Bankruptcy by catastrophes for major multi-nationals: stock exchange sensitivity for three catastrophes

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Abstract: This paper investigates the effect of major catastrophes have on stock exchange values for the major multi-nationals. The paper demonstrates that the Sharpe analysis is more sensitive in identifying effects than just following the daily stock values for assessing market response. It was found that major multi-nationals are capable of absorbing incredible amounts of financial damage following from catastrophes before stock markets react. This is partly due to the complexity of modern financial market risks that can be sold or transferred easily from the operative entity to another entity. The findings suggest that Hudson's (2007) HSE culture ladder requires a step below the pathological to reflect the reaction of the stock exchange market on major catastrophes: the indifferent level. If the financial risks of catastrophes are covered, market traders rarely assign further consequences for the loss of life to the company through the lowering stock prices. Despite that, there may be a threshold value for financial loss that could bring major multi-nationals to bankruptcy due to market capital loss.

Keywords: chemical and processing industry; enterprise risk management; catastrophes.

1. INTRODUCTION

According to Gupta (2002) fewer accidents happen in the chemical process industry than would have happened if the Bhopal catastrophe had not changed managers' and governments' attitudes towards safety in the chemical process industry. Despite that, the analysis of the MARS database that Nivolianitou et al. (2006) performed shows that the occurrence of major accidents persists. And yet again we were surprised by the Deepwater Horizon disaster, its extensive environmental consequences and its staggering cost. According to the BP annual report of 2010 the cost of controlling the Deepwater Horizon crisis was 40,858 million dollars in 2010. It is this staggering cost that raises questions about the survivability of corporations after a major disaster. As part of the development of an integrated risk management model for the chemical process industry it was decided to analyze the effect of catastrophes on stock exchange values because top management regard the stock exchange value increase as an indicator for success of their company.

One of the objectives of the integrated risk model for Shell is to develop risk metrics that clarify the effects that local risks have on the company as a whole; catastrophes such as the Deepwater Horizon can have that effect. A distinct possibility for a risk indicator is the effect that accidents and catastrophes have on the market value of the company. This kind of indicator could be useful in an enterprise risk management framework.

2. BANKTRUPCY BY CATASTOPHES FOR MAJOR MULTI-NATIONALS

When Reason sets out describing how to prevent organizational accidents (1997) he describes an area of viable operation for an organization where production and (safety) protection are related. When safety protection is too extensive, the cost of operation is too expensive and a company goes bankrupt. On the other extreme, if there is too little protection catastrophes await. A catastrophe can also lead to bankruptcy when they are too expensive.

We hypothesize that accidents and catastrophes have an effect on the stock exchange market because they are extremely costly and they cause reputation damage. Since the relationship is complex, the first step of this work is to investigate whether accidents have had an effect on the stock exchange values of large chemical and oil companies in the past.

The history of the chemical and oil industry is dotted with incidents that are etched in the collective memories of safety workers. These events did not only spur the industry to improve their safety methods to their current high standards but also enable us to perform a historic analysis of these incidents. Therefore, these incidents make excellent starting points for this investigation.

Since the body of knowledge for safety sciences focuses on combatting accidents and incidents, it focuses on safety methods and solutions. It is not aimed at finding a relation between accidents and stock market behavior. The relation between regulation and risk are studied both for corporate and governmental bodies but the effect on the market is usually not taken into account.

However, in the econometric literature there are some papers that directly analyze the effects of large-scale catastrophes on stock exchange values. This provides us with a starting point albeit one where chemical industry and oil industry play a minor role.

A paper by Fodor et al. (2010) analyzes the effect that the Deepwater Horizon catastrophe had on the shares value of BP. They found that value of stocks dropped steadily for three months to -53% of their original value and subsequently stabilized on a value of -23% lower than their value prior to the accident. The analysis showed that the prolonged drop in value is not typical for accidents. This was explained by the continuation of bad news about the growing environmental damage. Once the well was capped, the stock values rose and stabilized. The severe drop in value put BP's continuation at risk but eventually it survived. This is contrary to Union Carbide that was taken over by DOW chemical after the Bhopal catastrophe.

The Exxon Valdez oil spill in Alaska turned out to have no significant effect on Exxon's stock values (Herbst et al. 1996). The exchange market took about two weeks to figure out that Exxon would be able to carry the financial load that the consequences of the incident would induce and decided that the corporation would survive the environmental catastrophe without significantly affecting Exxon's financial performance. Note that the Exxon Valdez case is remarkable in its own right since a part of the damages was claimed from insurance companies (Dolin, 1997). This unlikely juridical success was awarded the lawyers with the honors of '10 leading lawyers in the US' in 1997. Still, the about 780 million insurance payment is a relatively small part in relation to the estimated total damage of 10 billion or higher.

The Three Miles Island incident had a negative effect on all power corporations that owned nuclear power generators in the US (Bowen et al. 1983). The drop in value was about 10%. The corporations were valued lower because investors suspected that the incident would lead to expensive safety measures that would make nuclear power generation significantly more costly and thereby less attractive to customers. It was the not knowing if safety measures would be changed that also made the stock prices volatile; e.g. market prices started to swing vigorously and large volumes of stocks were traded. The Chernobyl accident also had a significant effect on public electric-utility stock prices in the United States (Fields & Fanjigian, 1989). In this case all electric-utility companies suffered a 3% loss and those that used nuclear power lost about double. This incident demonstrates that a company does not have to be the victim of a disaster itself but can also be influenced by catastrophes in the industry, even if it happens halfway around the world.

The effect of natural catastrophes was also investigated; in this case their effect on insurers. The 1989 earthquake in California led to an increase of stock exchange values for insurers that had to pay damages (Shelor, 1992). In this case the large losses in insurance payments were compensated by an increased sales of insurance. More citizens insured themselves against future damages. This is different than with 1995 hurricane Andrew where large damage payments set insurer stock values back by 10% (Lamb, 1995).

Some methodology can be derived from papers that treat even larger scale economic consequences such as natural disasters on national income (Albala-Bertrand, 1993) and global market analyses (Perron, 1989). The most important lessons from these papers are that the methods for the analysis of stock exchange values consider the same variables: the stock exchange value, the volume of trade and the volatility of the stocks.

The literature demonstrates that there is a relation between catastrophes and stock exchange values. Individual companies can affect their stock value by their own catastrophes. BP and Union Carbide are prime examples of that, though the Exxon Valdez oil spill seems to contradict that. Sometimes, catastrophes in the industry can influence stock values of other companies in that same industry. Papers on the Three Miles Island and the Chernobyl meltdown demonstrate this. Natural disasters also affect companies but the scientific literature only reports the influence on insurers. The findings in the literature suggest that it is worth our while to investigate the complex relation between catastrophe and stock exchange reactions. Not only is this an interesting academic challenge, it could also yield guidelines to prevent bankruptcy for risk industries that can be used in enterprise risk management frameworks.

3. METHOD

3.1. Choice of methods

The analysis methods that are used in the papers above are all based on historic data of stock exchange values. The paper by Brown and Warner (1985) called 'using daily stock returns: the case of event studies' describes the methods that are used by nearly all papers above. All papers study a catastrophe and the effect that it had on stock values. The methods are based on statistical analysis of breaches in trends for absolute value of stock values and of volatility of the stock values based on Sharpe methods. Note that the analysis is on daily stock exchange values so the minimum time step is one day. Another parameter for this uncertainty is the trading volume: the total amount of shares that are traded on that day. High trading values indicate an unstable stock.

The volatility is an important parameter since it indicates when traders are uncertain about the future of the company. When prices drop rapidly due to a catastrophe, the volatility indicates whether the traders are simply devaluating an overrated stock or whether they are trying to get rid of stocks in a panic. Since a sudden drop in value is relatively easily detectable in historic data, this work will not focus on statistical analysis of values but on volatility. For clarity, we shall use a simplified Sharpe analysis to study the volatility of stocks; that means that the Sharpe analysis is not performed on a day-by-day basis but averages over longer times are used (20 days and 60 days).

3.2. Sharpe analysis

The Sharpe ratio is a measure for the volatility of the stock values in relation to a larger control group. Figure 1 demonstrates this. The black line represents the value swings of a control group. On the New York Stock Exchange (NYSE) the Dow Jones Index (DJI) is such a control group index. The red line represents the value of an individual stock value. The individual stock is said to be more volatile when it reacts to market forces more strongly than the control group. In figure 1, the red line swings more profoundly than the control group and the peaks and valleys so it is more volatile, a less stable investment, than the market as a whole.

The volatility can be indicated by the Sharpe method. This is a linear regression model that relates both variables. Determining the Sharpe parameters works as follows. The fractional daily change of the individual stock (on the y-axis) is plotted as a function of the fractional daily change of the control group (on the x-axis) for that same day. This results in a scatter plot through which a linear regression line is drawn. The inclination of that line is a measure for the volatility; if it is higher than 1 the stock is said to be more volatile than the average of the control group, if it is lower it is less volatile.

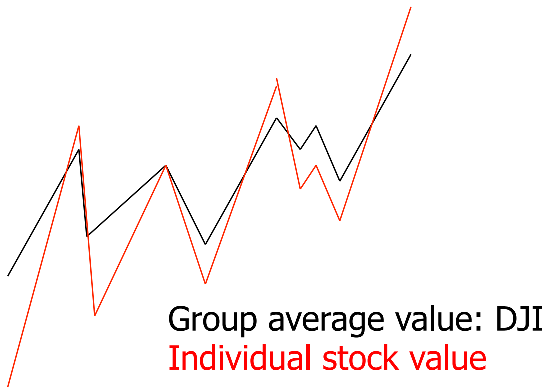

Figure 1: schematic representation of values: group and individual.

The papers in section 2 show that a catastrophe usually spurs a market reaction within days. This helps us decide on a time window for our analysis. Two time-frames are chosen for our analysis: the Sharpe value for 20 trading days after an incident (one month) and for 60 trading days (three months from the incident).

Three cases are investigated here: Deepwater horizon (DWH); the Texas City refinery explosion (TXC) and the Piper-α (PA) the most deadly incident in the history of oil exploitation.

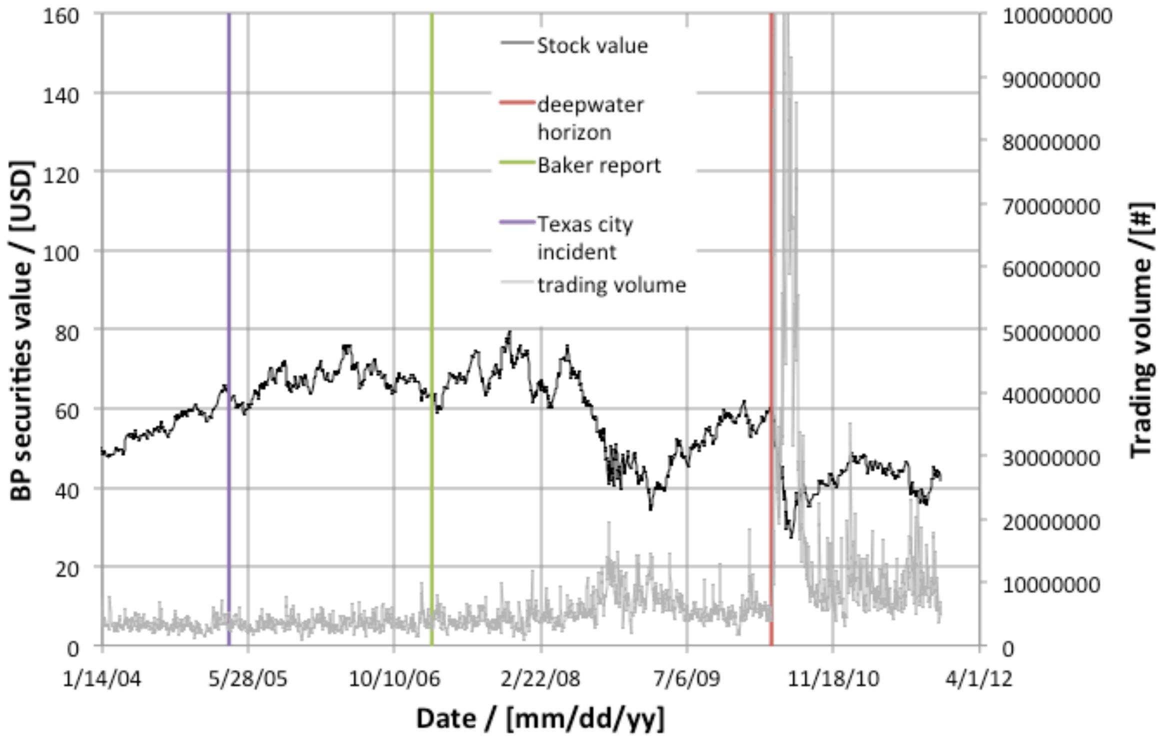

Figure 2: Historical data for BP Jan. 2004 – dec. 2011. The left vertical line indicates the date of the Texas city incident, the stock value decreases from 63$ to 59$. The right vertical line indicates the date of the Deepwater horizon incident, the stock value decreases from 60$ to 24$.

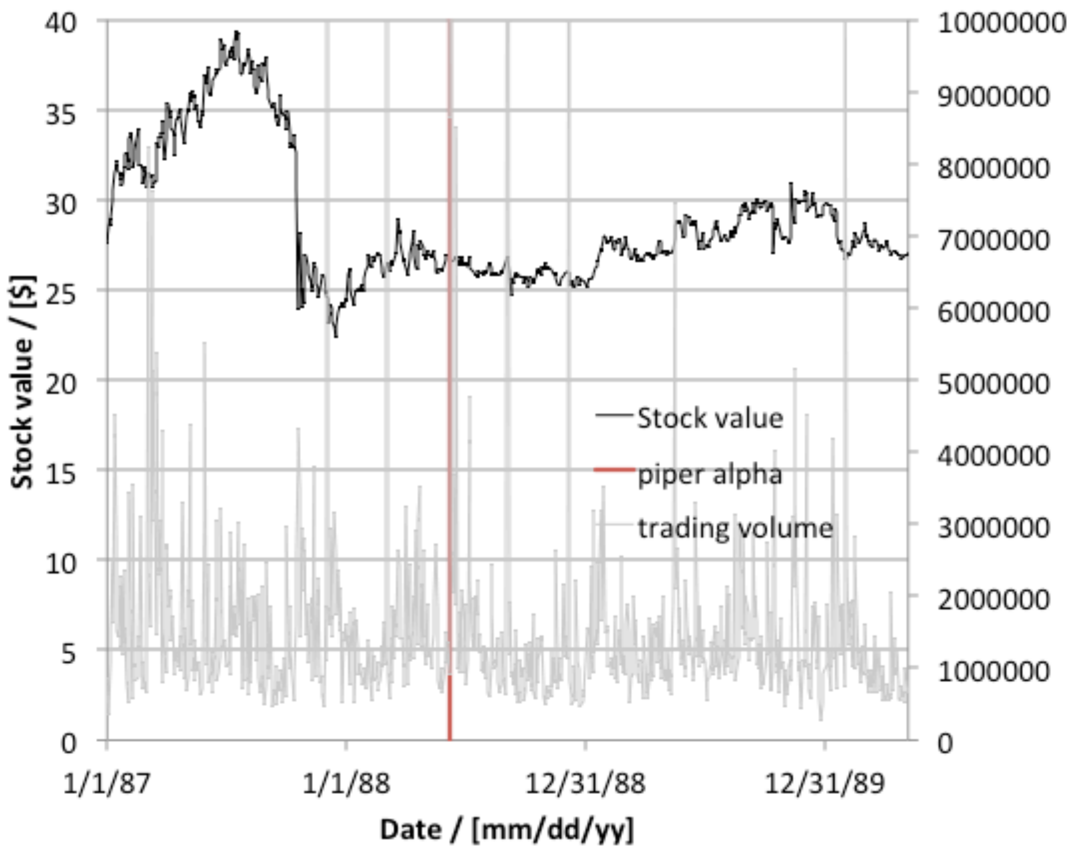

Figure 3: Historical data for OXYcorp Jan. 1987 – jan. 1999. The red line indicates the date of the Piper-α catastrophe, there is no significant stock value decrease.

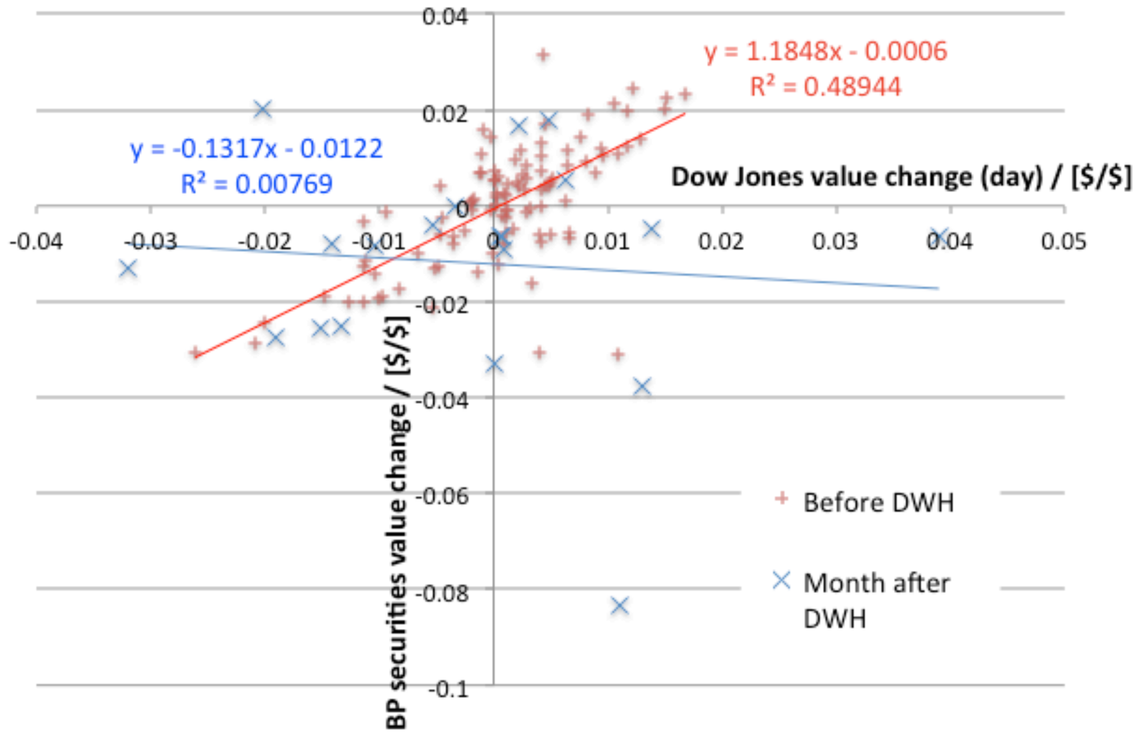

Figure 4: Sharpe analysis prior to and 1 month following the Deepwater horizon catastrophe: the slope drops from 1.18 to -0.13.

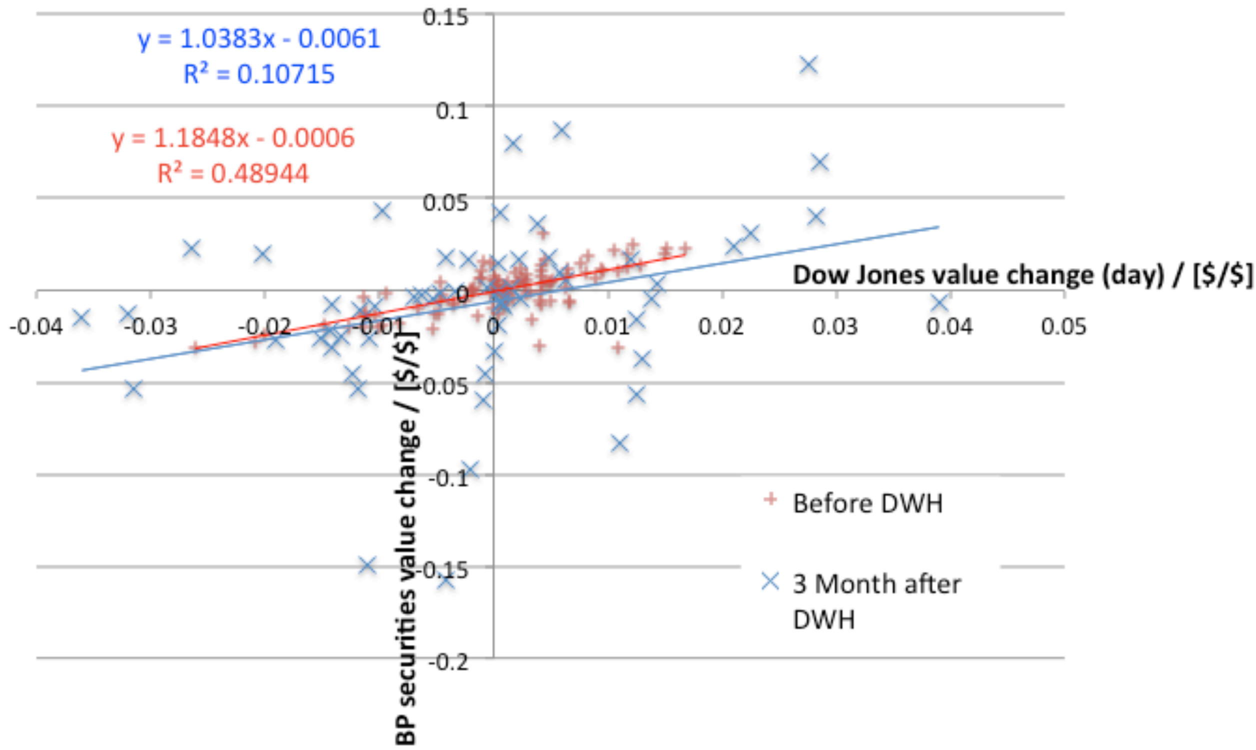

Figure 5: Sharpe analysis prior to and 3 months following the Deepwater horizon catastrophe: the slope recovers to 1.04, almost equal to before the incident.

4. RESULTS

Figure 2 shows the historical values of BP in US$ on the New York Stock Exchange. The left vertical line indicates the date of TXC. That incident caused a drop of only 4$ on 63$. DWH caused a steep decrease of the stock value: it dropped from 60$ to 24$. Note that the Baker report, which contained very negative image for BP in relation to the TXC incident, had a negligible effect. Figure 3 shows that OXYcorp, the owner of the Piper-α did not suffer any loss on its stock value despite the fact that their UK-branch went out of business.

Figures 4 and 5 show the Sharpe ratio's for DWH for twenty days of trading and for sixty days of trading respectively. The Sharpe ratio is 1.18 (R^2 = 0.48) before DWH, it drops to -0.13 (R^2 = 0.0077) in one month and recuperates to 1.04 (R^2 = 0.12) The short term effects on the Sharpe ratio for DWH is that it drops from 1.18 to -0.13 which indicates that the stock becomes detached from ordinary stock value fluctuations; it drops regardless of the Dow Jones index. With the Texas city catastrophe the same happens. The Sharpe ratio drops from 0.62 (R^2 = 0.15) to 0.36 (R^2 = 0.26) which indicates a change in the behavior of the traders (not shown in figures). The change in Sharpe ratio for the OXY-corp is also negative from 0.011 (R^2 = 0.009) to -0.17 (R^2 = 0.087) but the change is not significant (not shown in figures).

5. DISCUSSION

The literature search shows that catastrophes can have an effect on the stock exchange values of companies but this effect is not necessarily a decrease. The Exxon Valdez did not damage the stock exchange value for Exxon. This does not mean that there were no costs associated with the Exxon Valdez, but those costs can be borne by the company and they do not translate into losses for shareholders. Exxon was large enough to absorb the financial damage and there was no loss of (human) life. The literature search also shows that natural disasters can actually increase stock exchange values for insurers. As a rule, nuclear incidents have negative effects on stock exchange values; this is mostly due to the investors fear for additional (costly) safety measures that decrease the profitability of nuclear power. For a safety analyst many of these effects are counter-intuitive since the accidental loss of life is abhorred. For the stock exchange traders, it is simply the cost of doing business or as Herbst (1996) puts it: 'some would call the market cynical, while others would call it realistic'. If we would compare this behavior with Hudsons (2007) HSE culture ladder we would have to include a level below the pathological that would be characterized by 'anything goes as long as you don't go bankrupt'. We call this the indifferent level.

The BP cases show that if the Sharpe ratio is lowered in the month following the catastrophe. Apparently, the traders' trust in the company was lowered in the time immediately following the catastrophe. In the case of TXC the damage was too small to affect the company as a whole, in the case of DWH the effect threatened the existence of the company. Since the loss in stock exchange values was so large, it is remarkable that BP survived its initial market crisis.

This case study shows that the stock exchange value itself is an insensitive instrument and that using the Sharpe ratio is more sensitive to market unrest following a catastrophe. Below the relatively small effect on BP's value after TXC the Sharpe analysis detected some unrest amongst the traders in the first weeks following the accident. For reasons we do not fully understand the Sharpe ratio lowers after the incident; it could be due to uncertainty about the future finance of the company but also emotional responses to the loss of life could play a role. Either way, the behavior of the stock changes. It follows the normal market variations less well and thereby detaches from the ordinary market behavior. We hypothesize that the value of the stock becomes influenced by the incident rather than by the market forces alone. How this works exactly, we cannot tell from the limited number of cases that were analyzed. Also, the complexity of financial constructs for these companies complicates the interpretation. Still, in the case of PA, OXYcorp never experienced any loss of confidence from traders despite being held responsible for the most deadly accident of its kind. Despite that we hypothesize that if a market sensitive indicator for safety is sought, the Sharpe ratio is a better candidate.

Note that the effect on the stock value and the effect on the volatility of the stock were analyzed with a relatively simple instrument. The method is crude because our initial hypothesis was that a catastrophe would always be followed by a (strong) market response. In reality, the financial market is complex and the Sharpe ratio is only an indicator for unrest on the stock exchange market. From the mid 1990's the complexity increased because the variety of financial products to re-trade risks increased sharply. They may be packaged in a number of forms such as bonds, options, credit default swaps, loans and insurance. Also, joint-venture ownership of installations can distribute responsibility and financial burden. That could spread the financial burden over more than a single market player and thereby weaken the direct financial impact. A deeper analysis could reveal its influence. However, the company that is held responsible would still carry the operational cost of the accident and suffer most from negative attitudes making it most vulnerable and for which to stock price fluctuations are the most serious threat for the survival of the company. The papers in the literature review for this paper corroborate this view. Whatever the explanation is, it disproves our initial hypothesis that catastrophes lead to market capital loss. Finally, note that bonds, which are a kind of loans, tend to react more strongly to costly accidents since it threatens the possibility that the loans are paid back. Therefore, the bond market could be a candidate for a market sensitive indicator for safety.

To increase our insight, we used additional information for catastrophes that shed light on the stock values. Table 1 contains the estimated costs of catastrophes and the estimated value of the company. The information was gathered from internet sources and annual reports which makes these figures inexact. Note that the TXC and PA, whilst being mind-bogglingly large, are relatively small when compared to the total value of the company. Damages with Deepwater horizon and Bhopal were significant in relation to the total value of the company. In the last two cases, the damage to stock values was also extensive: for BP about 50,000M$ and for Union Carbide about 1,800M$. These kinds of costs force the market to react.

Table 1. Approximate values for company value and catastrophe cost with catastrophes

Catastophy	**Estimated Catastrophe cost**	**Company**	**Estimated Company value**	**Cost/value ratio**
Deepwater horizon	BP	40,000 – 60,000 M$[1]	111,000 M$[1]	40-50%
Texas City	BP	3,100M$[2]	100,000M$[1]	2-3%
Piper-α	OXY	1,300M$[3]	32,000M$[4]	4-5%
Bhopal	UC	1,300M$[5]	9,000M$[6]	14%

[1]: BP annual report 2010
[2]: Marsh (2010)
[3]: http://home.versatel.nl/the_sims/rig/i-expense.htm (accessed in Jan. 2012)
[4]: value for 2005 http://www.answers.com/topic/occidental-petroleum-corp#Wikipedia_on_Answers.com_d (accessed in Jan. 2012)
[5]: Garzia, A (1985) a cloud over Bhopal, http://www.grazian-archive.com/governing/bhopal/index.htm 4-12-2011 (accessed in Dec. 2011)
[6]: estimate derived from: McLaughlin, M. (1999) Dow and Union Carbide to merge: two companies that have profited from the deaths of thousands, http://www.wsws.org/articles/1999/aug1999/chem-a06.shtml (accessed in Dec. 2011)

Based on these findings, we hypothesize that that damages in the order of about 15% or larger have the potential to induce stock value losses for companies in the order size of 100,000 M$ in the chemical- or oil industry. Possibly, this is the kind of damage that such a company can absorb or trade-off to other financial risk bearers.

Even when we use this additional information, this initial investigation demonstrates that the relation between catastrophes and stock exchange values is not straightforward. Firstly, we did not find that catastrophes always influence stock exchange values. Something that we, being safety researchers, expected or better formulated: wished. Secondly, the negative Sharpe ratio suggests that the market does react to the incident in a sense that the stock becomes detached from ordinary market forces and an additional shaping force that is related to the accident enters the equation. We suspect that this is due to the incident but are unable to prove this with the current data. Third, we found it to be much more difficult to come by reliable financial data about catastrophes than we originally expected. Probably much of that data is kept from the general public and apparently the type of analysis that we are performing is not common. All these factors together make this investigation not only academically challenging but also relevant for companies and society as a whole.

6. CONCLUSION AND FUTURE WORK

The first and foremost conclusion is that there is no straightforward relation between stock values and catastrophes. This is contrary to our initial hypothesis. Historically, major multi-nationals have absorbed mindboggling amounts of financial damage in environmental and loss-of life catastrophes without apparent loss of market value. This is partly a characteristic of the industry: the demand for oil and chemicals is relatively stable and companies have stable income over long periods of time, even with when some misfortunes and loss of life occurs.

Though the stock exchange capital of a large chemical- or oil company does not exclusively exist of stocks they are important indicators for the overall performance of the company. The limited information in this work suggests that damages that exceed about 15% of the total value of a chemical- or oil company influences stock values negatively and depending on the financial situation of the company may become vulnerable for takeover or bankruptcy. The Sharpe ratio is negative for all catastrophes that were analyzed here which indicates that the value swings of stocks are influenced by the incident (but not necessarily lead to significant lowering of the stock). This makes the Sharpe ratio a better candidate for a market sensitive indicator for safety. A major multi-national chemical- or oil company that wishes to protect itself from hostile takeovers due to a drop in share values is wise to search for incidents that can cause damages in excess of about 15% of its total value as a relevant indicator in enterprise risk management. However, it is not likely to be a relevant indicator for the day-to-day safety performance of such a company.

The crude Sharpe method needs to be refined with the methods available in the econometric literature, including alternative financial risk transfer instruments. It is possible that this will yield better insight in the day-to-day behavior of the stocks after a catastrophe. It is unclear at this point whether this detailed information actually improves the insights but it could. Also, more cases need to be analyzed. This has to be done for two reasons. Firstly, more incidents give more insight into the effects of a catastrophe. Secondly, it is worthwhile comparing the fate of corporations in relation to the damage as percentage of the company as a whole. It seems likely that there is a relation between the size of the incident and the risk of ruin for a company. In addition to that, the bond market could be a candidate for a market sensitive indicator for safety since it is more directly related to the capacity of a corporation to pay back its loans.

Originally, the objective was to develop risk metrics for the integrated risk model for Shell to clarify the effects that local risks have on the company as a whole. It is unlikely that the effects of catastrophes on the stock exchange are a useful safety performance indicator to help managers decide on safety measures in their companies; the relation with day-to-day safety performance is too weak. The Sharpe ratio and bond value are better candidates but their usefulness it is uncertain since there is no evidence whatsoever that suggests that loss of life has any influence on these financial indicators.

Finally, we suggest that Hudson's (2007) HSE culture ladder requires a step below the pathological one to describe the safety culture on stock exchanges: the indifferent culture step. This step is characterized by 'anything goes as long as you are financially viable'. For the stock exchange traders, loss-of-life catastrophes are simply the cost of doing business or as Herbst (1996) puts it: 'some would call the market cynical, while others would call it realistic'.

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