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The Financial Impact of Terrorist Attacks on the Value of the Oil and Gas Industry: An International Review

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David Holwerda and Bert Scholtens

Abstract

Energy firms operate in a strategic industry and their operations are vulnerable to terrorist attacks. We investigate how terrorism impacts stock returns of these firms. We analyze the effect of 105 terrorist attacks on oil and gas companies during 2001–2012. We find that there is no evidence that shareholders respond in a significant manner to these attacks. The reason may be that financial market participants are already got used to terrorism and that attacks on oil and gas companies occurring on a large scale and, therefore, are already included in the risk premium. As such, the financial market participants seem to assume that firms already efficiently manage the threat of terrorism in the energy industry. We conclude that financial markets seem to be efficient in absorbing the impact of terrorist attacks.

Keywords

Energy finance • Terrorism • Stock market • Event study • Energy security

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5.1 Introduction

This paper investigates the impact of terrorist attacks on the stock market returns of firms in the oil and gas industry. Investigating how sensitive companies are for this type of events is very important in enterprise risk management. Since the 9/11 attacks the effect of terrorism on financial markets has been investigated by various studies. From 9/11 onwards, it became clear that terrorism is a risk that investors have to face (Chen and Siems 2004; Brounen and Derwall 2010; Chesney et al. 2010). Most studies about terrorism take a security perspective and focus on the impact at the country level (see e.g., Smith Stegen 2011). Furthermore, most energy security studies take a country perspective (see e.g., Blum and Legey 2012; Zhang et al. 2013; Lilliestam 2014). However, in many instances, it is companies that are being hit by terrorists and this is a real risk for energy projects (Komendantova et al. 2012) as well as for companies or even complete industries (Kollias et al. 2013). Kollias et al. (2013) investigate the effects of war and terrorism on the covariance between oil prices and major stock market indices with the help of GARCH. They find that the covariance is affected by war but that terrorism does not seem to affect the covariance between the S&P500 and the FTSE100 and oil returns, but does so for the CAC40 and DAX. To complement the literature, we will focus on the firm perspective. In particular energy firms are prone to terrorism as they manage strategic resources and have operations that are vulnerable, such as pipelines, oil depots, etc. Therefore, we investigate the effect of a terrorist attack on an oil or gas firm's returns. Based on the definition of the National Consortium for the Study of Terrorism and Responses to Terrorism (2013) (hereafter START), we define terrorism as *“the threatened or actual use of illegal force and violence by a non-state actor to attain a political, economic, religious, or social goal through fear coercion, or intimidation”*.

Most studies about terrorism and corporations discuss the effect of major terrorist attacks on stock returns. Chen and Siems (2004) examine the effect of terrorism on global capital markets using 14 major terrorist events in the period of 1915 until 2001. Besides significant negative reactions, they find that US capital markets appear to be more resilient in recent times than they have been in the past. Eldor and Melnick (2004) find that the stock market reacts negatively to attacks in Israel. Arin et al (2008) investigate whether there is any difference in the reaction of different countries on terrorism. They find that the response to these attacks varies across the six countries investigated. It appears that Spain and the UK are least affected by the attacks. This would suggest that financial market participants in these two countries are more resilient to terrorist attacks. Brounen and Derwall (2010) find that terrorist attacks lead to a mild short-term effect, mainly on the event day. Apart from the attack on 9/11, financial markets restore to pre-attack levels within a week. The attacks on 9/11 had a clear long-term effect on the financial market, mainly due to an increase of systemic risk. Chesney et al. (2010) study the impact of terrorism on the behavior of stock, bond and commodity markets. They point out that the non-parametric approach is essential to a correct interpretation of the findings. Karolyi and Martell (2010) find that especially Royal Dutch Shell is hit

hard by terrorist attacks. Suleman (2012) studies the effect of terrorism with regard to the Karachi stock market in Pakistan (2012). He finds that news of terrorist attacks has a negative impact on all the sector indices, but that the effect on individual companies is insignificant. Kollias et al. (2013) use 14 terrorist events in their study, derived from secondary sources. Seven are in what they call the center, and seven in what is called periphery. They rely on a BEKK-GARCH model to establish the effect of terrorism (and war) on the covariance between stock market indices and oil prices. Kollias et al. (2013) find that terrorism does affect this relationship for CAC40 and DAX, but not for S&P500 and FTSE100, and that especially there is an effect with ‘center’ attacks rather the ‘periphery’ ones.

According to START’s Global Terrorism Database, the number of terrorist attacks on companies in the utility sector is increasing. Karolyi and Martell (2010) argue that information about terrorist attacks can induce investors to demand either a higher risk premium or flee the market searching for more stable financial assets. It is relevant for both the investors as well as for the companies to know about the effect of terrorist attacks on company returns. Previous studies on the effect of terrorism on financial markets focuses mainly on major terrorist events or the effect of general terrorist events on stock prices of industries or even the stock market as a whole. However, these studies do not account for potential differences in sensitivity and vulnerability of different industries. Furthermore, they tend to be biased as they mainly investigate terrorist attacks on ‘western’ corporations. Our research focuses on terrorist attacks on international oil and gas companies. We do conduct an event study to detect the impact of these attacks on the stock market return of the corporations. We look into different subsamples of the data to investigate interesting cross-sectional characteristics, such as firms that are hit incidentally versus those that are hit more frequently.

Here, we particularly focus on the effect of terrorism that is aimed at a specific oil and gas company on the company’s stock market returns. In contrast to Karolyi and Martell (2010) and Kollias et al. (2013), we do not focus on the most spectacular attacks as we feel this would result in a selection bias. We test the following hypothesis: Companies that are the target of a terrorist attack experience a significant abnormal return at or short after the event date.

5.2 Data and Methods

Our dataset consists of oil and gas firms that were attacked by terrorists between 2001/2010 and 2012/2012. October 2001 was used as starting point for the reason that this was the year terrorism became a number one priority due to the 9/11 attacks. The year 2012 was the last year for which accurate data was available at the time our research took place. The dates of the attacks are obtained from the Global Terrorism Database. The company had to be listed at a stock exchange at the time of the attack. Events of threatened use of violence and prevented attacks are not included. The final dataset consists of 105 terrorist attacks on gas and oil firms. Tables 5.1 and 5.2 show main data characteristics. Table 5.1 shows that four of the

Table 5.1 Companies involved and distribution of the attacks

Company	Number of attacks	Percentage of total
Ecopetrol	22	21.0
Sui Southern Gas Company	20	19.1
Royal Dutch Shell	13	12.4
Agip/ENI	11	10.5
EnCana	6	5.7
Chevron	5	4.8
Gazprom	4	3.8
Pakistan Petroleum Limited	4	3.8
Oil and Gas Development Company	4	3.8
Oil and Natural Gas Corporation	3	2.9
Sui Northern Gas Company	3	2.9
British Petroleum	2	1.9
Indian Oil Corporation Limited	2	1.9
Pakistan State Oil	2	1.9
Nexen Inc.	1	1.0
Petrobank Energy and Resources Ltd.	1	1.0
Atmos Energy	1	1.0
China Petroleum and Chemical Corporation	1	1.0
Total	105	100

18 companies are involved in the majority (namely 63 %) of the events: Ecopetrol, Sui Southern Gas Company, Royal Dutch Shell and Agip/ENI. The majority of events (66 out of 105) relates to firms headquartered in ‘emerging’ countries, the remainder to firms in ‘developed’ countries. Furthermore, only seven terrorist attacks did occur in ‘developed’ countries. Table 5.2 reveals that the number of terrorist attacks seems to have increased. This is because four fifths of the recorded terrorist attacks on energy companies did occur in the second half of the period under review.

To investigate the impact of terrorist attacks on the value of energy companies, we use the event-study methodology, which is based on the efficient market hypothesis. This hypothesis states that as new information becomes available, it is fully taken into consideration by investors assessing its current and future impact. This approach is undertaken on a frequent basis in the finance literature (MacKinlay 1997). Boersen and Scholtens (2011) use it to study the impact of accidents on the value of energy corporations. The method is also employed in other studies after the impact of terrorist attacks on firm value (e.g. Chen and Siems 2004). We account for both firm- and market specific information (Campbell et al. 2010). The event day is defined as the day on which the attack took place. When the event day was not a trading day, the first trading day after the attack is used as the event day. The event window consists of the event day and 2 days after the event day. Because a terrorist attack is completely unexpected, this research does not take into account of any days prior to the attack. A short event window is also examined in order to see

Table 5.2 Distribution of terrorist attacks over time

Year	Number of attacks	Percentage of total
2001	1	1.0
2002	0	–
2003	4	3.8
2004	1	1.0
2005	3	2.9
2006	10	9.5
2007	5	4.8
2008	15	14.3
2009	21	20.0
2010	12	11.4
2011	16	15.2
2012	17	16.2
Total	105	100

how fast the market digested the news and we use cumulative average abnormal returns (CAARs) as well to assess the size of the impact.

To arrive at the expected returns with which the actual returns of the firm's stock are confronted in the event window, we rely on the market and risk adjusted returns model (Campbell et al. 2010). In order to use this model, the returns in the event window have to be adjusted with the normal returns of the firm. To this extent, we apply an estimation window of 250 trading days. Given that we investigate unexpected terrorist attacks, it is important to keep the event window small. The actual returns R_{it} are calculated by applying the following formula:

$$R_{it} = \ln\left(\frac{P_t}{P_{t-1}}\right) \quad (5.1)$$

where P_t is the price at trading day t and P_{t-1} is the price at the previous trading day. The market and risk adjusted returns model is specified as follows:

$$AR_{it} = R_{it} - \alpha_i - \beta_i R_{mt} \quad (5.2)$$

where:

$$\alpha_i = \mu_i - \beta_i \mu_m \quad (5.3)$$

$$\beta_i = \frac{\sum_{t=-249}^{t-1} (R_{i,t} - \mu_i)(R_{m,t} - \mu_m)}{\sum_{t=-249}^{t-1} (R_{m,t} - \mu_m)^2} \quad (5.4)$$

where α_i is the intercept estimated over the estimation window, μ_i is the average stock return in the estimation window, μ_m is the average market return in the estimation window, β_i describes the asset's risk in relation to the market index estimated over the estimation window, and R_{mt} is the return on the market index on the trading day. We use the country index of the country where the company

attacked is listed as the market index (Appendix). As such, we adjust for country-wide factors.

To calculate the average abnormal returns (AARs) in the event window the following formula is used:

$$AAR_t = \frac{\sum_{i=1}^N AR_{i,t}}{N} \quad (5.5)$$

Calculating the CAAR is required while measuring the effect of the attack in the entire event window. We calculate the CAAR by summing up all the AARs in the event window:

$$CAAR_i = \sum_{t_0}^{t_2} AAR_t \quad (5.6)$$

For the analysis of the data, both a non-parametric test and a parametric test is used. For the parametric testing, we rely on the Student T-test, and for non-parametric testing we employ a sign test. The Student T-test is a relatively straightforward test, which gives a clear first analysis of the data. We define the test statistic for AAR and CAAR as:

$$T = \frac{\bar{x} - \mu_0}{s/\sqrt{N}} = \frac{AAR}{s/\sqrt{N}} \quad (5.7)$$

$$T = \frac{CAAR_t}{\sigma_{CAAR_t} / \sqrt{n}} \quad (5.8)$$

where N is the number of observations and s is the standard deviation of the estimation window. For the test statistics a p-value is calculated using the Student T distribution with $N-1$ degrees of freedom. In case of $P < \alpha$ the results will be considered significant for α values of 0.05.

For the non-parametric testing, we use the sign test. The advantage of a non-parametric test is that it can be used for testing the data without imposing any parametric assumptions. Campbell et al. (2010) argue that especially the sign test performs very well in a multi-country setting and with a three day event window, which is the same setting for our data. The test statistic can be defined as:

$$Z_G = \frac{w - N\hat{p}}{\sqrt{[N\hat{p}(1 - \hat{p})]}} \quad (5.9)$$

where w is the number of stocks on the event date for which the abnormal return is positive, and $\hat{p}$ is defined as:

$$\hat{p} = \frac{1}{N} \sum_{i=1}^N \frac{1}{M_i} \sum_{t=-249}^{-1} S_{it} \quad (5.10)$$

$$\text{With } S_{it} = \begin{cases} 1 & \text{if } u_{it} > 0, \\ 0 & \text{otherwise.} \end{cases} \quad (5.11)$$

where M is the number of non-missing returns in the estimation window for security i .

A limitation of this research design is that the majority of the events took place between the years 2009 and 2012. Another limitation is the fact that only the short-term reaction of the firm has been studied, not taking into account the possibility of longer-term effects on cash flows nor risk premium effects.

5.3 Results

The main characteristics of the AARs in the estimation window are provided in Table 5.3. It shows that the alpha is not significantly different from zero which suggests that companies that are hit by terrorist attacks do not outperform. The beta is 0.88 which is in line with that of the energy industry in general. As should be the case, the market and risk adjusted returns in the estimation window are zero on average. However, they clearly are not normally distributed.

Next we turn to the main analysis. We first discuss the estimation results for the AARs and CAARs in the event window, which are in Tables 5.4 and 5.5. Then, we turn to the results of the sensitivity analyses in Table 5.6.

The results in Table 5.4 shows the AAR in the days of the event window. Although a minor negative effect is found on day one, this effect is not significant. Table 5.5 displays the CAARs of two different event windows. Again, no statistically significant results are found by using the (parametric) Student t -test and the (non-parametric) sign test.

Table 5.3 Descriptive statistics estimation window

	Alpha	Beta	Market and risk adjusted returns
Average	0.0002	0.8792	0.0000
Median	0.0002	0.8662	-0.0004
STD	0.0008	0.2509	0.0162
Minimum	-0.0028	-0.1764	-0.2422
Maximum	0.0023	1.3414	0.1626
Skewness	-0.1129	-1.6066	-0.2791
Kurtosis	1.2210	4.9254	14.8966
Jarque-Bera	14.0692	61.3892	620.5494

$N = 105$. Degrees of freedom: 104

Table 5.4 AAR in event window

Day	AAR	p-value of the parametric test	p-value of the non-parametric test
0	0.0015	0.8346	0.2177
1	-0.0016	0.8492	0.5000
2	0.0039	0.9916	0.9608

Table 5.5 CAAR for two different event windows

	CAAR	p-value of the parametric test	p-value of the non-parametric test
[0;1]	0.0006	0.5172	0.2912
[0;2]	0.0050	0.9131	0.7123

Table 5.6 Sensitivity analysis

Panel A: Frequency comparison						
Time	Group 1 ^a	Group 2 ^b	Difference	Degrees of freedom	t value	p value
0	0.0017	0.0014	0.0003	104	0.1723	0.8635
1	-0.0003	-0.0039	0.0036	104	2.1723	0.0243
2	0.0027	0.0059	0.0032	104	2.0452	0.0434
Panel B: Period comparison						
Time	Group 1 ^c	Group 2 ^d	Difference	Degrees of freedom	t value	p value
0	-0.0076	0.0000	0.0076	56	3.5055	0.0007
1	-0.0024	-0.0003	0.0021	56	0.9638	0.3374
2	0.0030	0.0024	0.0006	56	0.2893	0.7729
Panel C: Country comparison						
Time	Group 1 ^e	Group 2 ^f	Difference	Degrees of freedom	t value	p value
0	0.0028	-0.0058	0.0083	104	0.2833	0.7775
1	0.0047	0.0044	0.0003	104	0.9712	0.3337
2	-0.0032	0.0001	0.0033	104	0.7910	0.4307

^aGroup 1: >10 attacks *N*: 66^bGroup 2: ≤10 attacks *N*: 39^cGroup 1: 2001–2007 *N*: 24^dGroup 2: 2011–2012 *N*: 33^eGroup 1: 'Developed' *N*: 39^fGroup 2: 'Emerging' *N*: 66

The results from Tables 5.4 and 5.5 suggest that terrorist attacks do not significantly impact the market returns of the firms that are hit. This implies that terrorism does not seem to result in abnormal returns for oil and gas companies. Therefore, we conclude that there is no evidence for our hypothesis about the impact of terrorist attacks on energy firms. This finding is in line with that of Suleman

(2012), partly in line with that of Kollias et al. (2013), and it contradicts the outcomes of Karolyi and Martell (2010). While the latter two rely on a selection of a small number of terrorist attacks, our study investigates a large number of attacks and takes 'minor' attacks into account as well. Therefore, we feel that we do contribute to the existing literature by not only having a broad coverage of terrorist attacks (not only those that are widely covered in western media) but also investigating the response to attacks in various countries.

The sensitivity analysis is reported in Table 5.6. The first sensitivity analysis regards companies that are attacked more than ten times, and companies that have been attacked at most ten times. These boundaries have been chosen with regards to the timespan of this research, starting from 2001 until 2012. More than ten attacks in this timespan averages to one attack per year, which can be perceived as regularly. Appendix shows that this regards four companies. Panel A reports the findings. It appears that on the event day both groups react slightly positive, with no significant difference between the two. Interesting is that although both groups react, the group of companies which is attacked less than ten times reacts significantly more than the group of companies which is attacked more than ten times. This is in line with finance theory: It appears that the market more appropriately 'prices' the risks of attacks of those firms with a richer history of previous attacks. But the market updates its assessment of firms that are rarely attacked and the stock prices move accordingly. The reversal of the market's reaction on day 2 compared to that on day 1 suggests mean reversion.

The effect that financial markets might be getting used to terrorism is being analyzed by comparing the years 2001–2007 with 2011–2012 (see Panel B in Table 5.6). We leave out the in-between period 2008–2010 as we are not able to find a clear a priori break in the series. There is a negative reaction of -0.7% on day 0 in the period of 2001–2007, which is significantly different from the response in the period 2011–2012, when no reaction is found. On day 1 and 2 after the terrorist attack, no statistically significant reaction is detected. As this sensitivity analysis goes into whether financial markets might be getting used to terrorism, the comparison suggests that financial markets are becoming less sensitive to terrorism indeed. The result from this analysis fuels the argument that financial markets are getting used to terrorism and that the findings of Chen and Siems (2004) may be valid for non-US financial markets as well.

Our third and last sensitivity analysis compares the reaction of stock market participants to terrorist attacks on firms headquartered in 'developed' countries in relation to those on firms which have their headquarters in 'emerging' countries. The former group holds companies from Canada, Italy, UK, and the US. The latter has companies from China, Colombia, India, Pakistan, and Russia. Panel C in the Table 5.6 shows that on the event day there is a slightly negative response in the

emerging countries and a very small positive one in the developed countries. On the first day after the event, the response to firms from both types of countries is about the same and slightly positive. On the second day after the event, we witness a slightly negative response with companies from developed markets and no response from firms headquartered in emerging markets. In none of the cases we detect a significant difference in the response. This might be due to the fact that most of the attacks did occur in emerging markets. Relatedly, whether participants in developed markets would respond stronger to terrorist attacks than those in emerging markets cannot be tested with our dataset.

5.4 Conclusion

We investigate the effects of terrorism on the stock market returns of corporations in the oil and gas industry, i.e. the financial market perspective regarding terrorism. This is important from the perspective of strategic risk management. We analyze 105 terrorist attacks aimed at oil and gas companies in the period 2001–2012. We hypothesize that companies that are the target of a terrorist attack will experience an abnormal return at the event date or in the two days after the attack. Previous literature suggests either zero or negative returns. For the energy companies studied, we were not able to detect a significant response of the stock market returns to terrorist attacks. This result is in line with Suleman (2012) and partly with that of Kollias et al. (2013), but contrasts with less focused and older studies. We do find that companies that are attacked more often react significantly different from companies that are attacked less often. Furthermore, it appears as if investors in energy firms seem to be almost getting used to terrorism, because they react significantly less negative in 2011–2012 compared to 2001–2007. This in fact suggests that financial market participants come to view terrorism regarding energy firms as a ‘fact of life’ and seem to assume that firms already efficiently manage the threat of terrorism in the energy industry (Karolyi and Martell 2010). Overall, we conclude that financial markets seem to be efficient in absorbing the impact of terrorist attacks.

From a policy perspective, our findings do not infer that one should not worry about attacks on energy companies. Cities, regions or countries—and, of course, especially the people living there—may be vulnerable to terrorist attacks (Lilliestam 2014). However, the protection of energy firms as such need not be the first priority in energy security. In contrast, it seems that protecting vulnerable infrastructure would be short-term priority, whereas switching to resilient energy systems is a long term strategy. Here, energy companies have an important role to play as they are key actors in the transition to a more resilient energy system.

Appendix: Company Characteristics

Company	Number of attacks	Country listed	Market index used
Ecopetrol	22	Colombia	MSCOLML
Sui Southern Gas Company	20	Pakistan	MSPAKIL
Royal Dutch Shell	13	United Kingdom	MSUTDKL
Agip/ENI	11	Italy	MSITALL
EnCana	6	Canada	MSCNDAL
Chevron	5	United States	MSUSAML
Gazprom	4	Russia	
Pakistan Petroleum Limited	4	Pakistan	MSPAKIL
Oil and Gas development Company	4	Pakistan	MSPAKIL
Oil and Natural gas Corporation	3	India	MSINDIL
Sui Northern Gas Company	3	Pakistan	MSPAKIL
British Petroleum	2	United Kingdom	MSUTDKL
Indian Oil Corporation Limited	2	India	MSINDIL
Pakistan State Oil	2	Pakistan	MSPAKIL
Nexen Inc.	1	Canada	MSCNDAL
Petrobank Energy and Resources Ltd.	1	Colombia	MSCOLML
Atmos Energy	1	United States	MSUSAML
China Petroleum & Chemical Corporation	1	China	MSCHINL
Total	105		

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