ABSTRACT

Title of dissertation:	Essays in Corporate Finance
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Dissertation directed by:	Professor Michael Faulkender Department of Finance Professor Vojislav Maksimovic Department of Finance

Prior research has been divided regarding how firms respond to bankruptcy risk, largely revolving around two competing forces. On the one hand, asset substitution encourages firms to increase the riskiness of assets to extract value from creditors. On the other, firms want to minimize bankruptcy risk, either by reducing cash flow risk or through increasing the size of the firm.

I test these two theories using a natural experiment of chemicals used in production processes being newly identified as carcinogenic to explore how firms may respond to potential negative cash flow resulting from litigation risk. I use plant-level chemical data to study firm exposure to risk. I examine how responses between firms of differing levels of chemical exposure may vary within the industry, how firm financial distress affects firm response and whether public and private firms respond

differently. In general, my research provides support for the asset substitution theory.

My first paper studies how investment response varies based on level of carcinogenic exposure. I find that firms with moderate levels of exposure make efforts to mitigate their cash flow risk and reduce their exposure. At the same time, firms with high levels of exposure increase their exposure and riskiness of future cash flows. These findings are consistent with asset substitution theory.

My second paper analyzes the interaction of financial distress and risk exposure. I find that firms in a stronger financial position are more likely to limit their exposure by reducing the number of exposed facilities. On the other hand, not only do firms in weaker financial position not decrease their exposure, I find that, in some instances, they increase their exposure to carcinogens. This work again supports the theory of asset substitution.

Finally, in my third paper, I explore if public firms respond differently to a potential negative cash flow shock than do private firms. I test whether existing public firms are more likely to attempt to minimize their cash flow risk and thus reduce their carcinogen exposure than are private firms. I do not find evidence that public firms respond differently to this shock than do private firms.

Essays in Corporate Finance

by

G. Austin Starkweather

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Advisory Committee:
Professor Michael Faulkender, Co-Chair
Professor Vojislav Maksimovic, Co-Chair
Professor John Chao, Dean's Representative
Professor Laurent Fresard
Professor Gerard Hoberg
Professor Liu Yang

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Chapter 1: General Response to Risk

Abstract

Prior research has been divided regarding how firms respond to bankruptcy risk, largely revolving around two competing forces. On the one hand, asset substitution encourages firms to increase the riskiness of assets to extract value from creditors. On the other, firms want to minimize bankruptcy risk, either by reducing cash flow risk or through increasing the size of the firm.

I test these two theories using a natural experiment of a chemical used in the production process being identified as carcinogenic, thereby potentially introducing the firm to litigation over exposure and higher insurance premiums. I find some evidence that moderately exposed firms decrease their exposure. I find evidence that highly exposed firms actually increase their exposure. These findings are consistent with asset substitution theory. Next, I test whether exposure had any effect on international and domestic deal activity and find that moderately exposed firms are actually more likely to invest abroad, particularly in the same industry. This suggests the possibility that firms take into account labor regulations when considering investment and acquisition opportunities.

1.1 Introduction

This paper explores how firms respond to business risk. Every firm is exposed to an array of risks that might adversely affect the firm; examples would include increased regulation, technology that reduces barriers to entry, reduced trade tariffs, or even getting caught attempting to skirt regulation as in the recent case of Volkswagen. Therefore, it is important for scholars to understand how or if firms address these potential shocks. Intuition might lead us to assume that firms will try to mitigate the potential risk, but asset substitution theory has shown that in some cases, firms near bankruptcy actually have an incentive to increase cash flow risk in order to increase the value of equity at the expense of creditors. Other principal agent strands of literature have shown that managers of firms in financial distress will sometimes choose projects with lower cash flow risk in order to lower the chances of bankruptcy and avoid losing their jobs.

My paper hopes to add more nuance to the prior literature. First, I show that not all firms will attempt to minimize cash flow risk. Instead, I find evidence that only those firms with relatively low levels of bankruptcy risk make efforts to mitigate their cash flow risk. On the other hand, I find that firms highly exposed to cash flow risk actually *increase* their risk by investing in projects with riskier cash flows. These findings provide support for asset substitution theory. Additionally, I find evidence that some firms will actually take into account their cash flow risk when making acquisition decisions, perhaps even investing in countries in which their risk exposure might be mitigated.

Specifically, I utilize a pseudo-natural experiment of a chemical used in their production process being identified as carcinogenic to examine how firms subsequently change their investment patterns. A prior paper uses an industry-wide measure of chemical exposure to find that principal-agent issues might arise when firms are exposed, and that managers hoping to keep the company afloat in order to preserve their own jobs might attempt to increase the size of the firm to avoid bankruptcy risk, even at the expense of shareholder value. [1] Yet whereas their paper was only able to use industry-wide exposure to chemicals, mine utilizes a database of facility-level chemical usage from 1987 through 2014 to explore the issue more deeply. This additional level of detail enables me to examine intra-industry variations between firms of differing levels of chemical exposure. Moreover, as the facilities database includes both public and private firms, I am able to explore differences in how the two groups respond to this introduction of bankruptcy risk.

There are numerous examples in which employees ended up suing their employers over carcinogen exposure. Asbestos litigation, according to one study, has cost defendants and insurers roughly $70 billion as of 2002. [2] And while asbestos/mesothelioma litigation may be the most serious, it is not the only one. In the past two years, for instance, chemical giant Univar was hit with a suit over employee exposure to benzene-containing chemicals used as an applicator in its factories. [3] Separately, Monsanto was sued by some of its workers over exposure to Roundup herbicide. [4] Separately, in 2015 alone, ConocoPhillips, du Pont, Exxon, Firestone, Goodyear, Gulf Oil, Huntsman and others have been sued or ordered to pay over their use of chemicals deemed to be carcinogenic. [5] [6] [7] [8]

For my analysis, I separate firms into three groups of carcinogenic exposure − unexposed, moderately exposed, and highly exposed. I find that firms that are highly exposed to increased bankruptcy liability are actually likely to do little to mitigate their exposure risk and may even increase their risk. This finding is akin to that in which firms that are close to bankruptcy sometimes invest in riskier projects that, while increasing the likelihood of bankruptcy, also increase the value of the equity. Interestingly, I find that moderately-exposed firms actually make significant efforts to decrease their exposure; these firms are more likely to sell or convert exposed facilities, as well as acquire unexposed facilities. Further, they are more likely to invest abroad, either through acquisition or joint venture, and I find some evidence that their foreign investment is in search of lower labor protection standards and, potentially, lower litigation risk.

The remainder of my paper proceeds as follows in my next section, I explore the literature related to my paper. In section 3, I examine the data that my paper uses. In section 4, I explore the methodology used in my regressions and other statistical analysis. In section 5, I present the results and related analysis. Finally, section 6 concludes the paper.

1.2 Literature Review

This paper leans on three strands of literature in particular. The first includes the principal-agent model of the firm that takes into account risk of bankruptcy that would affect employment loss as motivation for managers to deviate from profit-maximizing investments. The second strand is related to bankruptcy, but instead of considering employment loss, it examines more closely how firms near bankruptcy potentially expropriate value from debt holders in the form of risky investments. Finally, my paper relates to the international investment literature, as I show that exposure alters international investment activity.

Principal Agent Literature

In the normal course of business, managers are exposed to all sorts of adverse business risks, whether they be litigation risk, regulatory risk, potential entry of a new competitor, trade barriers, etc. My paper, in part, examines how managers respond to these risks. Ideally, shareholders want managers to exert all of their energy toward the job and also to make decisions that maximize the value of the equity. [9] But research has shown that managers do not always conform to the ideal. Holmstrom [10] develops a model that demonstrates that managerial career concerns can be misaligned with maximizing shareholder value. Jensen and Meckling [11] explores these agency issues in detail and help explain why managers may make investments that reduce shareholder value. For instance, Morck, Shleifer and Vishny [12] suggests that misaligned managerial incentives may result in bad acquisitions that reduce the value of the acquiring firm. Along the same lines, Bliss and Rosen [13] find that, at least among bank mergers during the 1980s and 1990s, CEO compensation increased after acquisitions even though these acquisitions normally did not exhibit abnormally positive returns. Others have found evidence that managers excessively increase the size of the firm to increase their salaries. [14] Other research has shown that some managers make investment choices (such as cuts in R&D spending) that increase short-term profits at the expense of long-term profits. [15]

Another avenue by which managers might fail to maximize shareholder value is through taking actions to decrease the risk of bankruptcy while harming shareholder value. Eckbo and Thorburn [16] suggests the CEOs who will certainly lose their jobs will delay filing for bankruptcy, even at the potential expense of shareholders, in order to preserve private control benefits. Berk et al [17] suggests that managerial entrenchment and aversion to job loss may lead firms to assume suboptimal levels of debt. By extension, it could also lead managers to make suboptimal investments intended to outgrow potential bankruptcy.

More recently, Gormley and Matsa [1] uses a creative natural experiment, which I build off of, to examine the behavior of firms that use chemicals newly determined to be carcinogenic. They argue that this is an external shock that increases the likelihood of future costs in the form of workers compensation, higher insurance and even legal costs and potential liability for exposing employees to carcinogens. Examining industry-wide levels of exposure, they find that firms in exposed industries are more likely to aggressively grow the size of their firms via capital expenditures and acquisitions. Further, they find that this growth is often at the expense of shareholder value. As the title "Growing out of Trouble" suggests, they argue that a manager facing new exposure would attempt to grow the firm to the point in which potential future costs would no longer pose a threat to the firm's viability. The authors present further support for this argument by pointing out that firms with weaker corporate governance measures are more likely to pursue these aggressive growth strategies.

And whereas the Gormley and Matsa paper suggested that CEOs might increase investment in order to stave off bankruptcy and protect their jobs, research by Eckbo et al [18] observes that very few CEOs remain with their firms after bankruptcy, even among firms that emerge from Chapter 11 bankruptcy. Moreover, their paper finds that those who leave their jobs end up earning significantly less afterwards. Therefore, the GM finding suggests that managers alter their investment behavior from maximizing shareholder value in order to decrease the likelihood that they, too, might suffer financially in the event of bankruptcy.

Financial Distress

Corporations in financial distress face opposing incentives with respect to the management of cash flow risk. On one hand, a negative shock to a distressed firm could lead to bankruptcy or the inability to invest in profitable projects. [19] Hence, firms have incentive to minimize cash flow risk. With regards to pensions, Rauh [20] finds that required contributions creates an incentive for firms to reduce risk taking in pension plans. Other papers examine models in which managerial reputation concerns limit risk shifting. [21]

On the other hand, the theory of asset substitution suggests that firms near bankruptcy have the incentive to actually increase risk, as doing so transfers value from creditors to shareholders. [11] This is due to the fact that the responsibility of managers is to stockholders rather than bondholders and will attempt to maximize the value of equity rather than the value of the firm as a whole. Consequently, they might eschew safe projects or assets for risky ones. Or, they might avoid hedging cash flow risk. This is the finding of a recent paper by Rampini et al. [22], which finds that more-constrained airlines hedge fuel prices less than their peers. Another study examining how distressed firms operate finds that distressed savings and loan institutions appear to increase dividends to shareholders. [23]

Green and Talmor [24] explore the agency costs of debt in a theoretical model to solve endogenously for optimal risk policy. Their results support the argument that more debt increases shareholder incentives to take risk. In another paper, Flannery examines the asset substitution problems confronted by banks. [25]

International Investment

Finally, my paper contributes to the international investment literature. Only in the last few years has research focused upon the drivers of international investment. Erel, Liao and Weisbach [26] find that high stock market valuation and recent currency appreciation lead to more firms being acquirers, with firms from economies in which the market has been performing poorly and that have experienced recent currency depreciation are more likely to be targets. Similarly, Makaew finds that in addition to the country-level component, there is also an industry-level component to merger waves. [27] More recently, Ahern et al [28] find that various dimensions of national culture such as trust, hierarchy and individualism affect merger volume and synergy gains. They conclude that more culturally distinct countries have lower merger volume. My paper, though, appears to be the first to present evidence that labor regulation and potential litigation are factors that might affect foreign investment.

1.3 Data

1.3.1 Toxic Release Inventory

For plant-level chemical and carcinogen data, I use the Toxic Release Inventory (TRI) TRI.NET database of chemicals that are used, produced or disposed of by over 58,000 unique facilities across the United States. Produced by the U.S. Environmental Protection Agency (EPA), TRI includes facility-level release information for about 650 different chemicals between 1986 and 2014. All facilities that meet the following three requirements are required to report to the TRI program: 1) it is included in a TRI-covered North American Industry Classification System NAICS described in Appendix A, 2) it has at least 10 full-time employees and 3) it manufactures, imports, or otherwise uses any of the chemicals outlined in the Emergency Planning and Community Right to Know Act Section 313 above a specific threshold that varies for each chemical or type of usage/disposal. Data is self-reported, though the EPA imposes fines for non-compliant facilities.

As shown in Table 3.1, about 10,000 firms (both public and private) every year appear in the TRI database, with 2.3 facilities per firm on average.

A hurdle imposed by the TRI database is that facility information is provided not by the ultimate parent of each facility but instead by each facility separately. Therefore, even in instances in which different facilities belong to the same parent, it is more often than not the case that the facility does not list the same parent name. In some cases, the difference is as simple as Corp. and Corporation. In such instances, I matched these facilities. In other instances, the parent name was obviously misspelled, in which case I would correct the spelling and match the facilities to the same parent firm.

1.3.2 Report on Carcinogens

This paper also uses several editions of the Report on Carcinogens (ROC) produced by the U.S. Department of Health and Human Services. The ROC is a congressionally-mandated public health report that identifies substances (chemicals, compounds, mixtures, etc.) that pose a carcinogenic hazard to people residing in the United States. Chemicals are included on the list after a multi-stage review process that involves a review of the scientific literature, a preliminary release of chemicals to be reviewed for inclusion, solicitation for commentary and feedback, and finally the official release of the report.

For this study, I use the reports published in 1989, 1991, 2000, 2004 and 2011. I do not use the first four ROC editions, as they were released (1980, 1981, 1982 and 1985) before plant-level chemical data became available in 1986. Further, I do not use ROCs published during 1994, 1998, and 2002 due to the lack of facilities exposed to these chemicals. The most recent ROC was published in October 2014 but is not used due to a lack of TRI data since then (TRI data runs through 2014).

I identify a chemical's 'exposure year' as the year in which it was first identified as either a 'known' or 'highly likely' carcinogen in an edition of the Report on Carcinogens. A facility is deemed to be newly exposed if it reports using a chemical

Table 1.1: Summary Statistics for Firm Exposure

	All Firms					Firms with >1 Facility				
Year	Firm Count	Mean Total Facilities per Firm	Exposure Percent	Mean Exposed Facilities per Firm	Public Firm Count	Firm Count	Mean Total Facilities per Firm	Exposure Percent	Mean Exposed Facilities per Firm	Public Firm Count
1987	10,891	2.23			1,051	2,805	5.70			564
1988	10,711	2.22			1,033	2,782	5.71			559
1989	11,275	2.20	9.6%	0.21	1,062	2,886	5.69	10.0%	0.57	576
1990	11,591	2.19			1,065	3,002	5.60			592
1991	11,517	2.18	1.0%	0.02	1,065	2,922	5.64	1.1%	0.06	567
1992	11,406	2.17			1,015	2,889	5.63			543
1993	11,279	2.16			988	2,854	5.57			533
1994	10,898	2.16			972	2,741	5.61			505
1995	10,549	2.18			936	2,704	5.60			500
1996	10,267	2.20			935	2,672	5.62			505
1997	10,174	2.21			895	2,644	5.64			489
1998	10,568	2.30			956	2,806	5.90			534
1999	10,264	2.28			904	2,739	5.80			510
2000	10,445	2.32	2.5%	0.06	908	2,800	5.91	2.2%	0.13	512
2001	10,881	2.38			930	2,962	6.07			542
2002	10,667	2.37			892	2,833	6.14			535
2003	10,452	2.36			852	2,808	6.08			495
2004	10,245	2.39	40.1%	0.96	847	2,786	6.11	43.3%	2.65	501
2005	10,065	2.42			827	2,754	6.18			500
2006	9,803	2.43			830	2,714	6.18			495
2007	9,400	2.48			792	2,637	6.29			477
2008	9,034	2.52			763	2,551	6.38			470
2009	8,673	2.50			748	2,453	6.32			455
2010	8,769	2.49			777	2,490	6.26			460
2011	8,707	2.50	8.7%	0.22	756	2,488	6.26	7.8%	0.49	448
2012	8,601	2.53			747	2,467	6.33			436
2013	8,248	2.68			690	2,465	6.61			418
2014	8,521	2.55			657	2,454	6.40			401

the same year as the chemical's exposure. A firm's level of exposure is dependent upon the percentage and number of facilities that are exposed in a given exposure year. Firms are considered to be 'unexposed' if they have no facilities that use a newly-exposed chemical.

Table 3.1 provides figures on the percentage of facilities that are exposed to a carcinogen for each of the ROCs. It should be noted that the majority of facility exposures took place in 1989, 2004 and 2011, during which 9.6%, 40.1% and 8.7% of the facilities were exposed, respectively. I also present the number of public firms listed on American exchanges that appear in the TRI database each year. On average, public firms constitute about 8-10% of all firms each year, though about 18% of firms with more than one facility and 29% of those with more than 5 facilities.

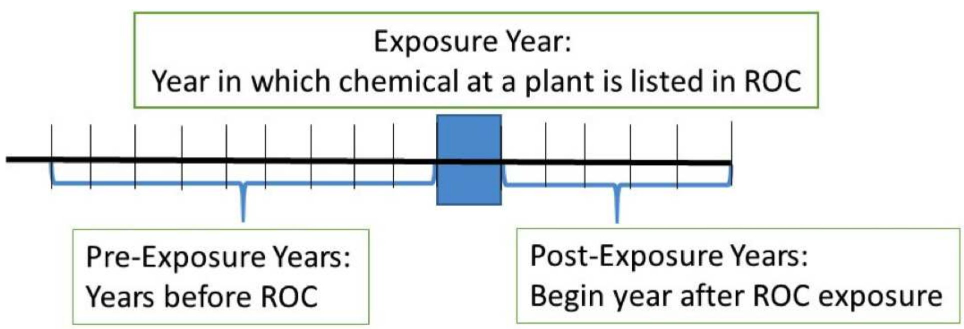

Figure 1.1: Exposure Timing

1.3.3 Securities Data Company (SDC)

I use the Securities Data Corporation (SDC) Mergers and Acquisitions database for data on acquisitions and joint ventures by American firms of both American and international targets. I only consider acquisitions and joint ventures. I exclude deals in which the target is a government agency or in the financial or utilities industry. I collect data on announcement date, completion date, target's name, primary industry measured by its four-digit Standard Industrial Classification code, country of domicile, the name of the acquirer and ultimate parents, as well as its primary industry and country of domicile.

1.4 Methodology

1.4.1 Methodology: Intra-industry Exposure Variation

One shortcoming of the data used by GM is that it does not allow for intra-industry carcinogen exposure variation between firms. The advantage of using TRI data, though, is that it provides plant-level chemical production and usage. This allows me to examine differences in chemical/carcinogen exposure between firms in the same industry that might have differing levels of exposure.

I use GMs exposed industries for the 1989, 1991, 2000 and 2004 ROCs. Their approach to identifying exposed and unexposed industries involves many steps. First, they use the National Occupational Exposure Survey (NOES) conducted by the National Institute for Occupational Safety and Health between 1981 and 1983. This survey of roughly 4,500 U.S. businesses and 1.8 million workers identified the percent of workers by 4-digit 1972 SIC that were exposed to carcinogens. Both GM and I obtained custom extracts of the ROC chemicals through the 2004 ROC across 522 industries.

Firms in Compustat do not report their industries using 1972 SIC codes, though. Instead, they use 1987 SIC codes. Therefore, a conversion between the two must be made. For instances in which industries changed (e.g. two industries merge to become one), they use an employee-weighted concordance table from the Bureau of Labor Statistics (1989) to allocate industry exposure.

Next, they make the decision to remove from potentially exposed industries those that are exposed to a chemical announced during the 1980 or 1981 ROC, stating that most chemicals released in these reports were known ahead of time to be carcinogenic, which defeats the intent of examining only those industries that are newly exposed to carcinogenic chemicals. Their approach yields 106 industries and 2,209 firms over 6 ROCs between 1983 and 2004.

It should not be viewed, though, that the sample of industries and exposure is a one-to-one mapping of that which I am able to derive using the TRI database. Given that the TRI facility-level data only begins in 1986, I'm only able to match to the ROCs they use in 1989, 1991, 2000 and 2004. This covers about 73% of the exposed firms in their sample, but still omits ROCs in 1980, 1981, 1982 and 1985. Another important difference that should be noted is whereas NOES seeks to identify actual employee exposure to a given chemical, the TRI database instead tracks usage or emissions of a chemical. Finally, the TRI database tracks includes a limited list of industries provided in Appendix A, whereas the GM approach accounts for all industries.

In addition to the exposed firms, GM also develops a control group of 8,373 unexposed firms across 249 industries. The unexposed firms are firms in the same Fama-French industries as exposed firms but not exposed themselves during that ROC period.

A special feature of the TRI database is that every facility identifies in which industry it operates. So any firm might have different facilities operating in different industries, which is different from the GM database, in which each firm is in just one industry.

Using the industries GM identify as being exposed or unexposed, I then examine facilities that identify as being in these industries and observe the percentage of facilities that actually have newly-listed ROC carcinogens. This is compared to the proportion of facilities in GM-determined unexposed industries that actually report the presence of a newly-listed ROC carcinogen. Results are presented in Table 1.3.

1.4.2 Methodology: Facility Count and Exposure after ROC Years

One finding of GM is that exposed firms subsequently invest more, both via capital expenditures and acquisitions, in order to outgrow the potential cost of litigation. These investments might not be optimal for shareholders, but due to the managers' desires to avoid steep costs from litigation and penalties that might lead to bankruptcy and them losing their jobs, they invest more than they otherwise would have in order to increase the size of their firms.

I examine if this is true by observing if firms with more exposed facilities are more or less likely to decrease the number of facilities than those with fewer exposed facilities. I find the comparison is most straightforward if I also separate firms into those with 1 facility, 2 facilities, and more than two facilities. For each of these groupings, I observe the number of total facilities and exposed facilities held by the firm two years later. I present aggregated statistics in Table 1.4.

1.4.3 Methodology: Post-ROC Exposure Reduction

Table 1.4 gives us insight into how firms changed their chemical exposure after an ROC announcement. Using this observation, I next want to observe if highly exposed firms are more likely to increase or decrease their chemical exposure. I use a cross-sectional econometric model to determine if those firms that are more exposed might be more likely to reduce their exposure over the two years following the ROC. In order to test for this, I examine the post-ROC change in number of facilities for firms that are exposed to a carcinogen and those that are not. The naive approach might be to simply regress the percentage change in exposure to chemicals before and after the ROC. However, due to simple mean reversion, which causes highly exposed firms to naturally have lower exposure afterwards (and vice versa for unexposed firms), it makes sense to match chemicals. In my model, for each newly-announced ROC chemical, I assign a non-ROC chemical that is present in the most similar number of facilities during the ROC year. Therefore, while firms that are 100% exposed during the ROC year are going to show negative changes on average, I examine how firm exposure to carcinogens changes compared to exposure to their matching non-carcinogens.

The model is written as follows:

$$
\begin{aligned}
y_{t=2,c,i} - y_{t=0,c,i} \\
&= \alpha + \beta_1(ROC \times ExposureTerm) + \beta_2 ExposureTerm + \beta_3 ROC \\
&\quad + \beta_4 FirmChemicalExposure + \beta_4 FirmFacilityCount + \varepsilon,
\end{aligned}
$$

where $y_{t,c,i}$ represents the percentage of firm i's facilities that are exposed to chemical c at time t, with $t = 0$ representing the exposure year and $t = 2$ representing two years later. The variable ROC indicates whether or not that chemical is included in that year's ROC (0 if one of the matching non-carcinogens), $ExposureTerm$ is either a dummy variable for highly exposed firms (those with greater than half of their facilities exposed during an exposure year), or a variable representing the percentage of firm i's facilities that are exposed to carcinogens during $t = 0$. $FirmChemicalExposure$ indicates the percentage of facilities owned by firm i that are exposed to chemical c at $t = 0$, with c being either a carcinogen or one of the matches. And $FirmFacilityCount$ represents the number of facilities owned by firm i at $t = 0$. In all, there were 36 chemicals used 18 newly identified carcinogens and 18 matches. I also use cross terms in this analysis. $CarcinogenXHighlyExposed$ indicates a cross term for if the chemical being observed is a carcinogen (1) or one of the non-carcinogenic matches (0) crossed with a dummy for if the firm is highly exposed (whether to the carcinogen or to the match). Also, a firm is classified as 'highly exposed' if either the carcinogen or its non-carcinogenic match is found in 50% or more of its facilities. Similarly, a firm is considered moderately exposed if the carcinogen or its non-carcinogenic match is

Table 1.2: Use of Carcinogens and Their Matches During Years Surrounding ROC

	t-2	t-1	ROC	t+1	t+2	t+3
Carcinogens	13.8%	14.0%	13.6%	13.5%	13.3%	13.0%
Match	14.7%	14.8%	14.5%	14.8%	14.4%	14.3%

found in at least one but fewer than half of its facilities.

One concern when matching chemicals is that the matched chemicals might be exhibiting different trends. For instance, perhaps the matched chemicals are becoming more highly used than are the carcinogens. In Table 2.11, I put forth the use of carcinogens compared to their non-carcinogenic matches. Both groups demonstrate similar usage trends before the ROC year, while the use of carcinogens declines slightly more afterwards.

See Table 1.5 for results.

1.4.4 Methodology: Exposure and Facility Sales

To more deeply understand the changes in facility count (and, by extension, risk exposure) after the ROC, I explore if highly exposed or moderately exposed firms are more likely to sell exposed facilities than they (or unexposed firms) are to sell unexposed facilities. Again, I match carcinogens with the same matching non-carcinogenic chemicals as I did in the prior subsection.

I define a facility as being 'sold' if it appears with one firm one year and another firm the next year (or, in the event that the facility temporarily exits the database and later returns, any of the subsequent two years).

I estimate the following model using a logit approach:

$$y_{j,e,t} = \alpha + \beta_1(cross) + \beta_2(ROC_j) + \beta_3(FirmExpose_{f,t})$$
$$+\beta_4(industry) + \beta_5(year) + \varepsilon$$

In the model above, $y_{j,e,t}$ is the probability that facility j and exposure e is sold during the two years following ROC year t. The variable $ROC_{j,t}$ represents if the facility is exposed to a carcinogen (assigned a value of 1) or not (assigned a value of 0) in year t. The variable $FirmExpose_{f,t}$ indicates if the firm is exposed to a carcinogen or a matching non-carcinogenic chemical. The variable cross is a cross term for ROC and also $FirmExpose$. Industry and year represent fixed effects. Results are reported in Table 1.6. Standard errors are clustered at the year and industry levels.

In separate sensitivity analysis, I've examined exposure and facility sales using a difference-in-difference approach. Results and an explanation of my approach can be found in Appendix G.

1.4.5 Methodology: Exposure and Facility Conversion

Next, I want to determine if firms are more likely to convert their facilities affected by a carcinogen. I define a 'converted' facility as one that has a chemical during the ROC year and then no longer has the chemical (but remains in the database) two years later. Again, I need to employ a matching approach of pairing up each carcinogen with its most-similar non-carcinogenic chemical in terms of facility counts.

I take a similar approach to examine exposure and facility conversion as my approach to examine exposure and the likelihood of a facility being sold, except that for my control group, I need to create matching 'unexposed' facilities. To identify these facilities, I first match each of the 18 carcinogens in my sample with a non-carcinogenic chemical that is present in the most similar number of facilities as of the year of the ROC. This provides 36 chemicals in $31,840$ facilities.

I estimate the following model using a logit approach:

$$y_{j,e,t} = \alpha + \beta_1(cross) + \beta_2(ROC_j) + \beta_3(FirmExpose_{f,t}) \\ + \beta_4(industry) + \beta_5(year) + \varepsilon$$

In the model above, $y_{j,e,t}$ is the probability that facility j and exposure e is converted during the two years following ROC year t. The variable $ROC_{j,t}$ represents if the facility is exposed to a carcinogen (assigned a value of 1) or not (assigned a value of 0) in year t. The variable $FirmExpose_{f,t}$ indicates if the firm is exposed to a carcinogen or a matching non-carcinogenic chemical. The variable cross is a cross term for ROC and also $FirmExpose$. Industry and year represent fixed effects. Results are reported in Table 1.7.

Additionally, I've examined exposure and facility conversion using a difference-in-difference analysis. Results and an explanation of my approach can be found in Appendix G.

1.4.6 Methodology: Exposure and Facility Acquisition

Next, I analyze the effect of exposure upon the likelihood that a firm will acquire another facility in general, as well as an exposed or unexposed facility in particular. I classify a facility as being acquired if it is with one firm during the ROC year and another firm in the subsequent two years. I include every firm in the TRI dataset during an ROC year as an observation, giving me 52,089 observations in total.

For my analysis, I estimate the following model using a logit approach:

$$y_{j,e,t} = \alpha + \beta_1(moderately_{f,t}) + \beta_2(highly_{f,t}) + \beta_3(facilitycount_{f,t}) + \beta_5(year) + \varepsilon$$

In the model above, $moderately_{f,t}$ and $highly_{f,t}$ are dummy variables for the level of exposure for firm f in year t. The variable $facilitycount_{f,t}$ is the number of facilities held by firm f during the ROC year. I also include year fixed effects.

1.4.7 Methodology: International and Domestic Deal Activity

Next, I analyze the effect of liability exposure on a firm's deal (acquisitions and joint ventures) activity. It is unclear, a priori, whether or not exposure might have an effect. One of the findings from the GM paper is that firms in exposed industries are more likely to make acquisitions than firms that are not in exposed industries, with the rationale being that managers want to make more acquisitions in order to outgrow potential liabilities. But their analysis does not examine deal activity based on the number of facilities that might be exposed, or whether the deals are domestic or international. I use the SDC database for deals and include all deals conducted by a firm in the three years after the ROC year. The observation level is firm-year, and firms are considered 'highly exposed' or 'moderately exposed' during the year of and two years after the ROC.

To test these questions, I estimate the following OLS regression model:

$$y_i = \alpha + \beta_1 ExposureVariable_i + \beta_2 FacilityCount_i + \varepsilon$$

where y_i is the log of the number of acquisitions made by firm i in the 3 years after the ROC year plus one, $ExposureVariable$ represents firm i exposure variables high exposure dummy (firms with at least half of their facilities exposed during an exposure year), and moderate exposure dummy (firms with at least one exposure but no more than half of their facilities exposed) being tested, and $FacilityCount_i$ represents firm i's total facility count during the ROC year. Results are presented in Table 1.9.

1.4.8 Methodology: Worker Labor Protection

In this section, I explore the possibility that firms potentially take into account local labor standards when investing abroad. If the countries in which American firms invest have lower labor regulation standards, then it might be the case that the exposed American firms are pursuing more lax regulations for their production. Ideally, I would test this hypothesis by observing if newly-exposed firms do indeed pursue deals in countries with lower regulation standards. Developing a consistent measure for regulation standards across countries, however, is difficult. Instead, I use number of injuries compiled by the International Labour Organization (ILO). Given that different countries have different mixtures of safe versus dangerous industries, though, I standardize the industry weighting for each country to ensure that I am comparing injury rates across the same industries.

I use a difference-in-difference approach and separate firms into two groups those with greater than 25% exposure (which I call ‘exposed’ for this section) and those with no exposure (‘unexposed’). I monitor acquisitions over two periods; the three years leading up to the ROC and the three years after. As there are more unexposed firms than exposed, I match each exposed firm randomly with a different unexposed firm within the same industry or (if unavailable) Fama French industry grouping. I choose the matching approach to help whittle away any industry-related differences between typical exposed and unexposed firms. Choosing other firms within the same industry or Fama French industry grouping enables me eliminate industry differences as one of the potential factors driving my results.

I use the following model:

$$
\begin{aligned}
& y_{country,exposuregroup} \\
& \quad = \alpha + \gamma_((injuries \times exposed) + \beta_1(injuries) + \beta_2(exposed) \\
& \quad\quad + \beta_4(prioracquisitions) + \beta_5(facilitycount) + \varepsilon
\end{aligned}
$$

in which *injuries* represents the number of worker injuries and deaths per

100 workers in the year of the ROC, exposed is a dummy variable for exposed firms, and the cross-term, $injuries \times exposed$, measures the interaction for the two. Additionally, $prioracquisitions$ indicate the number of acquisitions made by those firms (exposed or unexposed) in that country during the three years before the ROC, and the dependent variable is the log of 1 plus the number of acquisitions made by that group (exposed or unexposed) during the three years after the ROC. For each sample period, I use the 50 countries that are most targeted by American firms (regardless of exposure) during that ROC year. Each observation is the number of acquisitions made by the exposure group, hence there are 100 observations post-ROC and 100 observations pre-ROC. Given the lack of ILO data since 2008, I use just four ROC releases 1989, 1991, 2000, 2004 providing exactly 800 observations. Results are presented in Table 1.11.

1.5 Results and Analysis

Table 1.3 shows the presence of newly-declared carcinogens in those facilities and firms deemed exposed and unexposed using the GM methodology. As we would expect through the GM approach, firms in those industries GM deems 'exposed' do exhibit greater actual exposure to ROC carcinogens, but we see that there is intra-industry variation. For instance, for the 2004 ROC, we see that 42% of facilities that identify as being in an industry that GM deems exposed are actually exposed, while about 24% of facilities that identify themselves in an industry as being unexposed are actually exposed. Similarly, for firms that identify themselves in Compustat as being in an exposed industry according to GM's derivation, about 40% of facilities are actually exposed, compared to 36% for firms that identify themselves as being in an industry that GM determines to be unexposed.

Interestingly, in the 2000 ROC, we actually see the opposite of what we might expect. In this ROC, GM exposed industries actually have lower facility exposure rates than GM unexposed industries $--$ 1.6% compared to 2.0%. It is unclear why this ROC in particular demonstrates exposure opposite of what we might otherwise expect, though the difference is small enough (and sample size is small enough) that the results are not significant. The fact that we see some firms within each industry that are actually exposed while some are not grants me more insight into intra-industry variations in how firms respond to potential liability.

Table 1.3: TRI Exposure by GM Industries

		Individual Facilities		Firm-wide exposure	
		GM Exposed	GM Unexposed	GM Exposed	GM Unexposed
1989	Actual Exposure	14.4%	8.8%	12.7%	9.4%
	Count	3,059	11,333	252	876
1991	Actual Exposure	0.9%	0.8%	1.0%	0.8%
	Count	119	4,141	9	337
2000	Actual Exposure	1.6%	2.0%	1.7%	2.1%
	Count	1,085	11,017	98	871
2004	Actual Exposure	42.0%	24.3%	39.8%	36.0%
	Count	417	1,035	31	91

1.5.1 Results and Analysis: Response to Carcinogens

My next analysis looks at all firms, regardless of the number of facilities owned by each. Table 1.4 shows how the number of facilities changes for firms based on their level of exposure. Firms without any exposure to a newly-identified ROC chemical are labeled ‘unexposed’. Those with at least one exposure but no more than half of their facilities exposed are labeled ‘moderately exposed’. Those with at least half of their facilities exposed during an exposure year are labeled ‘highly exposed’. The rows labeled ‘Percent Change’ represent the percent change in facility count from the ROC year to 2, 3 and 5 years later. A two-tailed t-test was also applied to compare the percent changes of the unexposed firms compared to the highly exposed firms. Statistically significant results at the 90%, 95% and 99% confidence levels are identified with '*', '**', and '***', respectively.

The first two columns show changes in number of facilities for firms that start out with just one facility. We see that while the facility count declines on average for all firms, regardless of exposure level, firms that are exposed see a slightly smaller decline than those that are unexposed. This pattern persists two years, three years and five years after exposure and is statistically significant at least at the 10% level at each of those three intervals. I find a similar pattern when examining firms that start out with two facilities. After 5 years, firms that start out with two facilities, both exposed, end up with about 1.81 facilities. This contrasts with firms that start out with two facilities, both unexposed, which end up on average with 1.67 facilities. At both sizes (firms with 1 facility and those with 2), we see that there is a steeper decline in facility count for unexposed firms than for those that are highly exposed. These results would support the GM prediction, which is that managers of exposed firms will attempt to increase the size of their firms in order to outgrow potential litigation costs.

Similar results hold up for firms with more than two facilities, though comparison across groups is difficult given that they have different mean facility counts. Still, though, we see that the facility counts for firms with higher levels of exposure decline more slowly than those for firms with lower levels of exposure.

Interestingly, though, when examining firms with more than two facilities, we find that highly exposed firms as of the ROC year actually increase their exposure in subsequent years (72.7% to 75.7% from the ROC year to year 5). We will explore this finding in more detail throughout this chapter.

I use several statistical techniques to determine if the slower average decline in facilities for highly exposed firms was due to a few of the highly exposed firms increasing vastly in size while the other firms demonstrated similar behavior to unexposed firms. I do not find this to be the case. While both groups demonstrate skewed distributions, no significant differences emerge between them at the high end of facility growth when comparing the top 5% or 1% of firms with the most facility growth. This evidence fails to provide further support for the argument that certain firms will try to 'outgrow' their legal liabilities, as argued in GM. As a separate sensitivity to this analysis, I examine if the firms that grew the most in size increased their exposure levels. I do not find any consistent pattern in this analysis, but rather that the firms that increase the most in size tend to have the same changes in exposure as those that remain the same size or decrease in size.

As a robustness check to this analysis, I also explore the idea that even when comparing firms with a similar number of facilities, those that are exposed might, on average, simply have larger facilities with more chemicals (both carcinogenic and non) in general, and that these facilities with more chemicals in general would be less likely to be disposed of. To rule out this idea, I repeated the analysis including chemical count along with facility count and achieved similar results.

Table 1.4: Post-ROC Facility Count

	Firms with 1 Facility			Firms With 2 Facilities				Firms With >2 Facilities			
	Unexposed	Highly Exposed	t-test	Unexposed	Moderately Exposed	Highly Exposed	t-test	Unexposed	Moderately Exposed	Highly Exposed	t-test
ROC Year											
Firm Count	32,592	5,615		5,069	660	384		5,430	1,604	735	
Mean Facility Count	1.00	1.00		2.00	2.00	2.00		7.22	14.71	10.01	
Exposed Facility %	0.0%	100.0%		0.0%	50.0%	100.0%		0.0%	18.1%	72.7%	
Two Years Later											
Mean Facility Count	0.88	0.90		1.83	1.86	1.87		6.93	14.77	9.81	
Percent Change	-12.2%	-9.7%	**	-8.5%	-7.1%	-6.8%		-4.0%	0.4%	-2.0%	
Exposed Facility %	1.5%	91.9%		1.4%	42.3%	94.1%		0.6%	16.1%	77.4%	
Three Years Later											
Mean Facility Count	0.84	0.87		1.77	1.83	1.85		6.73	14.40	9.67	
Percent Change	-16.2%	-12.8%	**	-11.6%	-8.7%	-7.5%	*	-6.8%	-2.1%	-3.4%	
Exposed Facility %	1.2%	86.6%		1.5%	41.5%	91.9%		0.7%	15.6%	77.0%	
Five Years Later*											
Mean Facility Count	0.76	0.77		1.67	1.76	1.81		6.43	13.82	9.55	
Percent Change	-24.1%	-22.6%	*	-16.7%	-11.9%	-9.3%	*	-10.9%	-6.1%	-4.6%	*
Exposed Facility %	2.1%	79.2%		1.9%	39.1%	89.3%		0.9%	15.7%	75.7%	

Table 1.5: Change in Firm's Chemical Composition after ROC

Dependent variable: Change in firm's exposure to a chemical from ROC year to two years later		
	(1)	(2)
Cross Terms:		
Carcinogen X Highly Exposed	0.128**	
	(0.062)	
Carcinogen X Moderately Exposed	-0.089**	
	(0.040)	
Carcinogen X Firm Percent Exposure		0.035
		(0.080)
Exposure Terms:		
Highly Exposed Dummy	-0.066	
	(0.046)	
Firm Chemical Exposure Percent		-0.077
		(0.093)
Firm Facility Count	-0.048	-0.041
	(0.080)	(0.082)
Observations	19,908	19,908
R2	0.16	0.10

1.5.2 Results and Analysis: Change in Chemical Composition

Hypothesis 1: While most firms will reduce exposure to carcinogens, those that are already highly exposed will become even more-highly exposed.

GM finds evidence that firms newly exposed to carcinogens subsequently attempt to increase the size of their firms by investing in unrelated industries. This would seem to suggest that exposed firms should subsequently become less exposed afterwards. By separating firms into those that are highly exposed to carcinogens and those that are only moderately exposed, though, I am able to find evidence that those that are highly exposed are actually more likely to become more exposed to carcinogens after exposure.

I present my results in Table 1.5. I do find some evidence that firms attempt to reduce their exposure; the coefficient for Carcinogenic Chemical is -0.075 in column 1, meaning that firms exposed to a carcinogen during the year of the ROC will, after two years, have about 7.5% less of that chemical than the matching non-carcinogen. Interestingly, though, the cross term Carcinogen X Highly Exposed suggests that firms exposed to a carcinogen are actually likely to increase their exposure to the carcinogen. Column 1 shows a coefficient of 0.128, indicating that highly exposed firms have about 13% more exposed facilities after two years than their matching counterparts and matching chemicals. The fact that highly-exposed facilities actually increase their exposure would support the asset substitution argument. I also find evidence that moderately exposed firms reduce their exposure. This would correspond with firms attempting to decrease cash flow volatility risk.

I present a couple explanations for this finding. The first relates to the possibility that firms that are already highly exposed to a carcinogen might determine that they would quickly be bankrupt if litigation were to take place, so additional exposure would not necessarily increase their probability of bankruptcy. Therefore, they would not be quick to sell their exposed facilities and would even be willing to acquire exposed facilities if the opportunity presented itself. This could hypothetically be compounded by these facilities being sold at a discount, in which case these firms could more cheaply increase their exposure. In later sections, I explore if it is the case that these firms seem to increase their exposure via acquisitions or if it's simply the case that they are less likely to sell or convert their exposed facilities.

The second explanation is that heavily exposed firms may have foreseen future litigation over these chemicals and already installed (before the ROC announcement) efficient systems to protect their employees from the carcinogenic chemicals. With effective processes in place, then these firms would potentially be better at making new exposed facilities safe for workers. I attempt to explore these questions in more detail later on in this paper.

1.5.3 Results and Analysis: Exposure and Facility Sales

Next, I examine whether the level of carcinogenic exposure has an effect on the probability that a firm sell its exposed and unexposed facilities. The theory of asset substitution suggests that highly exposed firms would be less likely to sell exposed facilities than would moderately exposed firms.

In Table 1.6, I find evidence that supports this theory. I show that moderately exposed firms are more likely to sell an exposed facility than are highly exposed firms. The cross term "Facility Exposure X Highly Exposed" negative coefficients indicate that highly exposed firms are less likely to sell their exposed facilities than are moderately exposed firms.

1.5.4 Results and Analysis: Exposure and Facility Conversion

In addition to examining which firms are more likely to sell exposed facilities, I also examine which are more likely to convert their facilities from exposed to unexposed. The theory of asset substitution would suggest that highly exposed firms might be less willing to take the investment to convert their facilities. Therefore,

Table 1.6: Exposure and Facility Sales

Dependent variable= indicator for if facility is sold within two years of ROC		
	(1)	(2)
Cross Terms:		
Carcinogen x Highly Exposed	-0.081**	-0.074**
	(0.032)	(0.037)
Carcinogen x Moderately Exposed	0.043	0.064*
	(0.040)	(0.035)
Firm Exposure:		
Highly Exposed	-0.020	-0.017
	(0.051)	(0.056)
Facility Chemical Count		-0.001**
		(0.001)
Observations	31,840	31,840
R2	0.20	0.28
Fixed Effects		
Industry	x	x
Year	x	x

we might expect that moderately exposed firms are more likely to convert facilities upon exposure than are highly exposed firms. I present my results in Table 1.7.

I do find some evidence that exposed facilities are more likely to be converted than are unexposed. However, I do not any significant evidence to support or detract from the theory of asset substitution.

I do not believe that the lack of significance is due to a lack of sample size, as 513 facilities in my sample do appear to go through a conversion. It is possible that my metric for conversion simply is not a good enough measurement. Ideally, firms and facilities would report which facilities have converted their processes in order to eliminate use of a specific chemical. This is unavailable.

Another possible explanation is that conversion is expensive, and only a limited

Table 1.7: Exposure and Facility Conversion

Dependent variable=indicator for if a facility is converted within two years of ROC		
	(1)	(2)
Cross Term		
Carcinogen x Highly Exposed	-0.008	-0.019
	(0.057)	(0.055)
Carcinogen x Moderately Exposed	0.021	0.054
	(0.048)	(0.040)
Firm Exposure		
Highly Exposed	-0.012	0.009
	(0.083)	(0.070)
Facility Chemical Count		0.002**
		(0.001)
Observations	31,840	31,840
R2	0.11	0.13
Fixed Effects		
Industry	x	x
Year	x	x

number of financially secure firms are capable of doing so.Table 2.5 provides evidence to support this explanation, showing that financially secure firms are more likely to convert exposed facilities.

1.5.5 Results and Analysis: Facility Acquisition

Next, I explore if exposed firms are more likely to acquire exposed facilities. Asset substitution theory would suggest that highly exposed firms would be less concerned about the exposure level of the target facility. And if the target facilities are cheaper as a result of exposure, then it might even be the case that they would be more likely to acquire the facilities that happen to be exposed. On the other hand, if moderately exposed and unexposed firms want to keep their potential exposure at a minimum, then they would be less likely to seek out exposed facilities.

I present my result in Table 1.8. Column 2 shows us that it is the case that highly exposed firms are more likely to acquire other exposed facilities. We do not see any difference in exposed facility acquisition between unexposed and moderately exposed firms. When we look at probability of acquisition of any facility (exposed or unexposed), though, we do not see any significant difference between exposed and unexposed firms. Therefore, my findings do not support one of GM's findings, which is that exposed firms are likely to make more acquisitions.

Table 1.8: Exposure and Facility Acquisition

Dependent Variable = indicator for if a firm acquires a facility after ROC			
	Any Facility	Exposed Facility	Unexposed Facility
	(1)	(2)	(3)
Moderately Exposed	0.015	0.032	-0.005
	(0.071)	(0.081)	(0.084)
Highly Exposed	-0.049	0.155**	-0.095
	(0.054)	(0.072)	(0.059)
Facility Count	0.051***	0.068**	0.062**
	(0.017)	(0.023)	(0.025)
R2	0.19	0.27	0.16
Observation Count	52,089	52,089	52,089
Fixed Effects			
Year	x	x	x

1.5.6 Results and Analysis: Exposure and Firm Acquisitions

Hypothesis 2: Exposure might drive firms to invest offshore, specifically in countries that might have relatively lax labor regulations.

Next, I test whether ROC exposure had any effect on deal activity. The theory of asset substitution would suggest that highly exposed firms might try to acquire other exposed firms in the same industry, while moderately exposed firms may be more inclined to invest in other industries. In addition, though, I also differentiate in my analysis in Table 1.9 between domestic and international acquisitions. My hypothesis is that firms that wish to remain in the industry and use the same chemical but escape litigation in the U.S. may be more inclined to invest abroad. Hence, I would expect for moderately exposed firms to be more inclined to invest abroad in the same industry than would be heavily exposed firms.

In Table 1.9, I find that moderately exposed firms are significantly more likely to make acquisitions than unexposed firms. I do not find a significant difference in deal activity, though, between unexposed and highly exposed firms. Moreover, while highly exposed firms are less likely than unexposed firms to make international acquisitions, moderately exposed firms actually make significantly more international acquisitions, with the most coming in the same industry. This supports the argument above that moderately exposed firms that would like to remain in the same industry may be seeking other countries in which the labor standards might not be as high as those in the U.S.

Gormley and Matsa examine exposure and firm acquisitions as well, finding that exposed firms are more likely than unexposed firms to make acquisitions, especially in different industries. Their argument is that these firms are attempting to outgrow their potential liabilities. While I find some evidence that exposed firms make more acquisitions upon exposure, it is actually the moderately exposed firms that are doing so.

Table 1.9: Post-ROC Deal Count

Dependent Variable: Ln(Number of Acquisitions + 1)							
				Domestic Acquisitions		**Int'l Acquisitions**	
	All	Domestic Acquisitions	Int'l Acquisitions	Same Industry	Different Industry	Same Industry	Different Industry
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Highly Exposed	0.036	0.049	-0.066	0.115	-0.022	-0.053	-0.073
	(0.060)	(0.067)	(0.080)	(0.081)	(0.077)	(0.088)	(0.082)
Moderately Exposed	0.088**	0.063	0.136**	0.032	0.103*	0.146**	0.051
	(0.044)	(0.058)	(0.066)	(0.057)	(0.059)	(0.065)	(0.067)
Facility Count	0.074***	0.066**	0.085***	0.065**	0.068**	0.083***	0.076**
	(0.028)	(0.031)	(0.034)	(0.029)	(0.030)	(0.032)	(0.040)
Constant	0.286***	0.237***	0.052***	0.113***	0.136***	0.025**	0.031**
	(.048)	(0.016)	(0.010)	(0.010)	(0.012)	(0.007)	(0.008)
Observations	52,089	52,089	52,089	52,089	52,089	52,089	52,089
R2	0.37	0.32	0.36	0.34	0.39	0.35	0.31
Fixed Effects:							
Industry	X	X	X	X	X	X	X
Year	X	X	X	X	X	X	X

My results add additional nuance to the GM finding, which is that firms in exposed industries invest more. In Table 7 of their analysis, they show that exposed firms make about 6% more acquisitions. They then show that the bulk of these acquisitions are in different industries. I use their industries and replicate their analysis in 3.9, while additionally separating the analysis into international and domestic acquisitions. This added twist shows that firms in exposed industries are significantly less likely to acquire firms in different industries than are unexposed firms.

One potential issue with the analysis in Table 1.9 is that, because moderately exposed firms are larger on average, perhaps that is driving the results we find in which moderately exposed firms are conducting more acquisitions, both domestically and internationally. I do account for this with the $FacilityCount$ variable, but perhaps there is residual power that is unaccounted for. To eliminate this as a potential explanation, I match each highly exposed firm to a moderately exposed firm and an unexposed firm of the same size. All other firms are dropped. Therefore, I only include firms with at least two facilities in this analysis. This reduces my sample size substantially to 2,638, but I still get roughly the same results, directionally, as I did with my larger sample size. The lack of statistical power, however, causes these results to be insignificant. Results are presented in Table 1.10.

Table 1.10: Post-ROC Deal Count − Matched Sample

Dependent Variable: Ln(Number of Acquisitions + 1)							
				Domestic Acquisitions		**Int'l Acquisitions**	
	All	Domestic Acquisitions	Int'l Acquisitions	Same Industry	Different Industry	Same Industry	Different Industry
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Highly Exposed	-0.014	0.013	-0.037	0.132	-0.018	-0.036	-0.089
	(0.128)	(0.142)	(0.122)	(0.153)	(0.135)	(0.114)	(0.156)
Moderately Exposed	0.112	0.006	0.126	0.049	0.135	0.161	0.031
	(0.128)	(0.124)	(0.141)	(0.164)	(0.164)	(0.132)	(0.157)
Observations	2,638	2,638	2,638	2,638	2,638	2,638	2,638
R2	0.28	0.14	0.27	0.30	0.16	0.21	0.14
Fixed Effects:							
Industry	X	X	X	X	X	X	X
Year	X	X	X	X	X	X	X

Table 1.11: Effect of Worker Injuries on Deal Count

Dependent Variable=Ln(# of deals by exposed/unexposed firms in target country during three years after ROC + 1)		
	(i)	(ii)
Cross Term(# injuries x Exposed)	0.061*	0.063*
	(0.033)	(0.034)
# injuries/100 workers	0.041	0.033
	(0.132)	(0.095)
Exposed (>25% facilities)	-0.010	-0.031
	(0.095)	(0.061)
Prior Acquisitions per Year	0.602***	0.450***
	(0.218)	(0.166)
Constant	0.144***	0.108***
	(0.062)	(0.040)
Observations	800	800
R2	0.59	0.68
Gravity Model		x

1.5.7 Results and Analysis: Worker Injuries and Deal Count

In this section, I test if the search for weaker labor standards might be a factor affecting international investment by exposed firms. Ideally, I would have a clean measure for regulatory protections offered to employees that would be consistent across countries. I am unaware of such a clean measure, though. As such, I use worker injuries in a nation, standardized for the industry mixture in that country. In Table 1.11, I show that exposed firms are not only more likely to invest abroad, but the cross term $\#InjuriesXExposed$ suggests that they are especially likely to invest in countries with more labor injuries, which might suggest weaker labor standards.

The implications of this could be quite interesting. For instance, little is known or has been written about regulatory arbitrage considerations for international acquisitions. While traditional models assume that a rational firm will explore the cheapest means of production, few suggest that the regulatory or litigation environment should be taken into account.

1.6 Conclusion

My paper finds some evidence to support the theory of asset substitution in corporate finance. I show that managers of firms with greater risk are less likely to take measures to reduce their exposure than those with lower levels of risk. I find that highly exposed firms are less likely to sell exposed facilities than are moderately exposed firms. Further, I find that moderately exposed firms are less likely to make domestic acquisitions in the same industry. Interestingly, I even find some support for the argument that affected firms invest abroad in search of lax labor regulations. This brings up the interesting possibility that firms engage in a form of labor regulation/litigation shopping when considering their international investment opportunities. Further research would be warranted to explore this possibility in more detail.

1.7 Appendix A

Table 1.12: TRI-covered Industries

TRI-covered Industries
212 Mining
221 Utilities
31-33 Manufacturing
All other Miscellaneous Manufacturing (1119, 1131, 2111, 4883, 5417, 8114)
424 Merchant Wholesalers, Non-durable Goods
425 Wholesale Electronic Markets and Agent Brokers
511, 512, 519 Publishing
562 Hazardous Waste

1.8 Appendix B

The chemicals can be found on the following page:

http://www2.epa.gov/toxics-release-inventory-tri-program/tri-listed-chemicals

1.9 Appendix C

I use Gormley and Matsa's approach to identify industry exposure, this time breaking out into international/domestic acquisitions. Notably, the only significant result I get is that firms in exposed industries acquire fewer foreign firms of a different industry.

Table 1.13: Effect of Liability Exposure on Acquisition Activity (GM industries)

	Dependent variable=Ln(Number of Acquisitions + 1)						
	All	Same Industry	Different Industry	Same Domestic	Different Domestic	Same Int'l	Different Int'l
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Exposure	0.060	-0.011	0.057	0.001	0.071	-0.006	-0.108***
	(0.062)	(0.052)	(0.057)	(0.048)	(0.055)	(0.03)	(0.039)
R2	0.30	0.16	0.22	0.15	0.18	0.07	0.14
Observations	22,788	22,788	22,788	22,788	22,788	22,788	22,788
Fixed Effects:							
Industry	X	X	X	X	X	X	X
Year	X	X	X	X	X	X	X

Table 1.14: Post-ROC Facility Count – Highly Exposed Cutoff at 75%

	Firms with 1 Facility			Firms With 2 Facilities				Firms With >2 Facilities			
	Unexposed	Highly Exposed	t-test	Unexposed	Moderately Exposed	Highly Exposed	t-test	Unexposed	Moderately Exposed	Highly Exposed	t-test
ROC Year											
Firm Count	32,592	5,615		5,069	660	384		5,430	1,850	489	
Mean Facility Count	1.00	1.00		2.00	2.00	2.00		7.22	14.39	8.85	
Exposed Facility %	0.0%	100.0%		0.0%	50.0%	100.0%		0.0%	21.9%	87.5%	
Two Years Later											
Mean Facility Count	0.88	0.90		1.83	1.86	1.87		6.93	14.43	8.68	
Percent Change	-12.2%	-9.7%	**	-8.5%	-7.1%	-6.8%		-4.0%	0.3%	-1.9%	
Exposed Facility %	1.5%	91.9%		1.4%	42.3%	94.1%		0.6%	19.6%	86.8%	
Three Years Later											
Mean Facility Count	0.84	0.87		1.77	1.83	1.85		6.73	14.16	8.57	
Percent Change	-16.2%	-12.8%	**	-11.6%	-8.7%	-7.5%	*	-6.8%	-1.6%	-3.2%	
Exposed Facility %	1.2%	86.6%		1.5%	41.5%	91.9%		0.7%	19.2%	86.4%	
Five Years Later*											
Mean Facility Count	0.76	0.77		1.67	1.76	1.81		6.43	13.75	8.54	
Percent Change	-24.1%	-22.6%	*	-16.7%	-11.9%	-9.3%	*	-10.9%	-4.4%	-3.5%	*
Exposed Facility %	2.1%	79.2%		1.9%	39.1%	89.3%		0.9%	18.9%	84.9%	

1.10 Appendix D

Instead of a cutoff at 50%, the cutoff for Table 1.14 is 75% for firms with greater than 2 facilities. The cutoff does not affect firms with one facility. And I leave alone firms with two facilities, as it is easy enough to leave the three possible groups separated. Comparing these results to Table 1.4, we can see that the reaction by 'highly exposed' firms changes a similar amount at the two different cutoffs. This might suggest that, above a certain cutoff, firms respond similarly to carcinogenic exposure

1.11 Appendix E

I include Table 2.5 to demonstrate that it may be the case that financially secure firms are more capable of making the investments needed to convert a facility from one that is exposed to a carcinogen to one that is not. I explain this table and analysis in greater detail in Chapter 2.

Table 1.15: Financial Distress and Facility Conversion

Dependent Variable = Indicator for if facility is converted			
	(1)	(2)	(3)
Cross Terms:			
Financially Secure X Highly Exposed X Facility Exposed			0.006
			(0.078)
Financially Secure X Facility Exposed		0.148*	0.170**
		(0.081)	(0.073)
Financially Secure X Highly Exposed			-0.133
			(0.087)
Financially Secure X Moderately Exposed			-0.064
			(0.083)
Highly Exposed X Facility Exposed			-0.215***
			(0.073)
Financially Secure	0.120*	0.105*	0.076
	(0.075)	(0.065)	(0.058)
Exposed Facility	0.179***	0.156**	0.137**
	(0.063)	(0.071)	(0.059)
Firm Exposure:			
Highly Exposed			-0.068
			(0.059)
Moderately Exposed			0.074
			(0.049)
R2	0.17	0.22	0.36
Firm Facility Count	16,694	16,694	16,694
Fixed Effects			
Year	x	x	x
Industry	x	x	x

Table 1.16: Summary Statistics of Carcinogenic and Matching Chemical Facilities

	Carcinogenic Facilities		Matching Chemical Facilities
Percentage of Facilities as of ROC Year	13.6%	**	14.5%
Chemical Count per Facility	3.9		4.0
Age of Facility at ROC	12.1		11.9
% Sold Each Year prior to ROC	3.5%		3.3%
% Converted Each Year prior to ROC	2.0%		2.1%

Note: T-stat indicate if probability of selling is statistically different for financially distressed and financially secure firms. '*' indicates significance at the 10% level, '**' at the 5% level, and '***' at the 1% level.

1.12 Appendix F

I present Table 2.12 as evidence of the similarity of facilities with newly-announced carcinogens and the facilities with matching non-carcinogenic chemicals. The only significant different between the two groups is that are slightly more facilities with matching chemicals than with carcinogenic chemicals − 14.5% to 13.6%. Otherwise, the facilities are statistically similar.

1.13 Appendix G

In Appendix G, I use difference-in-difference analysis to determine if exposed firms are more likely to sell or convert exposed and unexposed facilities. For each chemical that is newly-determined to be a carcinogen, I use the non-carcinogenic chemical present in the most-similar number of facilities. Table 2.11 shows the concentration of such chemicals. What I want to examine is the likelihood of facilities that report using these carcinogens and matches before the report is released, and compare that to the likelihood of selling or converting facilities with the same chemicals after the ROC is released.

To accomplish this, I set up both pre-treatment periods and post-treatment periods around each ROC. The pre-treatment periods begin two years before the ROCs are released and end the year that the ROC is released. The post-treatment periods begin the year the ROC is released and end two years afterwards. Similar to my other analyses, I again classify firms as moderately exposed and highly exposed. A firm is moderately exposed if at least one but fewer than half of its facilities are exposed to either a carcinogen or matching chemical. I do not include firms and facilities without either a carcinogen or its match in my analysis.

I employ the following simple OLS econometric approach:

$$
\begin{aligned}
y_{j,e,f,t} = \alpha + \beta_1(TreatedCarcinogen_{j,t}) + \beta_2((HighlyExposed)_{f,t}) + \\
\beta_3((HighlyExposed \times Carcinogen)_{j,f,t}) + \\
\beta_4((ModeratelyExposed \times Carcinogen)_{j,f,t}) + \varepsilon,
\end{aligned}
$$

where a firm is indexed by f, a facility is indexed by j, a firm's exposure level (high or moderate) is indexed by e, and the respective year is indexed by t. The variable $y_{j,e,f,t}$ is a 1/0 indicator variable for if an action is taken on a facility (either converted or sold). The variable $TreatedCarcinogen$ indicates if the facility has a chemical determined to be carcinogenic. The variables $HighlyExposed$ and $ModeratelyExposed$ indicate the firm-level exposure for that year.

I also use chemical and year fixed effects. My results are in table 2.13.

Table 1.17: Difference-in-Difference Analysis of Exposure and Sales/Conversions

Dependent variable=Indicator for if a facility is sold/converted within two years of ROC		
	Sold	Converted
Carcinogen x Highly Exposed x Post-ROC	-0.095**	0.011
	(0.039)	(0.037)
Carcinogen x Moderately Exposed x Post-ROC	0.076**	0.048
	(0.032)	(0.036)
Carcinogen x Highly Exposed	0.039	0.017
	(0.048)	(0.046)
Carcinogen x Moderately Exposed	0.041	0.004
	(0.056)	(0.050)
Highly Exposed	-0.005	0.021
	(0.088)	(0.058)
Post-ROC	0.017	0.007
	(0.045)	(0.041)
Observations	64,092	64,092
R2	0.25	0.13
Fixed Effects		
Chemical	x	x
Year	x	x

1.14 Appendix H

I repeat the facility sales analysis to examine if highly exposed firms are more likely to sell exposed facilities than moderately exposed firms. The cross term, Facility Exposure X Highly Exposed, suggests that there is some evidence this is the case. Again, I use logit regression.

Table 1.18: Exposure and Facility Sales (No Matching)

Dependent Variable = Indicator for if specific facility is sold	
	(1)
Cross Term:	
(Facility Exposure X Highly Exposed)	-0.120***
	(0.044)
Facility Exposure	0.039
	(0.040)
Highly Exposed Firm	-0.031
	(0.047)
R2	0.22
Facility Count	38,656
Fixed Effects:	
Year	x
Industry	x

Table 1.19: Exposure and Change in Chemical Composition, Sales, Conversion

Dependent variable= (1) change in firm's exposure to a chemical (2)indicator for if facility is sold and (3)indicator for if facility is converted			
	(1)	(2)	(3)
Cross Terms:			
Carcinogen x Highly Exposed	0.131*	-0.088**	-0.034
	(0.069)	(0.042)	(0.061)
Carcinogen x Moderately Exposed	-0.072	0.055	0.006
	(0.049)	(0.049)	(0.054)
Highly Exposed Firm	-0.062	-0.006	-0.028
	(0.051)	(0.057)	(0.079)
Observations	14,792	23,338	23,338
R2	0.14	0.18	0.12
Fixed Effects			
Industry		x	x
Year	x	x	x

1.15 Appendix I

For Appendix I, I perform the same analysis on change in facility exposure, sales and conversion as I did in Table 1.5, Table 1.6 and Table 1.7 in Columns 1, 2 and 3. The one difference is that I now exclude firms that experienced exposure to any chemical previously known to be carcinogenic. This eliminates about 27% of "exposed" firms in the sample. However, the results do not change significantly from before.

1.16 Appendix J

It should also be noted that firms cannot shield themselves from liability already incurred from selling their exposed facilities. While they would not be liable for subsequent exposure, they would still be liable for past employee exposure. Therefore, when a firm makes the decision to sell or convert a facility that is exposed to a carcinogen, it is doing so in order to avoid future exposure.

This observation should only make it more difficult to generate significant results in my analysis. This is due to the effect of selling not eliminating the entire threat of an employee lawsuit, but only the future threat.

Chapter 2: Financial Distress

Abstract

This paper analyzes the interaction of financial distress and risk exposure as measured by the threat of potential litigation. I consider a firm's decision to increase or decrease exposure to carcinogenic chemicals as a measure of how firms of varying levels of financial distress manage risk. I find that firms in a stronger financial position are more likely to limit their exposure. On the other hand, not only do firms in weaker financial position not decrease their exposure, I find that, in some instances, they increase their exposure to carcinogens. My work supports the theory of asset substitution, in that firms in perilous financial health are more willing to pursue riskier investments than firms in a better financial position.

2.1 Introduction

Financial distress is thought to affect firm value in two competing ways. On the one hand, evidence suggests that distressed firms might mitigate the riskiness of their investments in order to conserve cash for future investment opportunities. This is would be the debt overhang problem that financially distressed firms encounter. On the other hand, the theory of asset substitution suggests that firms in financial distress might increase the riskiness of their investments in order to increase the value of equity at the expense of the debt.

Perhaps the best-known example of employee litigation over cancer-causing substance is the asbestos litigation that culminated in the 1980s and 1990s. According to one study, asbestos litigation cost defendants and insurers roughly $70 billion as of 2002. [2] Another study showed that, by the early 1990s, ”more than half of the 25 largest asbestos manufacturers in the U.S....had declared bankruptcy.” [29] And while the asbestos litigation may be the best-known and most harmful, it is by no means the only one. In the past two years, for instance, chemical giant Univar was hit with a suit over employee exposure to benzene-containing chemicals used as an applicator in its factories. [3] Separately, Monsanto was sued by some of its workers over exposure to Roundup herbicide. [4] Separately, in 2015 alone, ConocoPhillips, du Pont, Exxon, Firestone, Goodyear, Gulf Oil, Huntsman and others have been sued or ordered, settled out of court, or ordered to pay penalties over their uses of chemicals deemed to be carcinogenic. [5] [6] [7] [8]

This paper adds to the literature by examining how firms of varying levels of financial distress manage their exposure to potential future litigation. I use a pseudo-natural experiment of chemicals used and released through firms' production processes being identified as carcinogenic, thereby introducing the firms to potential litigation exposure by employees or others near the facility. If distressed firms were to want to decrease the riskiness of their cash flows in order to preserve future investment opportunities, then we would expect these firms to reduce exposure to these chemicals through either selling facilities or making adjustments so that they no longer need to use the chemical. Instead, though, I find that firms in financial distress actually increase exposure to these chemicals. My evidence supports the theory of asset substitution.

More specifically, I explore how firms respond to the adverse shock of a chemical used in production being identified as carcinogenic. While I use this shock to represent the introduction of a large business risk, every firm is exposed to risks emanating from various sources currency and commodities risk, relaxation of trade barriers, government regulation violations such as that committed recently by Volkswagen, changes to government regulations, and countless others. It is important to understand how firms respond to these shocks whether they still seek investments with the intent of maximizing value for shareholders or if the introduction of potential bankruptcy risk leads managers to invest in projects that are not profit maximizing. Prior literature has speculated that principal agent issues might arise and that self-seeking managers may attempt to increase the size of the firm to avoid bankruptcy risk even at the expense of shareholder value. Whereas prior literature was only able to use industry-wide exposure to chemicals, though, this paper utilizes a database of facility-level chemical usage from 1987 through 2014 to explore the issue more deeply. This additional level of detail enables me to examine intra-industry variations between firms in the same industry but with differing levels of chemical exposure, as well as differing levels of financial distress.

Another advantage my dataset affords me is to explore response variation driven by differences in financial distress between firms. I find that financially secure firms are more likely to try to reduce the number of exposed facilities and also more likely to invest abroad. Both of these findings would coincide with the possibility that these firms simply have greater at stake, and that the managers are perhaps investing in the interest of shareholders.

The remainder of my paper proceeds as follows: in section 2, I explore the literature related to my paper. In section 3, I describe the data that my paper uses. In section 4, I summarize the methodology used in my regressions and other statistical analysis. In section 5, I discuss and analyze the results from my tests. Finally, section 6 concludes.

2.2 Literature Review

Under normal conditions, we expect managers to take actions that maximize the expected value of the firm while minimizing project riskiness to the extent possible. Of particular interest has been the response of firms in financial distress to project riskiness, as they are confronted with considerations healthier firms are not. Interestingly, research has provided sometimes conflicting evidence for both increased and decreased project riskiness. I will discuss this literature below.

Numerous papers have provided arguments for why firms might want to decrease the riskiness of their projects. One argument relates to a firm's attempts to avoid debt overhang. [19] Debt overhang occurs when a firm has too little cash to invest in profitable projects and too much debt to go and raise more financing. Myers wrote about this underinvestment problem caused by risky long-term debt in his seminal 1977 paper. [30] Parrino and Weisbach [31] find that underinvestment increases most when a firm nears financial distress. Hirshleifer [21] finds that long-term managerial concerns might limit risk-shifting as well, with managers wanting to avoid risky projects that might be more likely to veer the firms toward bankruptcy.

More recently, Gormley and Matsa [1] uses a creative natural experiment, which I build off of, to examine the behavior of firms that use chemicals newly determined to be carcinogenic. They argue that this is an external shock that increases the likelihood of future costs in the form of workers compensation, higher insurance and even legal costs and potential liability for exposing employees to carcinogens. Examining industry-wide levels of exposure, they find that firms in exposed industries are more likely to aggressively grow the size of their firms via capital expenditures and acquisitions. Further, they find that this growth is often at the expense of shareholder value. As the title "Growing out of Trouble" suggests, they argue that a manager facing new exposure would attempt to grow the firm to the point in which potential future costs would no longer pose a threat to the firm's viability. The authors present further support for this argument by pointing out that firms with weaker corporate governance measures are more likely to pursue these aggressive growth strategies.

Gormley and Matsa also examine the role of financial distress in how firms respond to this liability risk. They find that firms that already have weak balance sheets at the time of the exposure are more likely to attempt to grow the size of their firms. They argue that, because these firms are more vulnerable to a future negative cash flow shock, they are more likely to take actions to outgrow the possibility of a shock leading to bankruptcy.

The premise of this research has been bolstered in recent years by analysis that has suggested that managers do indeed face negative earnings in the event of bankruptcy. Eckbo et al finds that top managers stand to lose millions of dollars in the event of corporate bankruptcy. [18]

At the other end, multiple papers have presented evidence that some firms, especially those in financial distress, actually increase the riskiness of investments. Jensen and Meckling [11] help develop the theory of asset substitution, in which financially-distressed firms seeking to maximize the value of their equity might invest in projects with higher volatility and lower returns than they might pursue under normal conditions. Similarly, other research has found that firms facing financial distress might alter their investment in other ways. Maksimovic and Titman [32] develop a theoretical model that shows when firms might become unable to provide high-quality products, thereby hurting their value in the long run. Phillips and Sertsios [33] find empirical evidence that the product quality of financially distressed airlines is lower than those that are financially more secure.

Green and Talmor [24] explore the agency costs of debt in a theoretical model to solve endogenously for optimal risk policy. Their results support the argument that more debt increases shareholder incentives to take risk. In another paper, Flannery examines the asset substitution problems confronted by banks. [25]

2.3 Data

Toxic Release Inventory

For plant-level chemical and carcinogen data, I use the Toxic Release Inventory (TRI) TRI.NET database of chemicals that are used, produced or disposed of by over 58,000 unique facilities across the United States. Produced by the U.S. Environmental Protection Agency (EPA), TRI includes facility-level release information for about 650 different chemicals between 1986 and 2014. All facilities that meet the following three requirements are required to report to the TRI program: 1) it is included in a TRI-covered North American Industry Classification System NAICS described in Appendix A, 2) it has at least 10 full-time employees and 3) it manufactures, imports, or otherwise uses any of the chemicals outlined in the Emergency Planning and Community Right to Know Act Section 313 above a specific threshold that varies for each chemical or type of usage/disposal. Data is self-reported, though the EPA imposes fines for non-compliant facilities.

As shown in Table 3.1, about 10,000 firms (both public and private) every year appear in the TRI database, with 2.3 facilities per firm on average.

Report on Carcinogens

This paper also uses several editions of the Report on Carcinogens (ROC) produced by the U.S. Department of Health and Human Services. The ROC is a congressionally-mandated public health report that identifies substances (chemicals, compounds, mixtures, etc.) that pose a carcinogenic hazard to people residing in the United States. Chemicals are included on the list after a multi-stage review process that involves a review of the scientific literature, a preliminary release of chemicals to be reviewed for inclusion, solicitation for commentary and feedback, and finally the official release of the report.

For this study, I use the reports published in 1989, 1991, 2000, 2004 and 2011. I do not use the first four ROC editions, as they were released (1980, 1981, 1982 and 1985) before plant-level chemical data became available in 1986. Further, I do not use ROCs published during 1994, 1998, and 2002 due to the lack of facilities exposed to these chemicals. The most recent ROC was published in October 2014 but is not used due to a lack of TRI data since then (TRI data runs through 2014).

I identify a chemical's 'exposure year' as the year in which it was first identified as either a 'known' or 'highly likely' carcinogen in an edition of the Report on Carcinogens. A facility is deemed to be newly exposed if it reports using a chemical the same year as the chemical's exposure. A firm's level of exposure is dependent upon the percentage and number of facilities that are exposed in a given exposure year. Firms are considered to be 'unexposed' if they have no facilities that use a newly-exposed chemical.

Table 3.1 provides figures on the percentage of facilities that are exposed to a carcinogen for each of the ROCs. It should be noted that the majority of facility exposures took place in 1989, 2004 and 2011, during which 9.6%, 40.1% and 8.7% of the facilities were exposed, respectively. I also present the number of public firms listed on American exchanges that appear in the TRI database each year. On

Table 2.1: Summary Statistics for Firm Exposure

	All Firms					Firms with >1 Facility				
Year	Firm Count	Mean Total Facilities per Firm	Exposure Percent	Mean Exposed Facilities per Firm	Public Firm Count	Firm Count	Mean Total Facilities per Firm	Exposure Percent	Mean Exposed Facilities per Firm	Public Firm Count
1987	10,891	2.22			1,051	2,805	5.70			564
1988	10,711	2.22			1,033	2,782	5.71			559
1989	11,275	2.20	9.6%	0.21	1,062	2,886	5.69	10.0%	0.57	576
1990	11,591	2.19			1,065	3,002	5.60			592
1991	11,517	2.18	1.0%	0.02	1,065	2,922	5.64	1.1%	0.06	567
1992	11,406	2.17			1,015	2,889	5.63			543
1993	11,279	2.16			988	2,854	5.57			533
1994	10,898	2.16			972	2,741	5.61			505
1995	10,549	2.18			936	2,704	5.60			500
1996	10,267	2.20			935	2,672	5.62			505
1997	10,174	2.21			895	2,644	5.64			489
1998	10,568	2.30			956	2,806	5.90			534
1999	10,264	2.28			904	2,739	5.80			510
2000	10,445	2.32	2.5%	0.06	908	2,800	5.91	2.2%	0.13	512
2001	10,881	2.38			930	2,962	6.07			542
2002	10,667	2.37			892	2,833	6.14			535
2003	10,452	2.36			852	2,808	6.08			495
2004	10,245	2.39	40.1%	0.96	847	2,786	6.11	43.3%	2.65	501
2005	10,065	2.42			827	2,754	6.18			500
2006	9,803	2.43			830	2,714	6.18			495
2007	9,400	2.48			792	2,637	6.29			477
2008	9,034	2.52			763	2,551	6.38			470
2009	8,673	2.50			748	2,453	6.32			455
2010	8,769	2.49			777	2,490	6.26			460
2011	8,707	2.50	8.7%	0.22	756	2,488	6.26	7.8%	0.49	448
2012	8,601	2.53			747	2,467	6.33			436
2013	8,248	2.68			690	2,465	6.61			418
2014	8,521	2.55			657	2,454	6.40			401

average, public firms constitute about 8-10% of all firms each year, though about 18% of firms with more than one facility and 29% of those with more than 5 facilities.

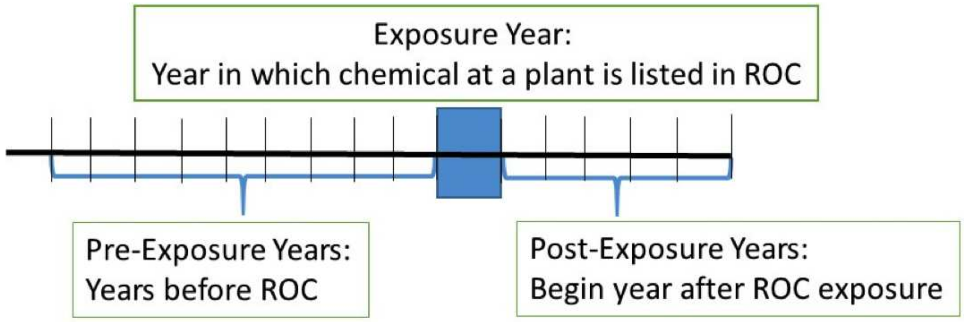

Figure 2.1: Exposure Timing

Securities Data Company (SDC)

I use the Securities Data Corporation (SDC) Mergers and Acquisitions database for data on acquisitions and joint ventures by American firms of both American and international targets. I only consider acquisitions and joint ventures. I exclude deals in which the target is a government agency or in the financial or utilities industry. I collect data on announcement date, completion date, target's name, primary industry measured by its four-digit Standard Industrial Classification code, country of domicile, the name of the acquirer and ultimate parents, as well as its primary industry and country of domicile.

Compustat

I use the Compustat database for all firm financial information. Especially for construction of the Altman Z-score on an annual basis, I use working capital (or current assets and current liabilities), total assets, retained earnings, net income, interest expense, income taxes – total, total liabilities and sales (net). Additionally, to calculate the market value of equity, I use the total number of shares outstanding and the actual price of common equity as of the end of the calendar year.

2.4 Methodology

2.4.1 Methodology: Measuring Financial Distress

I employ a few different approaches to examine the response to exposure by firms of varying levels of financial distress. To measure financial distress, I use the Altman Z-Score as of the year of the ROC. Altman Z-Score is constructed as follows:

$$z - score =$$

$$1.2 \times \frac{WorkingCapital}{TotalAssets} + 1.4 \times \frac{RetainedEarnings}{TotalAssets} + 3.3 \times \frac{EBIT}{TotalAssets}$$
$$+0.6 \times \frac{MVE}{TotalLiability} + 1.0 \times \frac{Sales}{TotalAssets}$$

where $EBIT$ represents Earnings Before Interest and Tax and MVE represents Market Value of Equity. All financial values are taken from Compustat and are measured as of the year of the ROC. In general, the lower the score, the likelier it is that the firm is financially distressed and potentially headed for bankruptcy, while firms with higher scores are considered more financially secure and less likely to be at risk for bankruptcy.

I calculate the Z-Score as of the year in which each ROC is released and separate firms into four quartiles accordingly. The 25% with the lowest Z-Score are deemed to be the financially distressed firms. Those with the highest Z-Score are least financially distressed (or the financially secure firms in my study). I determine quartiles every year comparing firms only to other firms in a given year. I do a sensitivity check, though, in which I only determine quartiles based upon the entire sample period.

2.4.2 Methodology: Financial Distress and Change in Exposure

I am interested in examining how exposed firms in the lowest quartile (more financially distressed) compare to firms in the highest quartile (less financially distressed) with regards to their exposure as measured by the number of exposed facilities they have in the years after an ROC.

For this analysis, I begin by examining only those firms that are exposed to carcinogens and first examine the change in the number of facilities that both financially distressed and financially secure firms have afterwards. In Table 2.2, I present summary statistics of exposed firms, separated into most financially distressed and least.

Results from Table 2.2 demonstrate a sizeable drop in facility exposure for financially secure firms, compared to only a very small drop for financially distressed firms. This drop in exposed facilities for financially secure firms could be due to a few different factors: 1) firms could be taking measures to convert their exposed facilities to unexposed, 2) firms could be selling unexposed facilities, 3) financially secure firms could be acquiring unexposed facilities or 4) some combination of the factors above.

2.4.3 Methodology: Financial Distress and Facility Sales

An issue with the TRI database is that facilities only appear in the database if they have at least one chemical whose usage is above some chemical-dependent threshold. Therefore, if a facility appears in the database with just one chemical, a carcinogen, but no longer uses that carcinogen or has a need to report any of the other 650 chemicals two years later, it will not appear in the TRI database two years later. However, if a facility uses two chemicals, one of which is a carcinogen, and it stops using the carcinogen, the facility will still appear in the database two years later assuming the non-carcinogenic chemical is still used above the threshold.

Therefore, in the scenario in which a facility with one chemical disappears from the database, I am unable to determine if the firm closed the facility or if it simply stopped using the chemical. We do know, though, if a facility changes hands from one firm to another (either the facility is sold or the entire firm is acquired). I explore both possibilities that financially secure firms are more likely to sell exposed facilities and also more likely to convert an exposed facility to unexposed.

First, I explore the possibility that financially secure firms are more likely to sell exposed facilities than unexposed facilities. For clarification, I define a 'sold facility' as a facility that appears with one firm one year and later appears with another firm, assuming that the first firm is still in existence (either in COMPUSTAT or TRI). My sample includes all financially secure and financially distressed public firms during an ROC year. Financially distressed firms are the 25% with the lowest Z-Score. Financially secure firms are the 25% with the highest Z-Score.

For each carcinogen, I select a matching non-carcinogenic chemical that is used the most similar number of times as of the ROC year. This results in 3,709 facility observations. I then examine if firms are more or less likely to sell these exposed facilities.

I use a logit model for my analysis. I repeat the analysis using a probit model and get roughly the same results, though the logit model is presented, as its results are perhaps more intuitive.

My logit model is as follows:

$$y_{j,e,f,t} = \alpha + \beta_1(cross) + \beta_2(FinancialDistress_{f,t}) + \beta_3(exposure_j) + \beta_4(firmexpose_{f,t}) + \beta_5(industry) + \beta_5(year) + \varepsilon$$

where $y_{j,e,f,t}$ is a 1/0 indicator variable for if facility j with exposure e, of firm f during year t is sold. The variable $FinancialDistress_{f,t}$ indicates the level of financial distress (1 if in the least distressed quartile and 0 if in the most distressed quartile) for firm f during year t. The variable ROC_j indicates whether a facility is exposed to a carcinogen (1) or to a non-carcinogenic match(0). The next variable, $FirmExposure_{f,t}$, indicates if the firm is highly or moderately exposed to carcinogen or non-carcinogenic matches. The variable $cross$ represents the various cross terms in the analysis. Finally, I also include industry and facility-year fixed effects in my analysis.

I report my results in Table 2.3. I include industry and year fixed effects.

Standard errors are clustered at the year and industry level.

Additionally, I've examined exposure and facility sales using a difference-in-difference analysis. Results and an explanation of my approach can be found in Appendix F.

2.4.4 Methodology: Financial Distress and Facility Conversion

Also in my analysis, I analyze the interaction of financial distress and exposure on the likelihood that a facility is converted from being exposed to a carcinogen to unexposed. I define a facility 'converted' as one that has either a carcinogen or a matching non-carcinogenic chemical during the ROC year, and then does not have that chemical (carcinogen or otherwise) two years later. Importantly, the facility must still appear in the database and also be owned by the same firm.

I estimate the following using logit:

$$
\begin{aligned}
y_{j,e,f,t} = \alpha + \beta_1(cross) + \beta_2(fincon_{f,t}) + \beta_3(exposure_j) + \beta_4(firmexpose_{f,t}) \\
+\beta_5(industry) + \beta_6(year) + \varepsilon
\end{aligned}
$$

where $y_{j,e,f,t}$ is a 1/0 indicator variable for if facility j with exposure e, of firm f during year t is sold. The variable $FinancialDistress_{f,t}$ indicates the level of financial distress (1 if in the least distressed quartile and 0 if in the most distressed quartile) for firm f during year t. The variable ROC_j indicates whether a facility is exposed to a carcinogen (1) or to a non-carcinogenic match(0). The next variable, $FirmExposure_{f,t}$, indicates if the firm is highly or moderately exposed to carcinogen or non-carcinogenic matches. The variable *cross* represents the various cross terms in the analysis. Finally, I also include industry and facility-year fixed effects in my analysis. Standard errors are clustered at the year and industry levels.

Finally, I also include industry and year fixed effects in my analysis. Results are reported in Table 2.5. And in Table 2.6, I present summary statistics for financial distress and facility conversion, showing the raw likelihood for different subgroups of firms of selling their facilities.

Additionally, I've examined exposure and facility conversion using a difference-in-difference approach. Results and an explanation of my approach can be found in Appendix F.

2.4.5 Methodology: Financial Distress and Facility Acquisition

Next, I explore the relationship between financial distress, exposure, and the acquisition of facilities. I define an 'acquired' facility as one that is in the TRI database with one firm during an ROC year but with another firm (the 'acquirer') after two years.

Ultimately, I want to determine if financially distressed firms are more/less likely to acquire exposed facilities than are financially secure firms, but first I estimate the following using logit:

$$y_{j,e,f,t} = \alpha + \beta_1(cross) + \beta_2(FinancialDistress_{f,t}) + \beta_3(FirmExposure_{f,t}) + \beta_4(industry) + \beta_5(year) + \varepsilon$$

where $y_{j,e,f,t}$ is a 1/0 indicator variable for if firm f acquires any facility during the next two years. The variable $FinancialDistress_{f,t}$ is an indicator variable for if the firm is in the most financially distressed quartile (0) or least (1) during the exposure year t. The variable $firmexpose_{f,t}$ indicates the firm's exposure level (highly, moderately, unexposed). Finally, industry and year account for fixed effects. Standard errors are clustered by year.

I use the model above for two more series of tests first, the likelihood of the acquisition of an exposed facility and then the likelihood of the acquisition of an unexposed facility. All results are presented in Table 2.7.

2.5 Results and Analysis

In this section, I present and analyze my results. In general, I assess whether financially distressed firms react to carcinogenic exposure differently than would financially secure firms. I hypothesize that financially secure firms will proactively reduce their levels of exposure, given that they potentially have the means and resources to address these issues, as well as greater future cash flows to protect. When applicable in my analysis, I will consider my results in light of one of the findings from the Gormley and Matsa paper, which is that financially distressed firms, when exposed, are more likely to pursue aggressive capital expenditure and acquisition strategies to outgrow their exposure. Their paper does not examine whether or not firms increase their exposure, though, which is the primary focus of this chapter.

2.5.1 Results and Analysis: Financial Distress and Changes in Firm Exposure

In my analysis, I first attempt to measure how financial distress affects the facility exposure count of firms that are exposed as of the exposure year. I present these initial results in Table 2.2.

Table 2.2 shows that while managers of financially distressed firms do not appear to change their exposure considerably, managers of financially secure firms are actually quite active in reducing the number of facilities that are exposed. Financially secure firms on average have 1.4 fewer exposed facilities, while adding 0.9 unexposed facilities. Their exposure thereby drops from 33.6% during the exposure year to 21.4%. This drop is significant at the 5% level. On the other hand, the exposure for financially distressed firms drops only slightly, from 35.0% to 32.9%. This drop is insignificant at the 10% level. Further, whereas the difference in exposure between financially distressed and financially secure firms during the ROC years was insignificant, the difference in exposure between the two groups after two years is significant at the 5% level.

These findings suggest that managers of financially secure firms are actively reducing their exposure. Moreover, we can tell from first glance that financially secure firms are drastically reducing the absolute number of exposed facilities (whether through selling them or by converting them), while increasing the number of unexposed facilities (whether through acquiring them or converting exposed facilities to unexposed).

The story is different for financially distressed firms, however. I find that these firms decrease their count of both exposed and unexposed facilities. These changes, however, are by statistically insignificant amounts. Therefore, this table would neither support nor reject Gormley and Matsa's finding that financially distressed firms would increase the size of the firm.

Table 2.2: Financial Distress and Exposed Firms

	Financially Distressed		Financially Secure
ROC Year			
Facilities per Firm	8.5	*	10.3
Exposed Facilities per Firm	3.0		3.5
Percentage Exposed	35.0%		33.6%
Two Years After ROC			
Facilities per Firm	7.6	*	9.8
Exposed Facilities per Firm	2.5		2.1
Percentage Exposed	32.9%	**	21.4%
Firm Count	226		226

2.5.2 Results and Analysis: Financial Distress and Facility Sales

Next, I explore financial distress and facility sales. Normally in corporate finance, financially secure firms are less likely to sell assets. [34] [35] [36] But the introduction of carcinogens provides a twist. I hypothesize that while financially secure firms will be less likely to sell facilities on average, the probability that they sell a facility will increase upon discovery that it is carcinogenic.

On the other hand, I hypothesize that financially distressed firms will be more likely to sell facilities in general. However, my hypothesis is that the discovery that a facility is carcinogenic will not considerably affect their decision to sell a facility.

In Table 2.3, column 1 shows that financially secure firms are significantly less likely to sell a facility on average, which is what theory suggests should take place. All else equal, column 1 suggests that financially secure firms sell about 11% fewer facilities than distressed firms. However, the cross term for Financially Secure X Facility Exposed in column 2 suggests that financially secure firms are actually more likely to sell exposed facilities. Columns 3-4 provide additional sensitivity analyses, showing that both financially secure and moderately exposed firms are significantly more likely to sell their exposed facilities.

The results from the table support the argument laid out above. Financially secure firms are less likely to sell a facility in general, but the introduction of facility exposure will make them more likely to sell.

And while it is difficult to interpret how financially distressed firms respond to exposure in Table 2.3, Table 2.4 provides a matrix summary, which makes it easier to

Table 2.3: Financial Distress and Facility Sales

Dependent Variable = Indicator for if facility is sold		
	(1)	(2)
Financially Secure X Highly Exposed X ROC		-0.083
		(0.059)
Financially Secure X ROC		0.167***
		(0.052)
Financially Secure X Highly Exposed		0.020
		(0.065)
Highly Exposed X ROC		-0.060
		(0.076)
Financially Secure	-0.097*	-0.064
	(0.058)	(0.061)
ROC	0.016	0.037
	(0.073)	(0.071)
Firm Exposure:		
Highly Exposed		0.060
		(0.056)
R2	0.17	0.40
Facility Count	3,751	3,751
Fixed Effects		
Year	x	x
Industry	x	x

compare across groups the likelihood that a firms sells a facility given its exposure. In Table 2.4 I show that there is a statistically insignificant difference to how financially distressed firms respond to exposure. Among all financially distressed firms, there is a 7.2% likelihood of selling an exposed facility compared to a 7.1% likelihood of selling an unexposed facility.

In general, these findings support the argument that financially secure firms are more likely to be proactive in addressing carcinogenic exposure. I do not, though, find evidence to support the Gormley and Matsa argument that financially distressed firms are likely to outgrow exposure. While they do not examine facility sales (or any type of sales other than revenue), the extension of their hypothesis is that financially distressed firms would be less likely to sell exposed facilities, whereas my results show that there is an insignificant difference.

2.5.3 Results and Analysis: Financial Distress and Facility Conversion

In addition to selling facilities, another way firms could conceivably reduce their exposure to liability is through converting exposed facilities to facilities that no longer use the carcinogenic chemical. I hypothesize that financially secure firms would be more likely to convert exposed facilities. This is due to them having greater resources to do so and also that they have greater future cash flows to protect.

Given the nature of the TRI data, I do not have insight into how or why the facility was 'converted.' As I explained in the Methodology section of the paper,

Table 2.4: Probability of Selling a Facility

	Probability of selling:		
	Financially Distressed	T-stat	Financially Secure
All facilities	7.1%	**	6.6%
Exposed facilities	7.2%		7.5%
Unexposed facilities	7.1%	**	6.5%
Exposed facility, unexposed firm	N/A		N/A
Exposed facility, moderately exposed	7.3%		7.6%
Exposed facility, highly exposed	7.1%		7.4%
Unexposed facility, unexposed firm	7.0%	*	6.6%
Unexposed facility, moderately exposed	7.2%	***	6.2%
Unexposed facility, highly exposed	7.4%	**	6.9%

Note: T-stat indicate if probability of selling is statistically different for financially distressed and financially secure firms. '*' indicates significance at the 10% level, '**' at the 5% level, and '***' at the 1% level.

Table 2.5: Financial Distress and Facility Conversion

Dependent Variable = Indicator for if facility is converted			
	(1)	(2)	(3)
Cross Terms:			
Financially Secure X Highly Exposed X ROC			0.006
			(0.078)
Financially Secure X ROC		0.148*	0.170**
		(0.081)	(0.073)
Financially Secure X Highly Exposed			-0.133
			(0.087)
Highly Exposed X ROC			-0.215***
			(0.073)
Financially Secure	0.120*	0.105*	0.076
	(0.075)	(0.065)	(0.058)
ROC	0.179***	0.156**	0.137**
	(0.063)	(0.071)	(0.059)
Firm Exposure:			
Highly Exposed			-0.068
			(0.059)
R2	0.17	0.22	0.36
Firm Facility Count	3,751	3,751	3,751
Fixed Effects			
Year	x	x	x
Industry	x	x	x

I can only see that a facility had a chemical during the ROC year, and that it either does or does not have the chemical afterwards. One possible explanation as to why the facility no longer uses the chemical is that the facility underwent some form of 'conversion' or refitting, in which the production process was adjusted so that the chemical was no longer needed. Such a process would presumably be costly, either in the form of up-front cost or lower marginal profit after measures are implemented. Following on our logic regarding financially distressed firms, it might be more difficult for them to undergo such a process, given that their immediate survival could be at stake.

I hypothesize that financially secure firms would be more likely to convert a facility $--$ not only because they have more free cash to direct toward such measures, but also because they have a greater incentive to protect their healthier cash flows.

Table 2.5 demonstrates this to be the case. While financially secure firms are more likely to convert their facilities in general, as can be seen in column 1, they are even more likely to convert exposed facilities, which can be seen in the cross term from column 2. Interestingly, though, when we cross financially secure firms with highly exposed firms (as in the first row of column 3), we see little to no effect. Essentially, the facts that the firm is financially secure and highly exposed seem to work against each other to effectively zero each other out.

I include Table 2.6 to make it easier to see the comparison across groups of how likely firms are of converting facilities. Again, we see that exposed facilities are, on average, more likely to be converted. On the other hand, while firms that are financially distressed are less likely to convert their facilities, financially distressed and moderately exposed firms are still more likely to convert facilities than financially distressed highly exposed firms.

2.5.4 Results and Analysis: Financial Distress and Facility Acquisition

Next, I explore if financially secure firms are more or less likely to acquire other facilities upon exposure, and whether or not those facilities are exposed. In general, I would hypothesize that financially secure firms are more likely to acquire other facilities. And given that financially secure firms have more future cash flows to protect, I would hypothesize that if they do acquire facilities, then those facilities would not be carcinogenic. It is difficult to make a prediction, though, as to how the acquisition strategy of a financially secure firm would change after exposure.

The corollary would suggest that a financially distressed firm would acquire fewer facilities in general. However, upon exposure, I would hypothesize that it would be more likely to acquire exposed facilities. This would support the argument that an exposed firm, especially one that is highly exposed, might figure that any sort of litigation would cause it to go bankrupt, so any further marginal exposure by acquiring an exposed facility would be negligible.

In table 2.7, I present my results on acquisition of other TRI-listed facilities. As expected, we see in columns 1 and 2 that financially secure firms are more likely, in general, to acquire facilities from other firms. However, in columns 3 and 4, I

Table 2.6: Probability of Converting a Facility

	Probability of converting:		
	Financially Distressed	T-stat	Financially Secure
All facilities	4.1%		4.4%
Exposed facilities	4.0%	**	4.7%
Unexposed facilities	4.1%		4.3%
Exposed facility, unexposed firm	N/A		N/A
Exposed facility, moderately exposed	4.8%	**	5.5%
Exposed facility, highly exposed	3.5%	**	4.2%
Unexposed facility, unexposed firm	4.1%		4.4%
Unexposed facility, moderately exposed	4.3%		4.3%
Unexposed facility, highly exposed	3.9%		4.0%

Note: T-stat indicate if probability of selling is statistically different for financially distressed and financially secure firms. '*' indicates significance at the 10% level, '**' at the 5% level, and '***' at the 1% level.

find that financially secure firms are not more likely to acquire exposed facilities. Finally, in columns 5 and 6, I find that financially secure firms are more likely to acquire unexposed facilities than are distressed firms. This is while accounting for firm exposure as well as year and industry fixed effects.

These results generally support the argument that financially secure firms would be more likely to acquire unexposed facilities and less likely to acquire exposed facilities, in comparison to distressed firms. In Table 2.8, I provide a matrix for easier comparison of facility acquisition probabilities among financially secure and distressed firms. I do not find significant evidence that distressed firms are more or less likely to make acquisitions upon exposure than secure firms. Gormley and Matsa find that exposed financially distressed firms are more likely to make acquisitions. My results do not support or reject that finding.

Table 2.7: Financial Distress and Facility Acquisition

Dependent Variable = Indicator for if firm acquires a facility after ROC						
	Any Facility		Exposed Facility		Unexposed Facility	
	(1)	(2)	(3)	(4)	(5)	(6)
Cross Term:						
Moderately Exposed x Financially Secure		0.092		-0.135		0.026
		(0.128)		(0.098)		(0.085)
Highly Exposed x Financially Secure		0.027		0.166*		-0.116
		(0.096)		(0.087)		(0.075)
Financially Secure	0.205***	0.282***	-0.017	-0.064	0.269***	0.286***
	(0.071)	(0.093)	(0.063)	(0.061)	(0.088)	(0.083)
Facility Count	0.047**	0.059**	0.091***	0.091***	0.061**	0.069**
	(0.022)	(0.029)	(0.033)	(0.035)	(0.027)	(0.027)
Firm Exposure:						
Moderately Exposed	-0.025	-0.040	-0.038	-0.047	-0.101	-0.129
	(0.094)	(0.088)	(0.087)	(0.083)	(0.071)	(0.073)
Highly Exposed	-0.019	-0.034	0.149	0.171	-0.210**	-0.235***
	(0.142)	(0.121)	(0.105)	(0.118)	(0.094)	(0.082)
R2	0.27	0.34	0.18	0.39	0.33	0.35
Firm Count	2,319	2,319	2,319	2,319	2,319	2,319
Fixed Effects						
Year	x	x	x	x	x	x

Table 2.8: Probability of a Firm Acquiring a Facility

	Probability of acquiring a facility:		
	Any Facility	Exposed Facility	Unexposed Facility
Distressed, unexposed firm	12.0%	2.3%	10.1%
Distressed, moderately exposed	11.5%	2.1%	9.7%
Distressed, highly exposed	11.6%	2.8%	9.0%
Secure, unexposed firm	15.4%	2.0%	13.6%
Secure, moderately exposed	16.0%	1.4%	14.8%
Secure, highly exposed	15.3%	2.8%	12.7%

2.6 Conclusion

While ample theoretical support has been provided for the theory of asset substitution, my paper provides important empirical evidence. I find that financially secure firms, in general, are more likely to take actions to reduce their carcinogenic exposure compared to firms that are financially distressed.

I find evidence that they pursue this strategy through three avenues: 1) they are more likely to sell exposed facilities, 2) they are more likely to convert exposed facilities to unexposed facilities and 3) they are less likely to acquire exposed facilities (in comparison to unexposed facilities). The corollary to this is that financially distressed firms take fewer actions to address carcinogenic exposure. Indeed, while they make fewer acquisitions in general, the facilities they acquire are more likely to be carcinogenic. These findings lend themselves to supporting the theory of asset substitution, which suggests that firms in financial distress are more likely to increase the volatility of their assets, hoping to increase the value of equity at the expense of the debt holders. I do not, though, find evidence that exposed firms in financial distress are likely to grow out of danger.

2.7 Appendix A

Table 2.9: TRI-covered Industries

TRI-covered Industries
212 Mining
221 Utilities
31-33 Manufacturing
All other Miscellaneous Manufacturing (1119, 1131, 2111, 4883, 5417, 8114)
424 Merchant Wholesalers, Non-durable Goods
425 Wholesale Electronic Markets and Agent Brokers
511, 512, 519 Publishing
562 Hazardous Waste

2.8 Appendix B

The chemicals can be found on the following page:

http://www2.epa.gov/toxics-release-inventory-tri-program/tri-listed-chemicals

2.9 Appendix C

I use Gormley and Matsa's approach to identify industry exposure, this time breaking out into international/domestic acquisitions. Notably, the only significant result I get is that firms in exposed industries acquire fewer foreign firms of a different industry.

Table 2.10: Effect of Liability Exposure on Acquisition Activity (GM industries)

	Dependent variable=Ln(Number of Acquisitions + 1)						
	All	Same Industry	Different Industry	Same Domestic	Different Domestic	Same Int'l	Different Int'l
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Exposure	0.060	-0.011	0.057	0.001	0.071	-0.006	-0.108***
	(0.062)	(0.052)	(0.057)	(0.048)	(0.055)	(0.03)	(0.039)
R2	0.30	0.16	0.22	0.15	0.18	0.07	0.14
Observations	22,788	22,788	22,788	22,788	22,788	22,788	22,788
Fixed Effects:							
Industry	X	X	X	X	X	X	X
Year	X	X	X	X	X	X	X

Table 2.11: Use of Carcinogens and Their Matches During Years Surrounding ROC

	t-2	t-1	ROC	t+1	t+2	t+3
Carcinogens	13.8%	14.0%	13.6%	13.5%	13.3%	13.0%
Match	14.7%	14.8%	14.5%	14.8%	14.4%	14.3%

2.10 Appendix D

Table 2.12: Summary Statistics of Carcinogenic and Matching Chemical Facilities

	Carcinogenic Facilities		Matching Chemical Facilities
Percentage of Facilities as of ROC Year	13.6%	**	14.5%
Chemical Count per Facility	3.9		4.0
Age of Facility at ROC	12.1		11.9
% Sold Each Year prior to ROC	3.5%		3.3%
% Converted Each Year prior to ROC	2.0%		2.1%

Note: T-stat indicate if probability of selling is statistically different for financially distressed and financially secure firms. '*' indicates significance at the 10% level, '**' at the 5% level, and '***' at the 1% level.

2.11 Appendix E

I present Table 2.12 as evidence of the similarity of facilities with newly-announced carcinogens and the facilities with matching non-carcinogenic chemicals. The only significant different between the two groups is that are slightly more facilities with matching chemicals than with carcinogenic chemicals − 14.5% to 13.6%. Otherwise, the facilities are statistically similar.

2.12 Appendix F

In Appendix F, I use difference-in-difference analysis to determine if financially distressed firms are more likely to sell or convert their facilities. For each chemical that is newly-determined to be a carcinogen, I use the non-carcinogenic chemical present in the most-similar number of facilities. Table 2.11 shows the concentration of such chemicals. What I want to examine is the likelihood of facilities that report using these carcinogens and matches before the report is released, and compare that to the likelihood of selling or converting facilities with the same chemicals after the ROC is released.

To accomplish this, I set up both pre-treatment periods and post-treatment periods around each ROC. The pre-treatment periods begin two years before the ROCs are released and end the year that the ROC is released. The post-treatment periods begin the year the ROC is released and end two years afterwards. Because there are not two years of ROC data preceding the 1989 ROC, I exclude it from my difference-in-difference analysis and only use ROCs from 1991, 2000, 2004 and 2011. Similar to my other analysis, I again classify firms as moderately exposed and highly exposed. A firm is moderately exposed if at least one but fewer than half of its facilities are exposed to either a carcinogen or matching chemical. I do not include firms and facilities without either a carcinogen or its match in my analysis.

I employ the following simple OLS econometric approach:

$$y_{j,e,f,t} = \alpha + \beta_1(FinanciallySecure_{f,t})$$

$$+\beta_2(Post - ROC_{f,t}) + \beta_3(FinanciallySecure \times Carcinogen_{j,f,t} \times Post - ROC_t)$$

$$+\beta_4(FinanciallyDistressed_{f,t} \times Carcinogen_{j,f,t} \times Post - ROCf, t)$$

$$+\beta_5(FinanciallySecure_{f,t} \times Carcinogen_{j,f,t})$$

$$+\beta_6((FinanciallyDistressed_{f,t} \times Carcinogen)_{j,f,t}) + \varepsilon,$$

where a firm is indexed by f, a facility is indexed by j, and the respective year is indexed by t. The variable $y_{j,e,f,t}$ is a 1/0 indicator variable for if an action is taken on a facility (either converted or sold). The variable $FinanciallySecure$ is a 1/0 indicator if the firm is financially secure. FinanciallyDistressed is a 1/0 indicator if the firm is financially distressed. The variable $Carcinogen$ indicates if the facility has a chemical determined to be carcinogenic (either already determined, for the post-treatment period, or about to be determined, for the pre-treatment period. The variable $Post - ROC$ is an indicator if the period is pre or post-ROC.

I also use chemical and year fixed effects. My results are in table 2.13.

Table 2.13: Difference-in-Difference Analysis of Financial Distress and Sales/Conversions

Dependent variable=Probability that a facility is sold/converted within two years of ROC		
	Sold	Converted
Financially Secure x Carcinogen X Post-ROC	0.114**	0.078*
	(0.058)	(0.049)
Financially Distressed x Carcinogen x Post-ROC	-0.027	0.028
	(0.074)	(0.070)
Financially Secure x Carcinogen	0.017	0.033
	(0.069)	(0.075)
Financially Distressed x Carcinogen	0.004	-0.019
	(0.068)	(0.073)
Financially Secure	-0.129**	0.036
	(0.057)	(0.066)
Post-ROC	-0.028	-0.060
	(0.084)	(0.075)
Observations	7,514	7,514
R2	0.28	0.35
Fixed Effects		
Chemical	x	x
Year	x	x

2.13 Appendix G

It should also be noted that firms cannot shield themselves from liability already incurred from selling their exposed facilities. While they would not be liable for subsequent exposure, they would still be liable for past employee exposure. Therefore, when a firm makes the decision to sell or convert a facility that is exposed to a carcinogen, it is doing so in order to avoid future exposure.

This observation should only make it more difficult to generate significant results in my analysis. This is due to the effect of selling not eliminating the entire threat of an employee lawsuit, but only the future threat.

Chapter 3: Response to Risk of Public and Private Firms

Abstract

This paper examines if public firms respond differently to a potential negative cash flow shock than do private firms. I use a pseudo-natural experiment to see how firms respond to the negative shock of discovering that chemicals used in their production processes are deemed to be carcinogenic. I do not find evidence that public firms respond differently to this shock from private firms. Hence, I do not find support for the argument that private firms might be stymied from investing due to a lack of access to capital markets. I also find no indication that differences in the corporate governance of public and private firms encourage them to act any differently.

3.1 Introduction

The abundance of financial data for public firms has led scholars to focus their empirical analysis on these firms and project findings for public firms onto private firms. Yet important differences exist between public and private firms. First, public firms generally have better access to financial markets. The very nature of them being public indicates that they have relatively liquid, publicly-traded equity. This creates a visible track record of financial performance and makes it easier for these firms to secure borrowing at lower levels of interest. Another difference relates to corporate governance. Private firms are more-closely held than public firms. For most public firms, the managers hold only a small proportion of the overall equity, and their pay is not always perfectly correlated with performance. For these two major reasons, it is important to assess whether these differences cause private firms to function differently than public ones.

I use a pseudo-natural experiment of a negative potential cash flow shock and do not find evidence that public firms invest or mitigate risk any differently than do private firms. On the other hand, I do find that new private firms are more likely to either build or acquire this potential risky cash flow. This evidence could potentially suggest that private firms are more capable of assuming risky projects than are public firms.

The amount of financial data available for public firms is striking compared to the paucity available for private firms. Public firms listed in the United States must submit several corporate filings each year, including a report each quarter detailing the firm's financial and operating performance. On the other hand, private firms are not bound by such requirements, and as a result, the majority of empirical research is done only on public companies, while scholars project these findings onto private companies.

My paper explores if private firms respond differently to a potential negative shock than do public firms. Every few years, the U.S. Department of Health and Human Services releases a Report on Carcinogens, which identifies new chemicals deemed to be carcinogenic. I use plant-level data to determine the exposure to these chemicals faced by a firm's employees. I then use this exposure as a proxy for subsequent potential litigation risk faced by the firm. It is unknown at the time of exposure whether or not lawsuits will come to fruition, which enables me to narrow my focus on how firms might respond to this potential risk.

Perhaps the best-known example of employee litigation over cancer-causing substance is the asbestos litigation that culminated in the 1980s and 1990s. According to one study, asbestos litigation cost defendants and insurers roughly $70 billion as of 2002. [2] Another study showed that, by the early 1990s, "more than half of the 25 largest asbestos manufacturers in the U.S....had declared bankruptcy." [29] And while the asbestos litigation may be the best-known and most harmful, it is by no means the only one. In the past two years, for instance, chemical giant Univar was hit with a suit over employee exposure to benzene-containing chemicals used as an applicator in its factories. [3] Separately, Monsanto was sued by some of its workers over exposure to Roundup herbicide. [4] Separately, in 2015 alone, ConocoPhillips, du Pont, Exxon, Firestone, Goodyear, Gulf Oil, Huntsman and others have been sued or ordered, settled out of court, or ordered to pay penalties over their uses of chemicals deemed to be carcinogenic. [5] [6] [7] [8]

Theory is unclear as to whether public or private firms should respond differently to this risk. Research has suggested that managers of widely held public firms might attempt to outgrow the risk in order to avoid bankruptcy and subsequent job loss, even if these investments are net losses for shareholders. The owner of a closely held private company, presumably, would have more consideration for his equity stake and perhaps not be quite as aggressive in growing the firm.

Separate theory suggests that firms in potential distress might make even riskier investments, in an attempt to shift value from creditors to equity holders. But this incentive might not be as strong for private firms if debt is collateralized by the owner's personal assets.

The second question I attempt to answer in this paper is whether new entrants and acquirers or builders of facilities using these carcinogens are likely to be public or private firms. This question relates to which type of firm is more capable of managing the special type of cash flow risk presented by carcinogenic exposure. The argument for public firms being more willing to assume litigation risk is that they have better access to financing. On the other hand, perhaps private firms have better access to the type of financing, such as private equity, that might be more interested in assuming such risks.

The rest of my paper proceeds as follows in my next section, I explore the related literature. In section 3, I examine the data used in my paper. In section 4, I discuss the methodology used in my regressions and other statistical analysis.

In section 5, I explore and present the results from my tests. Finally, section 6 concludes.

3.2 Literature Review

Despite the fact that the majority of firms in the United States are private, there has not been very much empirical literature focused on assessing how private firms differ from public firms. Some insight might be generated into asking why private firms make the decision to go public. [37] Rajan [38] argues that firms go public in order to gain access to the stock market and generate a public track record with investors, both of which lead to a lower cost of capital, are two of the reasons firms go public. Others have speculated that going public enables shareholders to better discipline and reward managers via using the value of the firm's stock to measure managerial performance. [39] Using a data set of public and private firms in the United Kingdom, Brav [40] finds that private firms are more dependent upon debt financing, more highly levered, and less inclined to pursue external capital markets. Other literature has demonstrated the usage of personal collateral to fund investment in private firms. [41]

These papers all have implications for how private firms might treat a potential liability differently than might public firms. Given closer access to capital markets, we might expect public firms to be more capable of divesting from facilities that are exposed. On the other hand, we might expect that private firms in which owners use personal assets as collateral would be less willing to take on risk.

Other research has managed to identify differences between public and private firms. Maksimovic, Phillips and Yang [42], for instance, find that public firms are more involved as buyers and sellers of assets during merger waves than are private firms. Moreover, they find that their participation is more affected by credit spreads and aggregate market valuation. In a forthcoming paper, Gilje and Taillard [43] find that private firms respond less than public firms in light of new investment opportunities, and even sell projects to public firms. They argue that differences in access to external capital help explain the differences between the firms. Another hypothesis they explore but rule out as to the greater response to investment, though, relates to the separation of ownership and control, as discussed in prior research by Jensen [44] and Stulz. [45]

3.3 Data

Toxic Release Inventory

For plant-level chemical and carcinogen data, I use the Toxic Release Inventory (TRI) TRI.NET database of chemicals that are used, produced or disposed of by over 58,000 unique facilities across the United States. Produced by the U.S. Environmental Protection Agency (EPA), TRI includes facility-level release information for about 650 different chemicals between 1986 and 2014. All facilities that meet the following three requirements are required to report to the TRI program: 1) it is included in a TRI-covered North American Industry Classification System NAICS described in Appendix A, 2) it has at least 10 full-time employees and 3) it manufactures, imports, or otherwise uses any of the chemicals outlined in the Emergency Planning and Community Right to Know Act Section 313 above a specific threshold that varies for each chemical or type of usage/disposal. Data is self-reported, though the EPA imposes fines for non-compliant facilities.

As shown in Table 3.1, about 10,000 firms (both public and private) every year appear in the TRI database, with 2.3 facilities per firm on average.

Report on Carcinogens

This paper also uses several editions of the Report on Carcinogens (ROC) produced by the U.S. Department of Health and Human Services. The ROC is a congressionally-mandated public health report that identifies substances (chemicals, compounds, mixtures, etc.) that pose a carcinogenic hazard to people residing in the United States. Chemicals are included on the list after a multi-stage review process that involves a review of the scientific literature, a preliminary release of chemicals to be reviewed for inclusion, solicitation for commentary and feedback, and finally the official release of the report.

For this study, I use the reports published in 1989, 1991, 2000, 2004 and 2011. I do not use the first four ROC editions, as they were released (1980, 1981, 1982 and 1985) before plant-level chemical data became available in 1986. Further, I do not use ROCs published during 1994, 1998, and 2002 due to the lack of facilities exposed to these chemicals. The most recent ROC was published in October 2014 but is not used due to a lack of TRI data since then (TRI data runs through 2014).

I identify a chemical's 'exposure year' as the year in which it was first identified as either a 'known' or 'highly likely' carcinogen in an edition of the Report on Carcinogens. A facility is deemed to be newly exposed if it reports using a chemical the same year as the chemical's exposure. A firm's level of exposure is dependent upon the percentage and number of facilities that are exposed in a given exposure year. Firms are considered to be 'unexposed' if they have no facilities that use a newly-exposed chemical.

Table 3.1 provides figures on the percentage of facilities that are exposed to a carcinogen for each of the ROCs. It should be noted that the majority of facility exposures took place in 1989, 2004 and 2011, during which 9.6%, 40.1% and 8.7% of the facilities were exposed, respectively. I also present the number of public firms listed on American exchanges that appear in the TRI database each year. On average, public firms constitute about 8-10% of all firms each year, though about 18% of firms with more than one facility and 29% of those with more than five

Table 3.1: Summary Statistics for Firm Exposure

	All Firms					Firms with >1 Facility				
Year	Firm Count	Mean Total Facilities per Firm	Exposure Percent	Mean Exposed Facilities per Firm	Public Firm Count	Firm Count	Mean Total Facilities per Firm	Exposure Percent	Mean Exposed Facilities per Firm	Public Firm Count
1987	10,891	2.22			1,051	2,805	5.70			564
1988	10,711	2.22			1,033	2,782	5.71			559
1989	11,275	2.20	9.6%	0.21	1,062	2,886	5.69	10.0%	0.57	576
1990	11,591	2.19			1,065	3,002	5.60			592
1991	11,517	2.18	1.0%	0.02	1,065	2,922	5.64	1.1%	0.06	567
1992	11,406	2.17			1,015	2,889	5.63			543
1993	11,279	2.16			988	2,854	5.57			533
1994	10,898	2.16			972	2,741	5.61			505
1995	10,549	2.18			936	2,704	5.60			500
1996	10,267	2.20			935	2,672	5.62			505
1997	10,174	2.21			895	2,644	5.64			489
1998	10,568	2.30			956	2,806	5.90			534
1999	10,264	2.28			904	2,739	5.80			510
2000	10,445	2.32	2.5%	0.06	908	2,800	5.91	2.2%	0.13	512
2001	10,881	2.38			930	2,962	6.07			542
2002	10,667	2.37			892	2,833	6.14			535
2003	10,452	2.36			852	2,808	6.08			495
2004	10,245	2.39	40.1%	0.96	847	2,786	6.11	43.3%	2.65	501
2005	10,065	2.42			827	2,754	6.18			500
2006	9,803	2.43			830	2,714	6.18			495
2007	9,400	2.48			792	2,637	6.29			477
2008	9,034	2.52			763	2,551	6.38			470
2009	8,673	2.50			748	2,453	6.32			455
2010	8,769	2.49			777	2,490	6.26			460
2011	8,707	2.50	8.7%	0.22	756	2,488	6.26	7.8%	0.49	448
2012	8,601	2.53			747	2,467	6.33			436
2013	8,248	2.68			690	2,465	6.61			418
2014	8,521	2.55			657	2,454	6.40			401

facilities.

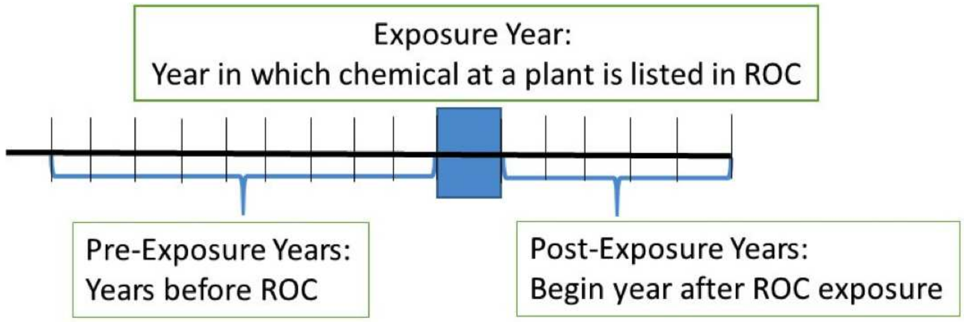

Figure 3.1: Exposure Timing

3.4 Methodology

The next section of my analysis examines how the response to carcinogen exposure by public firms might be different than that by private firms. For this section, I utilize the TRI database for facility-level exposure information and also the Compustat database to help determine which firms in TRI are public or private at a given time. Table 3.2 presents the basic statistics for how firms change number and exposure of facilities in the years following an ROC announcement. Given that public firms are larger on average than private firms, I divide firms into those with one facility, two facilities, and more than two facilities in order to make comparisons across groups more straightforward. I also compare changes in size and exposure for periods of two, three and five years after the ROC announcement.

3.4.1 Selling Facilities

In dissecting the change in facility count, I am interested in gaining more insight into how firms change the number of facilities they own. First, I examine if private firms are more likely to sell their exposed facilities than are public firms. The definition I use for 'selling' a facility after exposure is that the facility appears with one firm during the ROC year but appears for another firm in the two years afterwards. I also include a facility as being 'sold' if the 'seller' is no longer in the database afterwards, so long as the facility is with a new firm after two years.

As was done in previous chapters, for each carcinogen, I develop a non-carcinogenic match that has the most similar number of exposures during an ROC year.

I develop the following logit model to estimate the likelihood that a specific facility is sold:

$$y_{j,f,e,t} = \alpha + \beta_1(cross) + \beta_2(public_{f,t}) + \beta_3(FirmExposure_{f,t}) + \beta_4(ROC_{j,t})$$
$$\beta_5(industry) + \beta_6(year) + \varepsilon$$

where $y_{j,f,e,t}$ is a 1/0 indicator variable for if facility j of of firm f and carcinogenic exposure e in year t is sold to another firm in the subsequent two years. The variable $public_{f,t}$ assumes a value of 1 if the firm is public and 0 if private. The variable $firmexpose_{f,t}$ indicates the exposure grouping of a firm (highly, moderately, or unexposed). The variable $ROC_{j,t}$ indicates if the chemical is a carcinogen or a non-carcinogenic match. The variable $cross$ is a cross term for the firm's public/private status and the facility exposure. Finally, I account for industry and year fixed effects. Results are reported in Table 3.3.

3.4.2 Facility Conversion

Next, I perform similar analysis to determine if exposed facilities are more likely to be converted to unexposed by either public or private firms. First, I match each carcinogen to the most frequently observed non-carcinogenic chemical in the TRI database as of the exposure year, and follow the likelihood that a facility with that chemical is converted in the following year. The non-carcinogenic chemical matches are my matching control group for this econometric analysis. I define a facility to be ‘converted’ if it has a carcinogen during the ROC year, and then does not have that carcinogen the next year (or, for the matching group, if it has the matching chemical and then later does not). Importantly, the facility must still appear in the database and also be owned by the same firm.

I use the following logit model:

$$
\begin{aligned}
y_{j,e,t} = \alpha + \beta_1(cross) + \beta_2(public_{f,t}) + \beta_3(exposure_j) + \beta_4(highlyexposed_{f,t}) \\
+\beta_5(moderatelyexposed_{f,t}) + \beta_6(facilitycount_f) + \beta_7(firm) \\
+\beta_8(year) + \varepsilon
\end{aligned}
$$

where $y_{j,f,e,t}$ is a 1/0 indicator variable for if facility j of of firm f and carcinogenic exposure e in year t is converted in the subsequent two years. The variable $public_{f,t}$ assumes a value of 1 if the firm is public and 0 if private. The variable $firmexpose_{f,t}$ indicates the exposure grouping of a firm (highly, moderately, or unexposed). The variable $ROC_{j,t}$ indicates if the chemical is a carcinogen or a non-carcinogenic match. The variable *cross* is a cross term for the firm’s public/private status and the facility exposure. Finally, I account for industry and year fixed effects. Standard errors are clustered at the year and industry level. Results are reported in Table 3.4.

3.5 Results and Analysis

I now examine the findings of my statistical analysis. In table 3.2, I examine the response to carcinogenic exposure by public and private firms. Theory is unclear as to what we might expect beforehand. If the literature demonstrating that firms go public in order to increase their access to investment is to be believed, then we might see quicker divestment of exposed facilities and investment in unexposed facilities by public firms. Another argument that pushes for the same result might be that public markets might have a smaller appetite presented by carcinogenic exposure, and so we would again expect quicker divestment of exposed facilities and investment in unexposed. The counterargument, though, would be that having access to public markets would provide a greater ability for public firms to finance the sort of risk imposed by carcinogenic exposure, thereby holding onto these exposed assets.

When comparing public firms in the top panel to private firms in the bottom panel, I find similar patterns and few data points that would indicate that the two groups respond differently. The similarities are most striking when comparing public and private firms with more than two facilities as of the ROC year. If we begin with these two groups, we see that, among highly exposed firms, exposure levels hover around 75% for the next few years after the release of the ROC. For moderately exposed, levels hover around 15-18%. I find similar outcomes when comparing public firms with two facilities to private firms with two facilities. In terms of the total number of facilities after two years as well as the percentage of facilities that are exposed, both public and private firms demonstrate similar investment strategies. I do see some slight differences in the exposure levels between public and private firms that begin the period with one facility each, but these differences are insignificant in a two-tailed t-test at the 10% level.

Hence, my first results find little evidence that public and private firms respond differently to carcinogenic exposure on the whole. In subsequent tables, I will explore if their acquisition activity, divesting activity, or facility conversion response differs.

3.5.1 Results and Analysis: Public and Private Firms and Facility Sales

Next, I explore if public and private firms respond to carcinogens by divesting differently. I present my results in table 3.3. Again, I find little evidence that public and private firms respond differently. No results in my analysis are significant at even the 10% level, so I am unable to support or provide evidence against any of the aforementioned theory.

3.5.2 Results and Analysis: Public and Private Firms and Facility Conversion

As with the prior analysis, I am unable to find much evidence that private firms are more or less likely to convert their facilities than are public firms. I present my evidence in table 3.4. While I do see that exposed facilities are more likely to be converted, I find no evidence that private firms are more or less likely to convert their exposed facilities than are public firms.

Table 3.2: Exposure Response of Public vs Private Firms

Panel A: Public Firms

	Firms with 1 Facility			Firms With 2 Facilities				Firms With >2 Facilities			
	Unexposed	**Highly Exposed**	**t-test**	**Unexposed**	**Moderately Exposed**	**Highly Exposed**	**t-test**	**Unexposed**	**Moderately Exposed**	**Highly Exposed**	**t-test**
ROC Year											
Firm Count	1,730	250		534	74	39		1,249	441	208	
Mean Facility Count	1.00	1.00		2.00	2.00	2.00		7.94	15.19	10.59	
Exposed Facility %	0.0%	100.0%		0.0%	50.0%	100.0%		0.0%	18.3%	73.5%	
Two Years Later:											
Mean Facility Count	0.91	0.94		1.87	1.94	1.85		7.75	15.21	10.14	
Percent Change	-9.0%	-6.0%		-6.5%	-3.2%	-7.5%		-2.4%	0.1%	-4.2%	
Exposed Facility %	1.2%	81.0%		3.8%	39.2%	97.1%		0.5%	15.9%	77.5%	
Three Years Later											
Mean Facility Count	0.85	0.89		1.73	1.83	1.76		7.45	14.81	10.13	
Percent Change	-15.0%	-11.0%		-13.5%	-8.5%	-12.0%		-6.2%	-2.5%	-4.3%	
Exposed Facility %	1.9%	71.3%		3.9%	43.4%	92.3%		0.7%	15.3%	77.0%	
Five Years Later*											
Mean Facility Count	0.76	0.79		1.60	1.81	1.69		7.05	13.94	9.88	
Percent Change	-24.0%	-21.0%		-19.9%	-9.5%	-15.3%		-11.2%	-8.2%	-6.7%	
Exposed Facility %	2.2%	71.1%		3.1%	35.9%	87.7%		0.6%	15.5%	75.5%	

Panel B: Private Firms

	Firms with 1 Facility			Firms With 2 Facilities				Firms With >2 Facilities			
	Unexposed	**Highly Exposed**	**t-test**	**Unexposed**	**Moderately Exposed**	**Highly Exposed**	**t-test**	**Unexposed**	**Moderately Exposed**	**Highly Exposed**	**t-test**
ROC Year											
Firm Count	30,862	5,365		4,535	586	345		4,181	1,163	527	
Mean Facility Count	1.00	1.00		2.00	2.00	2.00		7.00	14.53	9.79	
Exposed Facility %	0.0%	100.0%		0.0%	50.0%	100.0%		0.0%	18.0%	72.4%	
Two Years Later											
Mean Facility Count	0.88	0.90		1.82	1.85	1.87		6.69	14.60	9.69	
Percent Change	-12.4%	-9.9%	**	-8.8%	-7.5%	-6.7%		-4.5%	0.5%	-1.0%	
Exposed Facility %	1.5%	86.6%		1.1%	42.7%	93.8%		0.6%	16.2%	77.4%	
Three Years Later											
Mean Facility Count	0.84	0.87		1.77	1.83	1.86		6.52	14.34	9.49	
Percent Change	-16.3%	-12.9%	**	-11.4%	-8.7%	-6.9%	*	-7.0%	-1.3%	-3.0%	
Exposed Facility %	1.2%	81.5%		1.2%	41.3%	91.9%		0.7%	15.7%	77.0%	
Five Years Later*											
Mean Facility Count	0.76	0.77		1.67	1.76	1.83		6.25	14.06	9.42	
Percent Change	-24.1%	-22.7%	*	-16.3%	-12.1%	-8.6%	*	-9.5%	-3.1%	-3.4%	
Exposed Facility %	2.1%	78.2%		1.8%	39.5%	89.5%		1.0%	15.7%	75.8%	

Table 3.3: Public and Private Firms and Facility Sales

Dependent Variable = Indicator for if facility is sold		
	(1)	(2)
Public Firm X Highly Exposed X ROC		0.028
		(0.039)
Public Firm X ROC		-0.019
		(0.050)
Public Firm X Highly Exposed		-0.019
		(0.057)
Highly Exposed X ROC		-0.114***
		(0.041)
Public Firm	-0.016	-0.039
	(0.033)	(0.42)
ROC	0.038	0.048
	(0.046)	(0.50)
Highly Exposed Firm		0.033
		(0.058)
R2	0.08	0.15
Facility Count	31,840	31,840
Fixed Effects		
Year	x	x
Industry	x	x

Table 3.4: Public and Private Firms and Facility Conversion

Dependent Variable = Indicator for if facility is converted		
	(1)	(2)
Public Firm X Highly Exposed X ROC		-0.007
		(0.039)
Public Firm X ROC		0.037
		(0.042)
Public Firm X Highly Exposed		-0.025
		(0.039)
Highly Exposed X ROC		-0.130**
		(0.055)
Public Firm	-0.019	0.023
	(0.037)	(0.43)
ROC	0.147**	0.125**
	(0.051)	(0.58)
Highly Exposed Firm		0.012
		(0.043)
R2	0.19	0.27
Facility Count	31,840	31,840
Fixed Effects		
Year	x	x
Industry	x	x

3.5.3 Results and Analysis: Firms with 0 Facilities During the ROC Year

For the next part of my analysis, I examine firms that actually have 0 facilities during an ROC year but have at least one facility 3 years later. I am interested in finding out if the facilities of these new firms are more or less likely to be exposed to a recently-declared carcinogen. Economic theory would suggest that these firms would be less likely to use exposed chemicals in their facilities, as they would not have the incentive to introduce themselves to exposure unnecessarily. Surprisingly, though, I find just the opposite effect, with these firms actually being more likely to be exposed to carcinogens.

I use a simple student t-test to determine if new firms are more likely to use newly-exposed carcinogens. First, I match each newly-exposed carcinogen with the non-carcinogenic chemical reported in the most similar number of facilities three years after the ROC. Next, I take all firms with 0 facilities as of the ROC year but at least 1 facility 3 years afterwards. Finally, I compare the percentage of facilities that report having the carcinogen and the percentage the report having one of the matching non-carcinogenic chemicals.

Of the 8,905 facilities that match the criteria, 3.1% reported having the carcinogen while just 2.4% reported having the matching non-carcinogenic chemical. Using a two-tailed student t-test, this is significant at the 5% level.

It is interesting that new firms entering an industry would make the decision to be more heavily exposed to the carcinogens than to other chemicals. One potential explanation is that facilities that use these chemicals might become less expensive due to the liability risk of using the chemical, and new firms might subsequently decide to buy these discounted facilities and earn outsized profits during those states of the world in which there are no lawsuits and declare bankruptcy if substantial litigation does take place. I do find that more of the firms that use carcinogens have names that suggest they are part of a private equity group (8.0% vs 6.9%), but the difference does not appear to be significant. Further research of this topic is needed.

3.6 Conclusion

Although the overwhelming majority of firms in the United States are private, the majority of empirical research conducted pertains solely to public firms. My paper attempts to add to this literature by examining if there is a difference in how public and private firms respond to a potential negative cash flow shock. For the most part, I am unable to find any differences in how firms respond to the exposure of their own facilities. On the other hand, I do find that new private firms are more likely to acquire or build facilities exposed to a carcinogen than are new public firms. This might suggest that private firms are more capable of assuming this type of cash flow risk than are public firms, though further research on the subject is warranted.

3.7 Appendix A

Table 3.5: TRI-covered Industries

TRI-covered Industries
212 Mining
221 Utilities
31-33 Manufacturing
All other Miscellaneous Manufacturing (1119, 1131, 2111, 4883, 5417, 8114)
424 Merchant Wholesalers, Non-durable Goods
425 Wholesale Electronic Markets and Agent Brokers
511, 512, 519 Publishing
562 Hazardous Waste

3.8 Appendix B

The chemicals can be found on the following page:

http://www2.epa.gov/toxics-release-inventory-tri-program/tri-listed-chemicals

3.9 Appendix C

I use Gormley and Matsa's approach to identify industry exposure, this time breaking out into international/domestic acquisitions. Notably, the only significant result I get is that firms in exposed industries acquire fewer foreign firms of a different industry.

Table 3.6: Effect of Liability Exposure on Acquisition Activity (GM industries)

	Dependent variable=Ln(Number of Acquisitions + 1)						
	All	Same Industry	Different Industry	Same Domestic	Different Domestic	Same Int'l	Different Int'l
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Exposure	0.060	-0.011	0.057	0.001	0.071	-0.006	-0.108***
	(0.062)	(0.052)	(0.057)	(0.048)	(0.055)	(0.03)	(0.039)
R2	0.30	0.16	0.22	0.15	0.18	0.07	0.14
Observations	22,788	22,788	22,788	22,788	22,788	22,788	22,788
Fixed Effects:							
Industry	X	X	X	X	X	X	X
Year	X	X	X	X	X	X	X

3.10 Appendix D

It should also be noted that firms cannot shield themselves from liability already incurred from selling their exposed facilities. While they would not be liable for subsequent exposure, they would still be liable for past employee exposure. Therefore, when a firm makes the decision to sell or convert a facility that is exposed to a carcinogen, it is doing so in order to avoid future exposure.

This observation should only make it more difficult to generate significant results in my analysis. This is due to the effect of selling not eliminating the entire threat of an employee lawsuit, but only the future threat.

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