# Unexpected Media Coverage and Stock Market Outcomes: Evidence from Chemical Disasters*

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**Abstract**

Using the event-study methodology and multivariate regressions, this paper examines the intensity of media coverage, its determinants and its marginal effect on stock returns following chemical disasters. To do this, we use an original dataset of chemical explosions that occurred worldwide from 1990-2005. *First*, our results show that news coverage increases with the social and environmental consequences of the accident. *Second*, to deal with the fact that news coverage is determined simultaneously with stock returns, we suggest two valid and original instrumental variables: a measure of the firm's newsworthiness and a measure of daily news pressure at the time of the disaster. We find that unexpected news coverage due to chemical disasters also respond to these conjunctural factors, and is truly exogenous to abnormal returns. *Third*, we show that, all else being equal (pollution, number of casualties, and firm profile), the stock market reaction to intense press coverage is delayed, and becomes negative in the long-term. At the same time, there is clear evidence that in the first days news coverage mitigates the market value losses. We interpret these results as evidence that investors are slow to recognize the extent of the loss associated with the implications for the public of news coverage (*e.g.*, image and public trust deterioration). In addition, in contrast to previous studies, we argue that press coverage is not necessarily associated with increased investor attention.

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# 1 Introduction

Over the last three decades, we have witnessed several environmental disasters. In many cases, large companies were involved. Union Carbide was responsible for the Bhopal explosion in 1984, Exxon for the Valdez oil spill in 1989, and BP for a large chemical explosion in Texas in 2005. All these events, which provoked either numerous deaths or serious pollution, were followed by enormous news coverage. It is commonly assumed that environmental disasters deteriorate the firm's public image and its reputation. Stock market value and public image are often considered as the two major motives that may induce firms to reduce the negative externalities they create. According to some, these two motives may complement, or even substitute for, the incentives provided by public regulation.[1]

To be effective, incentives coming from the stock market or from the public need to be ex-post credible, systematic, and proportional to the social cost entailed. Moreover, it is evident that reliable information about the firm environmental record is needed to discipline corporate behavior. Finally, concerning the reaction of stock markets, the incorporation of news about pollution and the social consequences of accidents into prices relies on the efficient market hypothesis, which rests upon strong assumptions about the cognitive abilities of investors.

In this article, we investigate the intensity of media coverage, its determinants and its marginal effect on stock returns following chemical disasters. More specifically, we wonder whether intense news coverage after an environmental disaster represents an additional cost to the firm. The drop in stock returns is used as a measure of uninsured cost, while media coverage is taken as a proxy for public image deterioration suffered by the firm. Moreover, we investigate the following questions. Is media response proportional to the social cost of the accident? What is the mechanism through which media influence stock markets after an accident? Is intensity of media coverage a good proxy for reputation damage? To our knowledge, virtually no empirical study has examined this issue.

To carry out our analysis, we build an original sample of explosions in chemical plants and refineries worldwide from 1990 to 2005. The software Factiva was used to search in a systematic way for the press articles mentioning companies responsible for disasters. Also, this search allowed us to build a number of variables of interest measuring the social consequences of each disaster, such as the number of fatalities and injuries and the occurrence of pollution.

The consequences on reputation of news coverage has been the subject of recent papers in the literature. For instance, Kyanazeva (2007) finds that media plays a disciplinary role on executives. Besides, in political science, media coverage is usually considered as a good proxy for public concern. In our study, this effect is particularly important. If the space devoted to chemical disasters in the media is a good indicator of its importance for the public, it may convey information about its legal consequences (clean-up cost, penalties, etc.) and might even indicate law reinforcement in the future (Kahn, 2007). In environmental economics, a number of event-studies show that stock prices incorporate the loss associated with pollution and industrial disaster news, and might confirm the credibility of stock market penalties as a disciplinary motive (for a survey see Margolis *et al.*, 2007). But, they limit their attention to short-term results (a few days after the announcement date), and largely ignore the ability of media to shape the informational environment of firms (Bushee *et al.*, 2007). Only Hamilton (1995), in a seminal study about the stock market reaction to the first publication of the Toxic Release Inventory announcement in the U.S., also intends to control for media coverage. He shows that whether the firms' pollution records received media coverage did not influence the stock market value

[1]For example, in a survey conducted by PriceWaterhouseCoopers among French firms, 90% of the managers cite public image as the main motivation to promote corporate social responsability inside the firm. See also McKinsey (2006, 2008).

loss incurred by firms.

Besides its consequences on public image, news coverage can affect stock prices for other reasons. Recent studies in empirical finance recognize the role of media as an information intermediary, uncovering and summarizing information that is sometimes costly to acquire and thereby increasing the number of informed investors or reducing the cost of contracting (Dyck *et al.*, 2006, Bushee *et al.*, 2007). The seminal paper of Fang and Peress (2007) shows that firms which benefit from higher news coverage incur lower expected returns, due to the fact that media coverage reduces information risk. Bushee *et al.* (2007) investigate the stock market response to earnings announcements. They find that greater press coverage increases public information about firms as measured by greater absolute returns and trading volume at the time of an earning announcement. In our study, this issue is particularly important because informational asymmetry between owners and managers is exacerbated by the difficulty of assessing the distribution of pollution and safety risks at the firm level (*i.e.* the firm's environmental and safety reputation). Furthermore, a great deal of uncertainty surrounds liability, insurance coverage, and litigation risk. In particular, uncertainty surrounding pollution news might explain why the stock market penalties as evidenced in the literature on pollution news are relatively low in the short term (Laguna, 2008). Thus, our second central hypothesis is that media in the event of disasters might help alleviate these informational problems.

Finally, there is a growing literature on the role of the media on stock markets characterized by the presence of cognitively biased investors. According to this literature, media alleviate bounded rationality problems such as inattention and limited capacity of information treatment. Chan (2003) uses headlines to represent the public nature of news as opposed to private signals (as measured by extreme price movements unaccompanied by press coverage). The main result of Chan (2003) is that prices are slow to reflect bad public news, and that reversal is found in the subsequent month after important price movements. In other words, investors appear to underreact to public signals and overreact to perceived private signals. On the other hand, Peress (2008) finds that news coverage has an attention-grabbing effect which favors the incorporation of earning news into stock prices. At the same time, his result and the study of Hirshleifer, Lim, and Teoh (2007) also show that the attention paid to earning announcements decreases if the number of available (and unrelated) news stories is greater on the same day. This interpretation is more behavioral than rational: media variables are used as exogenous measures of investor attention or news salience.

In this paper, in order to study the causal effect of news coverage on stock returns, we first investigate the determinants of media coverage. This research question is not a trivial one and raises a number of empirical problems. First, news coverage is determined simultaneously with stock returns. Second, the fact that stock returns reflect all public information available may lead to a potential endogeneity bias. More specifically, news coverage and stock market response may be be correlated even if the number of news stories has no effect on returns, because they both depend on other and unrelated newsworthy materials about the firm at the time of the disaster. For instance, the firm might be in the public eye for different reasons (threat of takeover, an earning announcement, etc.), and this may induce more disaster news coverage. Conceptually, this is a difficult question to analyze, because we must think of a situation where news coverage could vary exogenously, even though in the data stock returns and news coverage are generated simultaneously (Wooldridge, 2002). At least one instrumental variable is required, a variable which is exogenous to the unexplained part of the stock market returns and at the same time strongly correlated with news coverage. In this article, as instrumental variable, we use the firm's abnormal media coverage in the twenty days before the disaster to proxy for the firm's newsworthiness. In addition, we conjecture that the attention paid to chemical accidents by the press in a given period is driven by political agenda issues. In other words, attention may be crowded out by other, more important political events at the time of the disaster.[2] Therefore, we use a measure of news pressure provided by Eisensee and Strömberg (2007). News pressure, which is defined as the availability of other newsworthy material on a given day (elections, Olympics, wars, etc.), is a good candidate because it is a time-varying factor, independent of the accident occurrence as well as of the firm's idiosyncratic risk. This measure has not been used before in the financial literature. News pressure will constitute an alternative instrumental variable.

Therefore, from an empirical standpoint, our paper contributes to the literature by examining further the media coverage determinants, and by testing the exogeneity of news coverage to abnormal returns. From an economic standpoint, few studies examine the implications for the public of pollution and safety news as measured by news coverage metrics. More specifically, to our knowledge, this is the first study to use market value loss associated with news coverage to proxy for image deterioration and reputation.

Our results can be summarized as follows. First, by modeling the determinants of media, we find that news coverage is explained by the social cost of the accident, as measured by the occurrence of pollution, and by the number of casualties, as well as by the number of accidents previously experienced by each firm. Second, we surprisingly find that in the short term (*i.e.*, two days after the accident), all else being equal, media coverage *lowers* the market penalty. More precisely, more intense media coverage actually mitigates the financial drop incurred by firms responsible for the accident. However, when considering the average stock returns over the six months after the accident, the firms that received more important media coverage in the first two days after the disaster also incur lower abnormal returns regardless of the seriousness of the accident. In other words, the reaction to intense press coverage reverses (it becomes negative) in the long-term, and it is a delayed reaction. Therefore, we interpret this result as evidence that press coverage cannot be associated with increased attention. If this were the case, the loss should have increased with media instantenously (*e.g.*, due to a greater number of informed investors).

The remainder of the paper is organized as follows. Sections 2 describes the econometric model. Sections 3 describes the data, and the instrumental variables. The results are presented in Section 4 and 5. The paper concludes with a summary in Section 6.

# 2 Background and Data

In this section, we present the dataset, and how the media coverage associated to each disaster as well the instrumental variables are computed.

## 2.1 Sample selection

There is no global, publicly available list of the major chemical disasters that disclose the names of companies responsible for disasters.[3] To identify the chemical disasters, we compiled a corpus of print media articles for the period 1990-2005. A systematic search using the software *Factiva* was carried out. This software covers all major newspapers and publications in the world. We

[2]Eisensee and Strömberg (2007) show that the news coverage of natural hazards depends on the occurrence (or absence) of competing and more important news that capture the attention of mass media at the time of the disasters.

[3]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. But, due to a principle of commercial confidentiality, the names of companies responsible for accidents are not usually disclosed, at least outside the US.

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. 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.[4] Half of the firms are big multinationals and are among the 50 biggest firms in the chemical industry in terms of sales. In our sample, there are also smaller firms which have sales below US$2 million. The firms 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).[5]

## 2.2 Dependant variables

In the regression system, news coverage of chemical disasters ($NEWS_{i,[0;+t]}$) is the endogenous regressor, and the cumulated abnormal return after the disaster ($CAR_{i,[0,+t]}$) is the dependant variable.

**Disaster news coverage.** Data on news coverage is taken from the software Factiva. We restrict the attention to newspaper articles, and count all articles in English and for all regions mentioning both the names of companies, the disaster, but also the town (or the country) where the accident took place to ensure we account for the disasters and not for other events (for instance a refinery explosion due to warfare in a less developed country).

Two main measures of news coverage are considered: the total number of news articles on a daily basis ($News_t$), and the cumulated number of news articles up to $t$ days after the accident ($Cum.News_{[0,+t]}$).[6] Overall, our measures are in line with the new literature on the implications of news coverage for stock market returns which use the total number of articles mentioning the firm name or a specific event depending on the subject matter.[7] As in the studies of Bushee *et al.* (2007) and of Fang and Peress (2007), we are interested in the intensity of news coverage, and not in the information content of news coverage. But, in contrast to previous literature, it is worth noting that our measure of intensity of press coverage is a measure of unexpected media coverage in the event of chemical disaster. It deliberately does not incorporate the total number of news stories published in the disaster period.[8]

The median number of press articles published about the disaster in the first three days is 10, and the average number is 32 articles. [9] Moreover, the correlation between media coverage

[4]The dataset was built in a related paper (Capelle-Blancard and Laguna, 2006).

[5]See Table 1 for more details.

[6]The latter measures ignores the autocorrelated nature of press coverage, while measures of press coverage on a daily basis are well suited to measure information dissemination on stock markets. We also consider the natural logarithm of the number of press articles to account for the fact that the coverage distribution is right-tailed. See below for more details.

[7]Bushee et al. (2007) which investigates the effect of the firm's news coverage on its stock market returns before and after earnings announcements finds that using the total number of words instead of the total number of articles do not change the results. Another strand of literature dedicated to the journalist's decision to cover an event uses by contrast an indicator variable for whether a specific event is covered in a news broadcast within a certain time window (Erfle and McMillan, 1990; Hamilton, 1995; Eisensee and Strömberg, 2007).

[8]An alternative specification would have considered the abnormal media coverage in the post-event period, as measured by the difference between the media coverage on the accident day and the average media coverage in the pre-event period. This measure would have the advantage of accounting for the effect of other newsworthy material before and after the accident, but it is also more noisy.

[9]We also consider mentions in headlines only. The resulting variable is correlated at the 99% level with the

on day $t = 0$ (the accident day) and day $t = 1$ is far lower (64%) than between media coverage on day $t = 1$ (the accident day) and day $t = 2$, which is of 97%. As shown in Figure **??**, 80% of the press articles published in the ten days following disasters are printed in the first four days: 21.82%, 34.66%, 17.14% and 5.63% of news stories are reported respectively the first, second, third, and fourth days. These results confirm the fact that media coverage is partially delayed, but concentrated in the first two days. Yet, 19% of accidents do not receive media coverage in the first two days, and 36% of accidents do not receive coverage on the first day. Among this sub-group, as expected, the average number of injuries is also lower, in accordance with the fact that less serious accidents receive delayed, lower, or no media coverage. The average number of injuries for this sub-group is 0.33 injuries, whereas the average number for the 33 accidents which receive immediate coverage is 3.93 injuries. Finally, some accidents cause the distribution of the number of press articles to be right-tailed as shown in Figure 1. In fact, this effect is mainly due to the media coverage of an important chemical explosion in Texas on March 23, 2005. When this accident is excluded, the density of news articles in the first two days is normally distributed.

**Cumulative abnormal returns.** The second dependant variable is the cumulated abnormal return up to $t$ days after the accident ($CAR_{i,[0,+t]}$). $CAR_{i,[0,+t]} = \sum_{\tau=0}^{\tau=t} AR_{i,\tau}$ where $AR_{i,\tau}$ stands for the abnormal return on day $\tau$. Abnormal returns represent prediction errors from the market model parameters estimated with robust ordinary least squares through the period [-190; -10] in days relative to the accident date.

## 2.3 Instrument Choice

In this sub-section, we present the set of instruments we use to control for exogenous variations in the disaster news coverage, irrespective of accident seriousness. To identify the two-equation system, at least one instrumental variable is required, a variable which is exogenous to the unexplained part of the stock market returns and at the same time strongly correlated with news coverage.

**News Pressure and accident newsworthiness**. The variable $NEWSPRESSURE_t$ is provided by Eisensee and Strömberg (2007) and measures the median (across broadcasts in a day) number of minutes a news broadcast devotes to the top three news segments in a day. We first consider that other major political or public events may crowd out the coverage of disaster events. In contrast, in periods of news drought, disasters may draw the attention of journalists and investors to a greater extent. Thus, measures of the availability of other newsworthy material may be used as instruments. The intuition underlying this instrument variable is straightforward: journalists and editorial boards have a fixed number of words to write and pages to fill each day. If the amount of space taken up by big news stories is high, the space that can be devoted to other news stories is reduced, and therefore these other news stories may be crowded out (Eisensee and Strömberg, 2007). The variable is available from 1968-2003, and to our knowledge, this is the first study to document the implications of news pressure on stock market outcomes.[10]

In the Appendix, Figure 2 plots daily news pressure from 1968 to 2003. From 1990 to 2003, the average median time spent on top three news segments each day is of 7.8 minutes on average, with a standard error of 2.6 minutes (a max of 29.7 and a minimum of 1 minute). The autocorrelation of the variable daily news pressure is not high, less than 55% in one day-lag, and of less than 45% for a two-day lag. In our sample, on the accident day, the autocorrelation is even lower, around 25%, and between the two following days ($t = 1$ and $t = 2$), of 60%. Finally, there is need to control for the seasonality of the news pressure variable. In every specification,

number of mentions in the full article and our results do not change.

[10]Since the variable daily news pressure is available only before 2004, it reduces our size sample by almost ten observations.

a dummy is set at one for disasters occurring in July and August to control for the effect of summertime news droughts. For the same reasons, a dummy is used to control for accidents that occurred during the week-end.

**News pressure and concern about terrorist attacks.** A dummy which controls for the period after September 11 is also used as instrumental variable. Over this period, it is expected that concern over terrorist attacks has increased. A high level of news pressure is associated with events that include terrorist attacks and war-related events. Such events may increase concern about chemical explosions rather than reducing it, because public concern over war and terrorism, even before September 11, is also related to the threat of terrorist attacks on industrial plants. Thus, the overall effect of news pressure on the press coverage of chemical disasters is difficult to predict and unclear on average.

As a preliminary test, we examine the level of news pressure on the accident day in our sample. We compute summary statistics for the variable news pressure for all accident days in our sample (based on 57 observations from 1990-2003). The average median time spent on top the three news segments each day is of 8.45 minutes on the accident day, and is slightly higher than for the overall sample (with a standard error of 3.55, a minimum of 4.84, and a maximum of 29.25 minutes). Using a mean comparison test, we can reject at the 5% level the null hypothesis that news pressure is not significantly higher when a chemical explosion occurs. This preliminary evidence reinforces our intuition that the accident coverage may be not randomly selected conditional on the level of news pressure, so that E(News$\geq$1|High News Pressure)$\neq$E(News$\geq$1|Low News Pressure).[11] In addition, this result could confirm that the news coverage of chemical disasters increases with the level of news pressure.

**Abnormal media coverage and firm newsworthiness**. The variable $ABNBEWS_{i,t=[-22,-2]}$ represents the abnormal media coverage received by each firm shortly before the accident. It is obtained by computing 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. This variable is meant to capture the visibility of the firm at the time of the incident. Using the ratio should control for the fact that firms that have more important *Public Relations* budgets are more present in the media. This variable is equal to 5.5% on average, and varies between 0 and 20%. This confirms that some firms happen to be more newsworthy than others at the time of disasters. We are agnostic about which events or shocks may explain firm newsworthiness shortly before a disaster.

We conjecture that firms which benefit from higher abnormal media coverage before the disaster are more newsworthy and would also benefit from higher abnormal media coverage after the disaster, all else being equals. Firms which are more newsworthy should receive more coverage in case of accidents, because they are already under the scrutiny of journalists. At the same time, one may also argue that the accident occurrence is more salient to journalist if no other breaking news are available about the firm. Overall, the effect of the firm newsworthiness shortly before the disaster is difficult to predict. Finally, abnormal media coverage is potentially due to firm-specific shocks, which can be equally captured by other financial-based measures of informativeness: abnormal volumes, and absolute abnormal returns in the previous days are also ideally suited to measure the firm's salience in stock markets. Table 4 in the Appendix lists cross-sectional regression of the firm newsworthiness on measures of abnormal market activity in the twenty days before the disaster. Specifically, we document some correlation between abnormal trading volume and the firm newsworthiness, but, the result do not appear as significant as measured by the F-statistics of joint significance. However, to avoid spurious regressions, we include in every model specification, a complete set of financial control variables (which are

[11] This subject matter is left for future research.

detailed in the next section).

## 2.4 Control Variables

We use a number of variables to control for the accident seriousness (its information content), and structural effects such as the listing country of the responsible firm, its industry, size, as well as time dummies. These variables are expected to have an indirect effect on the media coverage and on the stock market responses, since they also affect the firm and accident newsworthiness.

**The information content of accidents.** The distinctive characteristics of accidents are also drawn from print media. Table 1 reports some descriptive statistics. We use three main variables to control for the informativeness of accidents. First, the variable "Fatalities and serious injuries" measures the number of injuries that were listed as "in serious condition" and the number of fatalities due to the accident. More than half of the accidents resulted in at least one fatality and a serious injury, while the average number of fatalities and serious injuries is 2.6. Second, pollution (the variable "Toxic release") is measured by a dummy set equal to one if we have information that the accident resulted in a toxic release on the basis of the statements issued by the authorities, environmentalist groups, and the companies themselves. In one quarter of the accidents, the chemical release was toxic enough to contaminate the environment. Third, the firm reputation is measured by the number of similar accidents previously experienced by each firm.[12] In the absence of perfect information, accident news constitute an informative signal that investors use to infer the environmental riskiness of each firm. Thus, stock market response should depend on the current accident but also on the previous safety and environmental records of firms. Finally, we use four country variables to control for accidents that occurred in the United Kingdom, in continental Europe, in Japan or in emerging countries (the reference variable is when accident occurred in North-America), and two five year-dummies to control for accidents that occurred between 1995 and 1999, and for accidents that occurred between 2000 and 2005.

**Financial controls.** In each regression, we include several standard financial control variables to assess whether intensity of news coverage is able to explain abnormal returns above and beyond already-known measures of information arrival and newsworthiness on stock markets. We include the firm close-to-close abnormal returns on each of the previous two trading days ($AR_{i,t-1}$, and $AR_{i,t-2}$), and, to reciprocate the firm newsworthiness instrument variable (as measured by abnormal news coverage), we include cumulated abnormal returns in the twenty days before the accident ($CAR_{i,[-22,-2]}$), and the average percentage increase in volume measured within the twenty days before the accident date ($AV_{i,[-22,-2]}$) using the estimation period $t = [-42, -32]$ to compute the expected level of trading volume.[13] In addition, we control for firm size and book-to-market ratios using each firm's log of market capitalization and log of book-to-market equity measured at the end of the most recent year. Obviously, in percentage value, all else being equals, the drop in equity returns incurred by small firms should be higher. Book-to-market is designed to control for firms in financial distress.

[12] In principle, environmental risk at the firm level could be proxied by the participation to voluntary initiatives such as the *ISO14000* management standard, or the *GRI* guidelines on environmental and social issues. Unfortunately, these programs were launched at the end of the 1990s.

[13] Trading volume before the disaster as measured by the ratio of the number of shares traded to the number of shares outstanding.

# 3 Methodology

In this article, I study the determinants and the implications of intense news coverage on abnormal returns following a chemical disaster (using the market model as a benchmark). From an empirical standpoint, the main problem raised by the use of news coverage metrics is related to the exogeneity of media with regards to new information arrival. For instance, news salience or stock visibility as measured by intense media coverage (or headlines in major newspapers) is difficult to disentangle from a pure information effect on stock returns, due to the fact that news coverage necessarily conveys information about the stocks. Few studies have tackled this issue, with the exception of Chan (2003) who uses a control group of extreme price movements that are not associated with any headlines in the press. In this article, I suggest instead to use a two-stage least squares strategy to test for the exogeneity of the intenstity of news coverage (due to chemical disasters) to stock returns.

## 3.1 News Coverage Bias and Event-study Econometrics

In this article, we attempt to relate the response of journalists to that of investors in the event of chemical disasters. This question raises a number of empirical issues.

**Can News Selection by the Press Be Ignored?** Since the late 1990s, the problem of sample selection bias has received much attention in the empirical finance literature (*e.g.* Fama, 1998, Prabhala, 1997, Li and Prabhala, 2005). A criticism has been made that samples were sometimes defined in an ad-hoc manner by the researcher in order to "dredge for anomalies" (Fama, 1998). Moreover, in many cases, announcements could not be considered as exogenous to the firm's choice (*e.g.* tender offers, stock splits, etc.). Chemical disasters, in contrast, can be considered as low-discretion and unexpected events, so that manipulation or selection of news announcement dates by firms is almost impossible.

Yet, in this sub-section, we focus on a new and unstudied issue: the selection of news announcements or corporate events by the press. In most event-studies, sample of events collected in the press cannot be considered as random. This is due to the fact that journalists track what they perceive as the most important (or newsworthy) news in a given day. To be disclosed or announced by journalists, the net value associated with the publication of news needs to be perceived as positive. Media coverage might then give rise to sample selection bias. But does this problem really matters, and does it have implications for the estimation of population parameters?

There is reason to suspect that only the least serious accidents (either in terms of pollution, human harm, or physical damage) would be ignored by the press. Let $s$ be a binary selection indicator representing a random draw from the population. By definition, $s = 1$ if we use the draw in the estimation, and $s = 0$ if we do not. In our study, $s = 1$ if at least once article is published about the chemical disaster. Most often, we do not use observations when $s = 0$ because data on $x$ (explanatory variables) or $y$ (dependant variables) are unobserved. The key assumption underlying the validity of ordinary least squares on selected sample as demonstrated by Wooldridge (2002, p.553) is that $E(u|x, s) = 0$. However, if only the most serious accidents appear in the press, so that $s$ is a deterministic function of $x$, therefore, it follows from the assumption $E(u|x) = 0$ that $E(u|x, s) = E(u|x)$, and the assumption $E(u|x, s) = 0$ holds. In that case, sample selection can be ignored, and the population parameters can be estimated using ordinary least squares.

**The Simultaneity Bias.** News coverage is determined simultaneously along with stock returns, as illustrated by the fact that the most severe disasters will appear more often in the news and will induce higher equity losses. Second, the fact that stock returns reflect all publicly available information also raises a potential endogeneity bias. Finally, news coverage and stock market response will be correlated even if the number of news stories has no effect on returns, because they both depend on other newsworthy materials at the time of disasters. The basic econometric problem is that there are many aspects of the disaster salience to the public that we cannot observe, for example, the direct cost of the disaster, or unobserved competing shocks affecting the firm. Consequently, residuals from the outcome variable may be correlated with the regressors, and we cannot identify the causal effect of news on stock markets from a regression of the latter on the former. Using a measure of unexpected media coverage (*i.e.* the media coverage associated with the chemical disasters) certainly alleviates this problem, but it is not sufficient to tackle the simultaneity problem if we suspect that media coverage also responds to firm newsworthiness at the time of disasters.

Conceptually, this is a difficult situation to analyze, because we must think of a situation where news coverage could vary exogenously, even though in the data stock returns and news coverage are generated simultaneously (Wooldridge, 2002). To counter this simultaneity bias, at least one instrumental variable is required, a variable which is exogenous to the unexplained part of the stock market returns, and at the same time strongly correlated with the news coverage. Therefore, to determine whether news has a causal effect on stock markets, we use two sets of instrumental variables, namely *firm newsworthiness* and *news pressure* at the time of disasters (see the Data section above).

### 3.2 A Triangular Recursive Equation System

This paper assumes that stock market returns following chemical disasters depend on the magnitude of the news coverage, and on the seriousness of the disaster. At the same time, the news coverage magnitude depends on the same variables, and on a set of instrumental variables as described above.[14]

Our econometric specification is of the following form. In our system, for each firm-disaster $i$, the dependant variable is $CAR_{i,[0,+t]}$, the cumulated abnormal returns up to $t$ days after the accident date, and the endogenous regressor is $NEWS_{i,[0;+t]}$, the cumulated number of news articles reporting the disaster $i$ up to $t$ days after the accident date. The vector $\theta_i$ contains disaster specific variables, such as the number of fatalities and serious injuries, a dummy for toxic release, but also, firm specific variables, number of previous accidents experienced, and fixed effects for country, time period, etc. Thus, for each firm-disaster $i$, and $t$ days after the accident date ($t = 0$), and $\forall t = 0, 1, 2$, the two-equation system is triangular as follows:

$$NEWS_{i,[0;+t]} = \delta_1 ABNNEWS_{i,t=[-2,-22]} + \delta_2 NEWSPRESSURE_t + \delta\prime\theta_i + \xi_i \quad (1)$$

$$CAR_{i,[0,+t]} = \gamma_1 NEWS_{i,[0;+t]} + \gamma\prime\theta_i + \epsilon_i \quad (2)$$

Note first that we assume that the increase in the firm news coverage after $t = 0$ is entirely due to the chemical disaster, since $NEWS_{i,[0;+t]}$ measures the total number of news articles published about the accident (and not about the firm $i$). Our central hypothesis to control for exogenous variations of the disaster news coverage is that disasters are more likely to be covered when the firm is more newsworthy, as well as when at the time of disasters, important political events break into the news (war, terrorist attacks, etc.), as respectively captured by the two variables

[14] The system is triangular or recursive rather than simultaneous, with X entering the equation determining Y , but not the other way around. This differs from the recursive form of the general simultaneous equations model (e.g., Hausman, 1983), where the recursive nature is by construction. In contrast to the recursive form in such linear simultaneous equations models the unobserved components are potentially correlated (Greene, 1993).

firm newsworthiness ($ABNNEWS_{i,t=[-2,-22]}$) and news pressure ($NEWSPRESSURE_t$) as described in the Data section above.

Empirically, several methodologies are implemented. First, our system of simultaneous equations is triangular, in that we assume that abnormal returns depend on the media coverage, but not the opposite. If the disturbances $\epsilon_i$ and $\xi_i$ are uncorrelated, then the system is a fully recursive model. In this case, the entire system may be estimated consistently and efficiently by ordinary least squares. In the more general case, in which the residual covariance matrix is not diagonal, the preceding argument does not apply, and we have to implement a two-stage least squares (TSLS). Assuming a linear model and assuming that the instrument variables are uncorrelated with the unobserved part of the stock market reactions, $\epsilon_i$, and unobserved news coverage, $\xi_i$, conditional on the variables in $\theta_i$, the model is identified and the parameters may be consistently estimated using two-stage least squares.

# 4 Results

## 4.1 What Drives the News Coverage of Chemical Disasters?

In this section, we document the disaster news coverage determinants in the first days after the accident date. Recall that disaster news coverage variables use the total number of newspaper articles published about the accident.

OLS regressions are used to relate the cross-sectional variance in the disaster news coverage to the accident-specific features, the firm-specific features, and various standard controls. Table 5 reports the results. Several measures of press coverage magnitude are used: the daily number of newspaper articles from $t = 0$ to $t = 1$ in event-time ($News_t$); and, the cumulated number of natural newspaper articles from $t = 0$ to $t = 2$ in event-time ($Cum.News_[0, +t]$). In the second set of regressions (columns (4)-(6)), our two time-varying instruments are included in the regression models: the news pressure variable at the time of disasters; and the firm newsworthiness shortly before the disaster (as measured by abnormal media coverage). Recall that instruments have to be strongly correlated with the endogenous regressor (in our study, the news coverage) to be relevant. It is worth noting that if we include instruments separately, results do not change notably.

Newspapers focus their attention on accidents which provoke fatalities and serious injuries. In every model specification, the coefficient for human harm is positive and statistically significant at the 5% level: One more fatality is associated with one additional newspaper article on the accident day (see model (4) in Table 5 which has the highest R-squared). Results also show evidence of a significant non-linear effect of the number of injuries and fatalities on the disaster news coverage. The coefficient associated with the squared number of fatalities and serious injuries is negative and significant at the 1% level. Therefore, the marginal effect of human harm on the number of newspaper articles decreases with the total number of injuries and deaths witnessed. The effect of pollution (and subsequent social costs due to containment and evacuation) is less robust. In columns (1)-(3), absent exclusion restrictions (instrument variables), the effect of the toxic release dummy on news coverage is positive and significant at the 10% level, but in specifications (4)-(6), the effect is no longer significant. Overall, the results confirm that press coverage is highly sensitive to the seriousness and social cost of accidents. Similarly, the reputation of firms as measured by the number of previous accidents experienced by each firm is crucial to explain the magnitude of the disaster news coverage. On the accident day, these two variables help explain almost 50% of the news coverage variance (as measured by the *adjusted R-squared* metric).

Surprisingly, most financial control variables (unreported results) do not increase the explanatory power of the regressions and in almost every specification, coefficients associated with these variables are not significant. However, regressions in columns (4)-(6) confirm that the news coverage of accidents is more intense when the firm responsible for the accident is bigger.

Disaster news coverage increases when the firm responsible for the disaster has been of major concern to journalists shortly before the disaster, and this is the case irrespective of firm-specific features such as size (columns (4)-(6)). On average, a 1% increase in the firm newsworthiness variable increases the disaster news coverage by almost two articles in the first two days, which represents a significant increase at the 5% level. This result is worth noting because our measure of the disaster news coverage captures articles related to the disaster (and ignores the other news articles related to the firm), so that, all else being equal, firms under the scrutiny of journalists before the accident will benefit from higher news coverage in the event of chemical disasters. One may be concerned that the introduction of the firm newsworthiness variable in addition to financial controls may spur the regressions. Actually, when the firm newsworthiness variable is excluded from the regression, neither financial control is significant.

In addition, we document that news pressure is another important predictor of media coverage. On the accident day, intense news pressure, as measured by the time devoted to the top three news stories in a day, increases the news coverage of disasters. This result is in accordance with the fact that news about chemical disasters is related to concern over other political issues, such as wars and terrorist attacks.[15] However, the intensity of news pressure decreases at the 10% level the cumulated number of articles on the day. This is in line with our initial assumption that other newsworthy material and intense news pressure crowd out the news coverage of disasters. From a purely journalistic point of view, the event is more newsworthy when news pressure related to other events is low (mainly geopolitical events unrelated to the firm). News pressure exogenously decreases the magnitude of the disaster news coverage, without affecting the firm's specific risks, and it is ideally suited to instrument disaster news coverage, more so than firm newsworthiness. Finally, news coverage is greater for accidents occurring in the U.S. compared to accidents occurring in continental Europe. In the first two days, accidents occurring in continental Europe receive on average 14 fewer articles (significant at the 1% level) than accidents occurring in the US (see column (6)). Since our sample also includes various non English-spoken countries such as Japan, this result cannot be due to the fact that newspaper articles are collected in the English press.

### 4.2 Effect of Disaster News Coverage on Stock Market Returns

In this section, we document the effect of disaster news coverage on the drop in equity returns following chemical disasters. To estimate the effect of the disaster news coverage on stock market returns, a two-equation triangular system is estimated, where the endogenous and dependent variables are respectively: (i) in the first equation, the disaster news coverage, and (ii) in the second equation, the cumulative abnormal returns. The two variables are regressed on the same exogenous variables, including a complete set of standard financial controls.

Results are reported in Table 6 (columns (4)-(8)), Table 8, Table 7. Table 6 estimates the contemporaneous effect of the disaster news coverage on the abnormal return using robust Ordinary Least Squares; Table 8 estimates dynamic equations (*i.e.* the effect of the disaster news coverage on the subsequent day abnormal return) using robust Ordinary Least Squares; while Table 7 estimates contemporaneous equations using Two-stage Least Squares.[16] To account for

[15] In unreported results, we also use a control for the total number of headlines mentioning either the word "war" or "terrorism", and its coefficient is positive and significant.

[16] Results from a three-stage least squares regression implemented to tackle more precisely the correlation

the effect of delayed news coverage on stock market outcomes, we use $News_{t=0}$ and $News_{t=1}$ jointly in some model specification. Recall that in the first two days, the disaster news coverage is particularly heterogenous, and delayed in some cases (for example, the correlation between $News_{t=0}$ and $News_{t=1}$ is of only 60% while the correlation between $News_{t=1}$ and $News_{t=2}$ is above 90%). In contrast, $CumNews_{[0,+t]}$ is a more conventional measure which captures the overall intensity of press coverage in the first $t$ days after the accident, and deliberately ignores daily autocorrelation in the news coverage metrics.[17]

Our first result is that in the first days after the accident, intense media coverage, which cannot be imputed to fatalities and pollution or to standard financial risk-factors, mitigates the drop in stock returns. In every specification, and irrespective of the estimator used (TSLS, or OLS), the effect of disaster news coverage on abnormal returns is positive and significant at the 5% level (at least). Moreover, both the cumulated number of news articles and the daily number of articles have a positive effect. As shown in Table 8, in the dynamic equation setting, intensity of news coverage on the day of the accident helps explain at the 1% level cumulated abnormal returns on the subsequent days.

Firm newsworthiness and (daily) news pressure prove to be good and valid instruments. First, as shown in Table 4, we use the test of overidentifying restrictions of Sargan, and confirm that, all instruments can be considered as exogenous.[18]. Second, as shown in Table 4, instruments are uncorrelated to the severity of disasters; chemical disasters, in particular, do not influence the daily news pressure variable. Third, the Cragg-Donald F-statistic for excluded instruments in the first stage is much greater than the critical values for the weak instrument test based on TSLS size provided by Stock and Yogo (2002), and the partial R2 for excluded instruments is very high (between 45% and 50%). Finally, over-identification tests (using the Hansen test statistic) are not rejected. Finally, a test for the presence of heteroskedasticity when one or more regressors is endogenous is also necessary in deciding whether instrumental variable or GMM is called for. Therefore, in unreported results, we have implemented the test of Pagan and Hall (1983) of heteroskedasticity for instrumental variables estimation, and the tests of Breusch and Pagan (1979). The null hypothesis of no heteroskedasticity are accepted at the 1% level.

**Endogeneity test.** Using our instrument variables, we are able to test for the endogeneity of disaster news coverage with regards to (unexplained) abnormal returns following chemical disasters. The null hypothesis of news coverage exogeneity is accepted (using the Hausman specification tests), such that the disaster news coverage can be considered as uncorrelated to other new information arrival at the time of disasters (as measured by the unexplained part of abnormal returns). This result confirms that the OLS estimator is the most consistent one for estimating the effect of news coverage on abnormal returns.

# 5 Discussion and Additional Evidence

## 5.1 Longer-term Evidence

In this section, we document the effect of chemical disasters on stock market returns over a longer period, looking at the cumulated abnormal return up to six months after the accident.

between equations is not reported, but do provide the same results.

[17]The cumulated number of news stories avoids problems deriving from the fact that certain disasters may occur in the late afternoon. Note also that the natural logarithm is used to correct for the right-tailed distribution of press coverage documented in the Data section.

[18]In unreported results, we find that using various combinations of instrumental variables do not change the results from the Sargan test.

*Descriptive evidence.* Graphically, and using sub-sample analysis (see Table 2, and, Figure 3), there is clear evidence that in the long-term, the most publicized accidents, as well as the most serious accidents, are associated with a stronger drop in equity returns. By way of comparison, cumulated abnormal returns associated with non-polluting accidents and with the least publicized accidents are close to zero levels. As shown in Table 2, the differences in abnormal returns across these sub-samples are significantly different from zero at the 1% level. This evidence is interesting but only preliminary: test statistics based on the historical variance can reject the null hypothesis too often, if there is an increase in the return variance in the announcement period (Brown and Warner, 1985). Moreover, univariate comparisons do not account for additional factors that might simultaneously affect the response of investors.

*Least squares analysis.* In Table 9, we report results from cross-sectional regressions using robust OLS, where the cumulated abnormal returns up to 120 (trading) days after the disaster is the dependant variable.

There is clear evidence that over the first six month after the disaster, abnormal returns incorporate the negative effect associated with pollution news and intense media coverage. Firms which benefit from more intense news coverage in the first three days after the disaster irrespective of the accident seriousness also incur lower abnormal returns twenty days after the accident. The coefficient associated with news coverage is negative and statistically significant at the 5% level. This result confirms that, all else being equal, marginally more intense press coverage is costly (and potentially, proxies for reputation loss and degradation of the firm's image). At the same time, in Table 9, we document the observation that the marginal loss associated with one additional newspaper article is only of 0.03% six months after the accident. Finally, we document that, after six months, the marginal loss associated with pollution news is 12% (see also Capelle-Blancard and Laguna, 2006). This effect is both statistically and economically significant at the 5% level. This result confirms that investors are slow to recognize the extent of the loss associated with pollution news. This result is not surprising since there is great uncertainty surrounding pollution news, with regard to litigation, reputation risk, and the extent of the damage. In contrast, the effect of the number of serious injuries and fatalities on abnormal returns in the long-term is not significant.

### 5.2 Effect of the Disaster News Coverage on Abnormal Return Variability

In this section, we investigate the effect of disaster news coverage on the variability of stock returns. The variance of abnormal returns in the event of disaster is used to capture the uncertainty (or noisiness) surrounding chemical disaster news. In Table 10, we report results from robust OLS regressions where abnormal return variance on the accident day is the dependant variable.

Results document two interesting effects. First, pollution news as measured by the toxic release dummy increase stock return variance significantly (at the 10% level). This result might confirm that pollution news is associated with greater uncertainty on stock markets. Second, intense media coverage is associated with return variability of a lower magnitude. The coefficient of news coverage, measured both on a daily basis and by the cumulated number of news articles, is negative and significant at the 1% level. This result is in line with the fact that news coverage induce abnormal returns of a lower magnitude following chemical disasters. Even if it is difficult to disentangle the effect of news coverage on mean abnormal returns from the effect on the return variance, this result may be due to the fact that intense media coverage reduces information uncertainty following chemical disasters. Therefore, it might confirm that intense media coverage marginally alleviates information problems on stock markets.

### 5.3 Effect of the Disaster News Coverage on Share Trading Volume

In this section, we document whether the price pressure observed on the short-term following chemical disasters is associated with increased turnover. The daily turnover is defined as the percentage of outstanding shares traded on a given day: $TO_{i,t} = NT_{i,t}/NSO_{i,t}$, where $NT_{it}$ is the number of shares traded for stock $i$ on day $t$, and $NSO_{it}$ is the firm $i$'s outstanding shares on day $t$. We use the mean-adjusted turnover approach to estimate expected turnover as in Campbell and Wasley (1996). The average turnover ratio logarithm is computed through the period [-190, -10] in event-time. We compute the abnormal turnover for stock $i$ in the period $t = [0, +h]$ in event-time ($ATO_{i,h}$) as the difference between the observed average turnover during the period $t = [0, +h]$ ($\frac{1}{(1+h)} \sum_{\tau=0}^{\tau=h} TO_{i,\tau}$) and the expected daily turnover as measured by $\bar{TO}_i = \frac{1}{181} \sum_{\tau=-190}^{\tau=-10} TO_{i,\tau}$. Note that we use log-transformed percentage of shares traded. In unreported figures, we document that turnover slightly increase on the accident day; average turnover is 6% higher than during the estimation period, but not statistically significant, and in the days following the accident date, abnormal turnover decrease to reach the expected zero level. These results are in line with the fact that investors incorporate immediately the information conveyed by chemical accidents, and that attention drawn by accidents on stock markets is brief and not significant.

*Descriptive statistics.* What drives this slight increase in share turnover? To draw further conclusions, we need to examine abnormal turnover at the sub-sample level. Results are reported in Table 3. We find that the increase in abnormal turnover associated with the most serious accidents (in terms of casualties and pollution occurrences) is higher than average, but not significantly different from zero. However, the difference in abnormal turnover between the most serious accidents and the rest of accidents is positive and significant at the 1% level up to the first month after the accident date. This result confirms that attention is driven by newsworthy information related to the number of injuries and pollution occurrences. Moreover, we also document that the percentage increase in turnover is much more important (and statistically significantly different from zero) for accidents which benefited from a high level of press coverage or from financial press coverage. This result is in line with the hypothesis that because press coverage features the public nature of news, it might increase the investor attention (or the number of informed investors).[19] Overall, this evidence suggests to us that pollution and human harm do not capture all relevant information in the event of accident, and that press coverage may convey additional information.

*Least squares analysis.* In Table 10, we report results from robust OLS regressions using abnormal trading volumes in the first $t$ days in event-time as dependant variables. Results do not show evidence of any significant determinant to explain the variability in abnormal volumes. This result is surprising, because it does not confirm preliminary evidence (using univariate comparisons) that investor attention is driven by the seriousness of disasters. In addition, this result casts doubt on the investor attention hypothesis that the number of informed investors (or the salience of news) increases with the intensity of news coverage.

## 6 Conclusion

In this article, we analyze news coverage following chemical disasters. This subject is relatively unexplored. In fact, most of the previous literature assumes that press coverage is exogenous, and does not attempt to model it (Veldkamp (2006) and Kyanezeva (2007) constitute two exceptions).

[19] In the behavioral literature, abnormal share turnover is also associated with disagreement among investors (Hong and Stein, 2006). This may be the case if press articles provide conflicting results for example.

In the first part of the paper, we show that news coverage is explained by the social cost of the accident, as measured by the extent of pollution, by the number of fatalities, and by the number of accidents previously experienced by the firm. It therefore confirms the credibility of this disciplinary motive. We also show that the news coverage of chemical disasters respond significantly to conjunctural factors such as the abnormal media coverage received by firms shortly before the accident, and to the news pressure at the time of the accident.

In the second part of the paper, we investigate the implications of news coverage on the market value of the firm that is responsible for the accident. We emphasize that, in contrast to previous literature on earnings announcements and media, we consider only the articles that specifically mention the accident and disregard those that discuss the firm for unrelated reasons.

The inclusion of disaster news coverage metrics into the specification models doubles their explanatory power, and confirms previous evidence that the social cost of accidents is incorporated into stock prices (Cappelle-Blancard and Laguna, 2006). Our results can be summarized as follows. First, disaster news coverage affects stock returns irrespective of the information content (we do not control for the positive or negative nature of news, for example), and is exogenous to the unexplained part of the abnormal returns at the time of disasters. Second, we document that intense news coverage is associated with lower losses in the first days. Since media coverage is usually considered as a good proxy for public concern, this result may appear counter intuitive. We may expect that more publicized disasters would result in a greater reputation loss for the firm and, consequently, in larger equity losses. Our results document instead that from a financial point of view, the link between media coverage and stock market outcomes is far less obvious. Various explanations can be advanced. First, it might be the case that more news introduce more noise. This might happen if the reports about deaths and pollution gravity are not unanimous. This may induce investors to disagree, as well as to hold on for more information. Another (and opposite) explanation of the mitigating effect of news coverage is that, differently from what assumed before, more news coverage disseminates more information: after an accident, investors that are more informed may react less (and stock returns would then drop by less) than non informed investors who suspect that the accident is more serious than in reality.

The former explanation would account for the fact that when looking at the effect of news coverage in the long term (as opposed to the short term), disasters that were more covered by the press experience, after controlling for the gravity of the accident, a slightly larger drop. Therefore, all else being equal (pollution, human harm, and firm characteristics), the stock market reaction to intense press coverage is delayed, and becomes negative only in the long-term. We interpret this latter result as evidence that investors are slow to recognize the extent of the loss associated with the implications for the public of news coverage (*e.g.*, image and public trust deterioration). we note that this result is in line with the evidence of Chan (2003) which documents that prices are slow to reflect bad *public* news, by contrast with *private* news. Finally, in contrast with previous evidence on media and stock markets, we argue that press coverage is not necessarily associated with increased investor attention, or information of a better quality (Bushee *et al.*, 2007, Peress, 2008). If this were the case, the loss should have increased with media coverage instantaneously (*e.g.*, due to a greater number of informed investors).

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# A Appendix

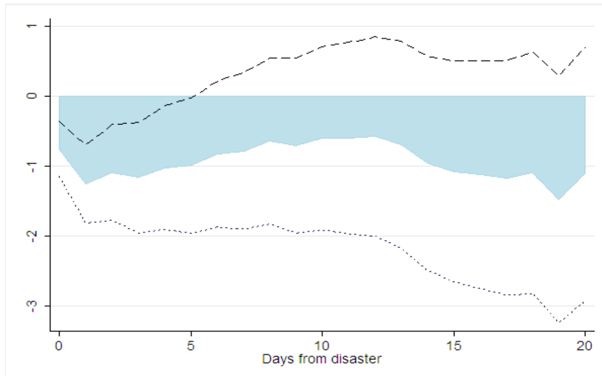
Table 1: **Summary Statistics**

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

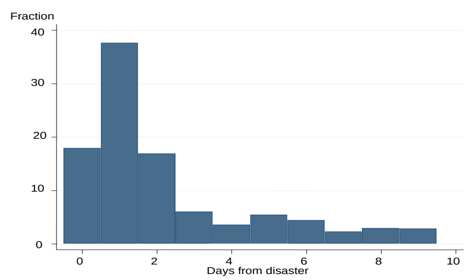
| | # | **Mean** | **Median** | **Std. Dev.** | **Min** | **Max** |
|---|---|---|---|---|---|---|
| **Dependant Variables** | | | | | | |
| $CAR_{t=0}$ | 64 | -0.81 | -0.64 | 1.57 | -6.36 | 2.93 |
| $CAR_{[0,1]}$ | 64 | -1.23 | -0.93 | 2.21 | -7.35 | 3.32 |
| $CAR_{[0,2]}$ | 64 | -1.16 | -0.90 | 2.86 | -7.91 | 5.13 |
| $NEWS_{t=0}$ | 64 | 7.92 | 2 | 16.39 | 0 | 81 |
| $NEWS_{[0;+1]}$ | 64 | 24.58 | 7 | 77.51 | 0 | 608 |
| $NEWS_{[0;+2]}$ | 64 | 32.06 | 10 | 104.37 | 1 | 826 |
| **Instrumental Variables** | | | | | | |
| Firm Newsworthiness (%) | 64 | 5.46 | 4.99 | 3.15 | 0.00 | 20.19 |
| News Pressure | 57 | 8.20 | 7.50 | 3.69 | 4.34 | 29.25 |
| **Explanatory Variables** | | | | | | |
| Ser. injuries and fatalities | 64 | 2.36 | 1 | 4.76 | 0 | 30 |
| Toxic release | 64 | 0.23 | 0 | 0.43 | 0 | 1 |
| # previous accidents | 64 | 0.73 | 0 | 1.13 | 0 | 5 |
| Chemicals | 64 | 0.68 | 1 | 0.47 | 0 | 1 |
| Dummy year > 1999 | 64 | 0.36 | 0 | 0.48 | 0 | 1 |
| **Financial variables** | | | | | | |
| log (Market value) (billion 2005 $) | 64 | 43.36 | 7.28 | 74.04 | 0.09 | 340.04 |
| **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 |

Abbreviations: $CAR_{[0,t]}$: Cumulative Abnormal Returns up to $t$ days after the accident date averaged across firms; $NEWS_{[0;+t]}$: Number of newspaper articles reporting the disasters for the first $t$ days the disaster date (Factiva database); Ser. injuries and fatalities: Number of serious injuries or fatalities; 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; # previous accidents: number of previous accidents experienced by each firm before the accident date; Dummy year > 1999 = 1 if the accident occurred after 1999 and 0 otherwise; Firm Newsworthiness is the ratio of headlines mentioning the firm over twenty days before disasters to the total number of headlines received in the previous year (Factiva database); News pressure is the number of minutes devoted to the top three news on a given day. Mean daily news pressure is 40-day average news pressure (Eisensee and Strömberg, 2007); Market Value is in billion 2005 constant $. See the text for further details concerning the sample and the variables.

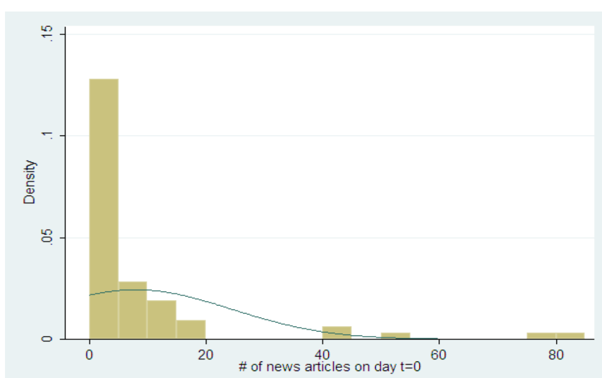
Figure 1: News coverage and stock market returns following chemical disasters




(a) Cumulative average abnormal returns (in %) with confidence intervals at the 5% level, by days from the disaster



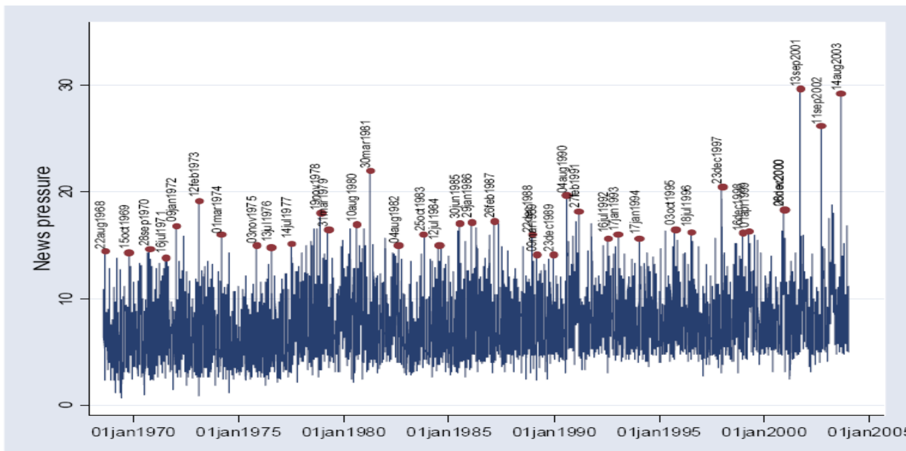

(b) News stories on disasters (in %), by days from the disaster



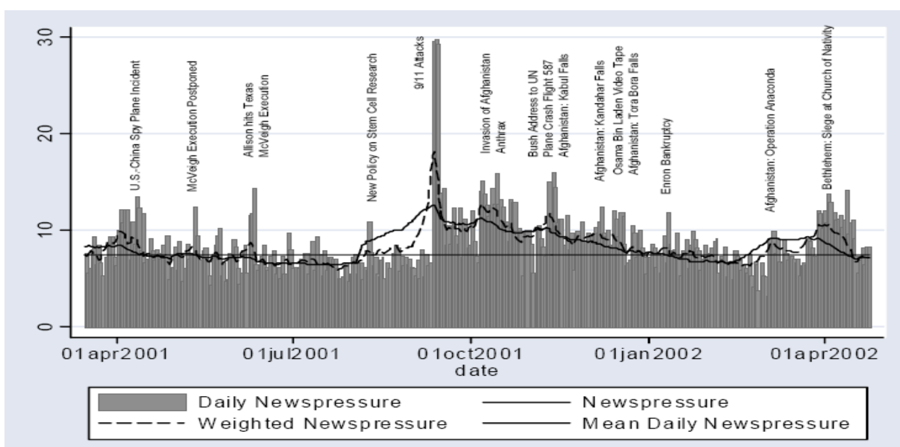

(c) News Articles Density on Day $t = 0$, 1990 – 2005

Notes: In figure (a), abnormal returns are computed given the market model parameters estimated with OLS through the period [-190; -10] in event time. The figure (c) represents the histogram of the number of news articles published about the chemical disaster on the accident day ($t = 0$). Bar width equals 5 articles. The dark line represents normal fitted distribution. The sample of chemical accidents is from 1990, January to 2005, March. Event time is days relative to the accident date.

Figure 2: Daily News Pressure (Eisensee and Strömberg, 2007), by Day



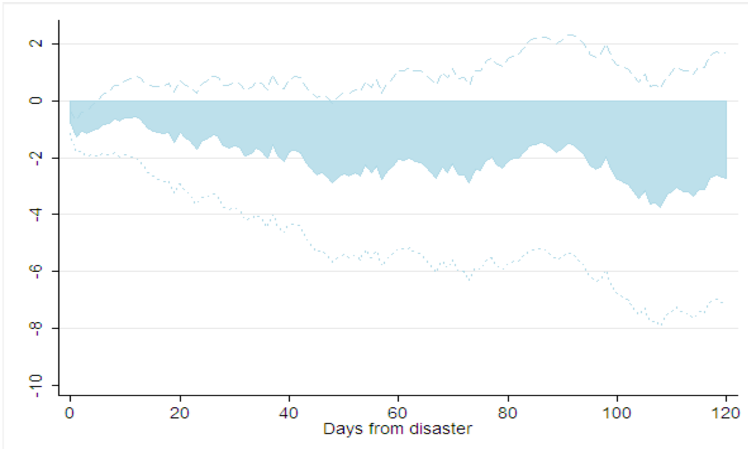

(a) Daily News Pressure (Minutes), 1968 – 2003, by Day. The horizontal flat line depicts the mean for the 1968—2002 period. The figure also displays the events occurring during the peaks of daily news pressure.



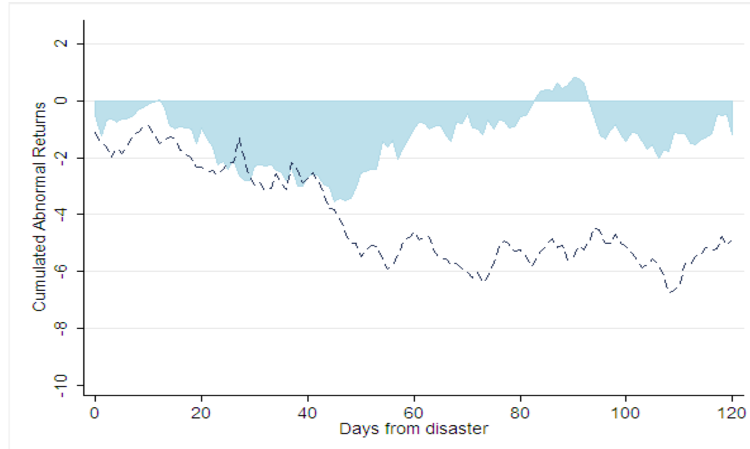

(b) News Pressure (Minutes) during 405 Days, 15 March 2001 – 23 Apr 2002, by Day

The figures are taken from Eisensee and Strömberg (2007) to illustrate major newsworthy events as measured by the variable daily newspressure. News pressure is the number of minutes devoted to the top three news on a given day. Mean daily news pressure is 40-day average news pressure. This measure puts an equal weight on all days during the 40 days.

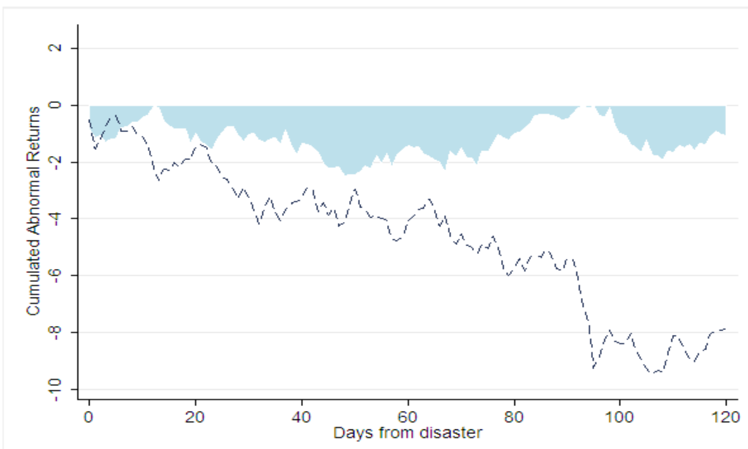
Figure 3: Abnormal Return following Chemical Disasters: Accident-specific Features



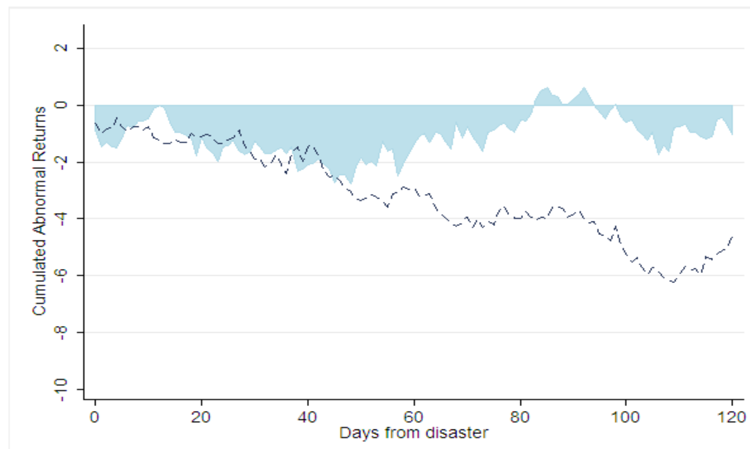

(a) The Whole Sample




(b) Human




(c) Pollution




(d) Press Coverage

Notes: Sub-samples (Human Harm, Pollution, Media Coverage, Financial Press Coverage) are built using respectively the median number of fatalities and serious injuries, a dummy set equal to one for toxic release, the median number of newspapers articles in the first two days ($t = [0, 1]$ in event-time), and a dummy set equal to one for disaster news coverage in the financial press. Abnormal returns are computed using 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 and News Coverage: Univariate Comparisons**

This table presents results from mean comparison test, where the abnormal return variance estimated during the market model estimation period ($t = [-190, -10]$ is used to compute the statistics test. The median number of press articles published in the first two days after the accident, as well as a dummy for accidents reported either in *The Wall Street Journal* or *The Financial Times*, are used to distinguish between accidents intensively covered by the press from the rest of accidents.

| | **High sample** | | | **Low sample** | | | **Two-sample mean comparison test High−Low** |
|---|---|---|---|---|---|---|---|
| *t* | *Mean* | *Std.Dev.* | $CAAR < 0$ | *Mean* | *Std.Dev.* | $CAAR < 0$ | *Z-stat* |
| # **News items** | | **N$_{High}$=29** | | | **N$_{Low}$=34** | | |
| 0 | −0.62 | 0.26 | 62% | −0.86 | 0.29 | 76% | 3.35 |
| 2 | −0.82 | 0.45 | 58% | −1.32 | 0.51 | 66% | 4.03 |
| 5 | −0.77 | 0.64 | 54% | −1.18 | 0.73 | 58% | 2.33 |
| 10 | −0.75 | 0.87 | 58% | −0.47 | 0.98 | 48% | −1.21 |
| 20 | −1.10 | 1.21 | 70% | −1.12 | 1.36 | 53% | 0.05 |
| 40 | −1.47 | 1.69 | 75% | −2.09 | 1.93 | 60% | 1.34 |
| 60 | −2.89 | 2.07 | 62% | −1.33 | 2.36 | 63% | −2.77 |
| 80 | −3.96 | 2.38 | 58% | −0.51 | 2.72 | 68% | −5.31 |
| 100 | −5.25 | 2.66 | 50% | −0.60 | 3.04 | 63% | −6.40 |
| 120 | −4.60 | 2.91 | 50% | −1.04 | 3.32 | 63% | −4.47 |
| **Financial Press** | | **N$_{YES}$=24** | | | **N$_{NO}$=39** | | |
| 0 | −0.50 | 0.26 | 65% | −0.91 | 0.28 | 76% | 5.86 |
| 2 | −0.68 | 0.46 | 68% | −1.34 | 0.48 | 58% | 5.41 |
| 5 | −0.48 | 0.65 | 62% | −1.30 | 0.69 | 52% | 4.73 |
| 10 | −0.66 | 0.88 | 58% | −0.56 | 0.93 | 47% | −0.43 |
| 20 | −0.92 | 1.21 | 72% | −1.22 | 1.29 | 50% | 0.92 |
| 40 | −1.27 | 1.70 | 68% | −2.11 | 1.83 | 63% | 1.83 |
| 60 | −2.45 | 2.07 | 68% | −1.80 | 2.23 | 57% | −1.15 |
| 80 | −2.47 | 2.39 | 75% | −1.90 | 2.57 | 54% | −0.87 |
| 100 | −2.95 | 2.67 | 68% | −2.65 | 2.87 | 48% | −0.42 |
| 120 | −2.65 | 2.92 | 65% | −2.73 | 3.14 | 51% | 0.10 |

Table 3: **Abnormal Turnover and Accident-specific Features**

Abnormal turnover is the percentage increase in logged turnover following the accident date at horizon $t = [0, +h]$ in event time ($h = 0, 1, ..., 120$), relative to the average logged turnover estimated during the period $t = [-190, -11]$ in event time. Turnover is the period average of daily dollar volume deflated by the period market capitalization. In the first sub-sample, the median number of serious injuries and fatalities is used to group the most serious accidents in one sub-sample; in the second sub-sample, the toxic release dummy is used to distinguish between non-polluting and polluting accidents; in the third and fourth sub-samples, the median number of press articles published in the first two days after the accident, as well as a dummy for accidents reported either in *The Wall Street Journal* or *The Financial Times*, are used to distinguish between accidents intensively covered by the press from the rest of accidents. *, **, ***: Significant at the 10%, 5%, and 1% level respectively.

| *t* | *Z-stat* | *Mean* | *Z-stat* | *Mean* | *Z-stat* | *Mean* | *Z-stat* | *Mean* |
|---|---|---|---|---|---|---|---|---|
| | **# Casualties** | | | | **Pollution** | | | |
| | **<Median** | | **>Median** | | **YES** | | **NO** | |
| 0 | 0.31 | 3.12 | 1.07 | 15.08 | 0.56 | 11.17 | 0.63 | 5.49 |
| 2 | −0.29 | −2.93 | 0.15 | 2.05 | 0.57 | 11.36 | −0.56 | −4.86 |
| 5 | −0.25 | −2.49 | 0.59 | 8.32 | 0.91 | 18.34 | −0.40 | −3.50 |
| 10 | −0.31 | −3.11 | 0.36 | 5.08 | 0.50 | 9.99 | −0.37 | −3.22 |
| 20 | −0.40 | −4.04 | 0.65 | 9.22 | 0.44 | 8.78 | −0.28 | −2.42 |
| 40 | −0.32 | −3.27 | 0.60 | 8.47 | 0.23 | 4.68 | −0.13 | −1.10 |
| 60 | −0.11 | −1.12 | 0.55 | 7.73 | 0.37 | 7.39 | 0.01 | 0.04 |
| 80 | −0.13 | −1.30 | 0.50 | 7.03 | 0.32 | 6.43 | −0.02 | −0.14 |
| 100 | −0.09 | −0.90 | 0.52 | 7.29 | 0.31 | 6.30 | 0.04 | 0.37 |
| 120 | 0.09 | 0.90 | 0.63 | 8.82 | 0.38 | 7.71 | 0.25 | 2.17 |
| | *Std.Dev.*= 10.08 | | *Std.Dev.*= 14.08 | | *Std.Dev.*= 20.09 | | *Std.Dev.*= 8.70 | |
| | **# News items** | | | | **Financial Press** | | | |
| | **<Median** | | **>Median** | | **YES** | | **NO** | |
| 0 | −0.52 | −5.85 | 1.68 | 19.67* | 2.07 | 29.14** | −0.62 | −6.41 |
| 2 | −0.76 | −8.56 | 0.51 | 5.93 | 0.80 | 11.21 | −0.86 | −8.82 |
| 5 | −0.73 | −8.21 | 0.89 | 10.46 | 1.26 | 17.68 | −0.83 | −8.59 |
| 10 | −0.49 | −5.48 | 0.39 | 4.59 | 0.94 | 13.26 | −0.81 | −8.34 |
| 20 | −0.39 | −4.33 | 0.38 | 4.45 | 0.67 | 9.48 | −0.55 | −5.70 |
| 40 | 0.01 | 0.12 | 0.01 | 0.11 | 0.22 | 3.11 | −0.16 | −1.60 |
| 60 | 0.17 | 1.91 | 0.09 | 1.00 | 0.22 | 3.03 | 0.06 | 0.64 |
| 80 | 0.15 | 1.71 | 0.04 | 0.51 | 0.20 | 2.75 | 0.03 | 0.27 |
| 100 | 0.25 | 2.80 | 0.02 | 0.21 | 0.09 | 1.23 | 0.17 | 1.74 |
| 120 | 0.40 | 4.46 | 0.17 | 1.99 | 0.24 | 3.36 | 0.31 | 3.23 |
| | *Std.Dev.*= 11.23 | | *Std.Dev.*= 11.72 | | *Std.Dev.*= 14.05 | | *Std.Dev.*= 10.31 | |

Table 4: **The Correlation of Instruments with Exogenous Variables**

OLS regressions with the instruments news pressure and firm news pressure as dependent variables, and including year, and regional fixed effects. Robust standard errors in parentheses. The F-test tests the joint significance of the explanatory variables in the regression.

| | Dependent variable is : Firm Newsworthiness$_{t=[-22,-2]}$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Std.Error | T-stat | Coef. | Std.Error | T-stat | Coef. | Std.Error | T-stat |
| $\text{Alpha}_{i,t=[-190,-10]}$ | −1.68 | 4.52 | −0.37 | −3.71 | 4.63 | −0.80 | −5.02 | 4.34 | −1.16 |
| $\text{CAR}_{i,t=[-22,2]}$ | −0.06 | 0.09 | −0.66 | −0.12 | 0.11 | −1.07 | −0.05 | 0.10 | −0.58 |
| $\text{AR}_{i,t=1}$ | −0.52 | 0.29 | −1.76 | −0.35 | 0.26 | −1.37 | −0.46 | 0.28 | −1.64 |
| $\text{AR}_{i,t=1}$ | 0.15 | 0.12 | 1.24 | 0.11 | 0.12 | 0.97 | 0.02 | 0.15 | 0.17 |
| $\text{Abn.V}_{i,t=[-22,2]}$ | 0.02 | 0.01 | 1.79 | 0.02 | 0.00 | 2.43 | | | |
| Constant | 5.66 | 0.49 | 11.38 | 5.45 | 0.49 | 11.07 | 5.44 | 0.43 | 12.52 |
| N | 56 | | | 56 | | | 64 | | |
| F-test of joint insignificance | 2.41 | | | 3.06 | | | 1.73 | | |
| (p-value, %) | (0.04) | | | (0.01) | | | (0.15) | | |
| R-squared | 0.20 | | | 0.14 | | | 0.06 | | |
| | Dependent variable is : Average News Pressure$_{t=[0,1]}$ | | | | | | | | |
| # Ser.Injuries and Fatalities | 0.11 | 0.07 | 1.56 | | | | | | |
| Toxic Release | −0.51 | 0.49 | −1.05 | | | | | | |
| Constant | 8.10 | 0.40 | 20.06 | | | | | | |
| N | 57 | | | | | | | | |
| F-test of joint insignificance | 1.74 | | | | | | | | |
| (p-value, %) | (18.49) | | | | | | | | |
| R-squared (%) | 6.13 | | | | | | | | |

Table 5: **News Coverage Determinants following Chemical Disasters**

This table reports results from robust OLS regression. The dependant variable is the number of newspapers articles published about the disaster. Several measures are used: $News$ represents the daily number of articles, while, $Cum.News$ represents the cumulated number of articles in a given period. In columns (1)-(3), natural logarithm of the number of newspaper articles is used to correct the news coverage right-tailed distribution. In columns (4)-(6), the news pressure variable represents the median time spent on top three news segments (minutes), which is available from 1990-2003. During this period (1990-2003), the disaster news coverage is not right tailed, and the log transformation is not necessary. Each model includes a complete set of regional dummies (UK, Emerging countries, Japan, and continental Europe), and a complete set of standard financial control variables. Firm newsworthiness represents the abnormal media coverage in the period $[-22,-2]$ in event-time. Standard financial control variables include: the firm close-to-close abnormal returns on each of the previous two trading days ($AR_{i,t-1}$, and $AR_{i,t-2}$); the cumulated abnormal returns in the twenty days before the accident ($CAR_{i,[-22,-2]}$); firm size as measured by the firm's log of market capitalization; and book-to-market ratios using log of book-to-market equity at the end of the most recent year; abnormal trading volume is measured by the ratio of the number of shares traded to the number of shares outstanding within the twenty days before the accident date ($AV_{i,[-22,-2]}$), using the estimation period $t = [-1Y, -32]$ to compute the expected level of trading volume; the Amihud's illiquidity ratio which is the stock's absolute daily return divided by its daily trading volume averaged across the most recent year (Amihud, 2002). The sample period is from 1990 to 2005.

| Dependant variable is: | $News_{t=0}$ (log) | $News_{t=1}$ (log) | $Cum.News_{t=[0,+1]}$ (log) | $News_{t=0}$ | $News_{t=1}$ | $Cum.News_{t=[0,+1]}$ |
|---|---|---|---|---|---|---|
| Constant | 0.113 | 0.929 | 0.980 | −13.829 | 2.631 | −11.756 |
| | [0.34] | [2.22]** | [2.37]** | [4.81]*** | [0.52] | [1.38] |
| Fatalities and serious injuries | 0.280 | 0.273 | 0.325 | 1.083 | 1.236 | 2.503 |
| | [4.02]*** | [4.47]*** | [5.07]*** | [2.10]** | [1.90]* | [2.42]** |
| Fatalities and serious injuries$^2$ | −0.007 | −0.007 | −0.008 | −0.048 | −0.048 | −0.100 |
| | [3.07]*** | [3.68]*** | [4.24]*** | [2.71]** | [2.26]** | [2.97]*** |
| Toxic release | 0.536 | 0.755 | 0.822 | −2.228 | 0.193 | −1.745 |
| | [1.79]* | [1.86]* | [2.09]** | [0.80] | [0.04] | [0.27] |
| # previous accidents | 0.325 | 0.133 | 0.215 | 3.656 | 3.455 | 7.134 |
| | [2.40]** | [1.22] | [1.66] | [2.38]** | [2.05]** | [2.30]** |
| Firm newsworthiness$_{[-22,-2]}$ | | | | 0.834 | 1.395 | 2.100 |
| | | | | [2.72]*** | [2.42]** | [2.33]** |
| News pressure | | | | 0.757 | | |
| | | | | [3.83]*** | | |
| Average news pressure$_{[0,+1]}$ | | | | | −0.981 | −0.062 |
| | | | | | [1.72]* | [0.06] |
| 11-sept | | | | 15.114 | 14.877 | 28.530 |
| | | | | [2.47]** | [1.82]* | [2.04]** |
| Market value (2005$, log) | 0.036 | 0.124 | 0.118 | 1.680 | 2.519 | 4.167 |
| | [0.47] | [1.39] | [1.29] | [2.23]** | [2.39]** | [2.50]** |
| $1994 < Year < 2000$ | −0.221 | −0.225 | −0.247 | 1.364 | −2.782 | −1.641 |
| | [0.69] | [0.51] | [0.59] | [0.67] | [0.75] | [0.35] |
| $> 1999$ | 0.566 | 0.716 | 0.746 | −1.194 | 3.098 | 2.352 |
| | [1.85]* | [2.24]** | [2.17]** | [0.44] | [0.78] | [0.38] |
| Continental Europe | −0.292 | −1.174 | −1.004 | −2.424 | −11.094 | −14.094 |
| | [0.92] | [3.86]*** | [2.99]*** | [1.06] | [3.57]*** | [2.99]*** |
| Emerging countries | 0.562 | −1.396 | −0.528 | | | |
| | [0.80] | [2.21]** | [0.72] | | | |
| Japan | 0.794 | −0.220 | 0.209 | 1.987 | 1.200 | 2.771 |
| | [2.08]** | [0.39] | [0.38] | [0.60] | [0.20] | [0.35] |
| UK | 0.197 | −0.606 | −0.396 | −4.878 | −15.994 | −20.224 |
| | [0.29] | [0.81] | [0.46] | [1.17] | [2.70]** | [2.18]** |
| Fin.Controls | | | | YES | | |
| N | 64 | 64 | 64 | 55 | 55 | 55 |
| F | 9.9288 | 10.6280 | 16.2392 | 11.1813 | 7.0838 | 9.0926 |
| Adj. R-squared | 46.65 | 43.51 | 45.66 | 59.05 | 47.31 | 53.69 |



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

Table 6: **The Marginal Effect of News Coverage on Stock Returns in the Event of Chemical Disasters**

This table reports results from robust OLS regressions, where the dependent variable is the raw return on the accident day ($R_t$, the cumulative abnormal return up to the second day following disasters ($CAR_{[0;+t]}$ for $t = 0, 1, 2$), as well as, in columns (9)-(11), the associated shareholder loss ($SL_{[0;+t]}$ for $t = 0, 1, 2$). In columns (5)-(8), measures of the number of newspapers articles published about the disaster are included: $News$ represents the daily number of articles, while, $Cum.News$ represents the cumulated number of articles in a given period. Each model includes a complete set of regional dummies to control for the continent where the accident occurred, as well as, standard financial variables. Standard financial control variables include: the firm close-to-close abnormal returns on each of the previous two trading days ($AR_{i,t-1}$, and $AR_{i,t-2}$; the cumulated abnormal returns in the twenty days before the accident ($CAR_{i,[-22,-2]}$); firm size as measured by the firm's log of market capitalization; and book-to-market ratios using log of book-to-market equity at the end of the most recent year; abnormal trading volume is measured by the ratio of the number of shares traded to the number of shares outstanding within the twenty days before the accident date ($AV_{i,[-22,-2]}$), using the estimation period $t = [-1Y, -32]$ to compute the expected level of trading volume; the Amihud's illiquidity ratio which is the stock's absolute daily return divided by its daily trading volume averaged across the most recent year (Amihud, 2002). Abnormal returns are computed using the one factor market model. The sample period is from 1990 to 2005. Note: Robust standard errors are in brackets: ***, **, * denote statistically significance at the 1%, the 5% and the 10% level, respectively.

| Dependant variable is: | $R_{i,t=0}$ (1) | $AR_{i,t=0}$ (2) | $CAR_{[0;+1]}$ (3) | $CAR_{[0;+2]}$ (4) | $R_{i,t=0}$ (5) | $AR_{i,t=0}$ (6) | $CAR_{[0;+1]}$ (7) | $CAR_{[0;+2]}$ (8) |
|---|---|---|---|---|---|---|---|---|
| $News_{t=0}$ | | | | | 0.136 | 0.094 | | |
| | | | | | [0.044]∗∗∗ | [0.031]∗∗∗ | | |
| $Cum.News_{t=[0,+1]}$ | | | | | | | 0.043 | |
| | | | | | | | [0.016]∗∗ | |
| $Cum.News_{t=[0,+2]}$ | | | | | | | | 0.028 |
| | | | | | | | | [0.023] |
| Fatalities | −0.146 | −0.118 | −0.113 | −0.115 | −0.209 | −0.164 | −0.153 | −0.159 |
| | [0.062]∗∗ | [0.044]∗∗ | [0.068] | [0.088] | [0.046]∗∗∗ | [0.042]∗∗∗ | [0.079]∗ | [0.089]∗ |
| Toxic release | −0.510 | 0.013 | −1.107 | −0.964 | −0.769 | −0.139 | −1.382 | −1.171 |
| | [0.497] | [0.389] | [0.573]∗ | [0.878] | [0.487] | [0.357] | [0.564]∗∗ | [0.922] |
| # prev. accidents | −0.378 | −0.409 | −0.264 | −0.460 | −0.529 | −0.550 | −0.412 | −0.597 |
| | [0.216]∗ | [0.174]∗∗ | [0.235] | [0.349] | [0.212]∗∗ | [0.175]∗∗∗ | [0.234]∗ | [0.355]∗ |
| 1994 <Year< 2000 | −0.299 | −0.483 | −0.146 | 0.195 | −0.094 | −0.339 | 0.213 | 0.414 |
| | [0.400] | [0.347] | [0.542] | [0.763] | [0.410] | [0.338] | [0.628] | [0.901] |
| > 1999 | −0.970 | −0.467 | −0.735 | −0.671 | −1.601 | −0.959 | −1.395 | −1.222 |
| | [0.600] | [0.455] | [0.663] | [0.960] | [0.623]∗∗ | [0.503]∗ | [0.716]∗ | [1.065] |
| MV ($2005, log) | 0.423 | 0.394 | 0.530 | 0.468 | 0.338 | 0.330 | 0.416 | 0.389 |
| | [0.170]∗∗ | [0.133]∗∗∗ | [0.197]∗∗∗ | [0.294] | [0.151]∗∗ | [0.117]∗∗∗ | [0.185]∗∗ | [0.308] |
| Regional dummies | | | | | YES | | | |
| Financial controls | | | | | YES | | | |
| N | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 |
| Adj. R-squared (%) | 17.41 | 23.97 | 19.58 | 7.08 | 30.87 | 34.34 | 25.92 | 6.71 |

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

Table 7: **Is News Coverage Exogenous to Stock Returns in the Event of Chemical Disasters? Two-stage Least Squares Results**

This table reports results from the two-stage least squares estimator where the dependent variable is the cumulative abnormal return up to the first day following disasters: $CAR_{[0;+t]}$ for $t = 0, 1$, and the endogenous regressor is the number of newspaper articles published about the disaster on day $t = 0, 1$, instrumented by the firm exposure to media before disasters (Firm Newsworthiness$_{t=[-20,-2]}$), and the news pressure variable. Each model includes a complete set of regional dummies (UK, Emerging countries, Japan, and continental Europe). Standard financial control variables include: the firm close-to-close abnormal returns on each of the previous two trading days ($AR_{i,t-1}$, and $AR_{i,t-2}$); the cumulated abnormal returns in the twenty days before the accident ($CAR_{i,[-22,-2]}$); firm size as measured by the firm's log of market capitalization; and book-to-market ratios using log of book-to-market equity at the end of the most recent year; abnormal trading volume is measured by the ratio of the number of shares traded to the number of shares outstanding within the twenty days before the accident date ($AV_{i,[-22,-2]}$), using the estimation period $t = [-1Y, -32]$ to compute the expected level of trading volume; the Amihud's illiquidity ratio which is the stock's absolute daily return divided by its daily trading volume averaged across the most recent year (Amihud, 2002). Abnormal returns are computed using the one factor market model. First stage results are not presented. The sample period is from 1990 to 2005.

| Dependant variable is: | $R_{i,t=0}$ | $AR_{i,t=0}$ | $CAR_{[0;+1]}$ | $CAR_{[0;+1]}$ |
|---|---|---|---|---|
| Constant | 0.164 | 0.233 | −0.274 | −1.174 |
| | [0.30] | [0.51] | [0.43] | [1.57] |
| $News_{t=0}$ | 0.133 | 0.106 | 0.132 | |
| | [3.94]*** | [3.77]*** | [3.35]*** | |
| $News_{t=1}$ | | | | 0.076 |
| | | | | [2.29]** |
| Fatalities and serious injuries | −0.375 | −0.396 | −0.547 | −0.388 |
| | [2.97]*** | [3.77]*** | [3.71]*** | [2.57]** |
| Fatalities and serious injuries$^2$ | 0.006 | 0.009 | 0.013 | 0.009 |
| | [1.32] | [2.43]** | [2.68]*** | [1.61] |
| Toxic release | −0.793 | −0.301 | −1.473 | −1.775 |
| | [1.82]* | [0.83] | [2.90]*** | [2.85]*** |
| # previous accidents | −0.648 | −0.676 | −0.591 | −0.416 |
| | [2.98]*** | [3.73]*** | [2.33]** | [1.46] |
| $1994 < Year < 2000$ | −0.253 | −0.603 | −0.419 | 0.144 |
| | [0.53] | [1.51] | [0.75] | [0.21] |
| $> 1999$ | −2.368 | −1.783 | −2.170 | −1.743 |
| | [4.36]*** | [3.94]*** | [3.42]*** | [2.47]** |
| Market value ($2005, log) | 0.337 | 0.271 | 0.481 | 0.486 |
| | [2.83]*** | [2.72]*** | [3.45]*** | [2.91]*** |
| Regional dummies | | YES | | |
| Fin.Controls | | YES | | |
| N | 55 | 55 | 55 | 55 |
| F-stat | 3.1672 | 2.9392 | 3.2225 | 2.1664 |
| Adj. R-squared | 0.3814 | 0.3513 | 0.4256 | 0.1942 |
| Partial R-squared (excl.IV) | 48.63 | 48.63 | 48.63 | 55.72 |
| F-stat (excl.IV) | 11.67 | 11.67 | 11.67 | 11.33 |
| Sargan $\chi^2$ | 3.49 | 2.31 | 4.20 | 13.43 |
| (p-value,%) | (17.47) | (31.46) | (12.24) | (0.38) |
| Wu-Hausman stat. p-value (%) | 26.47 | 25.97 | 83.66 | 9.76 |
| Durbin-Wu-Hausman $\chi^2$ p-value (%) | 18.04 | 17.59 | 80.29 | 4.88 |
| Pagan-Hall stat. p-value | 94.75(%) | 89.40 | 83.71 | 80.75 |

Note: Student t-statistics are in brackets: ***, **, * denote statistically significance at the 1%, the 5% and the 10% level, respectively.

Table 8: **Abnormal Return Determinants following Chemical Disasters - Dynamic Equations**

This table reports results from the robust OLS estimator where the dependent variable is the raw return on the accident day, the cumulative abnormal return up to the second day following disasters: $CAR_{[0;+t]}$ for $t = 0, 1, 2$, as well as, the associated shareholder loss: $SL_{[0;+t]}$ for $t = 0, 1, 2$. Each model includes a complete set of dummies to control for the continent where the accident occurred, as well as, standard financial variables. Standard financial control variables include: the firm close-to-close abnormal returns on each of the previous two trading days ($AR_{i,t-1}$, and $AR_{i,t-2}$; the cumulated abnormal returns in the twenty days before the accident ($CAR_{i,[-22,-2]}$); firm size as measured by the firm's log of market capitalization; and book-to-market ratios using log of book-to-market equity at the end of the most recent year; abnormal trading volume is measured by the ratio of the number of shares traded to the number of shares outstanding within the twenty days before the accident date ($AV_{i,[-22,-2]}$), using the estimation period $t = [-1Y, -32]$ to compute the expected level of trading volume; the Amihud's illiquidity ratio which is the stock's absolute daily return divided by its daily trading volume averaged across the most recent year (Amihud, 2002). Abnormal returns are computed using the one factor market model. The sample period is from 1990 to 2005.

| Dependant variable is: | $CAR_{[0;+1]}$ | $CAR_{[0;+2]}$ | $CAR_{[0;+1]}$ | $CAR_{[0;+2]}$ |
|---|---|---|---|---|
| Constant | −0.581 | −0.399 | 0.172 | −0.500 |
| | [0.86] | [0.56] | [0.17] | [0.43] |
| $News_{t=0}$ | 0.240 | 0.085 | 0.107 | |
| | [5.01]*** | [2.90]*** | [3.35]*** | |
| $News_{t=1}$ | | −0.004 | −0.004 | |
| | | [1.02] | [0.95] | |
| $Cum.News_{t=[0,+1]}$ | | | | 0.067 |
| | | | | [3.05]*** |
| Fatalities and serious injuries | −0.555 | −0.408 | −0.478 | −0.498 |
| | [3.77]*** | [2.32]** | [2.08]** | [1.89]* |
| Fatalities and serious injuries$^2$ | 0.015 | 0.010 | 0.012 | 0.013 |
| | [3.12]*** | [1.81]* | [1.66] | [1.55] |
| Toxic release | −1.845 | −1.111 | −0.937 | −1.613 |
| | [3.64]*** | [2.07]** | [1.16] | [1.83]* |
| # previous accidents | −0.501 | −0.702 | −1.037 | −0.737 |
| | [1.99]* | [2.38]** | [2.64]** | [2.07]** |
| $1994 < Year < 2000$ | −0.281 | −0.370 | −0.064 | 0.289 |
| | [0.51] | [0.65] | [0.08] | [0.30] |
| $> 1999$ | −2.348 | −1.843 | −2.051 | −2.252 |
| | [3.12]*** | [2.29]** | [1.81]* | [1.79]* |
| Market value ($2005, log) | 0.369 | 0.467 | 0.394 | 0.274 |
| | [2.40]** | [2.77]*** | [1.53] | [0.97] |
| Regional dummies | | YES | | |
| Fin.Controls | | YES | | |
| N | 64 | 64 | 64 | 64 |
| F-stat | 9.35 | 15.49 | 8.56 | 7.13 |
| R-squared | 60.93 | 52.06 | 42.09 | 38.58 |
| Adj. R-squared | 44.95 | 33.95 | 20.21 | 13.46 |

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

Table 9: **Long-term Abnormal Returns Determinants following Chemical Disasters**

This table reports results from robust OLS regressions. In columns (1)-(5), the dependent variable is the cumulated abnormal return computed from day $t = 2$ up to day $h = +120, 100, 80, 60, 40, 20$ in event-time, depending on the model specification ($CAR_{[+2,+h]}$. Each model includes a complete set of regional dummies (UK, Emerging countries, and Japan, and continental Europe), as well as, standard financial variables. Standard financial control variables include: the firm close-to-close abnormal returns on each of the previous two trading days ($AR_{i,t-1}$, and $AR_{i,t-2}$); the cumulated abnormal returns in the twenty days before the accident ($CAR_{i,[-22,-2]}$); firm size as measured by the firm's log of market capitalization; and book-to-market ratios using log of book-to-market equity at the end of the most recent year; abnormal trading volume is measured by the ratio of the number of shares traded to the number of shares outstanding within the twenty days before the accident date ($AV_{i,[-22,-2]}$), using the estimation period $t = [-1Y, -32]$ to compute the expected level of trading volume; the Amihud's illiquidity ratio which is the stock's absolute daily return divided by its daily trading volume averaged across the most recent year (Amihud, 2002). The sample period is from 1990 to 2005.

| Dependant variable is: | $CAR_{t=[+2,+120]}$ | $CAR_{t=[+2,+100]}$ | $CAR_{t=[+2,+80]}$ | $CAR_{t=[+2,+40]}$ | $CAR_{t=[+2,+20]}$ |
|---|---|---|---|---|---|
| Constant | 21.559 | 10.034 | 8.351 | 3.813 | −0.542 |
| | [2.41]** | [1.32] | [1.31] | [0.52] | [0.15] |
| $Cum.News_{t=[0,+1]}$ | −0.035 | −0.023 | −0.005 | −0.023 | −0.017 |
| | [1.69]* | [1.31] | [0.33] | [2.21]** | [2.09]** |
| Fatalities and serious injuries | 0.461 | 0.194 | −0.090 | −0.025 | 0.156 |
| | [0.89] | [0.39] | [0.19] | [0.08] | [1.23] |
| Toxic release | −12.853 | −8.875 | −4.010 | −2.126 | 0.407 |
| | [2.38]** | [2.22]** | [0.97] | [0.51] | [0.17] |
| # previous accidents | −0.268 | 0.880 | 0.148 | −1.113 | −0.411 |
| | [0.12] | [0.46] | [0.09] | [0.81] | [0.48] |
| $> 1999$ | −6.147 | −0.317 | 1.611 | 2.915 | 3.306 |
| | [1.11] | [0.08] | [0.43] | [0.90] | [2.03]** |
| $1994 < Year < 2000$ | −6.060 | −4.505 | −4.402 | 0.248 | 2.698 |
| | [0.99] | [0.87] | [0.98] | [0.07] | [1.29] |
| Market value ($2005, log) | 0.443 | 0.221 | −0.628 | 0.576 | −0.014 |
| | [0.29] | [0.21] | [0.63] | [0.65] | [0.03] |
| Regional Dummies | | | YES | | |
| Fin.Controls | | | YES | | |
| N | 64 | 64 | 64 | 64 | 64 |
| F-stat | 3.25 | 4.88 | 5.00 | 2.79 | 6.18 |
| R-squared (%) | 59.98 | 56.17 | 53.47 | 36.89 | 52.15 |
| Adj. R-squared (%) | 32.19 | 26.55 | 22.03 | −5.75 | 19.82 |

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

Table 10: **Abnormal Return Variability and Abnormal Volume Determinants following Chemical Disasters**

This table reports results from a robust OLS regression. In columns (1)-(3), the dependent variable is the abnormal return variability on day $t = 0, 1$, as measured by the square level of the abnormal return, while in columns (4)-(5), the dependant variable is the average logged abnormal volume on day $t = 0$ and in the period $t = [0, +1]$. Each model includes a complete set of regional dummies (UK, Emerging countries, and Japan, and the reported dummy for continental Europe), as well as, standard financial variables. Standard financial control variables include: the firm close-to-close abnormal returns on each of the previous two trading days ($AR_{i,t-1}$, and $AR_{i,t-2}$); the cumulated abnormal returns in the twenty days before the accident ($CAR_{i,[-22,-2]}$); firm size as measured by the firm's log of market capitalization; and book-to-market ratios using log of book-to-market equity at the end of the most recent year; abnormal trading volume is measured by the ratio of the number of shares traded to the number of shares outstanding within the twenty days before the accident date ($AV_{i,[-22,-2]}$), using the estimation period $t = [-1Y, -32]$ to compute the expected level of trading volume; the Amihud's illiquidity ratio which is the stock's absolute daily return divided by its daily trading volume averaged across the most recent year (Amihud, 2002). Abnormal returns are computed using the one factor market model. The sample period is from 1990 to 2005.

| Dependant variable is: | $AR^2_{i,t=0}$ | $AR^2_{i,t=1}$ | $AR^2_{i,t=1}$ | $AV_{t=0}$ | $AV_{t=[0,+1]}$ |
|---|---|---|---|---|---|
| Constant | 3.942 | 2.545 | 3.235 | 29.297 | 27.219 |
| | [1.86]* | [2.16]** | [2.63]** | [0.99] | [0.80] |
| $News_{t=0}$ | −2.090 | −1.228 | | −7.516 | |
| | [2.78]*** | [2.84]*** | | [0.76] | |
| $Cum.News_{t=[0,+1]}$ | | | −0.896 | | −1.405 |
| | | | [2.48]** | | [0.17] |
| Fatalities and serious injuries | 0.469 | 0.118 | 0.087 | 2.684 | 1.947 |
| | [2.55]** | [1.02] | [0.73] | [1.49] | [1.14] |
| Toxic release | 0.229 | 2.119 | 2.214 | −6.429 | −8.112 |
| | [0.17] | [1.77]* | [1.71]* | [0.29] | [0.37] |
| # previous accidents | 0.204 | 0.527 | 0.320 | 12.252 | 10.137 |
| | [0.38] | [1.58] | [0.99] | [1.43] | [1.31] |
| $1994 < Year < 2000$ | 0.155 | −1.507 | −1.425 | −3.138 | −0.108 |
| | [0.11] | [1.62] | [1.53] | [0.12] | [0.00] |
| $> 1999$ | 3.411 | 2.543 | 2.547 | −1.279 | −3.429 |
| | [2.49]** | [2.39]** | [2.32]** | [0.07] | [0.18] |
| Market value ($2005, log) | −0.483 | −0.550 | −0.488 | −10.758 | −10.775 |
| | [1.21] | [1.90]* | [1.77]* | [2.43]** | [2.34]** |
| Regional dummies | | | YES | | |
| Fin.Controls | | | YES | | |
| N | 64 | 64 | 64 | 56 | 56 |
| F-stat | 2.2436 | 1.6278 | 1.5595 | 4.0775 | 3.3945 |
| R-squared (%) | 36.31 | 43.64 | 41.30 | 29.91 | 28.63 |
| Adj. R-squared (%) | 15.99 | 25.65 | 22.57 | 03.63 | 1.87 |

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