How does the stock market respond to chemical disasters? A worldwide analysis *

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Abstract

In this paper, we examine the stock market reaction to 64 chemical disasters over the period 1990-2005. On average, petrochemical firms in our sample experienced a drop in their market value of nearly 1% the day of the accident and of 1.40% over the first week. The equity value decline is significantly related to human harm, and to chemical pollution. Besides, firms experiencing accidents in the US and in Japan incur a higher decline in equity returns, as well as firms that experienced accidents since 2000 by contrast with the 1990s. Thus, our results shed light on the current debate about the stock market's role as an enforcer of environmental regulation.

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Preliminary version

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1 Introduction

Chemical disasters are one of the major technological risks that modern societies face. Such accidents directly affect firms' revenues by disrupting their production process, but they also generate negative externality on health and ecosystems. Catastrophes like the explosion in Seveso (Italy) in 1976, the release of toxic gas in Bhopal (India) in 1984, or the explosion of a BP refinery in Texas (US) in 2005 clearly illustrate the enormous risk potential of petrochemical plants. These catastrophic accidents were very well publicized, but they are only the visible part of the iceberg. On average, an accident in the petrochemical industry occurs every 86 minutes in the United States, where each year chemical disasters kill 23 employees and injure 1,000, according to the National Environmental Law Center and the Wharton Risk Management and Decision Processes Center. In Europe, between 1971 and 2005, there was about 30 technological accidents that each resulted in 25 or more fatalities. For the rest of the world, there is no publicly available data, but as regulatory standards outside the USA and Europe are less stringent, it is reasonable to expect that industrial accidents there are at least as frequent and cause at least as many serious injuries and deaths.

Central to the debate over the need for government regulation of technological risks is the question of the incentive the private market could provide companies to take appropriate measures, comply with safety standards, or innovate in order to prevent accidents. A number of studies examine this issue. They use event-study methodology to assess to what extent shareholders react to firm-specific environmental news. Such news concerns the US Toxic Release Inventory (*e.g.* Hamilton, 1995), public disclosure programs in developing countries (*e.g.* Dasgupta, Hong, Laplante and Mamingi, 2004), lawsuits for environmental violations (*e.g.* Lanoie and Laplante, 1994, Karpoff, Lott and Wehrly, 2005), or broad sets of pollution news (*e.g.* Klassen and McLaughlin, 1996). Futhermore, a number of papers examine specific accidents: Three Mile Island (*e.g.*Bowen, Castanias, and Daley, 1983), Bhopal (*e.g.* Salinger, 1992), Chernobyl (*e.g.* Kalra, Henderson, and Raines, 1993)), Exxon-Valdez (*e.g.* White, 1996)...[1] However, to the best of our knowledge, there is no global approach to the phenomenon of chemical disasters. This paper seeks to fill this gap.

The aim of this paper is to examine the stock market response to chemical disasters. To do this, we build an original sample of 64 explosions in chemical plants and refineries worldwide for 1990-2005. The software *Factiva* (which covers more than 10,000 news titles) was used to search in a systematic way for the press articles mentioning companies responsible for industrial disasters. We also build a number of variables of interest featuring the social consequences of each disaster, such as their effect on health and the environment. On average, half of the accidents provoked at least one serious injury or death, and a quarter of them resulted in a toxic release. The advantage of such large dataset is twofold: it greatly improves the statistical significance of our assessment of the stock market reaction and, at the same time, it allows to examine the determinants of the market reaction.

The first part of the econometric analysis is dedicated to a global event-study. We assess losses incurred by shareholders, as well as shifts in the systematic risk of petrochemical firms experiencing a disaster. As firms carry insurance against most direct costs, the decline in firm value is likely to be related to costs that are uninsured. Indeed, in practice, firms are not insured against a wide range of costs related to accidents. Moreover, on the event of accidents, stakeholders are very likely to modify their belief about the safety of a particular plant or of the industry in general (insurance premiums may increase; the public authorities may reinforce regulations; customers, employees, suppliers and investors may abandon firms, etc.). Overall,

[1] See Capelle-Blancard and Laguna (2007) for a survey.

our results indicate that firms do incur a financial loss in the event of chemical disasters. Three out of four accidents in our sample are associated with negative abnormal returns, and only a small portion of them (17%) are followed by statistically significant losses. It is not really surprising that, *individually*, significance is difficult to detect given the stock returns volatility. Fortunately, since our dataset is large, we are able to draw *global* significance. On average, abnormal returns amount to -0.94% the day of the accident and to -1.40% the first week. This remains true even if we exclude the main accidents. In conclusion, the adverse effect on stock price is not peculiar to some (huge) accident.

In a second part, we attempt to explain the variability in abnormal equity returns. We find that the number of fatalities and serious injuries as well as incidental pollution increase the magnitude of market losses. Moreover, our results show that bigger firms incur lower losses and that disasters in the US and Japan are associated with higher losses. Finally, we find that equity losses have increased since 2000.

The paper is organized as follows. Section 2 describes the data and the key indicators. Event study results are discussed in Section 3. Cross-section analysis of abnormal returns is presented in Section 4. The paper concludes with a summary in Section 5.

2 Description of the data

2.1 The sample of accidents

The aim of this paper is to provide robust empirical evidence on the stock market reaction to chemical disasters. Unfortunately, there is no global, publicly available list of the major chemical disasters that disclose the names of companies responsible for disasters. Some countries list industrial accidents[2], but, due to a principle of commercial confidentiality, the names of companies responsible for accidents are not usually disclosed, at least outside the US. Note that this is all set to change with recent environmental policies aimed at disclosing pollution records, in order to inform consumers, shareholders and citizens and thereby facilitate their choice of socially responsible firms. To cite an example, we can mention, in the European Union, the *REACH* program for chemicals.

To identify the chemical disasters, we compiled a corpus of print media articles for the period 1990-2005. Note that all accidents considered in the literature so far occurred in the 1980's. Since then, many rules and regulations designed to prevent such disasters have come into effect, and in this respect it is interesting to investigate the stock market response to industrial accidents in the 1990s and 2000s.

A systematic search using the software *Factiva search 2.0 Beta* was carried out. The software *Factiva search 2.0 Beta* covers all major newspapers and publications in the world. We selected all news articles written in English (over 10,000). The search was carried out using two keywords: "explosion" and "chemical plant", and excludes all accidents reported by newspapers before 1990 and after 2005. Obviously, since the media focus attention on the more serious chemical disasters, there is a selection bias, and our sample understates the number of chemical explosions that have occurred since 1990. Using the two keywords, we started with about 200 events. Of these, two-thirds were eliminated because they do not involve publicly traded companies (they concerned state-owned companies, illegal factories, etc.).

Datastream, which covers more than 75% of publicly listed companies in the world, was used to identify a sample of 38 publicly traded companies responsible for the remaining 64 accidents.

[2]For instance, in Europe, since the accident of Seveso in Italy in the mid-seventies, all firms are obliged to notify accidents to public authorities. In the US, the Environmental Protection Agency provides a complete list of chemical accidents that have occurred in the US since the 1990s.

Half of the firms are big multinationals and are among the 50 biggest firms in terms of sales. [3] In our sample, there are also smaller firms which have sales below US$2 million: Daiichi Pharm., Lubrizol, Crompton, Albright&Wilson, Guerbet, and Lonza Group. Their shares are listed on the stock markets of ten developed countries (Australia, France, Germany, Japan, Netherlands, Norway, Spain, Switzerland, United Kingdom, the United States) and two emerging countries (South Africa and South Korea).

The list of accidents and a brief description of each is presented in the Appendix.

2.2 The features of accidents

The distinctive characteristics of accidents are also drawn from print media. We consider indirect speeches by local populations, public authorities, unions and company spokespersons, environmental interest groups, citizens' groups, fire brigades, the police, etc., as reported in newspaper articles. We group information into several indicators. Table 1 reports descriptive statistics on the economic, environmental and human effects of accidents.[4]

Pollution. In our study, pollution is measured by a dummy equal to one if we have information that the accident resulted in a toxic release. Chemical releases are classified as toxic on the basis of the statements issued by the authorities, environmentalist groups, and the companies themselves. For instance, the authorities state that "no dangerous chemicals were released into the air" (March 1992, Dow Chemical); or that "more than 10 tons of poisonous chemicals were released" (February 1993, Hoescht). Overall, we assess that in one quarter of the accidents, the chemical release was toxic enough to contaminate the environment.[5] The toxic release dummy variable is poorly and negatively correlated with media coverage (-0.05).

Human harm. More than half of the accidents resulted in at least one fatality and a serious injury. The average number of fatalities and serious injuries is 2.6. Note that only injuries that were listed as "in serious condition" are included.[6] The number of fatalities and serious injuries is weakly correlated with their media coverage (0.54).

Firm Newsworthiness. The news coverage of disasters may depend on whether at the time of the accident the firm which is responsible for the disaster is of major concern for journalists. In the same way, Hamilton (1995) intends to control for companies whose TRI receive media coverage during 1989, and uses as an exogenous dummy to explain the abnormal returns of each firm following the publication of the TRI. The problem is that in order to measure the effect of the news coverage of a disaster on the subsequent abnormal returns, we need to counter an obvious simultaneity bias. This bias is due to the fact that the news coverage of a disaster depends on the same variables, such as the number of fatalities, pollution cases, etc. Given the difficulty to find valid instruments, the newsworthiness of firms shortly before the disasters is used instead. To do this, we compute the number of newspaper headlines that mention the company in the twenty days before the accident.[7] It is reasonable to believe that the biggest

[3] They include the following firms, listed by ranking: Dow Chemical, BASF, Royal Dutch Shell, Exxon Mobil, Total, Bayer, BP, Mitsubishi Chemical, Mitsui Chemical, Akzo Nobel, Sumitomo Chemical, Air Liquide, DSM, Asahi Kasei, Yara, Rohm and Haas, Sasol, Rhodia, LG Petrochemical. Source: The Annual Survey of the American Chemical Society, Chemical & Engineering News (July 24, 2006).

[4] Table 8 in the Appendix gives the correlation matrix between variables.

[5] We also attempted to proxy the social cost of accidents using the number of nearby residents that were evacuated or warned to stay indoors as a precaution, but information was too limited.

[6] We also built a variable for the number of minor injuries, for all injuries that are not reported as serious, but this variable does not change the results.

[7] Cormier and Magnan (2007) use a very similar variable, called the "firm media exposure" as an explanatory variable to explain the news environmental voluntary reporting strategy of firms. They compute the total number of news stories referring to a particular firm's environmental activities in a given year; on the same as well as in distinct events.

Table 1: **Descriptive statistics for the sample of chemical disasters**

The sample is composed of 64 accidents in the petrochemical industry over the period 1990-2005. Accidents are identify using the software Factiva search 2.0 Beta. Only publicly listed firms are considered.

	#	Mean	Median	Std. Dev.	Min	Max	Expected effect on firm market value
Variables of interest							
Ser. injuries and fatalities	64	2.36	1	4.76	0	30	–
Toxic release	64	0.23	0	0.43	0	1	–
Variables of control							
# previous accidents	64	0.73	0	1.13	0	5	–
Dummy year > 1999	64	0.36	0	0.48	0	1	?
Firm Newsworthiness	64	0.06	0.05	0.03	0	0.2	?
Country of listing							
US	64	0.36	0	0.48	0	1	?
EU	64	0.32	0	0.47	0	1	?
Japan	64	0.11	0	0.31	0	1	?
Emerging countries	64	0.06	0	0.24	0	1	?
Country of accident							
US	64	0.39	0	0.49	0	1	?
EU	64	0.33	0	0.47	0	1	?
Japan	64	0.12	0	0.33	0	1	?
Emerging countries	64	0.06	0	0.24	0	1	?
Financial variables							
Sales (in log)	64	9.32	9.15	1.65	5.17	12.52	?

Abbreviations: Ser. injuries and fatalities: Number of serious injuries or fatalities; Toxic release = 1 if the accident provoked a toxic release and 0 otherwise ; Dummy year > 1999 = 1 if the accident occurred after 1999 and 0 otherwise. See the text for further details concerning the sample and the variables; *Firms Newsworthiness*: ratio of headlines mentioning the firm over twenty days before disasters to the total number of headlines received in the previous year (Factiva database).

firms are more "newsworthy" (*i.e.*, they receive more headlines) overall. Therefore, to avoid multicollinearity problem in our regressions, we use the variable *Firms Newsworthiness* which measures the ratio between the number of headlines that mention the firm in the twenty days before a disaster and the total number of headlines received in the previous year. As expected, the *Temporary Firms Newsworthiness* is equal to 5.5% on average, but it varies between 0 and 20%. This confirms that some firms happen to be more newsworthy than others at the time of disasters.

Countries. We expect that structural differences between countries may be relevant, as are differences in environmental liability (see Clarke, 2001), differences in the stringency of regulation (see Hammit et al., 2005), and differences in legal origin (see La Porta et al., 2002). Thus, we introduce six country dummy variables to control for: *i)* firms listed in the US; *ii)* firms listed in the European Union; *ii)* firms listed in Japan; *iii)* accidents that occurred in the US; *iv)* accidents that occurred in Europe; and *ii)* accidents that occurred in Japan.[8]

Time and previous occurrences. We use dummy variables to control for the period in which the disasters occurred. Several period lengths are tested in order to capture correctly the time effect: dummies are set equal to one if the accident occurred in the period before 1995, between 1995 and 1999, between 2000 and 2005, and also in the whole period before 2000. We also include a variables to measure the number of accidents previously experienced by each firm in our sample.

Economic variables. We control for the size of firms. Size is measured by the log of sales (in US$ million) the first year before the accident. We can assume that investors pay more attention, and are likely to be more sensitive, to accidents sustained by big firms. However, as the shares of small firms are less liquid, the impact of an accident in a small firm may be more severe. Moreover, small firms do not have the same opportunity as big firms to reallocate their production across plants in order to fulfill their contracts in the event of an accident.

3 Equity returns losses following chemical disasters

Studies on the financial cost of catastrophic events usually focus attention on a specific and notable event (see Capelle-Blancard and Laguna (2007) for a comprehensive survey). All these papers use the event-study methodology. The event study methodology is briefly reviewed in the first subsection. We then provide evidence of average equity value losses for the overall sample of accidents, and also show evidence of the effect on equity returns of each firm experiencing a disaster.

3.1 The event study methodology

To examine stock price behavior surrounding explosions in petrochemical plants, we performed a daily event study as implemented by MacKinlay (1997). The change in equity value associated with an explosion in a petrochemical plant is taken as an unbiased estimate of the financial consequences of the accident (all expected uninsured future costs).

The market model is applied to describe the behavior of asset returns and to separate out changes in value caused by overall market effects from those changes caused by the accident itself. The normal relation between the observed returns of a given stock i at time t, $R_{i,t}$, and the market returns at the same time, R_{mt}, is given by: $R_{i,t} = \alpha_i + \beta_i R_{mt} + \varepsilon_{i,t}$. The term $\beta_i R_{mt}$ is the portion of the return to security i on day t that is due to marketwide factors.

[8] We also considered country dummy variables for emerging countries, and common law countries, but they were not significant. Thus, to save space, we do not report the results.

The parameter α_i measures that part of the average daily return on the stock that is not due to market movements. Lastly, $\varepsilon_{i,t}$ measures that part of the change in the value of firm's i stock on day t that is not due to either movements in the market or to the firm's average daily return. On the day of an event (here the explosion in a chemical plant or in an oil refinery), the deviation in an individual stock's daily return from what is expected based on equation (1), that is, the prediction error, is taken as an unbiased estimate of the financial effects of the event. Let $AR_{i,t} = R_i - \widehat{\alpha_i} - \widehat{\beta}_i R_{mt}$ stand for this abnormal return or prediction error where $\widehat{\alpha_i}$ and $\widehat{\beta}_i$ are respectively, the estimates of α_i and β_i.[9]

Following MacKinlay (1997), we calculate an individual t-statistic for each firm's abnormal return for each accident-day. Moreover, the average abnormal daily return for all accidents in the sample, AAR_t, is calculated along with its statistical significance. The sum of the individual t-statistics follows a distribution that is asymptotically normal with mean zero and variance equal to the number of observations. The z-statistic for the average is then the sum of the individual t-statistics divided by the square root of the number of observations.[10] Finally, to examine the total loss in return from explosions, we look at the cumulative average abnormal returns starting with the accident date, $CAAR_t$.

3.2 Full sample results

Figure 1 reports the average abnormal returns and the cumulative average abnormal returns for the first twenty trading days following the accident.[11] Further, in Table 2, we consider three different panels. In Panel A, $CAR_{i,t}$ are aggregated across all accidents (N = 64). In Panel B, we consider only accidents which do not cause statistically significant negative $CAR_{i,t<10}$ at the 5% level (N = 11). In Panel C, $CAR_{i,t}$ are aggregated across accidents which cause statistically significant negative $CAR_{i,t<10}$ at the 5% level (N = 53); therefore, Panel B is Panel A less Panel C.

On average, shareholders suffer a significant loss of 0.94% the day of accident, of 1.38% the following day, and reach a maximum of 1.40% the fourth day after the accident, associated with t-stat of -3.95, -4.08 and -2.95 respectively, so that, all the figures are statistically significant at the 5% level. This result is consistent with the efficient hypothesis, according to which stock prices quickly reflect news announcements.

About three quarter of firms experienced negative abnormal returns the day following the accident, but only eleven accidents caused individually significant abnormal returns at the 5% level.[12]

In Panel B, we still find for the remaining 53 firms significant and negative cumulative average abnormal returns at the 5% level for the day of accident and the following day (-0.65% and -0.94%, respectively). In Panel C, we remove the 53 accidents that did not provoke a significant drop in the equity value of each corresponding firms at the 5% level. On average, investor's reactions tend to persist over a period of 20 days, much longer than for the Panel A of accidents.

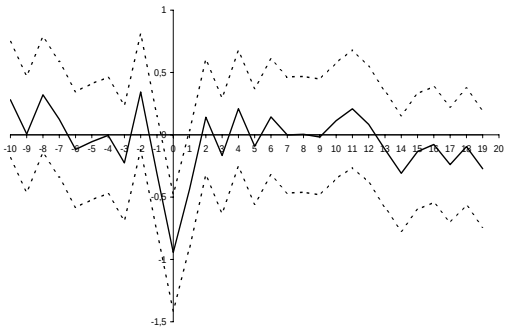
[9] To check the robustness, we have dropped accidents when the parameters $\widehat{\beta}_i$ is not significant. It does not change the results.

[10] Another measure of significance aggregates, into a single portfolio, the abnormal returns of all petrochemical companies experiencing an accident for the day of each firm's explosion. It then uses the daily variance of returns on this portfolio to calculate a t-statistic. This test, however, attributes more weight to observations of firms with a high variance in returns, and is therefore more sensitive to distortions from very noisy observations.

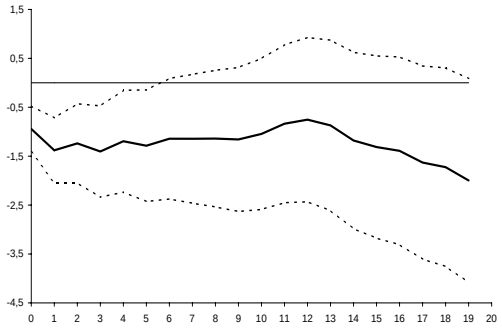
[11] See figures B and ?? in the Appendix for long term $AAR_{t=[1;120]}$ and $CAAR_{t=[1;120]}$.

[12] We also examined whether the price pressure was associated with a significant shift in trading volumes. We defined abnormal volume as the difference between the average turnover ratio logarithm through the period [-190; -10] and the observed turnover ratio logarithm after the disaster. volumes of stocks were not statistically significant from zero.

Figure 1: Abnormal Returns with Confidence Intervals at the 5% level



(a) Average abnormal returns (in %)



(b) Cumulative average abnormal returns (in %)

Notes: Abnormal returns are computed given the market model parameters estimated with OLS through the period [-190; -10] in event time. Event time is days relative to the accident date. The sample period is from 1990 to 2005.

Table 2: **Abnormal returns following accidents in the petrochemical industry**

This table reports cumulative average abnormal return ($CAAR_t$) up to the specified day t in event time (in %). Event time is days relative to the accident date. Abnormal returns are computed given the market model parameters which are estimated with OLS through the period [-190; -10] in event time. $CAR_{it} < 0$ is the percentage of firms i with a negative CAR_{it}. Panel A: All accidents. Panel B: Accidents which cause statistically significant negative $CAR_{it,t<10}$ at the 5% level. Panel C: Panel A less Panel B. The sample period is from 1990 to 2005.

	Panel A: 64 events			**Panel B: 11 events**			**Panel C: 53 events**		
t	$CAAR_t$	*t-stat*	$CAR_{it} < 0$	$CAAR_t$	*t-stat*	$CAR_{it} < 0$	$CAAR_t$	*t-stat*	$CAR_{it} < 0$
0	-0.94***	-3.95	69%	-2.31***	-5.14	92%	-0.65**	-2.36	64%
1	-1.38***	-4.08	75%	-3.39***	-5.23	92%	-0.94**	-2.43	71%
2	-1.24***	-3.00	64%	-3.88***	-4.94	92%	-0.66	-1.40	58%
3	-1.40***	-2.95	63%	-4.88***	-5.43	100%	-0.65	-1.18	55%
4	-1.19**	-2.25	60%	-4.59***	-4.56	100%	-0.45	-0.75	51%
5	-1.29**	-2.21	55%	-4.32***	-3.93	92%	-0.63	-0.94	47%
6	-1.14*	-1.82	60%	-4.50***	-3.81	92%	-0.41	-0.57	53%
7	-1.14*	-1.70	57%	-5.23***	-4.14	92%	-0.25	-0.33	49%
8	-1.14	-1.60	49%	-5.49***	-4.11	92%	-0.19	-0.23	40%
9	-1.16	-1.54	55%	-5.30***	-3.76	83%	-0.25	-0.30	49%
10	-1.05	-1.33	55%	-5.44***	-3.68	83%	-0.09	-0.10	49%
15	-1.31	-1.38	52%	-5.63***	-3.16	75%	-0.37	-0.34	47%
20	-1.72	-1.58	58%	-6.05***	-2.97	83%	-0.78	-0.62	53%
40	-1.80	-1.18	63%	-5.46*	-1.92	67%	-1.00	-0.57	62%
80	-2.27	-1.06	60%	-4.70	-1.18	67%	-1.74	-0.71	58%
120	-1.09	-0.42	54%	-8.95*	-1.84	67%	0.62	0.21	51%

Note: *, **, *** denote statistically significance at the 10%, the 5% and the 1 % level, respectively.

Shareholder suffer an equity loss of 2.31% on average the day of accidents at the 1% level. The cumulative returns for the following day is -3.39% and for the first twenty days is -6.05% (t-stat = -5.23 and -2.97 respectively).

Overall, the average abnormal returns documented in Table 2 are in line with expectations drawn from previous research, which examined the impact of various negative environmental events on market value (see Capelle-Blancard and Laguna, 2007). Particularly, *i)* Muoghalu, Robison and Glasckock (1990) showed that the drop in firm market value associated with lawsuit filings for hazardous waste mismanagement came to -1.23%; *ii)* Hamilton (1995) documented cumulative abnormal returns up to -1.20% following the first TRI release (-1.13% for Konar and Cohen (1997)); *iii)* Klassen and McLaughlin (1996) estimated that shareholders suffered a loss of -1.5% in case of environmental crisis, etc.

3.3 Two notable cases: Total (2001) and BP (2005)

In this subsection, we examine in greater detail the two most notable cases.[13]

BP America Refinery Explosion, Texas City, March 23, 2005. The most recent and famous accident in our sample is the explosion of a BP refinery in Texas on March 23, 2005. The refinery is BP's largest in the U.S. and the country's third largest. The explosion and fire killed 15 contract workers and injured more than 170 people. The explosions occurred when a distillation tower flooded with hydrocarbons and was overpressurized, causing a geyser-like release from the vent stack.[14]. The Chemical Safety Board had long maintained that in the past BP's bosses did not spend enough time and money on the safety of their employees. Its report released on March 20, 2007, was no different, and concluded that cost cuts mandated by the company's London headquarters contributed to the tragedy - and that bosses ignored successive warnings that an accident was imminent. BP had already been fined US$21 Million for 301 "egregious, wilful violations" of safety rules by the Occupational Safety and Health Administration - the biggest penalty in the body's 35-year history. [15] More than 800 press media articles mention this accident for the first ten days, and BP incurred a drop in equity returns of -2.43% at the 1% level the day after. hours worked by staff who are in critical safety roles.

Total France Agrochemical Plant Explosion, Toulouse, September 21, 2001. The worst accident in terms of number of deaths is the explosion of the AZF agrochemical plant in France on September 21, 2001. An explosion in a storage hangar in which 300 tonnes of ammonium nitrate granules were stored for recycling at the fertilizer plant killed 30 people and injured 200 more. It destroyed or damaged over 10,000 homes. We assess that the explosion resulted in a significant drop of $3 billion in Total's market capitalization, associated with a significant abnormal return of -3.74% on the explosion day. Market reaction did not last more than 3 days. The company benefited from $500 million of insured property damages, and public aid from the French government of Euro229 million.

Previous empirical evidence has focused on the most dramatic accidents that happened in the late 1970s and the 1980s. By contrast, our sample includes accidents after 1990, and it appears that the stock market reaction is faster but temporary, while the magnitude of the drop is somewhat lower. Indeed, according to Salinger (1992), for instance, after the explosion of the Union Carbide plant in Bhopal in 1984, the firm market value fell from $3.5 to $2.5 billion (-28%) and, the first month, the abnormal return was -31%. Concerning the Exxon-Valdez oil spill in 1989, White (1996) reports that little impact was observed for the first twenty or so

[13] Table 5 in the Appendix reports estimated cumulative abnormal returns for the first day, the first five days and the first 120 days following each accident.

[14] Source: U.S. Safety and Hazard Investigation Board

[15] Source: The Economist, March 22 2007, The Guardian, March 20, 2007

trading days after the accident; the stock price decrease was gradual, with a significant negative cumulative abnormal return of -19% even after 120 days.[16] Thus, three factors are likely to explain why the shareholder reaction is immediate and of lower scale: first, accidents have less dramatic consequences, thanks to stricter safety and environmental regulation; second, firms may have increased their insurance coverage; third, accidents are much more publicized and financial markets are more efficient.

3.4 Shift in the systematic risk

Up to now, we have only considered how firm market capitalization varies following a serious technological accident. It is probable, however, that such accidents also have an effect on firm systematic risk, *i.e.* the beta.

In this paper, we follow the approach proposed by Baginski, Corbett and Ortega (1991), and we estimated the following model: $R_{i,t} = a_i + \beta_i^1 R_{mt} + D_i + \beta_i^2 Post_i R_{mt} + u_{i,t}$ where t = [-180; 180], $R_{i,t}$ is firm i return on day t, R_{mt} is the day t market return, $D_i = 1$ on event day (mm/dd/yy) and the day after and $D = 0$ otherwise, $Post_i = 0$ for days -180 to -1 and $Post_i = 1$ for post-accident period (days 0 to 180). Parameters are estimated using robust ordinary least squares using White-corrected standard errors to correct for the presence of heteroskedasticity.

It must be pointed out that, given our large sample, it seems very difficult to theoretically predict the average sign or the magnitude of the beta shift. Indeed, recall that the systematic risk for the firm i is: $\beta_i \equiv Cov(R_{i,t}, R_m)/\sigma_m^2 = \rho_{i,m}\sigma_i/\sigma_m$ where $Cov(R_{i,t}, R_m)$ is the covariance between R_i and R_m, $\rho_{i,m}$ is the correlation rate between the two returns, whereas σ_m and σ_i represent their standard deviations. Thus, following a serious accident, the firm's betas are as likely to increase as to decrease: the increase may come from a higher variance of the firm's equity returns, while the decrease may come from the fact that the firm's stock price will not follow the market as it normally would, but will react to firm-specific news. And if the two effects offset each other, the beta may stay the same. To save space, we only report salient results.[17]

In our sample, nine chemical disasters significantly increased firms' systematic risk. Among them, we come across the two worst accidents of our sample in terms of number of deaths: the explosion of the AZF plant (Total) in France in 2001, and the explosion in a BP plant in the US in 2005. We have documented, in the previous subsection, an abnormal return of -3.74% for Total and -2.44% for BP. It appears now that the two firms also experienced a significant increase in their systematic risk: +0.31 for Total and +0.52 for BP.

Interestingly, we observe several cases for which we document no significant abnormal returns, but a beta increase. For instance, the explosion in one of the biggest hydrogen peroxide units in the world (Oxysynthèse, jointly owned by Air Liquide and Elf Aquitaine), on 22 April 1992 in France, provoked the shut down of the plant and obliged the company to declare *force majeure* to its customers. We find a significant increase in the systematic risk of the two parent companies, Air Liquide (+0.20) and Elf Aquitaine (+0.23), but no significant drop in their equity returns following the disaster. This is also the case for BASF (+0.32), following an explosion in July, 1990 that caused one death, four serious injuries, and the closure of the plant for several weeks; or, more recently, for Total (+0.21), after the explosion in July, 2001 in a petrochemical plant in the US, which caused one death and the evacuation of 2,000 people, but only minor economic losses.

Lastly, some accidents provoked a significant and negative change in the systematic risk of

[16] Some studies examine the impact of the nuclear accidents at Three Mile Island and Chernobyl, but results are not directly comparable since they concern the power industry as a whole. See, for instance, Capelle-Blancard and Laguna (2007).

[17] See Table 6 in the Appendix for complete results.

the firms responsible for those accidents. This is the case, for instance, for a fire in a German refinery of Shell in March 2000 (-0.46), for the explosion in a Marathon Oil refinery in January 2003 that resulted in the shut down of the plant (-0.27), for the explosion in February 2003 in an Exxon Mobil facility which caused three deaths (-0.38), or for the explosion in a LG Petrochemical plant in September 2004 (-0.41).

4 How to explain the stock market response to chemical disasters?

In this section, we estimate the determinants of equity value declines after serious accidents in the petrochemical industry.[18] Robust linear regressions are used to relate cross-sectional differences in the magnitude of abnormal returns to the features of accidents.

4.1 Determinants of abnormal returns following chemical disasters.

In columns (XX) and (XX) of Table 3, we report results from an OLS regression where the dependent variable is the *Cumulative Average Abnormal Returns* up to the first and second day following disasters.[19] The explanatory variables are: number of fatalities and serious injuries (in log); a dummy variable for accidents that released toxic chemicals; the number of previous chemical disasters experienced by firms (in our sample); the *Temporary Firms Newsworthiness* as described above; dummy variables for accident years after 1999; three country dummy variables for accidents that happened in the US, accidents that happened in Europe, and accidents that happened in Japan; and the log of sales in the year before that of accidents.

Our main result is that the seriousness of accidents, as measured by the total number of fatalities and serious injuries do increase abnormal losses in equity returns.[20] The result is statistically significant at the 1% level and robust using all specifications. This result is in line with previous studies on airplane crashes that find that investors are strongly sensitive to information on fatalities and serious injuries.[21]

Moreover, firms that release a toxic chemical as a result of disaster (often provoking the containment or the evacuation of thousands of persons) do incur losses of a greater magnitude.

[18] To the best of our knowledge, no such attempt has been made up to now. Most studies about the effects of environmental and industrial incidents on shareholder wealth do not provide further explanation of the determinants of investors' reactions. In contrast, the literature on airplane crashes, for instance, (*e.g.* Borenstein and Zimmerman, 1988) considers several explanatory variables (number of deaths, drop in sales, cause of accidents, etc.) to explain the magnitude of equity value losses following crashes. The paper by Broder (1990) is the most closely related to our work, in showing that investors are actually very sensitive to the number of deaths

[19] Muoghalu *et al.*(1990) also use abnormal returns, whereas Hamilton (1995) uses the dollar value of the estimated abnormal returns as a dependent variable. We test the alternative specification, but do not find any particular change. To check for robustness we also perform a robust logit regression, where the dependent variable is set equal to 1 if $CAR_{i,t=2}$ is negative and significant at the 5% level. Overall, our results do not change. Note that the event study relies on the assumption that residuals of the market model are Gaussian white noise. By contrast, the logistic distribution is similar to the normal except in the tails, which are considerably heavier. Results are available upon request.

[20] As shown above, the two most fatal accidents in our sample (Total in 2001 and BP in 2005) lead to significant abnormal returns. But, the third, the fourth and the fifth worst accidents in terms of number of deaths (Albright & Wilson Chemicals in the US in June 1991, Repsol in August 2003 in Spain, and Sasol in South-Africa in September 2004), which caused the deaths of at least ten employees, did not lead to significant abnormal returns. Furthermore, when we compute average abnormal returns only for accidents that provoked at least one serious injury or fatality (equal to the median of fatalities and serious injuries), we find that the magnitude of the loss is more important ($AAR_0 = -1.33\%$; $CAAR_{[0;+3]} = -2.07\%$).

[21] Broder (1990) finds significant and sustained losses following accidental deaths involving either a firm's workplace or product.

Given that environmental concerns is a burning issue and journalists as governmental authorities are very sensitive to pollution news, this result is quite promising. We infer from that result that toxic release does convey valuable information for investors. The reason may be that firms are perceived as liable for damage to nature, as is already the case in the US for instance. Therefore, compulsory disclosure of pollution incidents in financial statements as in the US or in France (*Nouvelles Régulations Economiques*, 2001) appear as a suitable tool. However, we do not find evidence of a reputation effect, in that the number of previous accidents experienced by firms do not increase the equity returns losses.

We also find that abnormal losses are lower for firms which are of major concern for journalists in the period before disasters. It appears that the *Firms Newsworthiness* has a positive effect on abnormal returns at the 1% level. We infer from that result that extensive publicity in the press shortly before disasters (for reasons we ignore) actually mitigate the financial impact of disasters.

Controlling for the size of firms is crucial, since it also gives a proxy for the liquidity of stocks, insurance coverage, and firms' opportunities to divert their production. Thus, we expect that bigger firms are less likely to be affected by accidents. This hypothesis is confirmed by the data: its coefficient is positive and significant at the 5% level in columns (1)-(4), and the the 10% in columns (5)-(6).

We find interesting additional evidence after controlling for country differences. In every specification, firms experiencing accidents in the US, in Japan and in the EU incur greater losses at the 1% level than firms experiencing accidents in other countries.[22] Given the stringency of the regulation in the US as well as a more developed tort liability jurisdiction, this result is not surprising.[23] Note that we have also tested separately country dummies for firms listed in the US, firms listed in Europe, and firms listed in Japan, but they were not significant and were excluded to improve the parsimony of our regressions.

We use several specifications to control for the time effect that are not reported to save space. We confirm that firms experiencing accidents since 2000 have incurred higher losses at the 5% and 10%level as shown in Table 3.

5 Conclusion

Firms carry insurance against many of the costs of an accident, such as equipment and business losses, and tort liability. But big accidents go beyond the limits of insurability and investors are expected to anticipate non-insured costs raised by lawsuits, damage to reputation... Consequently, accidents may cause significant drop in firm market value.

In this paper, we consider a unique sample of 64 accidents in the petrochemical industry over the period 1990-2005. A quarter of the accidents in our sample result in a toxic release, and half of them result in at least one death or serious injury. We find that the stock market reacts negatively (and instantaneously, which confirms the financial markets' overall efficiency with regard to the release of new information) to explosions in chemical plants and refineries. Shareholders of petrochemical companies suffer an equity loss of 1.38% on average on the first day following disasters. In this respect, our study confirms previous results based upon the study of harmful environmental events and industrial accidents.

The concomitance of several factors may explain negative abnormal equity returns: the number of fatalities, the release of a toxic chemical, past safety records, *etc.*. In contrast to

[22] But note that this result does hold when the same specification is used to explain $CAR_{i,t=0}$.

[23] See Hammit *et al.* (2005) for a challenging statement.

Table 3: **Determinants of Cumulative Abnormal Returns Following Chemical Disasters**

We report results from least squares regressions using White-corrected standard errors to correct for the presence of heteroskedasticity. The three dependant variables are the *Cumulative Average Abnormal Returns* up to second day following disasters: $CAAR_{[0;+]}$ for $t = 0, 1, 2$.

	t=0	t=1	t=2
log (Fatalities and Serious Injuries)	−0.662	−0.511	−1.017
	[0.00]***	[0.07]*	[0.00]***
Toxic Release	−0.375	−1.385	−1.554
	[0.28]	[0.02]**	[0.04]**
Firms Newsworthiness	10.723	19.326	31.384
	[0.03]**	[0.01]***	[0.00]***
# Previous Accidents	−0.265	−0.281	−0.295
	[0.06]*	[0.16]	[0.24]
Year > 1999	−0.797	−1.173	−1.357
	[0.03]**	[0.04]**	[0.05]*
Accident in Japan	−0.410	−2.266	−2.767
	[0.48]	[0.00]***	[0.00]***
Accident in the US	−0.216	−1.040	−1.987
	[0.69]	[0.08]*	[0.00]***
Accident in the EU	−0.525	−1.873	−3.133
	[0.34]	[0.01]***	[0.00]***
log Sales	0.505	0.596	0.570
	[0.00]***	[0.00]***	[0.01]**
N	64	64	64
Log pseudolikelihood	−104.8	−127.8	−142.2
F	5.8	4.1	10.8
Adj. R-squared (%)	25.3	23.6	28.2

Note: Robust p-values are in brackets: *, **, *** denote statistically significance at the 10%, the 5% and the 1 % level, respectively.

previous studies which consider a single major disaster, we are able with our database to examine in greater detail the determinants of investors' reactions.

In this paper, we present a cross-sectional analysis of abnormal returns. The estimated cost of an accident is often kept confidential by firms or is unknown at the time of accidents. To tackle this, we build indicators on the human and environmental impacts of accidents. We argue that the number of injuries, the number of deaths, and the number of people evacuated may provide useful, albeit imperfect, indicators of the direct cost of an accident. We find that declines in equity returns are related to the number of fatalities, and to incidental pollution. We infer that investors associate fatal human harm as well as incidental pollution with future uninsured costs, such as legal expenses, a drop in sales, safety compliance costs and advertising expenses. Furthermore, our study provides a unique insight into the international comparison of stock market reactions to chemical disasters. Investors are expected to respond partly to structural differences between countries, such as regulations over technological and environmental risks. Indeed, tort liability and liability for damage to nature are more strict in the US. Actually, we find that firms experiencing accidents in the US, but also in Japan and in the EU incur a stronger decline in equity returns, by contrast with other countries such as UK. Finally, in accordance with the growing importance given to environmental issues over time, we find that firms incur equity losses of a greater magnitude since 2000 by contrast with the 90s. Besides, we do not find evidence of a reputation effect, in that firms which experienced a greater number of accidents in the past do not incur a drop in equity returns of a greater magnitude. Finally, we also find that firms with greater media exposure shortly before accident (for reasons we ignore) incur equity value losses of a lower magnitude. We infer that a greater and temporary publicity in the newspapers actually mitigate the financial impact of disasters.

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A Appendix

List of accidents and main features

Date	Firm	Listing Country	Accident Country	# Serious injuries and fatalities	Dummy = 1 if Toxic release	# print media articles	Sales in USD million
03/20/90	Royal Dutch Ptl.	NL	UK	0	1	12	66.79
05/26/90	Daiichi Pharm.	JAP	JAP	7	0	5	1.49
07/19/90	BASF	GER	USA	5	0	23	32.81
03/12/91	Union Carbide	USA	USA	1	0	25	7.62
06/17/91	Tenneco	USA	USA	12	0	21	XX
12/13/91	DSM	NL	NL	7	0	9	6.16
02/10/92	BP	UK	UK	3	0	15	49.31
04/22/92	Elf Aquitaine	FRA	FRA	1	0	1	37.05
04/22/92	Air Liquide	FRA	FRA	1	0	1	5.87
09/08/92	Akzo Nobel	NL	NL	1	0	2	9.26
11/09/92	Total	FRA	FRA	6	0	22	26.41
01/26/93	Lubrizol	USA	USA	0	1	1	1.54
02/22/93	Hoechst	GER	GER	0	1	4	26.26
03/15/93	Hoechst	GER	GER	2	0	24	26.26
05/02/93	Dow Chemicals	USA	GER	1	0	1	18.97
05/03/93	Marathon Oil	USA	USA	0	0	1	12.78
07/04/93	Sumitomo Chemical	JAP	JAP	1	0	28	9.11
08/02/93	Exxon Mobil	USA	USA	3	1	18	100.03
04/08/94	Olin	USA	USA	0	0	3	2.42
05/27/94	Royal Dutch Ptl.	NL	USA	3	1	62	58.99
06/04/94	BP	UK	FRA	4	0	4	54.66
08/08/94	Exxon Mobil	USA	USA	0	0	32	97.82
10/15/94	Rohm Haas	USA	USA	0	0	3	3.27
04/04/95	Crompton	USA	CAN	1	0	5	0.59
08/16/95	Ashland	USA	USA	0	0	1	9.46
08/20/95	Du Pont De Nemours	USA	USA	0	1	8	34.04
11/21/95	Lyondell Chemical	USA	USA	0	0	2	3.86
12/05/95	Ak Steel Hdg.	USA	USA	1	0	19	XX
12/05/95	FMC	USA	USA	0	1	19	4.01
12/29/95	Mitsubishi Chem.	JAP	JAP	1	0	2	10.45
01/27/96	Hoechst	GER	GER	1	1	13	33.33
04/01/96	Crompton	USA	USA	1	0	3	0.66
07/17/96	Mitsui Chemicals	JAP	JAP	1	0	9	3.11
10/03/96	Albright & Wilson	UK	UK	0	1	26	1.19
11/17/96	FMC	USA	USA	0	0	6	4.51
12/04/96	FMC	USA	USA	0	0	2	4.51
12/22/96	Wyman Gordon	USA	USA	8	0	68	0.40
04/04/97	Du Pont De Nemours	USA	JAP	0	0	2	38.35
04/04/97	Mitsui Chemicals	JAP	JAP	0	0	2	3.01
12/23/98	Sumitomo Chemical	JAP	JAP	0	0	2	8.98
06/08/99	Bayer	GER	GER	0	1	14	28.28

03/23/00	Royal Dutch Ptl.	NL	GER	0	0	1	55.53
06/07/00	BP	UK	UK	0	0	30	77.21
06/10/00	BP	UK	UK	0	1	41	77.21
09/03/00	Total	FRA	FRA	0	0	3	39.21
10/12/00	Solutia	USA	GER	0	0	4	2.83
12/09/00	Exxon Mobil	USA	SG	3	0	8	160.90
04/25/01	Rhodia	FRA	FRA	1	0	1	6.61
07/14/01	Total	FRA	USA	3	1	79	102.10
09/21/01	Total	FRA	FRA	30	0	267	102.10
03/12/02	Asahi Kasei	JAP	JAP	0	1	42	10.70
09/03/02	Guerbet	FRA	FRA	0	0	0	0.22
01/08/03	Rhodia	FRA	FRA	0	1	2	8.35
01/12/03	Marathon Oil	USA	USA	0	0	14	31.46
02/21/03	Exxon Mobil	USA	USA	3	0	108	178.90
08/13/03	DSM	NL	AUS	2	0	9	7.11
08/14/03	Repsol YPF	SP	SP	10	0	46	44.85
02/22/04	Lonza Group	SW	SW	0	0	9	1.98
03/31/04	BP	UK	USA	0	0	74	272.80
06/11/04	Crompton	USA	CAN	0	0	15	2.18
08/25/04	LG Petrochemical	SK	SK	2	0	8	1.21
09/01/04	Sasol	SA	SA	10	0	64	11.48
01/04/05	Yara	NOR	FRA	0	0	0	6.37
03/23/05	BP	UK	USA	15	0	836	266.70

Table 5: **Abnormal returns following accidents in the petrochemical industry by firms**

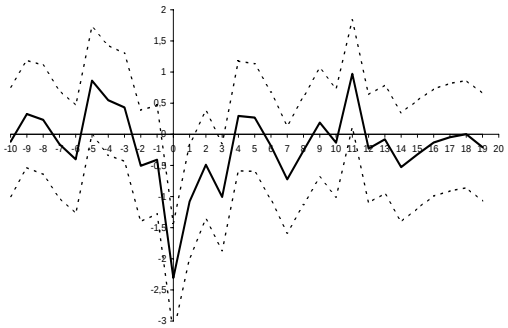
This table reports cumulative average abnormal return ($CAAR_t$) up to the specified day t in event time. Event time is days relative to the accident date (mm/dd/yy). Abnormal returns are computed given the market model parameters which are estimated with OLS through the period [-190; -10] in event time. The sample period is from 1990 to 2005.

Firm	Date	$t=0$	$t=1$	$t=5$	$t=120$	Firm	Date	$t=0$	$t=1$	$t=5$	$t=120$
ROYAL DUTCH PTL.	03/20/90	0.09	-0.21	-0.16	3.44	MITSUI CHEMICALS	07/17/96	0.04	0.69	1.68	-25.32
DAIICHI PHARM.	05/26/90	-2.46	-3.91	-4.29	17.03	ALBRIGHT & WILSON	10/03/96	0.70	1.75	5.32	-42.88
BASF	07/19/90	-0.88	-0.94	-2.78	-4.40	FMC	11/17/96	-0.37	-0.52	0.68	-15.15
UNION CARBIDE	03/12/91	-3.72	-4.19	-10.80	5.32	FMC	12/04/96	-0.22	-0.89	-3.00	-12.44
TENNECO	06/17/91	-1.75	0.55	-1.54	75.27	WYMAN GORDON	12/22/96	-6.36	-6.36	-3.41	12.07
DSM	12/13/91	-0.43	-0.92	-5.18	17.15	MITSUI CHEMICALS	04/04/97	-1.66	-4.20	-5.87	-31.74
BP	02/10/92	2.92	3.17	-2.06	-13.27	DU PONT DE NEMOURS	04/04/97	-0.12	-2.11	-2.44	-9.06
ELF AQUITAINE	04/22/92	0.42	1.58	0.89	10.23	SUMITOMO CHEM.	12/23/98	-0.14	-3.44	-3.42	-16.89
AIR LIQUIDE	04/22/92	-0.27	-1.53	-1.20	3.56	BAYER	06/08/99	-1.40	-2.62	0.28	-9.06
AKZO NOBEL	09/08/92	-0.69	-0.63	2.77	-6.39	ROYAL DUTCH PTL.	03/23/00	-1.47	-2.33	-4.84	16.59
TOTAL	11/09/92	-1.08	-1.54	0.02	6.62	BP	06/07/00	-2.48	-0.20	1.68	-3.93
LUBRIZOL	01/26/93	0.88	-0.89	-0.89	7.66	BP	06/10/00	-0.28	1.36	-0.10	-7.27
HOECHST	02/22/93	-0.96	-2.77	-3.54	-16.09	TOTAL	09/03/00	2.93	2.95	4.16	-14.48
HOECHST	03/15/93	-1.30	-1.98	0.48	-4.51	SOLUTIA	10/12/00	-0.59	1.01	-1.10	6.91
DOW CHEMICALS	05/02/93	0.35	0.59	0.06	11.20	EXXON MOBIL	12/09/00	-3.14	-2.22	-5.08	-0.45
MARATHON OIL	05/03/93	0.91	3.32	3.40	6.94	RHODIA	04/25/01	-3.29	-7.35	-4.62	-69.12
SUMITOMO CHEM.	07/04/93	-2.35	-0.96	-1.82	10.30	TOTAL	07/14/01	-0.85	-0.98	-1.35	-1.13
EXXON MOBIL	08/02/93	0.28	-1.03	-1.58	-7.82	TOTAL	09/21/01	-3.74	-3.21	-0.03	-3.63
OLIN	04/08/94	-0.05	-0.93	0.94	6.82	ASAHI KASEI	03/12/02	-0.20	-3.03	-1.05	0.36
ROYAL DUTCH PTL.	05/27/94	-0.11	-0.09	1.11	-2.92	GUERBET	09/03/02	-3.23	-4.72	-11.86	5.78
BP	06/04/94	-0.90	-1.73	-1.23	-8.43	RHODIA	01/08/03	-2.95	-7.18	-3.67	-28.03
EXXON MOBIL	08/08/94	1.22	-0.84	1.46	9.78	MARATHON OIL	01/12/03	0.75	1.26	3.67	27.45
ROHM HAAS	10/15/94	-0.57	-0.92	2.40	-6.39	EXXON MOBIL	02/21/03	0.32	1.51	0.81	-12.10
CROMPTON	04/04/95	-0.78	-1.51	-1.51	-8.66	DSM	08/13/03	-0.30	-2.03	-0.48	-5.88
ASHLAND	08/16/95	-0.75	-1.13	-2.23	6.73	REPSOL YPF	08/14/03	0.53	0.48	1.71	-6.67
DU PONT DE NEMOURS	08/20/95	1.00	-0.28	-0.39	2.62	LONZA GROUP	02/22/04	-1.75	-1.79	-0.28	-2.36
LYONDELL CHEMICAL	11/21/95	-0.80	0.12	2.17	30.39	BP	03/31/04	0.27	-0.36	3.41	9.16
FMC	12/05/95	-1.13	-3.00	-2.91	-20.05	CROMPTON	06/11/04	0.14	0.66	2.31	74.12
AK STEEL HDG.	12/05/95	0.34	-0.69	0.74	21.47	LG PETROCHEMICAL	08/25/04	-1.28	-1.41	-1.90	-22.15
MITSUBISHI CHEM.	12/29/95	0.09	0.18	-1.36	8.18	SASOL	09/01/04	-1.60	-0.51	-1.60	-12.11
HOECHST	01/27/96	-1.02	-0.87	0.68	1.99	YARA	01/04/05	-3.71	-5.69	-7.25	-4.59
CROMPTON	04/01/96	-1.78	-0.98	-2.57	13.83	BP	03/23/05	-1.30	-2.44	-1.47	1.09

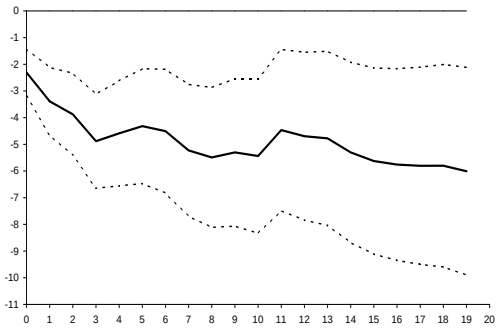
Note: Statistically significant at the 5% level in bold. Statistically significant at the 10% level in italic.

B Additional appendix (not intended for publication)

Figure A: Abnormal Returns with confidence intervals at the 5% level (Panel C)



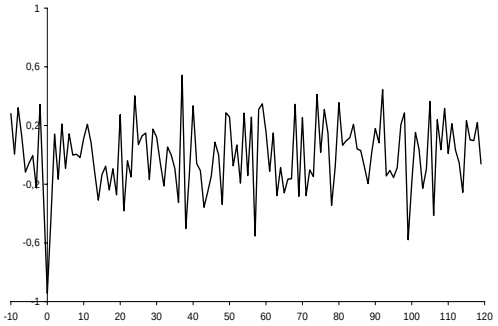
(a) Average abnormal returns (in %)



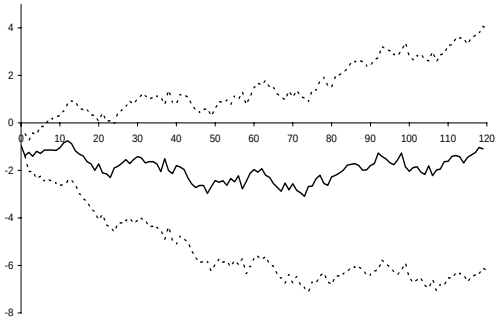
(b) Cumulative average abnormal returns (in %)

Notes: Abnormal returns are aggregated across accidents that cause statistically significant negative $CAR_{t,t<10}$ at the 5% level.

Figure B: Long Term Abnormal Returns and Cumulative Abnormal Returns



(a) Average abnormal returns



(b) Cumulative average abnormal returns

Notes: Abnormal returns are computed given the market model parameters estimated with OLS through the period [-190; -10] in event time. Event time is days relative to the accident date.

Table 6: **Impact of an accident on the risk and returns in the petrochemical industry**

The model estimated is: $R_{i,t} = a_i + \beta_i^1 R_{mt} + D_i + \beta_i^2 Post_i R_{mt} + u_{i,t}$ where t = [-180; 180], $R_{i,t}$ is firm i return on day t, R_{mt} is the day t market return, $D_i = 1$ on event day (mm/dd/yy) and the day after and $D = 0$ otherwise, $Post_i = 0$ for days -180 to -1 and $Post_i = 1$ for post-accident period (days 0 to 180). Parameters are estimated using robust ordinary least squares using White-corrected standard errors to correct for the presence of heteroskedasticity. The sample period is from 1990 to 2005.

Firm	Date	a	β^1	D	β^2	R^2	Firm	Date	a	β^1	D	β^2	R^2
ROYAL DUTCH PTL.	03/20/90	0.04	**0.97**	-0.04	0.02	0.74	MITSUI CHEMICALS	07/17/96	-0.11	**0.51**	0.39	*0.42*	0.13
DAIICHI PHARM.	05/26/90	0.09	**0.62**	**-2.01**	*0.22*	0.37	ALBRIGHT & WILSON	10/03/96	-0.09	**0.88**	0.91	-0.24	0.11
BASF	07/19/90	-0.06	**0.59**	-0.05	**0.32**	0.47	FMC	11/17/96	-0.06	**0.68**	-0.12	-0.20	0.20
UNION CARBIDE	03/12/91	0.01	**0.96**	-1.31	0.19	0.28	FMC	12/04/96	-0.07	**0.65**	-0.27	-0.12	0.20
TENNECO	06/17/91	0.10	0.22	-1.75	0.54	0.02	WYMAN GORDON	12/22/96	0.16	*0.42*	**-3.79**	-0.44	0.04
DSM	12/13/91	-0.01	**0.71**	-0.10	-0.06	0.20	MITSUI CHEMICALS	04/04/97	**-0.24**	**1.11**	*-2.20*	**-0.59**	0.19
BP	02/10/92	*-0.14*	**1.07**	1.29	-0.27	0.18	DU PONT DE NEMOURS	04/04/97	0.02	**0.98**	-0.64	0.21	0.35
ELF AQUITAINE	04/22/92	0.07	**0.80**	0.32	**0.20**	0.57	SUMITOMO CHEM.	12/23/98	0.10	**1.01**	-1.14	0.03	0.32
AIR LIQUIDE	04/22/92	0.00	**0.99**	-0.12	**0.23**	0.55	BAYER	06/08/99	0.03	**0.61**	-0.85	0.01	0.26
AKZO NOBEL	09/08/92	0.00	**0.71**	0.13	**0.62**	0.32	ROYAL DUTCH PTL.	03/23/00	0.02	**1.05**	-0.98	**-0.46**	0.35
TOTAL	11/09/92	0.01	**0.90**	-1.13	0.11	0.37	BP	06/07/00	0.00	**0.50**	0.01	-0.11	0.05
LUBRIZOL	01/26/93	-0.05	0.35	-0.22	*0.52*	0.05	BP	06/10/00	0.01	**0.49**	0.63	-0.13	0.05
HOECHST	02/22/93	0.01	**1.00**	-0.72	-0.01	0.44	TOTAL	09/03/00	0.05	**0.46**	1.44	0.07	0.12
HOECHST	03/15/93	0.02	**1.01**	-1.06	*-0.08*	0.44	SOLUTIA	10/12/00	0.00	0.00	-1.31	**0.69**	0.05
DOW CHEMICALS	05/02/93	-0.02	**1.05**	0.08	-0.15	0.16	EXXON MOBIL	12/09/00	0.05	0.04	-0.60	*0.24*	0.02
MARATHON OIL	05/03/93	-0.07	**0.94**	1.35	-0.23	0.10	RHODIA	04/25/01	-0.14	**0.62**	-1.58	**0.40**	0.20
SUMITOMO CHEM.	07/04/93	-0.06	**0.93**	-0.74	-0.12	0.37	TOTAL	07/14/01	0.03	**0.58**	0.02	*0.21*	0.33
EXXON MOBIL	08/02/93	0.02	**0.63**	-0.43	-0.30	0.10	TOTAL	09/21/01	0.06	**0.58**	**-2.13**	**0.31**	0.39
OLIN	04/08/94	0.08	**0.72**	0.05	*-0.43*	0.08	ASAHI KASEI	03/12/02	-0.02	**1.14**	-0.66	-0.03	0.46
ROYAL DUTCH PTL.	05/27/94	-0.02	**1.06**	-0.10	0.02	0.72	GUERBET	09/03/02	0.15	0.04	-1.61	0.23	0.02
BP	06/04/94	0.11	**1.02**	-0.68	-0.15	0.24	RHODIA	01/08/03	-0.13	**0.69**	-1.28	*0.32*	0.26
EXXON MOBIL	08/08/94	0.00	**0.55**	-0.40	0.16	0.14	MARATHON OIL	01/12/03	-0.01	**0.72**	0.40	**-0.27**	0.40
ROHM HAAS	10/15/94	-0.01	**0.65**	-0.27	0.07	0.09	EXXON MOBIL	02/21/03	0.02	**0.95**	0.60	**-0.38**	0.58
CROMPTON	04/04/95	-0.04	*0.45*	-0.68	*-0.72*	0.01	DSM	08/13/03	-0.05	**0.62**	-0.75	-0.02	0.41
ASHLAND	08/16/95	-0.04	**0.45**	-0.07	-0.07	0.04	REPSOL YPF	08/14/03	0.03	**0.74**	0.06	0.13	0.51
DU PONT DE NEMOURS	08/20/95	0.02	**1.02**	0.04	-0.13	0.15	LONZA GROUP	02/22/04	-0.09	**0.70**	-0.54	-0.16	0.13
LYONDELL CHEMICAL	11/21/95	-0.02	**0.85**	0.26	-0.07	0.08	BP	03/31/04	0.02	**1.00**	0.69	-0.01	0.33
FMC	12/05/95	-0.04	**0.80**	-0.82	-0.15	0.18	CROMPTON	06/11/04	0.11	**2.39**	-1.12	-0.52	0.29
AK STEEL HDG.	12/05/95	0.16	0.39	-0.79	0.03	0.02	LG PETROCHEMICAL	08/25/04	-0.03	**0.76**	0.41	*-0.41*	0.23
MITSUBISHI CHEM.	12/29/95	-0.07	**1.02**	0.24	0.14	0.32	SASOL	09/01/04	0.07	**0.98**	-0.98	-0.05	0.27
HOECHST	01/27/96	**0.13**	**0.91**	-0.61	0.27	0.30	YARA	01/04/05	*0.17*	**0.87**	*-1.87*	0.11	0.22
CROMPTON	04/01/96	0.00	**0.67**	0.52	-0.32	0.04	BP	03/23/05	0.02	**1.00**	-0.77	**0.52**	0.35

Note: Statistically significant at the 5% level in bold. Statistically significant at the 10% level in italic.

Table 7: **Normality Tests**

Variable dependent: $CAR_{i,t=2}$. Abnormal returns are computed given the market model parameters estimated with OLS through the period [-190; -10] in event time. Event time is days relative to the accident date.

Skewness/Kurtosis Test	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
	0.011	0.053	8.82	0.0121
Shapiro-Wilk Test	Obs	z	Prob>z	
	67	2.172	0.01493	

Table 8: **Correlation matrix**

	Media	**Fat.**	**Toxic release**	**Chemicals**	**OIL**	**# prev. acci.**	**> 1995**	**Country of listing**					**Country of accident**			
Media	1															
Fatalities	0.54	1														
Toxic release	-0.05	-0.21	1													
Chemicals	-0.31	-0.30	-0.02	1												
OIL	0.03	0.24	-0.04	-0.41	1											
# prev. acci.	0.45	0.17	0.10	-0.43	-0.03	1										
> 1995	0.19	0.11	-0.07	-0.06	0.00	0.12	1									
Listing								**CL**	**USA**	**EU**	**Japan**	**EC**				
CL	0.09	-0.15	-0.04	-0.03	-0.25	0.14	-0.15	1								
USA	-0.13	-0.23	-0.11	0.18	-0.11	-0.10	-0.17	0.76	1							
EU	-0.03	0.13	0.17	-0.16	0.33	0.05	-0.01	-0.68	-0.52	1						
Japan	-0.07	-0.08	-0.07	0.24	-0.19	-0.14	0.03	-0.34	-0.26	-0.24	1					
EC	-0.02	0.35	-0.14	0.04	0.01	-0.16	0.11	-0.13	-0.19	-0.17	-0.09	1				
Accident													**USA**	**EU**	**Japan**	**EC**
USA	0.18	-0.05	0.02	0.00	0.10	0.08	-0.27	0.59	0.64	-0.33	-0.27	-0.07	1			
EU	-0.07	0.14	-0.04	-0.05	0.11	-0.02	0.09	-0.53	-0.43	0.75	-0.23	-0.17	-0.51	1		
Japan	-0.08	-0.11	-0.09	0.25	-0.20	-0.12	0.07	-0.28	-0.18	-0.25	0.93	-0.09	-0.29	-0.24	1	
EC	-0.03	0.23	-0.14	-0.10	0.01	-0.05	0.24	-0.13	-0.06	-0.17	-0.09	0.73	-0.20	-0.17	-0.09	1

Abbreviations: Media: Number of print media articles for the first ten days following disasters (*Factiva search 2.0 Beta*); Fat.: Number of fatalities or serious injuries; Toxic release = 1 if the accident provoked a toxic release and 0 otherwise ; Chemicals = 1 in the firms belong to the chemical industry and 0 otherwise; OIL = 1 if the firm is a member of the Oil Insurance Ltd and 0 otherwise; # prev. acci.: Number of previous accident by the same firm (in our database); "> 1995" = 1 if the accident occurred after 1995 and 0 otherwise; CL: Common Law countries; EU: Europe; EC: emerging countries. See the text for further details concerning the sample and the variables.

Brief description of the accidents (article extracts)

ROYAL DUTCH PTL. (03/20/90)	An explosion ripped through part of a huge oil refinery. Concern is centered on leaks of the chemical xylene, some of which is believed to have been washed into the River Gowy, a tributary of the Mersey. But the National Rivers Authority said it was unlikely the company would face court action. Six production workers had been injured. One was transferred to the specialist burns unit, five casualties were treated for smoke inhalation, and four had been released after treatment, and the condition of the fifth was described as "fair".
DAIICHI PHARM. (05/26/90)	An explosion rocked a chemical factory. Seven people were killed and 21 others injured, several with serious burns.
BASF (19/07/90)	The explosion occurred when a vent line leading from a processing kettle became clogged, causing the kettle to become overpressurized. Up to 63 people were injured, killing one worker, four were critically injured. About 1,000 people were evacuated. Six homes had been declared uninhabitable. Air tests performed by the Ohio Environmental Protection Agency around the plant found no toxic gases in the smoke. The two explosions ignited a fire that took 2 hours to contain. The blast sent fireballs 50 feet into the sky. A column of thick, black smoke poured from the building into the surrounding residential neighborhood, shattering windows in houses and businesses up to a quarter-mile away. BASF has received about 1,500 reimbursement claims and has settled about half of them,
UNION CARBIDE (03/12/91)	The cause of the blast had not been determined. Two dozens residents who live within a mile of the plant were ordered to evacuate the area. 19 people at the plant were taken to the hospital. One person was seriously injured; the others appear to have relatively minor injuries. Carbide has declared force majeure on ethanolamine and glycol ether products. No dangerous chemicals were released into the air. moderately toxic colorless gas. It is an eye, skin and respiratory irritant.
TENNECO (06/17/91)	The explosion occurred as workers were mixing chemicals to make a flame retardant used in textiles. An explosion and fire at a chemical plant killed six workers (one company employee and five contract workers) and injured 33 others, four critically. The fire was quickly extinguished, and no toxic releases were detected. Many of the workers killed or injured were contract workers, not plant employees. Plant resumed operations June 29. Damage and environmental impact assessments to take 4-6 weeks.
DSM (12/13/91)	The explosion in a storage tank of benzoic acid set fire to adjoining tanks loaded with volatile hydrocarbon fuels and solvents. Six workers killed, one person was missing and injured another three. The blast temporarily brought all traffic to a halt in the world's busiest port. Workers were evacuated from the area. The explosion and fire sent a thick column of smoke over the port area, toxic smoke containing benzine enveloped the industrial zone, which is home to several oil refineries and dangerous chemical plants. DSM was quick to counter suggestions that the fumes could poison the surrounding area. Officials said the explosion did not cause the release of poisonous gases or fumes that would pose a danger to area residents. But people complained of eye irritation caused by the fumes.
BP (02/10/92)	The fire occurred in a storage area for propylene and ethylene about a mile from the petrol chemical complex and refinery at Grangemouth. A gas storage tank being built at docks near an oil refinery burst into a fireball. One man died and three others were injured. Two of the injured, both in intensive care, are in a "stable" condition with serious burns. No noxious emissions were reported. A gas detection van was sent to the north side of the River Forth, downwind of the incident but readings were negative. Neither the refinery nor petro-chemical complex was closed as a result of the fire.

AIR LIQUIDE (04/22/92)	An explosion ripped through the Oxysynthese hydrogen peroxide plant at Jarrie, the biggest unit in the world. An inquest is being held into the cause of the accident. One person was killed. Two more people were taken to hospital with burns.
ELF AQUITAINE (04/22/92)	Idem.
AKZO NOBEL (09/08/92)	The blast happened in a gas filtration system attached to a reactor outside the main chemical plant. The cause of the explosion is not yet clear. It was possible there could have been a pressure buildup following an unexpected chemical reaction inside the filter, but that human error has not been ruled out. No dangerous chemicals were released into the atmosphere and there was no need to evacuate nearby residents. Safety experts have begun an investigation into explosion at Akzo subsidiary Diosynth's chemical works in the Netherlands. One person was killed.
TOTAL (11/09/92)	La Mede plant near Marseille is the second largest of Total's three refineries in France. The explosions were thought to have been caused by a gas leak, which started a fire and blew up one of the facility's gas treatment units. Total said "any risk of major pollution is remote." This was the worst accident at a French oil refinery since 1966. No cause of the explosion has been found. Six deaths and two injured. The refinery won't operate at full capacity for several months
LUBRIZOL (01/26/93)	Nine employees form a nearby Shell Oil Co. chemical complex had to be treated after a cloud of sulfuric acid escaped from the Lubrizol Corp.'s chemical plant. Lubrizol officials have ruled out an explosion as the cause. The investigation is continuing.
HOECHST (02/22/93)	The blast occurred when explosive vapors were ignited by sparks from a hatch that was opened in error. Two tons of suspected carcinogen ortho-nitroanisole discharged from the company's Griesheim plant into the atmosphere. Although no-one was hurt, dozens of residents visited doctors after the leak and there was an expensive and high-profile clean-up campaign. The local state environment ministry said nearly 100 people had reported respiratory problems after the incident. The plant has been temporarily shut down by the Hesse environment ministry.
HOECHST (03/15/93)	An explosion ripped through a factory that manufactures the chemical polyvinylalcohol released a cloud of gas 3 miles long, 1,800 feet high and 1,500 feet wide. The blast is the seventh accident to happen at a Hoechst factory in the last three weeks - the first involving the loss of life - and it immediately prompted calls from regional and national politicians for tougher safety controls. An explosion ripped through a factory belonging to the Hoescht chemical concern in Frankfurt killing one worker and seriously injuring another. At least 12 kg of methanol was released with firefighting water into the River Main. But there was no trace of methanol in the ground. The accident came three weeks after noxious gases were released from the plant into a residential neighborhood nearby. Scientists from the Fresenius Institute collected samples for analysis at the request of the regional environment ministry, after Greenpeace members blockaded part of the works on Tuesday. Results of the analysis will be published. Greenpeace had suggested that dioxins would have been released. Hoechst said temperatures in the fire seemed not to have been high enough to release any dioxins.
DOW CHEMICALS (05/02/93)	An explosion in Dow Chemical Co group's Stade plant in Hambourg killed one worker and slightly injured another. The explosion took place in a plastics container. A Dow Chemical spokesman said the explosion does not pose any risks for the environment. The blast caused serious damage
MARATHON OIL (05/03/93)	The explosion occurred. in a 5,000-gallon "sour water" storage tank at the refinery. Officials said there were no effects outside the refinery. Only one minor injury

SUMITOMO CHEMICAL (07/04/93)	A worker died in an explosion and fire that destroyed a chemical plant in Niihama, Ehime Prefecture. Three others suffered minor injuries. The blast, which occurred at the factory's epoxy resin plant loosened doorways and broke windows in about 100 homes near the plant. At the time of the explosion, 11 workers were at the plant, which operates round-the-clock. The plant that produces more than half the world's supply of epoxy resin used in making semiconductors.
EXXON MOBIL (08/02/93)	Fire spewed noxious and toxic fumes and smoke, on people living and working near the plant. Material damages came to 65 M$. The fire killed three workers, caused personal and property damage to 2,700 people outside the plant. Less than three weeks after the fire, more than 400 people filed a class-action lawsuit contending the incident made them sick (sore throats, skin irritation, nausea and other maladies). The lawsuits maintain that the fire spewed "noxious and toxic fumes and smoke," including hydrogen sulfide, sulfur dioxide and carbon monoxide gases, on people living and working near the plant.
OLIN (04/08/94)	The explosion at a chemical plant forced the evacuation of at least 1,000 people and temporarily closed Interstate. The smoke carried the slight odor of chlorine but is non-toxic. No serious injuries were reported.
ROYAL DUTCH PTL. (05/27/94)	Homes within a mile of the plant were evacuated after an explosion that destroyed a building housing chemical tank. The explosion may have been caused by "an abnormal chemical reaction". Physical damage and the need to comply with environmental and safety rules will both delay a reopening. The fire left three presumed dead, the plant severely damaged and the company unable to fulfill its contracts. Firefighters from 16 area fire departments spent nearly 10 hours battling the blaze-which sent flames 300 to 600 feet in the air-and approximately 1,700 people within a one-mile radius of the plant were evacuated. The plant remains shut down and the force majeure on Kraton SBR shipments from the plant is still in place. The Belpre plant produced 325 million pounds of Kraton yearly, more than half the total annual worldwide production of Shell's parent, Royal Dutch/Shell Group.
BP (06/04/94)	Explosion at a BP France's 8.5-million tonnes/yr refinery at Lavera-de-Matigues, southern France. An inquest has been opened. Unofficial reports suspect the blast was caused by an accumulation of sulfurous gas. Unions have raised questions regarding safety of refinery workers. Two people were killed and two others were missing. Five other employees were slightly injured. There was no fear of pollution or toxic emissions.
EXXON MOBIL (08/08/94)	Several small explosions and a large fire caused heavy damage at Exxon Chemical's Baton Rouge, petrochemical complex. The cause of the explosion was not known. There were no direct injuries, but seven contract workers were slightly hurt. The explosion released a non-toxic hydrocarbon fuel oil into the air, officials said. But nearby residents were advised to turn off their air conditioners and keep windows and doors closed as a precaution. ethylene, propylene and butadiene, Residents, however, complained that the explosion was toxic and that it has affected their health.
ROHM HAAS (10/15/94)	A chemical exposure incident at Rohm and Haas's Deer Park complex that sent 32 people to area hospitals for treatment of nausea and dizziness. A suspected cyanide leak was blamed for making workers ill. The acetone cyanohydrin unit had been shut down for its annual turnaround three days before.
CROMPTON (04/04/95)	An explosion at a chemical plant ignited a blaze that injured one worker and forced hundreds from their homes and factories in Scarborough. More than 30 firefighters fought to prevent the fire from spreading to storage tanks filled with explosive liquids at Witco Surpass Chemicals Ltd. Thick clouds of black smoke, billowing from the blazing tank farm, were visible across the city.
ASHLAND (08/16/95)	The blast occurred as workers mixed undisclosed chemicals.

DU PONT DE NEMOURS (08/20/95)	Pipe burst releasing 23,000 gallons of sulphuric acid, 1,500 residents evacuated from nearby homes. At least 38 treated for exposure to chemical. The U.S. Environmental Protection agency proposed the fine. Officials report evacuation of 1,500 people in four Kentucky towns following gas leak at Du Pont chemical factory in Wurtland.
LYONDELL CHEMICAL (11/21/95)	Eighty construction workers at Lyondell-Citgo Refining Co. were taken to area hospitals after a chemical leak at the plant, but none was believed critically injured. The plant and surrounding areas were not evacuated. Emergency Medical Services Director said most of those exposed to the vapor complained of nausea, burning eyes, irritated throats and chest pains.
FMC (12/05/95)	The chemical leak forced about 30,000 residents indoors in five communities and closed several roads for two hours. The leak posed no danger to the community. Emergency crews contained the colorless liquid at the chemical plant before it formed more than a trace of hydrochloric acid vapor.
AK STEEL HDG. (12/05/95)	The explosions occurred in an area that had been shut down for maintenance. One employee was in critical condition. A series of explosions at the AK Steel Corp. Middletown (Ohio) Works injured 13 workers, six of whom were hospitalized. One man was listed in critical condition. Five workers were listed in fair condition.
MITSUBISHI CHEMICAL (12/29/95)	A chemical tank plant exploded at Japan's largest chemical company killing one worker. No other workers were injured.
HOECHST (01/27/96)	Two separate leaks at Hoechst plants resulted in the emission of noxious substances into the air and water. On Jan. 27, a lid blew off a large vacuum dryer, ripping a hole in the roof of the Griesheim plant. A cloud of white toxic powder that contained cancer-causing substance isoproturon spread to a nearby community. Production workers failed to report that incident for 34 hours, according to a Hoechst spokesman, before notifying the company fire department, which then reported the incident to the city. In a third incident, an employee was seriously injured on Jan. 30. The Hesse Environment Ministry, a state government body, ordered sections of both plant to be shut down pending an investigation of the accidents.
CROMPTON (04/01/96)	In an afternoon explosion and fire at the Witco Corp. plant in Taft after a spark from a torch apparently ignited material in a wastewater tank. The explosion triggered a large fire, sending plumes of thick, black smoke that could be seen for miles above the plant. Five workers were injured, one seriously. An environmental quality specialist with the state Department of Environmental Quality, said the off-site impact was limited to contamination in nearby storm drainage ditches after the tank ruptured.
MITSUI CHEMICALS (07/17/96)	The fire, emitting thick black smoke, was extinguished 90 minutes after the first explosion. Within the next 40 minutes there were two more blasts. The initial explosion occurred at 10 a.m., sending smoke and flames hundreds of meters skyward.
ALBRIGHT AND WILSON (10/03/96)	The explosion in a phosphate storage area lasted about three hours and caused emissions of hydrogen chloride, prompting police to close several major highways in the area and issue warnings to stay away. The black smoke erupted 200 feet into the atmosphere. The company would not comment on how toxic the cloud of smoke was. Environmental group Friends of the Earth called for an inquiry into the incident. None of the injuries were serious, but six firefighters were treated for smoke inhalation. Police advised people in the area to stay indoors and keep doors and windows shut, while the cloud of coloured smoke caused by the explosion dispersed.

FMC (11/17/96)	The explosion occurred in a chemical mixing vessel that contained heptane, which is dangerous because it is a water-reactive chemical. About 350 people living within a half-mile of the plant were evacuated. The smoke contained no detectable toxins, and the evacuation was ordered as a precaution. The evacuation was ordered as a precautionary measure. Hundreds of people around a lithium plant returned to their homes early. It mixes with water, it forms lithium hydroxide, which is not toxic but is an irritant. The part of the plant that caught fire won't be reopened until FMC/Lithium can pinpoint the accident's cause.
FMC (12/04/96)	A tank of paint solvent, Heptane, caught fire and exploded at a chemical plant. Six people were hurt. None of the injuries, all employees or contractors, is life-threatening.
WYMAN GORDON (12/22/96)	An explosion ripped through a metal-fabricating plant, killing eight employees. A pressurized bottle with about 5,000 pounds of nitrogen per square inch blew when a maintenance crew was changing its seals. Workers were preparing to shut the plant down for the holidays. Two other workers were injured in the blast. They were in stable condition.
DU PONT DE NEMOURS (04/04/97)	The explosion may have been caused by the release of ethylene gas through a defective safety device designed to react to irregular gas pressure. Sending smoke and flames hundreds of meters skyward. Eight people were injured, one seriously. Polyethylene production.
MITSUI CHEM. (04/04/97)	Idem.
SUMITOMO CHEM. (12/23/98)	A fire broke out at a feed-manufacturing plant. No harmful chemicals were released. There were no injuries.
BAYER (06/08/99)	The accident occurred at an insecticide production facility. It left about 100 local residents complaining of illness or eye or respiratory irritation caused by escaping fumes from burning toluene. The force of the explosion broke windows in neighbouring houses and residents were advised to remain indoors with windows closed. The investigation found that the explosion resulted when employees added the wrong chemical to a compound in a vat. The environmental authorities have confirmed that the escaping fumes did not contain constituents at levels that were damaging to health. Local environmental group Coordination Against Bayer Dangers (CABD) is suing Bayer. 100 local residents complaining of illness or eye or respiratory irritation caused by escaping fumes from burning toluene. Thirty Bayer workers and 20 individuals living nearby were treated at a local hospital for respiratory ailments and eye irritation; all have been released. No serious injuries were reported. Bayer says the explosion posed no public risk, but the German environmental agency says it released toluene.
ROYAL DUTCH PTL. (03/23/00)	A fire at Royal Dutch/Shell's 170,000-barrel-a-day Godorf refinery in Germany. No one was injured in the inferno that broke out, sending a cloud of smoke 300 meters (1,000 feet) into the air and over a nearby autobahn, which was closed for several hours. While some people at a nearby shopping center and residents close to the plant complained of irritated eyes and breathing difficulties, measurements by a refinery team and state environmental experts said no dangerous pollution occurred.
BP (06/07/00)	Tonnes of earth, insulation and lumps of metal were hurled onto a main road when a steam pipe exploded, causing a deafening roar that lasted for an hour. An investigation was underway. Grangemouth one of Europe's largest industrial complexes has a notorious safety record with four workers killed and several more severely injured in explosions and fires over the years.
BP (10/06/00)	A leak of liquified petroleum gas at the catalytic cracker starts a major fire. Steel workers were evacuated. Some of the chemicals used are described as "very toxic", others as "dangerous for the environment" or "extremely flammable ".

TOTAL (09/03/00)	Fire broke out at refinery following two explosions. Production was halted at nearby units and a security cordon was placed around the industrial zone at Le Havre port.
SOLUTIA (10/12/00)	A vat of hot liquid resin exploded. No environmental damage was caused, and local community was not affected. Six employees and several firefighters were treated at a local hospital for smoke inhalation and one employee for minor injuries. Eleven people were injured in the fire.
EXXON MOBIL (12/09/00)	An explosion occurred at a utility steam boiler at the petrochemical complex of Exxon Chemical Singapore.
RHODIA (04/25/01)	Three people were injured after an explosion at Rhodia's factory here, firefighters at Colmar said. The factory has not halted production and output tomorrow will be normal. No explanation for the accident was provided.Trois personnes ont été blessées, dont une grièvement, à la suite d'une explosion hier en fin d'après-midi à l'usine chimique Rhodia, située à Chalampé dans le sud du Haut-Rhin. Aucune explication n'a été donnée sur les causes de cette explosion. L'accident n'a pas provoqué de pollution, a indiqué Marc-Laurent Boutin, ingénieur de permanence à l'usine Rhodia.
TOTAL (07/14/01)	A railcar containing loaded with methyl mercaptan, a dangerous chemical, exploded at the factory. An estimated 2,000 people were evacuated immediately. Repeated exposure can lead to paralysis, severe breathing problems and death. The exact cause of the explosion was still uncertain. Residents have launched a class-action suit. Killing three employees and injuring at least nine. An estimated 2,000 people were evacuated immediately after the 25,000-gallon rail car exploded and spread a yellow haze
TOTAL (09/21/01)	An explosion in a storage hangar in which 300 tonne of ammonium nitrate granules were stored for recycling at Atofina's Grande Paroisse fertilizer plant in Toulouse in southwest France kills 30 people and injures 200 more. National authorities investigating the Sept. 21 explosion say it was an accident, destroyed or damaged over 10,000 homes. The total number of lawsuits could eventually run into the thousands. The Lloyd's market is expected to face a net claim of around $50m from the massive explosion.
ASAHI KASEI (03/12/02)	Order to evacuate a total of 4,861 people living near the factory due to toxic gases emitted from the fire. The Asahi Kasei plant has 11 liquid-level gauges that contain cobalt 60, a radioactive substance. The Miyazaki prefectural government decided to conduct air and water quality checks to verify if any toxic substances, such as dioxins, were emitted by the fire. Analyses could take over one week. According to the Nobeoka fire department, there was a small fire at another factory owned by Asahi Kasei for production of pharmaceutical products on Jan. 29.
GUERBET (09/03/02)	Une violente déflagration s'est produite dans une cuve de fabrication de de dichloro dicyanoquinone.
RHODIA (01/08/03)	The cyclohexane leak occurred on 17 December in a pipe linking two plants. The leak was divulgated to authorities the 8/01/03. An operation to recover leaked cyclohexane at its polyamide intermediate plant is currently underway. A spokeswoman said a firm that specialises in cleaning up polluted sites was hired to undertake this operation.
MARATHON OIL (01/12/03)	Fire broke out at a refinery and burned for more than four hours in the plant's crude oil unit. A malfunctioning electric transformer caught fire. Marathon's air monitoring crews did not find any pollution in neighborhoods around the plant. The cause of the fire was unknown. There were no injuries. Nobody was hurt, but the blaze, which dropped soot on some homes and cars in the immediate area, appeared to frighten a number of residents who rushed to the hospital in case of possible exposure to harmful chemical fumes.

EXXON MOBIL (02/21/03)	Operator of the Staten Island Port Mobil oil product transfer terminal, a 100,000 bbl barge caught fire while offloading to the 3 million bbl facility. The explosion left the oil facility ablaze, sending thick black smoke hundreds meters into the air. A powerful explosion ripped through an oil storage terminal on the edge of Staten Island, Leaving one people injured and two others unaccounted for. Killing two workers on the barge. Another worker at the facility was seriously injured U.S. Coast Guard officials said that any unburned gasoline would evaporate quickly and cause no permanent damage to the environment.
DSM (08/13/03)	The explosion went off at about 11 a.m. Company spokesman said it wasn't yet clear what caused the explosion. There was no danger for the environment. The explosion injured 17 people, including two seriously, in a Dutch-owned chemical plant outside Linz, northern. None of the injured were in a serious condition and the causes of the explosion were not immediately known. An environment official said there appeared to be no threat to the surrounding area.
REPSOL YPF (08/14/03)	A two-day fire at a 140,000-bpd Repsol refinery at Puertollano, south of the capital, Madrid, has claimed the lives of six workers, while four others still remain in a critical condition. Repsol is currently investigating the cause of the accident and the refinery remains shut. One of Spain's worst ever refining accidents. As the burning fuel was lead-free officials were confident there was no pollution risk for the area. Caused a plume of smoke 500 metres high, but the authorities say this does not pose any health risks.
LONZA GROUP (02/22/04)	Production at Lonza Holding AG's Viege site should resume "shortly" after a water tank exploded. A flare and heavy smoke emission was visible from the surrounding area and foam used to extinguish the fire was observed. However, the company maintained that there was no damage to the nearby environment. Nine people were slightly injured. Production will soon resume. No sign of a danger of pollution or poisonous fumes, the police said.
BP (03/31/04)	Several massive explosion rocked a Texas, refinery at night forcing the evacuation of the plant. Other area industrial plans were ordered evacuated as a precaution, while residents were asked to remain indoors with all windows and doors shut for about two hours after the fire began. Roads leading into the complex were closed as a precaution. The fire was contained, and there was no danger of it spreading, but no injuries were immediately reported.
CROMPTON (06/11/04)	A wastewater storage tank exploded and burst into flames at a chemical plant. Fire crews spent a day to contain the fire at a giant chemical plant. A plume of black smoke hung over forcing residents in the town of 8,200 to stay in their homes. No danger posed to Canagagigue Creek, which flows beside the Crompton property and into the Grand River. 250 employees were evacuated. Cloud of black smoke. No injuries in the blaze. The explosion occurred in an oxygen tank. A plume of black smoke hung over, forcing residents in the town of 8,200 to stay in their homes after a wastewater storage tank exploded and burst into flames at a chemical plant. "It's not a toxic chemical." An Environment Ministry official said there was no danger posed to Canagagigue Creek, which flows beside the Crompton property and into the Grand River.
LG PETROCHEMICAL (08/25/04)	A loud explosion and thick clouds of smoke came from the factory after the fire broke out a line. Investigations were still underway to determine the full cause of the explosion, but preliminary inquiries revealed the blast could have been triggered by a malfunctioning of a valve. The explosion blew out windows of houses up to 300 meters away. The explosion at South Korea's LG Petrochemicals' butadiene line killed one plant worker and seriously burned another. The injured worker was hospitalized, but not in critical condition. There was a loud explosion and thick clouds of smoke came from the factory after the fire broke out a line producing benzene, toluene and xylene. The company is an affiliate of LG Group and the leader in a basic process of the petrochemical industry known as cracking.

SASOL (09/01/04)	The blast at the Sasol Polymers ethylene facility (Sasol is the world's largest coal-to-fuel producer) was caused by a cloud of gas which ignited while the plant was undergoing routine maintenance. Sasol's safety record is under the spotlight after three deadly blasts at its operations since June. The recent spate of accidents at Sasol facilities and growing calls by the influential trade union movement that the firm change its practices and do more to protect its workers. The number of deaths from the explosion at South African energy firm Sasol's Secunda petrochemicals complex has risen to eight and two workers remain in intensive care. Although the ethylene plant was undergoing a maintenance turnaround at the time of the blast, this statement was difficult to reconcile with reports that very serious damage has been caused to the olefins facility.
YARA (01/04/05)	Une pompe électrique d'une unité de péroxyde d'azote en phase de démarrage a explosé.
BP (03/23/05)	The possibility a car's ignition caused the blast in the plant's isomerization unit, which boosts octane levels in gasoline. The refinery is BP's largest in the U.S. and the country's third largest. Explosion and fire hits BP's Texas City refinery, killing 15 contract workers and injuring more than 170 people. BP attributed the explosion to a series of mistakes by its personnel before and during the start-up of an isomerisation process unit. BP says no asbestos, benzene, or other volatile organic compounds have been detected in the air, but that monitoring of air quality around the facility remains in place. Witnesses have told investigators there was a hydrocarbon liquid and vapor release that fell to the ground moments before the powerful explosion, which shot flames, ash and blackened metal into the sky and was felt miles away.