Working Draft: In Press

Do industrial incidents in the chemical sector create equity market contagion?

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ABSTRACT

Purpose: This paper examines a number of US chemical industry incidents and their effect on equity prices of the incident company. Furthermore, this paper then examines the contagion effect of this incident on direct competitors.

Findings: This paper finds that the incident company experiences deeper negative abnormal returns as the number of injuries and fatalities as a result of the incident increases. The equity value of the competitor companies suffer substantial losses stemming from contagion effects when disasters occur causing ten or more injuries and fatalities, but benefit from the incident through increasing equity value when the level of injury and fatality is minor.

Practical implications: This research can be used as a resource to promote and justify the cost of safety mechanisms within the chemical industry, as incidents have been shown to negatively affect the equity value of the not just the incident company, but also their direct competitors.

Keywords: Chemical incidents, Stock markets, Contagion effects, Risk management, Event study.

JEL Classification: G14, G15, G32.

1 Introduction

This paper examines the influence a chemical related industrial incident has on the post-incident valuation of the company that experienced the incident, and whether the degree of influence on its direct competitors is closely related to the severity of the incident as identified by the number of injuries and fatalities. When a company experiences a headline-grabbing incident, like a chemical accident, its stock price typically falls (Capelle-Blancard and Laguna, 2010) due to anticipated costs of clean-up; lost business due to a non-operational plant; fines and penalties for environmental damage as well as potential lawsuits stemming from personal injuries and health concerns.

Capelle-Blancard and Laguna (2010) examine stock market reaction to industrial disasters using multivariate analysis – showing that stock market losses for incident companies are significantly related to the seriousness of the investigated incident, as measured by the number of casualties and the presence of an environmental pollutant. Klassen and McLaughlin (1996) and Rao (1996) also found that pollution incidents in the late 1980s and early 1990s were associated with significant drops in stock returns. Event studies, signalling similar results, have also been carried out for the Exxon-Valdex oil spill of 1989 and the Bhopal explosion of 1984 (Salinger, 1992; Herbst et al. 1996). Lee and Garza-Gomez (2012) investigated the Deepwater Horizon Oil spill of 2010 to find that stock market valuations indicated a $104.8 billion loss, but this recovered to a loss of $68.2 billion six months later when the well was permanently sealed. This was found to significantly outweigh the cost that BP allocated in its annual report of $40.9 million[1] (pre-tax). We can see clearly the substantial costs that are incurred from disasters of such a severe nature. To clarify the link between the transmission of news and the contagion effect, Kothari and Warner (2004) reported that more than 500 papers have been published in premium journals, showing that stock prices react as theoretically expected to news stories. This is a key idea in modern finance that stock prices react reasonably and promptly to news events.

The effect of such an incident on competitors' stock price is less clear. On the one hand, competitors may benefit from any break in operations of the incident company since consumers will shift their purchases to other firms. However, if the incident raises concerns about health and safety regulations being inadequate, this could lead to recommendations and/or requirements imposed on all firms within the sector, thereby raising the cost of compliance for all the firms in the sector. In other words, the impact of the incident on the competitors will depend on whether the incident is viewed as being adverse only to the incident company or whether the incident raises concerns about the entire industry overall.

Ho, Qui and Tang (2012) group these varying impacts on competitor firms' stock prices into two categories: a contagion effect and a switch effect. Investigating the effects of airline crashes on equity market contagion, they propose that the direction of the impact of aviation disasters on the stock price of the crash airline's rivals (competitors) depends on the interaction of the 'contagion' effect and the 'switch' effect. This paper adopts a similar approach and denoting reactions to incidents chemical companies in the same manner. If the 'switch' effect dominates, a chemical incident in one company can present an opportunity to its main competitors when

[1] This figure is taken from the 2010 BP Annual Income statement (BP plc ADS Annual Financials). In direct association with the incident, BP state: '*The group income statement for 2010 includes a pre-tax charge of $40.9 billion in relation to the Gulf of Mexico oil spill. This comprises costs incurred up to 31 December 2010 and estimated obligations for future costs that can be estimated reliably at this time*'.

consumers 'switch' their consumption away from the product provided by the chemical incident company to the products provided by its competitors. These gains in sales and reputational benefits, all of which are valued by financial markets, are likely to bring about a stock price increase for the competitor firms while the stock price of the incident company is expected to fall. Alternatively, the 'contagion' effect arises when the news of a chemical disaster also influences the business of the non-incident competitors, if it provokes the general public's concern towards their operating sector, or indeed has the potential to increase regulatory and future health and safety costs. This will have an adverse effect on the stock prices of the incident company and also on the stock prices of its main competitors

This study relates the degree of severity of chemical related industrial disasters to post-event stock price reactions of the incident companies and their main competitors. The size of the incident is classified based on the number of injuries and fatalities. The size of the incident may affect not only how the incident company's stock price is affected but also how the stock prices of its competitors behave. A small, localised incident may be more likely to result in a switch effect while a larger incident may generate a greater contagion effect due to greater adverse publicity towards the entire industry, leading to more calls for preventative measures and increased safety protocol. These measures may reduce stock valuations as they would be perceived as an increase in operating costs incurred by companies within the sector.

2. Data and methodology

The information on the U.S. industrial incidents that occurred between 2000 and 2013 was obtained from the U.S. Chemical Safety Board (CSB) database[2] and by completing a thorough search of the LexisNexis database[3] using a comprehensive list of key words. To be included in the study, companies must also meet the following criteria. First, they must be U.S. based companies listed on the NYSE or NASDAQ at the time of the incident. Second, the company must have at least 200 pre-event daily prices available. Thirdly, only the incidents that have caused injury and death to employees are investigated. To avoid confounding effects, our analysis eliminates the incident companies with other significant corporate events within five days of the incident. Non-incident companies are identified as those most directly related to the incident company through the nature of their operating business purposes, sector and market capitalisation. The closest related companies are selected to compare with the incident company. The final sample includes 60 industrial incidents with 580 non-incident companies. Stock price/return information for the study period was then extracted from Bloomberg.

Similar to Ho, Qiu and Tang (2012), the events were classified into three categories based on the degree of severity of the incident measured by the number of digits in the fatality figures. Inspired by the psychology literature, 10 and 100 were used as the cut-off fatality rates. Mitchell (2001) claims that the use of a decimal system suggests a natural tendency for people to think in terms of 10s and powers of 10, therefore grouping by the powers of 10 facilitates the mental ordering of the events and provides computationally convenient breaks between groups. Apart from reporting the actual numbers of deaths following an incident, the news media will often describe the seriousness of the event in terms of the number of digits of the injury and death

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[2] The United States Chemical Safety Board (CSB) website can be found at http://www.csb.gov/. The CSB acts as an independent federal agency charged with investigating industrial chemical accidents. It is headquartered in Washington DC, and the agency's board members are appointed by the President and confirmed by the Senate.

[3] The Lexisnexis database can be found at https://www.lexisnexis.com. It provides the most expansive collection of online content, including media coverage, which was used to identify the key statistics based on the chemical incidents included in this research.

toll. Therefore, we use 10 and 100 as the cut-off combined injury and fatality rate, which may reflect the psychological levels of the public's perceived seriousness of the event. Our low injury and fatality group consists of disasters with single-digit numbers of injuries and fatalities and involves 47 chemical-events and 464 non-incident companies. The medium injury and fatality group includes the disasters that injured or killed between 10-99 people and affects 10 chemical companies and 98 non-incident companies. The high fatality group contains disasters with three-digit numbers of injuries and fatalities and involves two companies and 20 non-incident companies. The non-incident companies are selected as the most comparative competitive companies to the company that experienced the chemical industrial incident. This is ranked by the nature of the industry, the associated sector and by the size of the company as represented by the market capitalisation level.

The stock market reaction to the incident is measured using event study methodology which is commonly employed in capital markets research. Event study methodology captures the abnormal returns (returns that cannot be explained by general market movements) and uses statistical tests to determine if the abnormal returns are statistically different from zero (Brown and Warner, 1980, 1985; Cowan, 1992). The date that the incident occurred is defined as the event day (day zero). If an incident occurred on a non-trading day or after market close on day zero, then the following day is used as day zero. The market model is estimated over the time interval from 230 to 30 trading days prior to the event. The abnormal return (AR_{it}) for company i as of event day t is defined as:

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

where R_{it} is the actual stock return on the ith company on day t, and R_{mt} is the return of the S&P 500 stock market index on day t. $\hat{\alpha}_i$ and $\hat{\beta}_i$ represent the regression constant and the coefficient of market returns for the 200 trading day market regression – providing evidence of the effects of short-term market dynamics for each company investigated. Non-trading days are excluded from the regressions. The coefficients are then used to regress the daily returns of the incident company at the time of the chemical incident to calculate results explicitly related to the event. The abnormal return (AAR_t) of a group of incident companies is calculated as:

$$AAR_t = \frac{\sum_{i=1}^{N} AR_{it}}{N}$$

The cumulative average abnormal return $\left(CAR_{T_1T_2}\right)$ over an event window between days T_1 and T_2 is:

$$CAR_{T_1T_2} = \frac{\sum_{i=1}^{N} \sum_{t=T_1}^{T_2} AR_i}{N}$$

To test for significance within our estimates, we have selected the Patell-test and the SIGN test. As the cross-sectional t-test does not account for event-induced variance and thus overstates significance levels, Patell (1976) suggested to correct for this overstatement by first standardising each AR_i before calculating the test statistic using the standardised AR_i. By cumulating these standardised abnormal returns over time, the test-statistic is defined as:

$$t_{Patell} = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \frac{CSAR_i}{\sigma_{CSAR_i}}$$

Where $CSAR_i$ represents the cumulative standardised AR_i. The sign test was proposed by Cowen (1992) and builds on the ratio of positive cumulative abnormal returns P_0^+ present in the event window. Under the null hypothesis, this ratio should not be significantly different from 0.5. The test statistic is represented as:

$$t_{SIGN} = \frac{p_0^+ - 0.5}{\sqrt{\frac{0.5(1-0.5)}{N}}}$$

3. Results

Table 1 shows that both incident and non-incident companies experience negative post-incident abnormal stock returns. A noticeable difference is that the stock prices of the non-incident companies reverse and tend to increase after the day of the incident, while the company that experienced the chemical incident causing injury and fatality tends to experience a significant increase in abnormal returns for 15 days. Panel A shows that incident companies tend to lose 0.60% of their market value on the incident date and this loss is statistically significant. Panel B shows that the non-incident companies lose 0.33% of their market value on the crash date, but this reverts with gains of 0.23% and 0.51% on the following two days respectively. Figure 1 demonstrates their cumulative abnormal returns (CARs) over the next 30-day post-event window.

Table 1
Post-chemical incident abnormal returns.

Date	AR	Patell test	Sign test	Window	CAR	Patell test	Sign test
Panel A: Incident companies							
0	-0.60	3.53***	-2.10**	(0,0)	-0.60	-1.26	-2.77***
+1	-0.86	3.23***	-1.92*	(0,1)	-1.46	-1.09	-4.08***
+2	-0.08	2.60***	-1.15	(0,2)	-1.54	2.05**	-5.40***
+3	-0.16	2.55**	-1.61	(0,3)	-1.70	-3.01***	-3.27***
+4	0.11	1.18	-1.17	(0,4)	-1.59	2.06**	-1.59
+5	-0.14	-1.43	-2.03**	(0,5)	-1.74	0.14	-2.08***
+10	-0.05	0.16	-2.44**	(0,10)	-1.61	-2.01**	2.22***
+15	0.13	1.25	-2.01**	(0,15)	-2.35	1.17	-1.56
+20	0.13	1.07	-2.31**	(0,20)	-1.50	-1.43	-1.26
+25	-0.19	-1.18	-4.98***	(0,25)	-1.18	5.18***	-1.88***
+30	0.03	1.65*	-3.66***	(0,30)	-1.24	5.47***	-1.48
Panel B: Non-incident companies							
0	-0.33	2.43***	-1.83*	(0,0)	-0.33	1.95*	-1.83*

+1	0.23	2.17**	-2.38**	(0,1)	-0.10	-2.38**	-2.31**
+2	0.51	2.73***	1.12	(0,2)	0.40	-5.52***	-2.66***
+3	-0.23	2.75***	-1.79*	(0,3)	0.17	-2.99***	1.49
+4	-0.14	1.28	-1.81*	(0,4)	0.03	-2.86***	1.49
+5	0.20	1.14	-0.94	(0,5)	0.24	2.44**	4.88***
+10	-0.11	1.90*	-2.73***	(0,10)	1.54	3.16***	4.65***
+15	0.33	0.72	-1.96**	(0,15)	1.61	2.06**	6.08***
+20	0.31	2.61***	-1.21	(0,20)	2.17	1.02	1.56
+25	0.15	3.36***	-5.83***	(0,25)	2.28	1.08	2.58***
+30	0.03	2.54**	-3.64***	(0,30)	2.28	2.07**	3.78***

AR is the average abnormal return and CAR stands for cumulative average abnormal return. Figures are reported in percentage rate terms. *, **, and *** represent statistical significance at the 10%, 5% and 1% levels respectively.

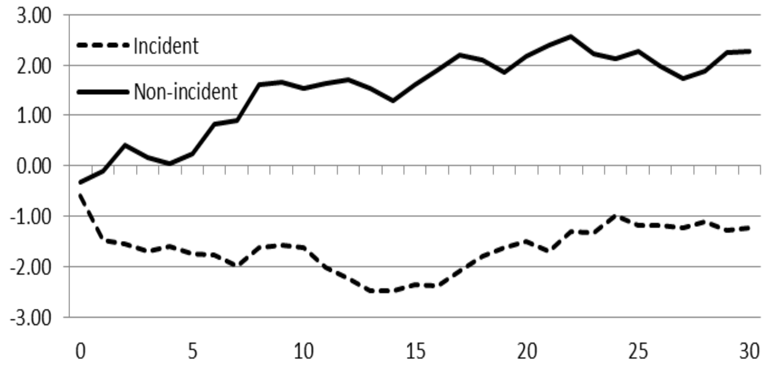

Figure 1. Post-chemical incident CARs for all investigated companies

Table 2 shows that the investors of the incident companies suffer larger losses on the incident date as the number of people injured or killed increases. As expected, the largest incidents are associated with the largest abnormal returns. The initial response to a comparatively small event is in line with that of a large event for the first day after the incident, but the abnormal returns of events with 1-9 injuries and fatalities reverts, though the CAR remains negative for 30 days after. Larger events experience longer term negative ARs. Specifically, the average abnormal return of the incident company on the event date for single-digit disasters (panel A) is as low as -0.85% compared to -0.64% for the double-digit disasters (panel B) and -1.37% for the triple digit disasters (panel C). Over time, these abnormal returns tend to be more persistent when the event is more severe. After thirty days, the abnormal return for single-digit disasters is -3.10%, for double-digit disasters -4.01% and for triple-digit disasters -5.80% (with the most significant negative abnormal returns of -8.20% twenty days after the incident). Figure 2 reveals the same findings with the largest injury and fatality incidents related to the largest negative abnormal returns. The negative abnormal returns for low and medium injury and fatality companies tend to disappear between 35 and 40 days after the incident, whereas the effects of large events last for between 40 and 45 days after the events.

Table 2
Abnormal returns of chemical incident company ranked by injury and fatality.

Date	AR	Patell test	Sign test	Window	CAR	Patell test	Sign test
Panel A: Low injury and fatality companies							
0	-0.84	1.65*	-1.87*	(0,0)	-0.84	-1.00	-1.87*
+1	-1.07	1.14	-2.81***	(0,1)	-1.90	1.41	-3.34***
+2	0.15	-2.74***	-3.57***	(0,2)	-1.75	1.71*	-0.73
+3	0.35	1.60	-1.36	(0,3)	-1.40	2.16**	-1.91*
+4	-0.05	2.23**	-1.98**	(0,4)	-1.45	2.36**	-1.10
+5	0.20	2.73***	-3.62***	(0,5)	-1.26	2.45**	-1.46
+10	0.18	1.38	-4.56***	(0,10)	-0.96	3.16***	-2.36**
+15	0.38	1.24	-4.79***	(0,15)	-2.10	3.87***	-3.48***
+20	-0.40	2.24**	-6.00***	(0,20)	-3.40	2.47**	-4.56***

+25	0.28	1.88*	-2.55**	(0,25)	-3.42	3.17***	-3.55***
+30	0.15	1.44	1.11	(0,30)	-3.10	1.80*	-4.88***
Panel B: Medium injury and fatality companies							
0	-0.64	2.88***	-1.13	(0,0)	-0.64	-1.42	-2.37**
+1	-0.54	1.41	-1.47	(0,1)	-1.18	1.75*	-3.26***
+2	0.05	1.73*	-0.89	(0,2)	-1.13	1.73*	-4.39***
+3	-0.16	1.31	-1.61	(0,3)	-1.29	2.84***	-4.98***
+4	0.02	2.23**	-1.35	(0,4)	-1.26	2.82***	-6.04***
+5	-0.15	3.27***	-2.05*	(0,5)	-1.41	2.44**	-5.91***
+10	-0.17	0.28	-3.00***	(0,10)	-3.44	1.72*	-1.76*
+15	-0.24	1.45	-4.08***	(0,15)	-3.78	3.97***	-2.34**
+20	-0.10	4.47***	-3.79***	(0,20)	-4.00	4.47***	-2.85***
+25	0.36	2.01**	-1.02	(0,25)	-4.00	4.12***	-3.81***
+30	-0.08	-1.46	-4.47***	(0,30)	-4.01	3.55***	-3.49***
Panel C: High injury and fatality companies							
0	-1.37	2.02**	-1.33	(0,0)	-1.37	2.29**	-3.39***
+1	-1.49	2.60***	-2.21**	(0,1)	-2.86	2.41**	-2.45**
+2	-0.29	1.65*	-0.70	(0,2)	-3.15	2.71***	-4.65***
+3	-0.05	-1.07	-0.37	(0,3)	-3.20	2.24**	-1.34
+4	-0.20	1.51	-1.56	(0,4)	-3.40	2.64***	-3.12***
+5	-0.64	1.03	-1.96**	(0,5)	-4.04	2.82***	-1.64
+10	-0.52	1.10	-1.43	(0,10)	-4.73	3.16***	-1.65*
+15	-0.37	0.72	-1.65*	(0,15)	-5.87	-2.11**	-1.42
+20	-0.45	2.37**	-5.69***	(0,20)	-8.20	-2.48**	-2.46**
+25	0.14	1.60	-1.54	(0,25)	-7.40	-1.96**	-2.77***
+30	0.64	2.67***	-2.71***	(0,30)	-5.80	-1.55	-2.86***

Incidents leading to less than 10 injuries and fatalities are included in low injuries and fatalities. Incidents that have caused between 10 and 99 injuries and fatalities are included in the medium injuries and fatalities. The high injuries and fatalities panel includes all incidents that caused the injury or death of over 100 people. AR is the average abnormal return and CAR stands for cumulative average abnormal return. Figures are reported in percentage rate terms. *, **, and *** represent statistical significance at the 10%, 5% and 1% levels respectively.

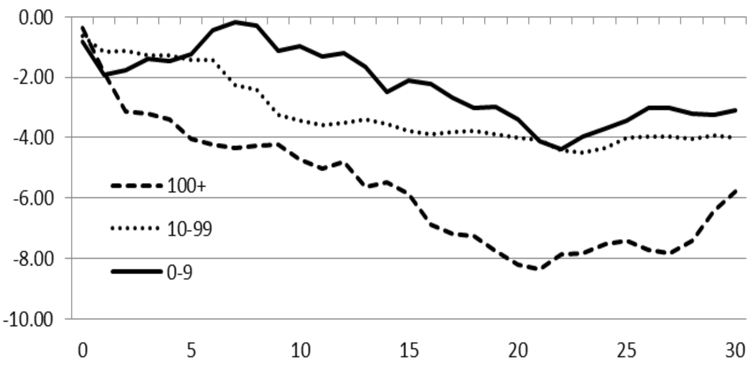

Figure 2. Degree of injury and fatality and cumulative abnormal returns for incident companies

Table 3
Abnormal returns of non-chemical incident competitor company ranked by injury and fatality.

Date	AR	Patell test	Sign test	Window	CAR	Patell test	Sign test
Panel A: Low injury and fatality companies							
0	0.05	3.16***	-1.67*	(0,0)	0.05	-1.72*	-1.67*
+1	-0.02	2.56**	0.71	(0,1)	0.04	-3.44***	-1.56
+2	0.10	-0.68	-1.75*	(0,2)	0.14	-1.86*	-1.50
+3	-0.01	-1.00	-1.49	(0,3)	0.12	-1.23	-2.11**
+4	0.00	-2.48**	-1.67*	(0,4)	0.13	-0.97	-2.67***
+5	0.00	0.56	-3.00***	(0,5)	0.12	2.44**	-3.16***
+10	-0.17	2.76***	-2.93***	(0,10)	0.33	3.16***	-0.80
+15	0.06	-0.87	-3.11***	(0,15)	0.41	3.87***	1.06
+20	0.05	-1.06	-3.52***	(0,20)	0.70	2.36**	-2.62***
+25	0.07	0.33	-4.87***	(0,25)	0.94	5.64***	-3.87***
+30	-0.08	0.94	-2.72***	(0,30)	0.82	1.49	-4.29***
Panel B: Medium injury and fatality companies							
0	-0.42	2.53**	-1.92*	(0,0)	-0.42	-1.81*	-0.92
+1	-0.38	1.89*	-1.25	(0,1)	-0.80	1.41	-1.84*

+2	-0.86	2.11**	-2.73***	(0,2)	-1.66	1.73*	-4.32***
+3	0.13	1.17	-0.91	(0,3)	-1.54	1.08	-4.99***
+4	-0.23	1.42	-2.06**	(0,4)	-1.76	-1.04	-6.39***
+5	0.31	1.97**	-1.55	(0,5)	-1.45	1.24	-6.16***
+10	-0.07	3.16***	-2.54**	(0,10)	-2.74	2.40**	-1.45
+15	0.09	1.04	-2.25**	(0,15)	-1.30	-1.07	1.82*
+20	0.07	0.95	-2.70***	(0,20)	-0.92	-2.99***	-1.89*
+25	0.31	5.63***	-1.38	(0,25)	-1.90	5.84***	-1.69*
+30	0.20	5.47***	-2.32**	(0,30)	-1.20	-1.11	-1.31
Panel C: High injury and fatality companies							
0	-1.92	3.82***	-0.54	(0,0)	-1.92	-3.88	-0.65
+1	-0.43	1.77*	-0.73	(0,1)	-2.35	-6.17	-0.45
+2	0.35	2.79***	-1.25	(0,2)	-2.00	-6.19	-1.20
+3	-0.11	-1.36	-2.98***	(0,3)	-2.11	-4.80	-1.05
+4	-0.09	1.42	-2.54**	(0,4)	-2.20	-3.23	-1.91
+5	-0.05	0.71	-2.44**	(0,5)	-2.25	-1.65	1.15
+10	0.12	2.54**	-2.71***	(0,10)	-3.04	3.16	-0.76
+15	-0.09	2.12**	-2.41**	(0,15)	-3.19	3.87	-1.49
+20	-0.41	1.43	-2.86***	(0,20)	-4.39	4.47	1.26
+25	-0.06	1.91*	-3.01***	(0,25)	-4.94	5.30	3.11
+30	0.14	3.66***	-4.46***	(0,30)	-5.05	3.22	2.47

Incidents leading to less than 10 injuries and fatalities are included in low injuries and fatalities. Incidents that have caused between 10 and 99 injuries and fatalities are included in the medium injuries and fatalities. The high injuries and fatalities panel includes all incidents that caused the injury or death of over 100 people. AR is the average abnormal return and CAR stands for cumulative average abnormal return. Figures are reported in percentage rate terms. *, **, and *** represent statistical significance at the 10%, 5% and 1% levels respectively.

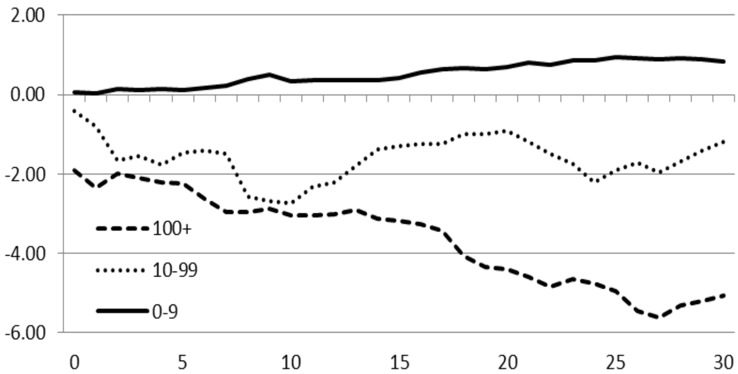

Figure 3. Degree of injury and fatality and cumulative abnormal returns for non-incident companies

Figure 3 shows that the direction of the impact of chemical disasters on the stock prices of non-incident companies is determined by the relative importance of the 'switch' effect and the 'contagion' effect. These companies were selected as those most directly related to the incident company in terms of sector, business type and size (market capitalisation). It is expected that the 'switch' effect dominates the 'contagion' effect when the fatality figure is minor while the 'contagion' effect begins to dominate the 'switch' effect as injuries and fatalities increase. In the first scenario, competing companies may benefit from the incident company's misfortune, potentially obtaining new business, increased sales and perhaps enhanced reputation. But with larger incidents, this scenario may change as incidents of this size and nature may be met with increased regulation, increased safety standards and associated costs and detrimental reputational effects. In this scenario, increased regulation and a focus on health and safety may be seen as a significant increase in company costs; therefore, leading to a contagion impact on the non-incident company's equity value.

Table 3 presents the test of this hypothesis. Panel A shows that both the ARs and CARs for the low-injury and fatality chemical incidents are consistently positive, suggesting that investors perceive that a small incident with a low injury and fatality toll may benefit the non-incident company due to the benefits described. On the contrary, as the number of people injured and killed exceeds 10, investors begin to adjust their valuations of the non-incident competitive companies. The consistently negative CARs of the non-incident companies reported in panels B and C above clearly provide supportive evidence for the argument that the 'contagion' effect prevails in large-scale disasters.

Conclusion

The stock market performance of companies who have experienced chemical related industrial incidents causing different levels of injuries and fatalities was examined. The results show that investors perceive differently the degree of severity with which these incidents influence the stock prices of the incident company and its main competitors. The incident company suffers larger losses in equity value than their competitors when the chemical incident occurs. When less than 10 injuries and fatalities occur, the non-incident competitors share price increases after an initial fall, lasting for two days, after the event. One explanation is that competitor profits may increase substantially from increased sales and the absence of legal cost and reputational damage, thus offering more feasible alternative exposure to the sector for investors.

At higher levels of injury and fatality, denoting more serious chemical incidents, the stock prices of competitor companies are found to contain significant ARs, indicating a strong presence of contagion effects within the sector. In this situation, investors may perceive long term sectoral reputational damage stemming from the incident, combined with reduced company profits stemming from costs associated with an increased focus on the legislation and the creation and implementation of more stringent health and safety measures in the period after the incident.

At a time when cost cutting measures are being implemented to increase the probability of company survival through financial crisis, it can become difficult to justify greater expense on health and safety and risk mitigation measures. However, this paper shows that the cost of the incident is not exclusive to lawsuits and compensation claims, but must also include the deep equity market damage associated. The incident does not only have to be within the incident company, as contagion effects from health and safety negligence by direct competitors can also have deep negative effects on the non-incident company's finances. Therefore, there is a collective need for increased focus on health and safety and risk management across the entire chemical industry rather than pressures on individual firms to meet standards.

In terms of regulation, when complemented by government penalties, the findings in this paper present evidence that financial markets are self-regulating when chemical disasters occur. Prices adjust for the severity of the incident, not just for the company responsible for the incident, but for their main competitors within the sector.

Some incidents may well have wider implications for other industries and society in general and this needs to be investigated further. Moreover, other firm-specific characteristics as well as prior history of similar incidents may influence how the investors react – prices for companies with a history of such incidents may already reflect the expectation of such incidents in the stock price so that the investors will react only if the incident is strikingly different from previous incidents in size or scope. Again, this is something that needs to be investigated further in order to enhance our understanding of the implications of such incidents on the pricing of such risk.

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