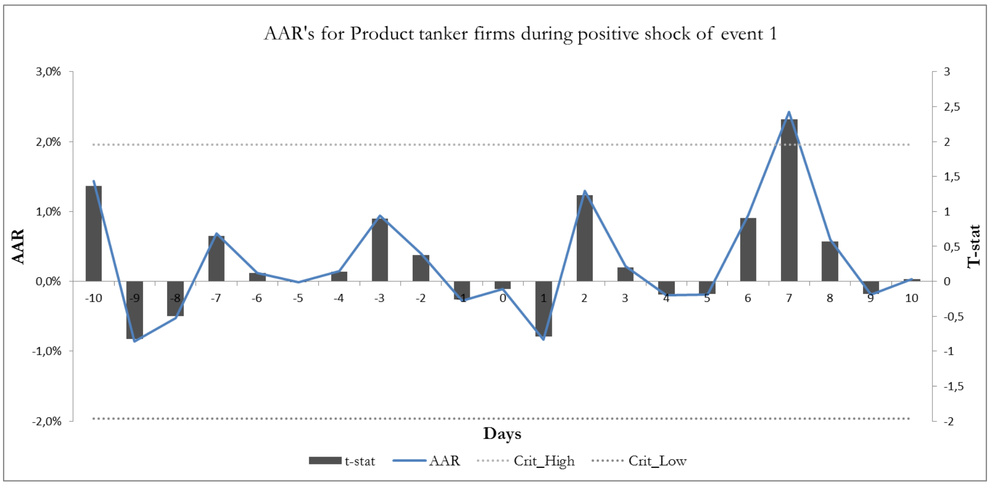
| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 2,90% | -0,85% | 3,85% | 3,89% |
| Std. Dev | 4,81% | 3,48% | 2,35% | 1,82% |
| t-test | 0,603 | -0,246 | 1,640 | 2,138 |
| p-value | 57,28% | 81,58% | 16,20% | 8,55% |
| N | 5 | 5 | 5 | 5 |

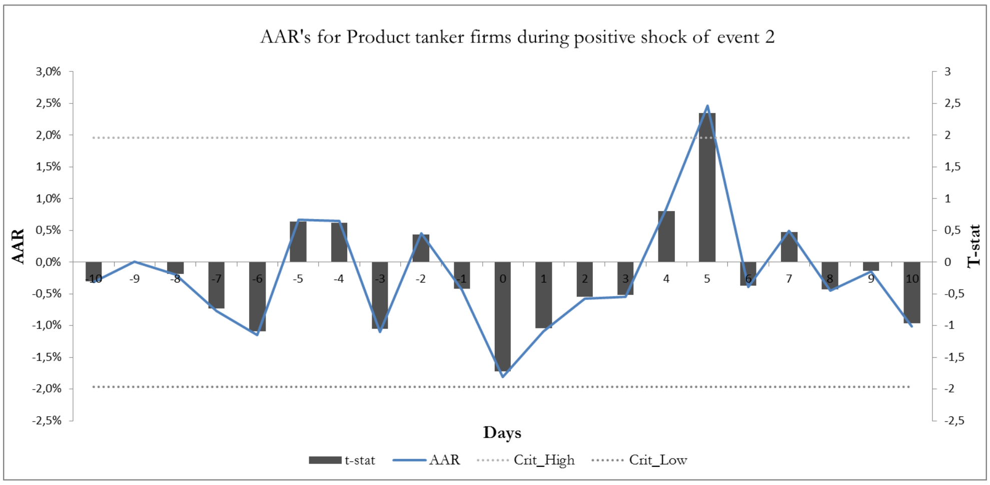
| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 3,14% | 0,62% | 0,21% | 0,52% |
| Std. Dev | 14,24% | 10,31% | 6,95% | 5,38% |
| t-test | 0,220 | 0,060 | 0,030 | 0,097 |
| p-value | 83,20% | 95,38% | 97,66% | 92,52% |
| N | 7 | 7 | 7 | 7 |

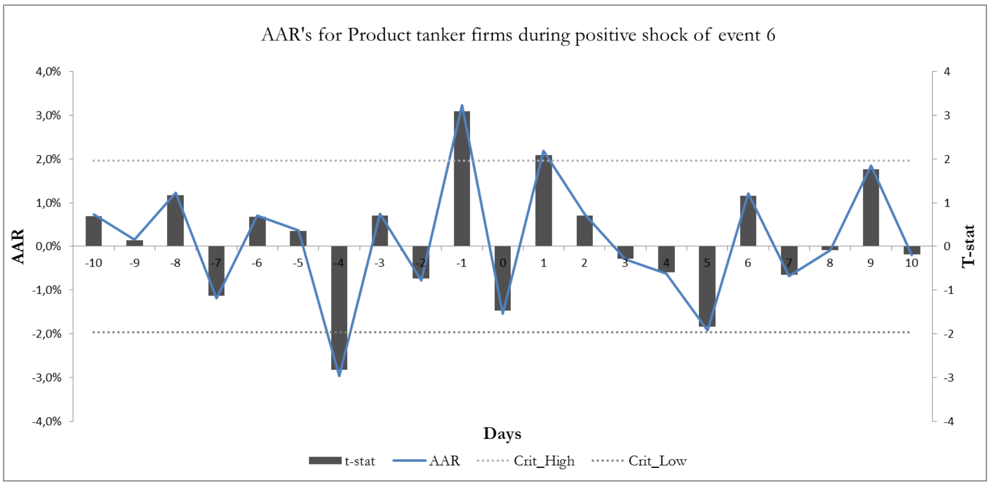
| EVENT 12 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | 2,02% | 0,32% | -4,77% | -5,11% |
| Std. Dev | 6,51% | 4,71% | 3,17% | 2,46% |
| t-test | 0,311 | 0,067 | -1,502 | -2,078 |
| p-value | 76,40% | 94,82% | 17,14% | 7,13% |
| N | 8 | 8 | 8 | 8 |

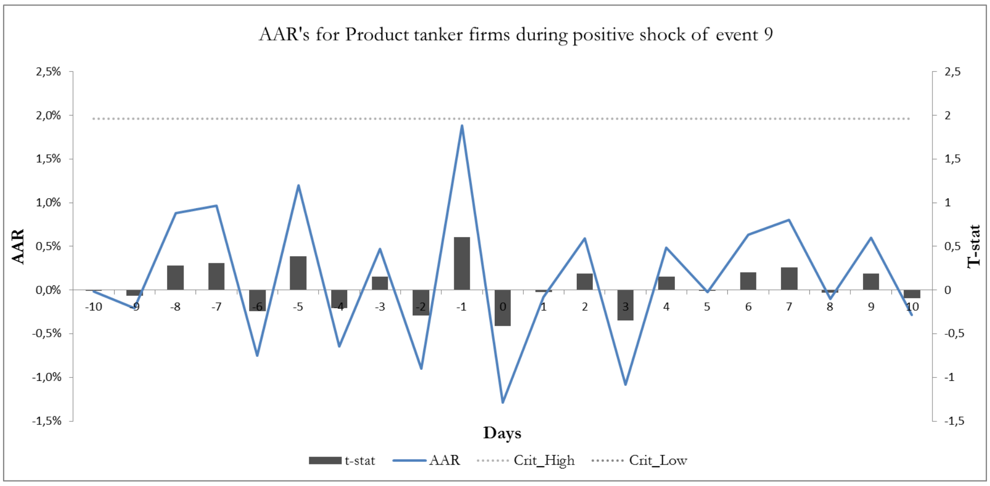
| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| CAAR | -1,78% | 3,15% | 3,97% | 2,47% |
| Std. Dev | 6,51% | 4,71% | 3,17% | 2,46% |
| t-test | -0,274 | 0,668 | 1,250 | 1,004 |
| p-value | 79,13% | 52,26% | 24,67% | 34,48% |
| N | 8 | 8 | 8 | 8 |

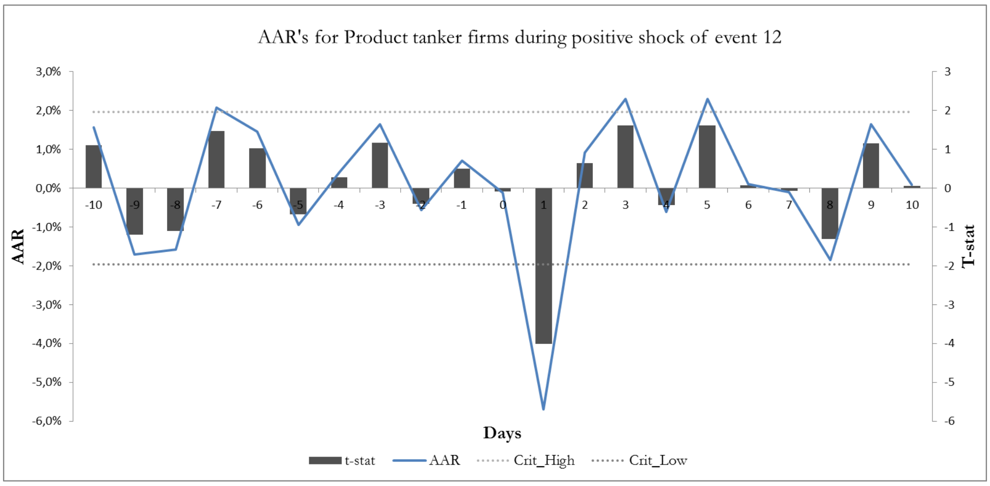
## $\overline{AR}$ *results for positive shocks of product tanker firms*

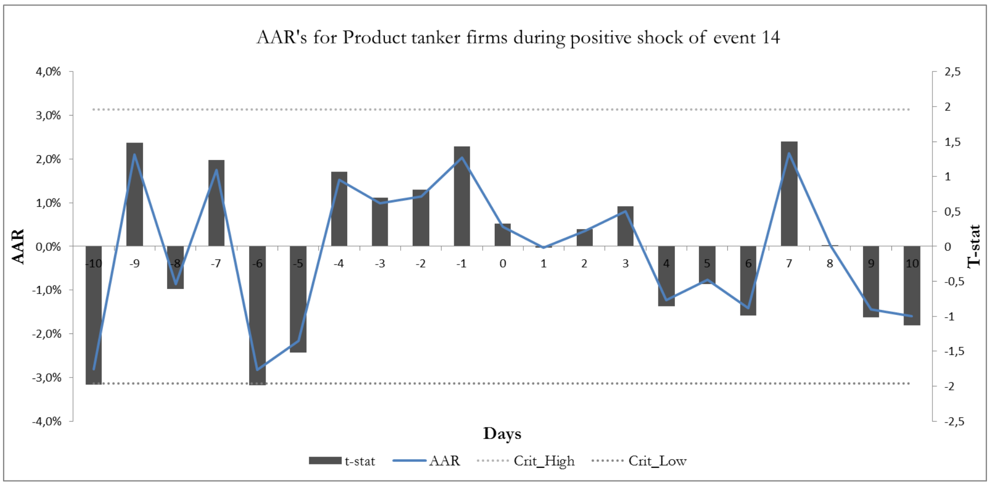


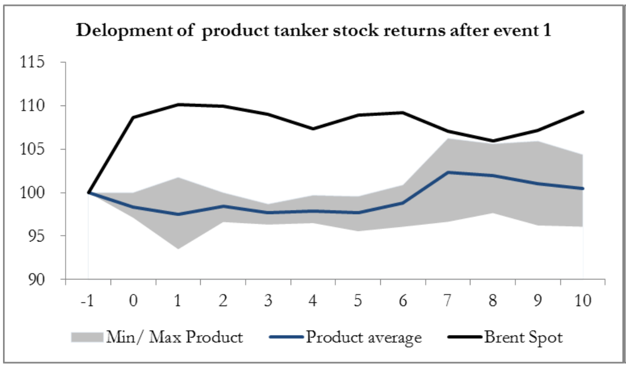

AAR's for Product tanker firms during positive shock of event 6
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

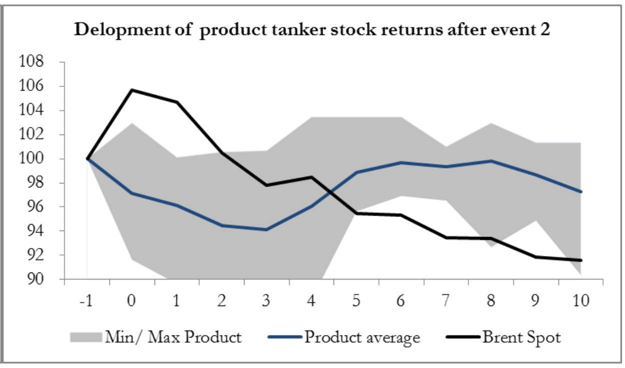

AAR's for Product tanker firms during positive shock of event 9
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

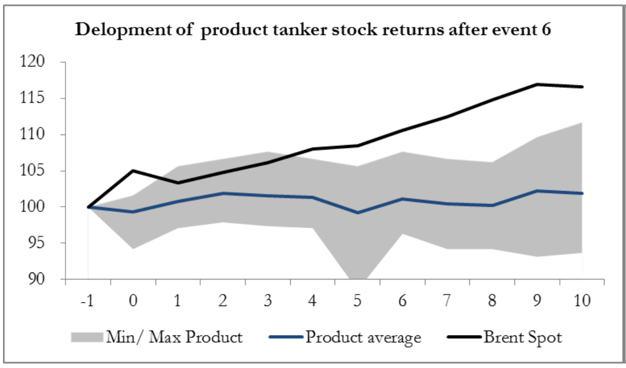

AAR's for Product tanker firms during positive shock of event 12
AAR
T-stat
Days
t-stat
AAR
Crit_High
Crit_Low

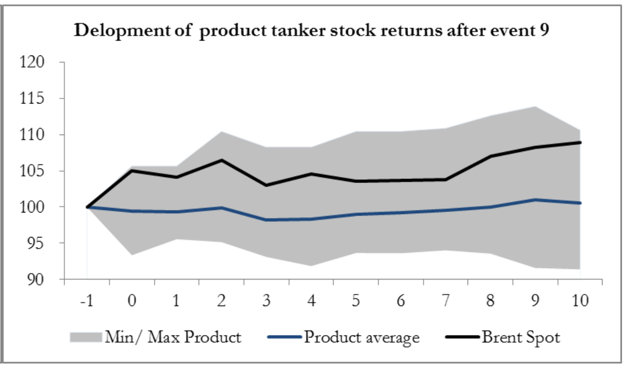


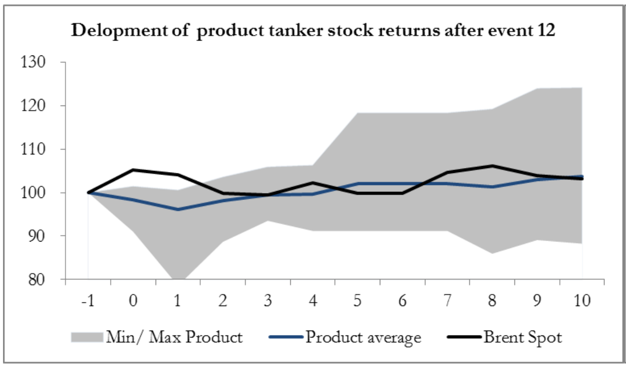

## *Development in stock returns for positive shocks of product tanker firms*

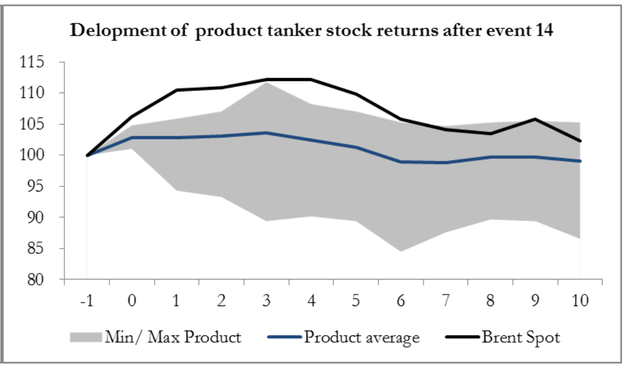


## *Rank test results for positive shocks of product tanker firms*

| EVENT 1 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,541 | 0,528 | 0,509 | 0,428 |
| Std. Dev | 13,71% | 13,71% | 13,71% | 13,71% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 1,362 | 0,687 | 0,144 | -0,907 |
| p-value | 18,76% | 50,63% | 89,12% | 43,13% |

| EVENT 2 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,493 | 0,515 | 0,443 | 0,406 |
| Std. Dev | 13,61% | 13,61% | 13,61% | 13,61% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | -0,246 | 0,363 | -0,935 | -1,195 |
| p-value | 80,77% | 72,33% | 39,26% | 31,80% |

| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,513 | 0,507 | 0,548 | 0,575 |
| Std. Dev | 13,74% | 13,74% | 13,74% | 13,74% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,439 | 0,160 | 0,785 | 0,942 |
| p-value | 66,51% | 87,60% | 46,80% | 41,55% |

| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,520 | 0,513 | 0,508 | 0,513 |
| Std. Dev | 11,56% | 11,56% | 11,56% | 11,56% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,802 | 0,381 | 0,150 | 0,200 |
| p-value | 43,13% | 71,03% | 88,68% | 85,43% |

| EVENT 12 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,533 | 0,556 | 0,486 | 0,495 |
| Std. Dev | 11,98% | 11,98% | 11,98% | 11,98% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 1,278 | 1,538 | -0,254 | -0,069 |
| p-value | 21,53% | 15,23% | 80,97% | 94,96% |

| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,508 | 0,561 | 0,647 | 0,641 |
| Std. Dev | 11,89% | 11,89% | 11,89% | 11,89% |
| Days in event | 21 | 11 | 5 | 3 |
| t-stat | 0,324 | 1,698 | 2,766 | 2,055 |
| p-value | 74,92% | 11,76% | 3,96% | 13,21% |

## *Sign test results for positive shocks of product tanker firms*

| EVENT 1 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,610 | 0,600 | 0,520 | 0,400 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 3,606 | 3,262 | 0,649 | -3,237 |
| p-value | 0,04% | 0,13% | 51,71% | 0,14% |

| EVENT 2 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,562 | 0,636 | 0,520 | 0,467 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 2,038 | 4,448 | 0,649 | -1,079 |
| p-value | 4,25% | 0,00% | 51,71% | 28,15% |

| EVENT 6 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,505 | 0,473 | 0,480 | 0,467 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,157 | -0,890 | -0,649 | -1,079 |
| p-value | 87,55% | 37,45% | 51,71% | 28,15% |

| EVENT 9 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,517 | 0,506 | 0,457 | 0,524 |
| Days in total | 213 | 208 | 205 | 204 |
| t-stat | 0,496 | 0,187 | -1,227 | 0,680 |
| p-value | 62,01% | 85,16% | 22,11% | 49,72% |

| EVENT 12 | (-10,10) | -5,5 | -2,2 | -1,1 |
|---|---|---|---|---|
| Event window average | 0,554 | 0,580 | 0,550 | 0,542 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 1,764 | 2,595 | 1,622 | 1,349 |
| p-value | 7,89% | 1,00% | 10,61% | 17,85% |

| EVENT 14 | (-10,10) | (-5,5) | (-2,2) | (-1,1) |
|---|---|---|---|---|
| Event window average | 0,506 | 0,580 | 0,725 | 0,708 |
| Days in total | 271 | 266 | 263 | 262 |
| t-stat | 0,196 | 2,595 | 7,298 | 6,744 |
| p-value | 84,48% | 1,00% | 0,00% | 0,00% |

# Appendix 7

## Amount of statistical significant results for parametric $\overline{CAR}$ tests during negative shocks

The tables below report the percentage of significant results from negative shocks the different shocks windows for the parametric $\overline{CAR}$ test.

| **(-10,10) Event Window** | | **Significance Level** | |
|---|---|---|---|
| Industry | 10% | 5% | 1% |
| All | 77,78% | 66,67% | 55,56% |
| Drill | 55,56% | 44,44% | 22,22% |
| OSV | 33,33% | 33,33% | 22,22% |
| Crude | 44,44% | 22,22% | 11,11% |
| Product | 22,22% | 11,11% | 0,00% |

| **(-5,5) Event Window** | | **Significance Level** | |
|---|---|---|---|
| Industry | 10% | 5% | 1% |
| All | 77,78% | 77,78% | 44,44% |
| Drill | 55,56% | 55,56% | 44,44% |
| OSV | 66,67% | 55,56% | 44,44% |
| Crude | 44,44% | 44,44% | 22,22% |
| Product | 22,22% | 0,00% | 0,00% |

| **(-2,2) Event Window** | | **Significance Level** | |
|---|---|---|---|
| Industry | 10% | 5% | 1% |
| All | 55,56% | 55,56% | 55,56% |
| Drill | 55,56% | 44,44% | 44,44% |
| OSV | 77,78% | 44,44% | 33,33% |
| Crude | 44,44% | 22,22% | 11,11% |
| Product | 22,22% | 11,11% | 0,00% |

| **(-1,1) Event Window** | | **Significance Level** | |
|---|---|---|---|
| Industry | 10% | 5% | 1% |
| All | 77,78% | 77,78% | 66,67% |
| Drill | 77,78% | 66,67% | 55,56% |
| OSV | 77,78% | 66,67% | 44,44% |
| Crude | 22,22% | 22,22% | 11,11% |
| Product | 0,00% | 0,00% | 0,00% |

## Amount of statistical significant results for parametric $\overline{CAR}$ tests during positive shocks

| (-10,10) Event Window | Significance Level | | |
|---|---|---|---|
| Industry | 10% | 5% | 1% |
| All | 33,33% | 33,33% | 16,67% |
| Drill | 16,67% | 16,67% | 16,67% |
| OSV | 16,67% | 16,67% | 0,00% |
| Crude | 0,00% | 0,00% | 0,00% |
| Product | 0,00% | 0,00% | 0,00% |

| (-5,5) Event Window | Significance Level | | |
|---|---|---|---|
| Industry | 10% | 5% | 1% |
| All | 50,00% | 33,33% | 33,33% |
| Drill | 50,00% | 50,00% | 33,33% |
| OSV | 33,33% | 16,67% | 16,67% |
| Crude | 0,00% | 0,00% | 0,00% |
| Product | 0,00% | 0,00% | 0,00% |

| (-2,2) Event Window | Significance Level | | |
|---|---|---|---|
| Industry | 10% | 5% | 1% |
| All | 50,00% | 33,33% | 33,33% |
| Drill | 50,00% | 50,00% | 33,33% |
| OSV | 16,67% | 16,67% | 16,67% |
| Crude | 33,33% | 16,67% | 16,67% |
| Product | 0,00% | 0,00% | 0,00% |

| (-1,1) Event Window | Significance Level | | |
|---|---|---|---|
| Industry | 10% | 5% | 1% |
| All | 66,67% | 66,67% | 50,00% |
| Drill | 66,67% | 50,00% | 16,67% |
| OSV | 50,00% | 16,67% | 16,67% |
| Crude | 33,33% | 16,67% | 0,00% |
| Product | 33,33% | 0,00% | 0,00% |