Relative financial leverage, product market structure, and the wealth effects of product recalls [+]

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Abstract

We empirically document a previously overlooked cost for firms experiencing severe product failures. This cost stems from increased risk of predation by industry rivals following recalls and is exacerbated when recalling firms are financially constrained by higher levels of debt relative to their industry rivals. We find the wealth effects of recalling firms, industry rivals, and key suppliers upon announcements of product recalls depend on the relative financial position of the recalling firm compared to its rivals. Higher relative leverage negatively affects the recalling firm and its key suppliers, but benefits the industry rivals. Consistent with theory, these effects are confined to economic environments where competitive effects are likely to be discernible such as those with low entry costs, high product substitutability, and high product market risk, suggesting strategic effects are at play and that recalling firms with high relative leverage are especially vulnerable to strategic responses by rivals.

Keywords: Product recalls, product quality, product market interactions, leverage, financial distress, contagion.

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1. Introduction

Product recalls represent distinct quality failure events in the life of a firm that are associated with significant negative wealth effects and, thus, represent a major adverse shock for the recalling firm (see, for example, Jarrell and Peltzman, 1985; Hoffer, Pruitt, and Reilly, 1988; and Barber and Darrough, 1996). As we elaborate below, a rich theoretical and empirical literature suggests that strategic effects associated with having higher leverage relative to industry rival firms (henceforth "relative leverage") are likely to be particularly important when a firm faces an adverse shock. In this paper, we study the strategic consequences of having higher (or lower) debt relative to rivals in a product recalls setting by examining: (i) the role of relative leverage in explaining the value consequences of recalls for recalling firms, their industry rivals, and key suppliers and (ii) the impact of the nature of the product market environment on the role of relative leverage in affecting the recall's valuation consequences to the recalling firms and their rivals. In addition, we examine whether product recalls are associated with any contagion effects for industry rivals and key suppliers of recalling firms.

A product recall is an event where a firm recalls its products from the market because of a significant quality failure such as the presence of a safety hazard or one where the product is unable to perform its fundamental function.[1] Federal law requires that firms not only stop selling the product as soon as a safety defect is detected, but also report the defect to the relevant regulating agency.[2] Prior studies on

[1] Some recent recalls include certain Volkswagen vehicle models due to violation of emission control standards, Samsung Note S7 mobile devices because of battery defects, and Lotus heart valve devices due to problems at the time of implantation. Other well-known recalls include automobile recalls by Toyota Motor Corp due to malfunctioning accelerator pedals, Tylenol recalls by Johnson & Johnson due to foreign particles, laptop battery recalls by Sony Corporation due to fire hazard, malfunctioning defibrillator recalls by Boston Scientific, several food recalls due to E. Coli and Salmonella infections such as ConAgra's recall of Peter Pan peanut butter and Banquet potpies, and numerous toy recalls due to unsafe lead content (e.g., recalls of Barbie accessories by Mattel, and Bongo Band toys by Fisher-Price).

[2] For consumer products, Section 15(b) of the *Consumer Product Safety Act* requires that firms report safety defects immediately to the Consumer Product Safety Commission (*CPSC*). *Federal, Food, Drug, and Cosmetic Act,* which governs Food and Drug Administration (*FDA*) related recalls, has similar provisions. In the case of automobiles, firms are required to report safety defects to the National Highway Traffic Safety Administration (*NHTSA*) within five business days of determining that a safety defect exists. A case in point of this law in action is the large fine assessed against Toyota by the NHTSA for not reporting in a timely manner the "floor mat pedal entrapment" problem in their 2010 Lexus RX 350 SUVs, and the more recent Volkswagen emission scandal which resulted in a record $21 billion fine against the firm because of their attempting to avoid a recall by hiding emission control problems.

product recalls (e.g., Jarrell and Peltzman, 1985; Pruitt and Peterson, 1986; Hoffer, Pruitt, and Reilly, 1988; Barber and Darrough, 1996) show that recalls are significant adverse events in the life of a firm and they impose substantial direct costs such as those associated with repairing, and sometimes replacing, the malfunctioning product. More importantly, the overall costs of a recall are significantly more than just direct costs in that they include penalties imposed by regulating agencies, consequences of lawsuits brought on by the damaged parties, tarnished brand image, and overall reputational costs for the firm.

Prior theoretical work (e.g., Maksimovic and Titman, 1991; Chevalier and Scharfstein, 1996) shows that highly levered firms have distorted incentives that result in the firms underinvesting in product quality improvements. Consistent with this view, recent empirical work by Matsa (2011), Phillips and Sertsios (2013), and Kini, Shenoy, and Subramaniam (2017) shows that highly levered firms have a greater propensity for product and service failures. There is also reason to believe that high leverage impacts the strategic behavior of firms and their rivals and, consequently, has important product market effects. Fudenberg and Tirole (1986), Bolton and Scharfstein (1990), and Phillips (1992) present theoretical models in which high leverage places firms at a competitive disadvantage in the product markets. Consistent with these arguments, Chevalier (1995a, 1995b), Lerner (1995), and Khanna and Tice (2005) empirically show that leverage places a firm at a significant product market disadvantage in the supermarket, disk-drive, and retail industries, respectively.

In analyzing the product market consequences of high leverage, Opler and Titman (1994) show that high debt has a disproportionately negative effect on levered firms' sales, profits, and returns during industry downturns. More directly, Chevalier (1995b) and Phillips (1995) find evidence of predation following highly levered transactions, but only when the rivals are themselves not highly levered, i.e., only when the rivals are financially able to take advantage of the competitor's financial weakness. In a similar vein, Campello (2003) shows that the sales growth of highly levered firms is more adversely impacted during recessions compared to that of their relatively less levered rivals. One inference from these findings is that if there are strategic effects associated with relative leverage as the prior evidence suggests, such effects are especially likely to be important during adverse shocks such as a product recall. In addition, product recalls provide a setting that is particularly conducive to study the strategic effects of leverage because recalls are well-defined quality failure events which can be traced back to a specific announcement date, with material and measurable impact for the recalling firm and its product market rivals.

These features of product recalls enable us to study the variation in wealth effects of the recalling firms, their industry rivals, and key suppliers based on the relative leverage of the recalling firms and the product market environment in which the recalling firms operate. Specifically, we compute measures of relative leverage to test the predictions derived from Bolton and Scharfstein (1990), Phillips (1992, 1995), and Chevalier (1995a, 1995b) that high debt relative to industry rivals is likely to make the firm a weaker competitor in the product market. We argue that the relative leverage variable measures the relative financial strengths of the firm and its rivals. In particular, a high relative leverage for the recalling firm not only captures the potential financial difficulties faced by the firm in its own efforts to recover from the recall, but also captures the ability of its rivals to take advantage of the recalling firm's difficulties by engaging in predatory pricing and market-share enhancing investment policies.[3]

Our initial analysis examines the direct impact of the financial condition of recalling firms relative to their product market rivals on the wealth effects of the recalling firms, rival firms, and key supplier firms. To examine whether the link between the relative financial strengths of the recalling firms and their rivals and the wealth effects of recalls is due to the strategic role of leverage, we repeat the analyses by separating the recall events into two subsamples based on whether the recalling firm is in an industry with high or low entry costs, high or low product substitutability, and has high or low product market risk. The results in Kovenock and Phillips (1997), Lang and Stulz (1992), Chevalier (1995a, 1995b), Lerner (1995), Campello (2003), and Khanna and Tice (2005) indicate that industry rivals undertake strategic actions when the product market structure enables expropriation of value from competitors, that is, when strategic actions

[3] In sharp contrast to the models specified above, Brander and Lewis (1986) and Maksimovic (1988) both show that that increased leverage and financial distress makes firms compete more aggressively in the product market, which is not good news for the firms' rivals. In Brander and Lewis (1986) limited liability emboldens shareholders to be more aggressive, while in Maksimovic (1988) higher likelihood of future distress reduces firms' incentives to collude and, thus, increases incentives to be more aggressive. So, our tests will also be able to empirically distinguish between the two sets of theories on whether high relative leverage makes firms more or less aggressive in the product markets.

are likely to be more effective. If high relative leverage does indeed place a recalling firm at a disadvantage (and the rivals at an advantage) as may be seen from Chevalier (1995a, 1995b) and Phillips (1995), then the link between relative leverage and value consequences will be more apparent in the subsample of firms that operate in industries with low entry costs or high product substitutability or firms with higher product market risk, that is, in environments where firms are likely to face greater competitive threats. In other words, we expect to see the relation between relative leverage and wealth effects to be more discernible in subsamples where strategic effects are likely to be more pronounced.

To conduct the analysis in this paper, we build a comprehensive database of product recalls covering the automobile, food and drug, medical devices, and general consumer product industries. We hand collect data on product recall campaigns announced by publicly traded firms during the 2003–2013 period. Specifically, we collect data on consumer product recalls from the Consumer Product Safety Commission (*CPSC*), food, drug and medical device recalls from the Food and Drug Administration (*FDA*), and automobile recalls from the National Highway Traffic Safety Administration (*NHTSA*). Our final sample comprises of 1,592 recall events included in the regulating agencies' filings and with reliable announcement dates in the financial press.

Our examination of the valuation consequences across our large sample of 1,592 recalls indicates that recalls are material events in the life of the firm – they result in significant value destruction for the shareholders of the recalling firms. Specifically, we find that recalls in our sample are associated with average abnormal returns of –1.08% for the recalling firms over a (–5, +5) day window around the announcement date. In dollar terms this roughly translates into an average loss in value of $325 million to the recalling firms in our sample. In our analysis of wealth effects to rivals and suppliers, we show that rival firms and key supplier firms (suppliers who are heavily dependent on the recalling firm for sales) are negatively impacted by the announcement of a product recall. These effects are more pronounced for longer event windows. This suggests that recall events are, on average, associated with significant contagion effects for both rivals and suppliers.

We examine the drivers of the heterogeneity in recalling firms' stock price reaction around the announcement of recalls. After empirically accounting for the fact that the recall event may be partially anticipated by the market using a variety of econometric techniques, we find that when a firm is relatively more leveraged than its industry rivals, the stock market expects the recalling firm to suffer greater losses, perhaps due to predatory strategic actions taken in response to the recall by its financially less-constrained industry rivals. In our analysis of rival stock price reactions to the product recall, we find that when a recalling firm is relatively more levered than its industry rivals, the rivals benefit more from the recall. This bolsters the argument that there are more predation-related benefits to rivals when they are dealing with a financially vulnerable recalling firm as predicted in Bolton and Scharfstein (1990), Phillips (1992, 1995), and Chevalier (1995a, 1995b), and is consistent with the findings of Opler and Titman (1994) and Campello (2003).

We further explore whether the impact of relative leverage on the wealth effects of product recalls on recalling firms and their industry rival firms differs across strategic and non-strategic environments. Based on prior literature (Karuna, 2007; and Hoberg, Phillips, and Prabhala, 2014), we define firms in industries with low entry costs or high product substitutability, and firms with high product fluidity as firms with high potential for strategic product market interaction. We find that higher relative leverage for recalling firms leads to more negative abnormal returns for recalling firms and more positive abnormal returns for their rival firms only in the strategic environment subsample – that is, only in environments where rivals' predation-related benefits are likely to be high. As a further indication of the importance of relative leverage on the wealth consequences of recalls, we find evidence that key suppliers are worse off when the relative-to-industry leverage of the recalling firm is large – highlighting the negative consequences of relying on a customer firm which is financially weaker than its rivals.

Finally, once we control for the relative leverage of the recalling firm, we find that the rival firms' stock price reaction is positively related to the recalling firm's stock price reaction. Thus, bad news for the recalling firm is viewed in the market as bad news for the rivals too – alluding to contagion effects from the recall. Contagion effects of recalls may arise due to post-recall negative perceptions about the whole product category or due to any costly regulation that affects the entire industry. In a similar vein, after controlling for the adverse effects of high relative leverage of recalling firms, we find that the worse a recall is for the recalling firm, the worse it is for the key suppliers, highlighting the contagion effects for upstream firms. Taken together, the rival and key supplier wealth effects indicate that product recalls have both horizontal (industry-wide) and vertical (supplier) contagion effects.

Our paper makes the following contributions. First, although there are prior papers that have studied wealth effects of product recalls, they are confined to recalls in specific industries like automobiles and pharmaceuticals. In contrast, we analyze recalls of all types of products spread across 101 (37) different three-digit (two-digit) SIC code industries. This allows for more generalizable inferences about the wealth effects of recalls for recalling firms, their industry rivals, and their key suppliers. Second, our examination of the cross-sectional determinants of announcement-period abnormal returns provides insights into whether there are horizontal and vertical contagion effects associated with product recalls. Third, unlike any of the prior research in this area, we focus on the role of relative leverage on the wealth effects of recalls and present evidence that relative financial position of a firm plays an important role in determining the valuation consequences of a recall. Finally, we are able to materially add to the literature on strategic product market competition where firms' relative financial position affects not only the firms' own value, but also those of their rivals. The availability of product recall data across multiple industries enables us to conduct a nuanced analysis of the relation between relative financial condition of firms and the value consequences of recalls. Specifically, we test the contention in the literature that relative financial leverage of firms, and the resulting strategic actions, has an impact on rivals only in certain product market environments. Thus, we provide independent evidence on the relation between capital structure and product markets in an entirely new context.

The remainder of the paper proceeds as follows. Section 2 describes our hypotheses regarding the wealth effects around recalls for the recalling firms, their product market rivals, and key suppliers. In this section, we also highlight the expected relation between relative leverage and the wealth effects of recalls in different product market environments. Section 3 describes our data sources, sample selection criteria, and the salient characteristics of the sample. In Section 4, we empirically examine the relation between relative leverage of the recalling firm and the valuation consequences of the recall for recalling firms, their industry rivals, and their key suppliers. We examine the impact of the product market environment on the relation between relative leverage and the wealth effects of product recalls on recalling firms and their rivals in Section 5. Section 6 concludes the paper.

2. Hypotheses development: Relative leverage, product market environment, and the wealth effects of product recalls

2.1. Wealth effects of recalling firms, industry rival firms, and key supplier firms

Product recalls are costly events in the life of a firm involving both significant direct and indirect costs. The direct costs include costs associated with investigating the product failure and conducting the actual recall (which can include either repairing or replacing the defective product). However, the indirect costs of recalls may be much more than the direct costs. In addition to the reputational damage to the firm, it may also include expected damages from any product liability lawsuits, and costs associated with future changes to the design, sourcing, manufacturing, and packaging processes. If there are any regulatory violations, the costs may further include any anticipated penalties. Therefore, we expect the announcement-period abnormal returns (*Recalling firm CAR*) around product recalls to be significantly negative for the recalling firms (see, e.g., Jarrell and Peltzman, 1985; Pruitt and Peterson (1986); Hoffer, Pruitt, and Reilly, 1988; Barber and Darrough, 1996). Since key suppliers of recalling firms rely on the recalling firms for a significant portion of their business, a disruption in the production process of the recalling firm would cause significant damage to the sales of the suppliers. Therefore, we expect the key supplier wealth effects (*Supplier firms' CAR*) to be negative as well around recalls. A more negative wealth effect for the recalling firm would suggest that the recalling firm's troubles are more significant -- therefore, we would expect a more negative price reaction for the key suppliers as well in those instances. That is, in a regression setting, we expect a positive relation between *Recalling firm CAR* and the *Supplier firms' CAR*.

Product market rivals of recalling firms are exposed to two countervailing effects. The first is the *competitive* effect where product recalls have a negative effect on customer perception about the recalling company's product quality and this shifts demand to the firm's rivals. It is possible that industry rivals are able to exploit the crisis in the recalling firm to their own advantage via predatory pricing, advertising, and investment strategies that enable the rival to extract market share away from the recalling firm. This effect should result in positive announcement-period abnormal returns for the rivals (*Rival firms' CAR*).

The second effect is the *contagion* effect. If the reason for recall is not entirely firm-specific, but has an industry-wide component that may also apply to rival firms' products, then there would be a contagion effect associated with the product recall. This effect would suggest that rival firms will also experience negative announcement-period abnormal returns. Contagion effects of recalls may be in the form of additional direct costs such as packaging restrictions for the whole industry (e.g., the Tylenol recall), or negative perceptions about the whole product category (e.g., SUVs and rollover risk), or fear of other costly miscellaneous regulations that affect the industry as a whole (e.g., toy recalls due to unsafe lead content, battery-related fire hazard in mobile devices, etc.). For instance, following the Tylenol recall in 1982, costly new packaging regulations were introduced for the entire industry. Tylenol lost $2.31 billion in value over a nine-day period following the incident, but the industry as a whole also lost a very significant $8.68 billion – a loss of $310 million for each firm (Dowdell, Govindaraj, and Jain, 1992). Similarly, Crafton, Hoffer, and Reilly (1981) and Reilly and Hoffer (1983) show in their study of automobile recalls that industry rivals that produce similar line of cars suffered sales declines following severe automobile recalls. So, the contagion effect should result in a negative *Rival firms' CAR.*

Since a typical recall event has both competitive benefits and contagion costs to rivals, the observed wealth effect of rivals in a recall is the net consequence of the competitive and contagion effects combined. So, we do not have an *ex ante* prediction about the sign of the announcement-period abnormal returns to rivals. In a regression where *Rival firms' CAR* is the dependent variable and the *Recalling firm CAR* is the independent variable, *Recalling firm CAR* may have a positive or a negative coefficient depending on which of the two effects dominates. We expect the coefficient will be negative if the competitive effects are dominant, while it will be positive if the contagion effects are dominant.

2.2. Relative leverage and the wealth effect of recalls

Prior research has shown that firms with high leverage and those that are financially constrained experience a higher incidence of quality failures such as supermarket stock-out rates (Matsa, 2011), baggage handling failures of airlines (Phillips and Sertsios, 2013), and the overall incidence of product recalls across different types of products (Kini, Shenoy, and Subramaniam, 2017). The implication of these papers is that higher debt increasingly distorts the incentives to invest in product quality improvements, thereby resulting in a greater propensity for product failures. We expect financial constraints to also hinder a firm's recovery following a recall, especially if the firm's product market rivals are relatively less levered. This prediction derives from the strategic effect of debt. Fudenberg and Tirole (1986), Bolton and Scharfstein (1990), and Phillips (1992) present theoretical models in which highly levered firms operating under imperfect competition are at a disadvantage in their product markets.

Empirically, Opler and Titman (1994) show that high debt has a disproportionately negative effect on the levered firms' sales, profits, and returns during industry downturns. In addition, Campello (2003) shows that sales growth of highly levered firms is more adversely impacted during recessions compared to their relatively less levered rivals. Using scanner data of actual product prices, Chevalier (1995a, 1995b) finds that following LBOs in the supermarket industry, non-LBO rivals lower their product prices to prey on the highly levered firms. Subsequently, since the LBO supermarkets are unable to sustain a price war because of their financial condition, they exit the market. Consistent with these findings, she also finds that non-LBO rivals experience a positive stock price reaction to the announcement of LBOs, and that there is more entry into the industry. Lerner (1995) analyzes the disk-drive industry and finds that when undiversified and financially constrained firms launch a product, they are met with aggressive price reductions by their less constrained rivals, pushing the levered firms closer to distress. Similar findings are also in Khanna and Tice (2005) who study price changes in recessions. When high and low debt firms are both present in the same product market, there is more entry into those markets when there are more high debt firms and the price drop causes the high debt firms to exit.

An implication of these findings in our context is that when a firm is faced with a product market crisis such as a product recall, it is likely that the firm's ability to deal with the crisis is a function of its leverage. Additionally, if there are strategic effects associated with relative leverage as the prior evidence indicates, such effects are especially likely to be important during material adverse events such as a product recall. Therefore, the above findings suggest that we should expect recalling firms with high relative leverage to be targets of predation activities by rival firms and consequently suffer more following the recall. Thus, we would expect the *Recalling firm' CAR* to be negatively related to the relative leverage of the firm.

Since product market rivals expect more predation-related gains when the recalling firms have relatively more leverage, we would expect a positive relation between the recalling firm's relative leverage and the *Rival firms' CAR*. And, as key suppliers of the recalling firms are those suppliers who rely on the recalling firm for a substantial portion of their business, we expect the recalling firm's troubles to spillover to the suppliers as well. This is especially so if the recalling firms have high relative leverage and the rivals can steal market share and profitability away from the recalling firm. So, we expect a negative relation between *Supplier firms' CAR* and the relative leverage of the recalling firm.

We should state that the view that high leverage makes firms weaker competitors in the product markets is not unanimous in the theoretical literature. Brander and Lewis (1986) present a model where firms set output quantities to maximize shareholder value. They show that when firms operate under demand uncertainty, shareholders will be unconcerned about states in which the firm is bankrupt (which are also the states with the lowest marginal returns in their model) since shareholders have limited liability. Therefore, the shareholder value maximizing output for the levered firm is higher than that of the unlevered firm, allowing the levered firm to commit to an aggressive stance in the product market. Maksimovic (1988) arrives at the same conclusion that leverage makes firms more aggressive, albeit through a different mechanism. In a repeated game framework with tacit collusion between firms, he argues that collusion – to maintain an accommodating posture in the product market -- is less sustainable if shareholders expect to gain less from it. As leverage increases, so does default likelihood, and given the limited liability of the shareholders their benefits from collusion decreases as well. Thus increased leverage makes firms deviate from collusion, and therefore, be more aggressive in the product market. If, as these latter models suggest, leverage makes firms more aggressive in the product markets then our empirical predictions above will all be reversed. That is, we would expect the *Recalling firm CAR* to be positively related to the relative leverage of the firm, and the *Rival firms' CAR* to be negatively related to the relative leverage of the recalling firm. In addition, we would also expect the *Supplier CAR* to be less negative when the recalling firms are relatively more levered.

2.3. The product market environment and the wealth effects of recalls

We also expect the nature of the product market to play a significant role in the price reaction to the recalls. Theoretical models on the role of debt in product market competition all derive their predictions under the assumption that firms operate in product markets where strategic effects are material. Therefore, we expect relative leverage of recalling firms to be a salient factor in influencing recalling firm and rival wealth effects only in product market environments where the strategic effects of debt are likely to be discernible. Karuna (2007) presents arguments that show that sorting industries based purely on the level of industry concentration is often an incomplete method of classifying industries into those where strategic effects are likely to be present versus those where they are not. Building on arguments in Raith (2003), he suggests that proxies for industry entry costs and product substitutability can help identify industries where strategic effects are likely to be significant. He defines entry costs as the "costs that firms incur in entering an industry," and product substitutability as the "extent to which close substitutes exist for a particular product in an industry." A product market will have greater threat of entry and sustained presence of competition, and hence more room for strategic effects, if either entry costs are low or product substitutability is high.

Hoberg, Phillips, and Prabhala (2014) use textual descriptions of products to capture changes in rival firms' products in relation to a firm's products, to develop a novel metric they term "product market fluidity" to help measure the product market risk faced by a firm. A higher value for the product market fluidity measure will then suggest greater product market risk faced by the firm. The strategic effects of debt are likely to be more significant for recalling firms facing greater product market risk. Thus, if high relative leverage makes a firm a weaker competitor, then we expect relative leverage of recalling firms to be significantly negatively (positively) related to *Recalling firm CAR* (*Rival firms' CAR*) in industries with low entry costs or high product substitutability, and for firms with high product market fluidity. If, on the other hand, high relative leverage makes firms more aggressive in the product market, then the above predictions will reverse.

3. Data sources, sample selection, and salient characteristics

3.1. Data sources and sample selection

We collect data on product recall campaigns announced during the period January 2003 – December 2013 from three U.S. regulatory agencies that govern product quality and safety – *FDA*, *CPSC*, and *NHTSA*.[4] Specifically, we collect information on food, drug, and medical device recalls from the weekly enforcement reports published by the *FDA*. Each recall announcement by the *FDA* contains the name of the firm announcing the recall campaign, the product being recalled, the reason for recall, the recall date, and sometimes, the volume of recall. We collect information on consumer product recalls from *CPSC*. The *CPSC* covers a diverse range of industries such as children's products, household appliances, heating and cooling equipment, home furnishings, toys, nursery products, workshop hardware and tools, yard equipment among others. Finally, we collect information on automobile recalls from the *NHTSA*. Specifically, we collect information on the manufacturer of the product, the product being recalled, the number of units recalled, the reason for recall, and the recall date. Further, to be included in our recall sample, we impose two additional criteria: (i) recalling firms should be publicly traded because we need stock price and other financial information in our analysis and (ii) the recall announcement has to be covered by at least one of the publications or information sources in Factiva.

Table 1 provides a summary of our final sample. It comprises of 1,592 recall events during the 2003–2013 period. Of these, 544 events are automobile recalls from *NHTSA*, 437 are food, drug, and

[4] Our sample of FDA recalls begins in 2004 as data prior to this point in time was unavailable on the FDA recalls database.

medical devices recalls from *FDA*, and 611 are consumer product recalls from *CPSC*. With the exception of 2003, the total number of recalls is roughly evenly spread across the years although there are some clusters within each category in certain years. Our sample consists of recalls spanning a wide range of industries – in fact, covering industries in more than 101 three-digit SIC codes. Table 2 shows the industry break-up of the sample using two-digit SIC codes (37 different industry groups). Transportation Equipment had the most recalls (590) followed by Chemical and Allied Products (178), and Food and Kindred Products (117).[5] Industries such as Textile Mill Products, Primary Metal Industries, Oil and Gas Extraction, Petroleum Refining and Related Products, and Paper and Allied Products had nearly no recalls. Also, service industries such as Transportation Services, Business Services, and Health Services are associated with very few recalls.

3.2. Salient characteristics of product recall firms

Table 3 presents descriptive statistics on the recalling firms. With the exception of the "relative leverage" variables, all the other variables described in the table are the same as those used by Kini, Shenoy, and Subramaniam (2017) to explain the propensity for a product failure. The detailed definitions of these variables are contained in the Appendix. The variables include measures of the financial condition of the firm such as financial leverage based on book values (*Book leverage*) as well as market values (*Market leverage*). The key variables used in our analysis are, however, measures of relative leverage (*Firm-to-industry book leverage* or *Firm-to-industry market leverage*). These variables are computed as the ratio of the leverage measure of the recalling firm to the leverage measure of the recalling firm's industry rivals identified at the three-digit SIC industry level.[6] In addition, the table also includes descriptive statistics on: *Cash flow shock* – the change in the free cash flow of a firm relative to its mean free cash flow over the prior three years normalized by total assets of the firm, *Herfindahl index* – the sales-based Herfindahl index of the recalling firm's three-digit SIC industry, *Unionization* – the percentage of employees in the three-

[5] Note that not all Transportation Equipment industry recalls are associated with NHTSA recalls. Several of these recalls fall under the purview of CPSC.
[6] We exclude the recalling firm when we compute the average industry leverage.

digit SIC industry that are unionized, *Number of suppliers* – the number of actual suppliers used by the recalling firm, *Vertical integration dummy* – a dummy variable that equals one for vertically integrated firms, and zero for non-integrated firms, *R&D intensity* – R&D expenditures over total assets, and *Total factor productivity* – the firm's total factor productivity computed using the methodology in Faleye, Mehrotra, and Morck (2006), and *Size* – the logarithm of market value of equity.

The univariate statistics on the leverage variables (Other variables) for the recalling firms are presented in Panel A (Panel B). In Panel A, the mean (median) *Book leverage* is 0.288 (0.295) and the mean *Market leverage* is 0.313 (0.262). The mean (median) *Firm-to-industry book leverage and Firm-to-industry market leverage* are 1.088 (0.892) and 1.292 (1.085), respectively. Thus, these univariate results are generally consistent with the notion that recalling firms have higher leverage than their industry peer firms.

Further, in Panel B, we find that the mean cash flow shock for recalling firms is negative (–2.5%). The mean *Herfindahl index* of their industry is 0.196, suggesting that they operate in reasonably competitive industries. In addition, 7.8% of the recalling firms are vertically integrated, they have on average about 15 key suppliers, and their mean R&D intensity is 2.9%. Further, their total factor productivity is negative, suggesting that these firms are not using their factors of production (capital and labor) as effectively as their industry peer firms. Finally, 11.07% of the work force of the three-digit industry that the recall firms operate in is unionized.

3.3. Stock price reaction to recall announcements: Recalling firms, industry rival firms, and key supplier firms

3.3.1. Wealth effects for recalling firms

To examine the market reaction to a recall announcement, we compute the announcement-period stock returns over a variety of windows around the first announcement of the product recall. The recall date as reported by the *FDA* and *CPSC* is the date the firm first announces the recall campaign, usually through a press release or correspondence through email or letter. The *NHTSA*, however, reports three different dates related to the campaign: the date a safety issue was reported to *NHTSA* (*report received* *date*), the date of record creation, and the date of owner notification. The date of owner notification is typically several weeks or months after the *report received date*.

To identify the event date to be used in our event study analyses, we search for news articles related to the recall on the Factiva database for each recall identified from the above three sources. In particular, we attempt to find the date of the first news article on Factiva that reports the recall event. For matching our recall events to Factiva, we use the name of the recalling firm, the product being recalled, the reason for the recall, and the quantity of recall. We observe that the recall dates reported on the *CPSC* and *FDA* websites very closely match the date of the first news article in the media. Typically, the date of the first news article as reported in the media fell on the same day as the recall date indicated by the *FDA* and *CPSC*. Therefore, we use the recall dates collected from *CPSC* and *FDA* as the event date in our event study analyses. For the *NHTSA* sample, we find that the date of the first news article on Factiva was close to the *report received date* but was well before the date of owner notification. In fact, in the vast majority of the cases, we find that the date of the first news article is the same as the *report received date*. Hence, for the *NHTSA* sample we use the *report received date* as the event date.[7]

We compute the market model announcement-period abnormal returns (CARs) for a variety of windows including (–2, +2), (–5, +5), and (–10, +10) around event day 0 (the announcement date of the product recall) to estimate the wealth effects of recalls for recalling firms (*Recalling firm CAR*). We use the CRSP value-weighted market index as the proxy for the market portfolio. Our choices of event windows are slightly wider than those seen in event studies of other corporate events, but are consistent with those used in Jarrell and Peltzman (1985) and Hoffer, Pruitt, and Reilly (1988) in their study of product recalls. The reason for the wider windows in a recalls context is that some recall announcements are preceded by

[7] Dasgupta and Xie (2013) argue that firms may have some discretion in the amount of time they take in determining that a safety defect exists. They find that in the case of auto recalls, vehicle manufactures sometimes delay the recall of defective vehicles to avoid bad news prior to their financing activities. However, it should be noted that the discretion that firms have to delay recalls is likely to be limited given there can be severe criminal and civil penalties. One example is the then record fine assessed against Toyota by the NHTSA for not reporting in a timely manner the "floor mat pedal entrapment" problem in their 2010 Lexus RX 350 (see http://www.nhtsa.gov; NHTSA 49-12, December 18, 2012). Another is the more recent Volkswagen emission scandal which resulted in a record $21 billion fine against the firm because of their attempting to avoid a recall by hiding emission control problems.

news reports of accidents and adverse events related to the product use and, consequently, the impending recall may have been effectively "leaked" to the market. So, we study windows ranging from just two days prior to the event and up to ten days prior to the event. In a similar vein, since the extent of the recall-related damage is not always immediately obvious, often even to the firms, we allow for longer post-announcement date windows. Though not tabulated, we also compute the abnormal dollar losses (or gains) as the product of the recalling firm CAR and the market capitalization of the firm's equity before the recall announcement.[8] The announcement-period wealth effects for recalling firms are reported in Column (1) of Table 4.

For the overall sample of all recalls, *Recalling firm CAR* over the (–2, +2), (–5, +5), and (–10, +10) event windows are –0.57%, –1.08%, and –1.47%, respectively. These abnormal returns are statistically significant at the 1% level for each event window, and translate into dollar abnormal returns of –$168.33 million, –$324.57 million, and –$480.51 million over the (–2, +2), (–5, +5), and (–10, +10) event windows, respectively. The magnitudes of the dollar abnormal returns suggest that product recalls are significant economic events in the lives of corporations.[9]

3.3.2. Wealth effects for industry rival firms

In Column (2) of Table 4, we present the stock price reaction of industry rival firms to recall announcements by recalling firms. As we described earlier, we expect two effects to be at play here. The *competitive effect* would result in positive announcement-period abnormal returns for the rivals as they take advantage of the compromised position of the recalling firm. The *contagion effect* arises when the product recall comes with adverse effects for the industry as a whole, such as increased regulatory attention, or negative perception about the whole product category, or newer packaging or other product standards for

[8] For the (–2, +2) and (–5, +5) windows, we use the market capitalization ten days prior to the recall announcement date, while for the (–10, +10) event window we use the market capitalization twenty days prior to the recall announcement date.

[9] The abnormal returns and associated dollar abnormal returns numbers reported for recalling firms in Table 4 understate their true values because the product recall event for a firm is partially anticipated. In our cross-sectional regression analysis of the wealth effects to recalling firms, we also report specifications in which we use anticipation-adjusted abnormal returns as the dependent variable.

all firms in the industry. With the latter, we should observe a negative stock price reaction for the rivals too. If both competitive and contagion effects are in play, then the overall effect on rival firms will depend on which one of these two effects dominates.

To compute the announcement-period abnormal returns for the rivals (*Rival firms' CAR*), we identify rivals as all firms on Compustat that are in the same three-digit SIC code as the recalling firm during the recall year, but have not announced a recall of their own within a 20-day period on either side of the recall announcement. For each firm we then form an equally-weighted portfolio of the firm's rivals to compute the announcement-period abnormal returns over the various event windows using the market model. We use the CRSP value-weighted market portfolio as the proxy for market index. The rival abnormal returns are –0.03%, –0.20%, and –0.40% for the (–2, +2), (–5, +5), (–10, +10) event windows, respectively. With the exception of the smallest event window (–2, +2), the abnormal returns are significantly negative for the longer windows at least at the 5% level. This result is not surprising in light of the evidence in Cohen and Frazzini (2008) who show that there is a delay in the true overall consequence of material information about a firm being incorporated in the stock prices of related third parties such as customers and suppliers. Overall, these results suggest that, on average, the contagion effect dominates the competitive effect, and renders a product recall a negative event for the industry.

3.3.3. Wealth effects for key supplier firms

We also examine the abnormal returns to the key suppliers of the recalling firms. We identify key suppliers by analyzing the Compustat segment tapes of upstream firms. Compustat segment tapes utilize SFAS 14 and SFAS 131 guidelines, which requires public firms to report "key customers" that account for at least 10% of the firm's annual sales. This database, however, only lists customer names and does not have an identifier enabling an easy merge with Compustat. Using a combination of automated and hand-matching techniques, we construct a supplier-customer database for each year in our sample. Using this database, we identify the key suppliers of the recalling firms in the two years prior to the recall. For each recalling firm, we then form an equally-weighted portfolio of the firm's key suppliers to compute the announcement-period abnormal returns (*Supplier firms' CAR*) over the various event windows again using the market model. We expect the product recall to have a significant negative impact on the firm's key suppliers since these firms are largely dependent on sales to the recalling firms. Although suppliers who provide relatively non-specialized inputs may be able to re-tool and supply to the recalling firm's rivals, given the generally negative impact of the recall on industry rivals, we expect this possibility to not significantly offset the first-order negative impact of the recall on suppliers.

The abnormal returns upon recall announcements for key suppliers of the recalling firm are reported in Column (3) of Table 4. We observe significant negative abnormal returns for key suppliers of recalling firms in all the event windows. For example, the announcement-period abnormal returns are -0.44%, –0.73% and –1.30% in the (-2, +2), (–5, +5) and (–10, +10) event windows, respectively. All these abnormal returns are statistically significant at the 1% level. These results are consistent with the view that product recalls do have a significant negative impact on the demand for the products of upstream firms (key suppliers). Hertzel, Li, Officer, and Rodgers (2008) find similar vertical contagion effects following corporate bankruptcy events.

4. The relation between relative leverage and the wealth effects of recalling, industry rival firms, and key supplier firms around recall announcements

In this section, we will examine the effect of relative leverage, i.e., firm-to-industry leverage, on the wealth effects of product recalls on recalling firms, industry rival firms, and key supplier firms in a multivariate setting.

4.1. Wealth effects of product recall firms and relative leverage

Following the arguments set out in Section 2.2 we expect the relative leverage of a recalling firm to capture not only the financial weakness of the firm, but also the financial strength of the rivals to take advantage of the crisis by engaging in pricing policies or other strategic actions that would steal market share away from the recalling firm. If high relative leverage is indeed a disadvantage to firms, then we expect that the higher the relative leverage of the recalling firm vis-à-vis its industry rival, the more adverse will be its stock price reaction to recall announcements. Therefore, in the regressions explaining the announcement-period wealth effects of recalls to the recalling firms and those of their rivals and suppliers, we use the ratio of recalling firm leverage to the industry average leverage (either *Firm-to-industry book leverage* or *Firm-to-industry market leverage*) as our primary metric to capture the leverage effects. We use a dummy variable to indicate whether a recall by the firm is the first occurrence of a recall by the firm in our sample (*Initial Recall Dummy*) as a way to control for any incremental reputational effects (either more or less negative) that may be associated with an initial recall. We also control for firm size in all the regressions.

The results from this analysis for recalling firms are reported in Table 5. In this table, we report the results for three pairs of regression models. In each pair, the first model (Models 1, 3, and 5) uses *Firm-to-industry book leverage*, while the second model (Models 2, 4, and 6) uses *Firm-to-industry market leverage* as the measure of relative leverage. Further, all reported regressions are estimated using weighted least squares regressions, where the weights are the inverse of the standard deviation of market model residuals. The three pairs of regression models also differ in the choice of dependent variable. In the first pair, the dependent variable is *Recalling firm CAR* measured over the (-2, +2) days event window. The coefficients associated with *Firm-to-industry book leverage* (Model 1) and *Firm-to-industry market leverage* (Model 2) are negative and statistically significant at the 1% level.

To the extent that the market can partially anticipate the recall event, *Recalling firm CAR* may not completely capture the wealth effects of the product recall. In our empirical tests we also attempt to control, in two different ways, for the possibility that the recall event is partially anticipated. Both these approaches involve initially modeling the propensity for a product recall using a probit regression model. In the first approach (Models 3 and 4), we control for the propensity of a product recall and, therefore, for the fact that the recall is partially anticipated by the market, by including the inverse Mills ratio in the wealth effects regression. Note that under this approach, *Recalling firm CAR* continues to be the dependent variable in the reported regression models. What we are effectively employing here is a two-stage Heckman selection model. In the first stage, we model the propensity of a product recall while, in the second stage, we model the determinants of the stock price reaction to recalling firms.[10] In the second approach (Models 5 and 6), our dependent variable is *Adjusted Recalling firm CAR*, which is computed as *Recalling firm CAR* divided by (1 – the probability of a product recall), where the probability of a recall is estimated as before using the probit regression. By making this adjustment, we are attempting to capture the wealth effect of a product recall as if it is completely unanticipated.[11]

The control firms used in the first-stage regression model that examines the propensity for a recall are firms that belong to the same three-digit SIC industry as the recalling firm provided they did not have a recall during 2003 – 2013. We follow Kini, Shenoy, and Subramaniam (2017) by using *Market leverage*, *Cash flow shock*, *Unionization*, *Number of suppliers*, *Vertical integration dummy*, *Herfindahl index*, *Total factor productivity*, *R&D intensity*, *Size*, year dummies, and industry dummies as explanatory variables. As an additional control variable in the first stage of the Heckman selection model, for each firm-year in the model we include the proportion of firms in the industry with a recall in that year (excluding the recalling firm). We believe that this variable will be highly correlated with the likelihood of the firm having a recall since we expect to see a higher likelihood of a recall in recall-intensive industries. However, since the proportion of firms with recalls in the industry is likely a function of the regulatory environment or the nature of product, there is little reason to believe that this industry level variable will be directly related to firm-level outcomes such as the announcement-period abnormal returns (other than through its effect on the likelihood of the recall modeled in the first stage).

Our results for the first-stage regression are reported in Appendix Table 1. These results are similar to those reported in Kini, Shenoy, and Subramaniam (2017) and indicate that higher leverage, unionization, number of suppliers, firm size, and industry concentration significantly increase the propensity for a product

[10] See, for example, Cornett, Tanyeri, and Tehranian (2011) and Kale, Kini, and Payne (2012) for papers in financial economics that use this approach to control for partial anticipation of an event on wealth effects. Cornett, Tanyeri, and Tehranian (2011) provide a detailed discussion regarding the efficacy of this approach.

[11] Variants of this approach have also been widely used to control for anticipation in assessing the impact of a corporate event on stock prices. For example, Malatesta and Thompson (1985), Krishnaswami and Subramaniam (1999), Leuz, Triantis, and Wang (2008), and Kale, Kini, and Payne (2012) use this approach in investigating the value impact of acquisition, spin-off, voluntary SEC deregistration, and dividend initiation decisions, respectively.

recall, while higher R&D intensity significantly reduces the propensity for a product recall. Further, the coefficient on the proportion of recalling firms in the industry is significantly positive at the 1% level, thereby indicating that a firm is more likely to have a product recall if a higher proportion of industry peer firms have had recalls in the past.

In Models 3 and 4 of Table 5, we control for anticipation effects by including the inverse Mills from the above first-stage probit model in our second-stage regression models with *Recalling firm CAR* as the dependent variable. The relation between *Recalling firm CAR* and *Firm-to-industry book leverage* (*Firm-to-industry market leverage*) in Model 3 (Model 4) remains significantly negative at the 1% level of significance. In Models 5 and 6, we control for anticipation effects by using an *anticipation-adjusted wealth effects measure* (*Adjusted Recalling firm CAR*) as the dependent variable. This variable is computed as *Recalling firm CAR* divided by (1–the probability of the product recall), where the probability of the product recall is obtained from the above first-stage probit model. In both Models 5 and 6, we find that the relation between *Adjusted Recalling firm CAR* and the specific measure of relative leverage continues to be significantly negative at the 1% level of significance. These results are consistent with the view that recalling firms with higher relative leverage are more likely to be placed at a competitive disadvantage vis-à-vis their rivals because rival firms can more easily take strategic actions to exploit the weakness of the recalling firm. These results are inconsistent with the theories that argue that leverage makes firms aggressive in the product markets.

4.2. Relative leverage and the wealth effects of industry rival firms

In this section, we undertake an analysis of the wealth effects of product recalls on the firm's rivals. We estimate weighted least squares regressions to explain the announcement-period abnormal returns of rivals (*Rival firms' CAR*) using factors we expect can affect the returns in a multivariate setting. We report three pairs of regression specifications in Table 6; with abnormal returns to the rivals measured over the (–2, +2), (–5, +5) window, and (–10, +10) window in the first, second, and third pair of regressions, respectively. The reason for our considering longer windows arises from the findings in Cohen and Frazzini (2008) who analyze the stock prices of economically related firms, such as those of the principal customers of firms. They show that there is a delay in the true overall consequence of material information about a firm being incorporated in the stock prices of related third parties. We, therefore, consider longer windows in all rival and supplier regressions.

In the estimated regressions, we examine whether the financial position of the recalling firm has any value consequences for the rival firms. As described in the previous section, we use the variables *Firm-to-industry book leverage* (odd numbered models) *and Firm-to-industry market leverage* (even numbered models) to capture the relative strengths of the recalling firms and their industry rivals and examine their impact on any predation effects. We expect that when recalling firms are financially weak relative to their rivals, the rivals will benefit more from the recall since predation of such recalling firms and appropriation of their sales by these rivals is easier following the recalls. Thus, we expect *Firm-to-industry book leverage* and *Firm-to-industry market leverage* measures to have a positive coefficient. We use *Size* and *Initial recall dummy* as control variables in our regressions.

The results in Table 6 indicate that the coefficient associated with *Firm-to-industry book leverage* and *Firm-to-industry market leverage* are positive in all six estimated regressions. However, only *Firm-to-industry market leverage* is statistically significant in all the regressions that include it as an independent variable. The coefficient of *Firm-to-industry book leverage* always has a positive sign, but is statistically significant at the 10% level in only one of the regressions across all three windows. These results are broadly consistent with the view that rival firms stand to gain more in a recall when the recalling firms are relatively more highly levered than their industry counterparts, i.e., when recalling firms are more vulnerable to strategic actions like predation taken by rivals following the recall crisis. This result complements the finding in our previous table that the market expects recalling firms that are financially weaker compared to their rivals to lose more following recalls.

In addition to the leverage-related competitive effects that are beneficial to rivals firms, it is possible that there are adverse consequences to the rivals due to the contagion effect. If the contagion effect is strong, then a product recall that is bad news for the recalling firm will also be bad news for the rivals. If there are any contagion effects, we should see a positive relation between *Recalling firm CAR* and *Rival firms' CAR* after controlling for relative leverage. The results in Table 6 indicate that *Recalling firm CAR* is positively related to *Rival firms' CAR* in all six estimated regression models. The coefficient associated with *Recalling firm CAR* is significantly positive at the 1% levels in all estimated models that use the longer (–5, +5) and the (–10, +10) announcement-period windows. These results are consistent with the view that there are contagion effects in product recalls.[12] Overall, our results are consistent with the view that rival firms are in a better position to take advantage of the fallout from the product recall event for the recalling firm if the recalling firm has higher relative leverage.

4.3. Relative leverage and the wealth effects of key supplier firms

In this section, we examine the determinants of the wealth effects of key supplier firms (*Supplier firms' CAR*) to announcements of the product recall by a given firm. We again estimate weighted least squares regressions to explain the announcement-period abnormal returns of key suppliers using factors we expect can affect these returns in a multivariate setting. The results are reported in Table 7. The format of the table is the same as in Table 6.

We expect that the more financially weak the recalling firm is relative to its industry peers, the lower is its flexibility and ability to deal with the recall event, and greater are the benefits to its rivals. As a consequence, the firm's key suppliers will also be affected by their inability to fully deal with the aftermath of the product recall. We, therefore, hypothesize that there should be a negative relation between the abnormal returns to the key supplier firms and relative leverage of the recalling firm. Further, if the key suppliers themselves are highly levered, then a negative shock like a product recall to an important customer should have a greater adverse impact on their own ability to deal with and manage this event. Thus, we expect a negative relation between the abnormal returns to key supplier firms and their own leverage.

[12] Since *Recalling firm CAR* is related to the relative leverage measures, we estimate two additional specifications for each of the six regressions in Table 6. In the first specification we orthogonalize *Recalling firm CAR* by removing the component in the variable that is related to the relative leverage measures and use the *Orthogonalized CAR* as the independent variable in place of *Recalling firm CAR*. In the second specification, we drop *Recalling firm CAR* and only include the relative leverage measures along with the control variables in explaining *Rival firms' CAR*. In both sets of regressions, all the results are qualitatively similar to the results in Table 6. Due to space considerations, we do not tabulate these robustness tests in the paper.

R&D intensity has been used in the product markets literature as a proxy for relationship-specific investments (e.g., Allen and Phillips, 2000; Fee, Hadlock, and Thomas, 2006; Kale and Shahrur, 2007; and Jain, Kini, and Shenoy, 2011). Thus, if the recalling firm's key suppliers have greater *R&D intensity*, then it is likely that they have invested heavily in investments that are specific to the recalling (key customer) firm. Therefore, if a negative event like a product recall affects an important customer firm, then switching to a rival is costly for the key supplier due to these relationship-specific investments. The inability to easily switch customers due to these investments implies that any negative shock to an important customer firm will adversely affect key suppliers too. This leads to the prediction that the announcement-period abnormal returns of key supplier firms will be negatively related to their R&D intensity. As in Tables 5 and 6, *Initial recall dummy* and *Size* are control variables in Table 7 as well.

We find generally consistent evidence of a significantly negative relation between key suppliers' abnormal returns and relative leverage. Specifically, the coefficient associated with the specific measure of relative leverage is always in the correct direction (negative), and is significant at least at the 10% level in 5 out of the 6 models and at the 1% level in 3 out of 6 models. These results are consistent with the view that if the recalling firm is at a relative disadvantage compared to its rivals, then that represents more bad news for the suppliers of the recalling firm. The coefficient associated with *Supplier leverage* is always negative as predicted, but is never statistically significant at conventional levels. The coefficient on *Supplier R&D intensity* is insignificant in all models.

Finally, we include the recalling firm's abnormal returns as one of the determinants of suppliers' abnormal returns. Including this variable allows us to test whether there are vertical contagion effects. If there is vertical contagion, then there should be a positive relation between the abnormal returns to the key suppliers and the abnormal returns to the recalling firm, i.e. key supplier firms' losses are larger when the recalling firm's losses are higher. We find that the coefficient on the abnormal returns to the recalling firms is significantly positive at the 1% level in all six estimated models, which is consistent with the view that suppliers suffer more when recalling firms' losses are greater.[13]

5. The effect of relative leverage on the value impact of product recalls: The role of the nature of product markets

We had earlier hypothesized that we expect relative leverage of recalling firms to be a significant determinant of recalling firm and rival wealth effects only in economic environments where the strategic effects of debt are likely to be more important, i.e., when industry entry costs are low, or when the industry is characterized by high product substitutability, or if the firm faces greater product market risk. The proxies for industry product substitutability (*Differentiated*) and industry entry costs (*Entry Cost*) are constructed based on the methodology outlined in Karuna (2007). He defines product substitutability as the "extent to which close substitutes exist for a particular product in an industry," and entry costs as the "costs that firms incur in entering an industry." In particular, we compute *Differentiated* as sales over operating costs for each three-digit SIC industry-year based on business segments within a firm. A higher ratio would imply more differentiated products in the industry and, therefore, less industry product substitutability. In addition, we compute industry entry costs (*Entry Cost*) as the natural logarithm of the weighted average of the gross value of property, plant and equipment for each three-digit SIC industry-year based on business segments within a firm. A higher value for this measure of industry entry costs would imply greater barriers to entry. Finally, we use a novel metric termed "product market fluidity" developed by Hoberg, Phillips, and Prabhala (2014) to capture the product market risk faced by a firm. This construct uses textual descriptions of products to capture changes in rival firms' products in relation to the firm's products and, thus, captures competitive threats faced by a firm. A higher value for this product market fluidity measure will then suggest greater product market risk (*PM Risk*) faced by the firm. We provided a detailed description of the

[13] Similar to the robustness tests for the determinants of *Rival firms' CAR*, we conduct equivalent robustness tests for the *Supplier firms' CAR* as well in Table 7. That is, since *Recalling firm CAR* is related to the relative leverage measures, we estimate two additional specifications for each of the six regressions in Table 7. As before, in the first specification we orthogonalize *Recalling firm CAR* by removing the component in the variable that is related to the relative leverage measures and use the *Orthogonalized CAR* as the independent variable in place of *Recalling firm CAR*. In the second specification, we drop *Recalling firm CAR* and only include the relative leverage measures along with the control variables in explaining *Supplier firms' CAR*. In both sets of regressions, all the results are qualitatively similar to the results in Table 7. Due to space considerations, we do not tabulate these robustness tests in the paper.

construction of all three measures of product market competitiveness in the Appendix.

We examine the relation between the announcement-period wealth effects for recalling firms and relative leverage for sub-samples of recalling firms based on *Entry Cost* (Table 8), *Differentiated* (Table 9), and *PM Risk* (Table 10). The structure of all three tables is the same. Specifically, we sub-divide recalling firms into terciles based on each of the above measures and then estimate regressions separately for recalling firms in the top tercile and the bottom tercile of the measure. In each table, odd (even) numbered models contain the regression results for the sub-sample of recalling firms in the top (bottom) tercile of the measure. In addition, in all three tables, the dependent variable is *Recalling firm CAR* in Models 1–4 and *Adjusted Recalling firm CAR* in Models 5–8, both measured over the (–2, +2) days announcement-period event window. Finally, the relative leverage measure is *Firm-to-industry book leverage* in Models 1, 2, 5, and 6 and *Firm-to-industry market leverage* in Models 3, 4, 7, and 8.

In Table 8, we find that the coefficients associated with our two relative leverage measures are significantly negative *only* in the low *Entry Cost* sub-sample. Specifically, *Firm-to-industry book leverage* is significant at the 10% (1%) level in Model 2 (6), while *Firm-to-industry market leverage* is significant at the 1% (1%) level in Model 4 (8). In Table 9, we find that the coefficients associated with our two relative leverage measures are significantly negative (all at the 1% level) *only* in the low *Differentiated* sub-sample. Finally, in Table 10, the coefficients associated with our relative leverage measures are significantly negative (all at the 1% level) only in the high *PM Risk* sub-sample. Overall, even though relative leverage of the recalling firm is significantly negatively related to the announcement period wealth effects of recalling firms for the full sample of recalls (Table 5), the results in Tables 8, 9, and 10 indicate that this effect is confined only to the subsample of firms in industries with low entry costs, low product differentiation, and firms with high product market risk (fluidity). Thus, the results are consistent with the theoretical predictions that the relative leverage of recalling firms has an adverse impact on the announcement-period wealth effects of recalling firms only in economic environments where the strategic effects of debt are likely to be more important.

We examine the relation between the announcement-period wealth effects for industry rival firms and relative leverage of recalling firms for sub-samples of recalling firms based on *Entry Cost* (Table 11), *Differentiated* (Table 12), and *PM Risk* (Table 13). The structure of all three tables is the same. As before, we sub-divide recalling firms into terciles based on each measure (*Entry Cost*, *Differentiated*, and *PM Risk*) and then estimate regressions separately for recalling firms in the top tercile and the bottom tercile of the measure. The dependent variable in all estimated regression models in these tables is *Rival firms' CAR* measured over the (–2, +2), (–5, +5), and (–10, +10) days announcement-period event window in Panel A, Panel B, and Panel C, respectively. In each panel, the relative leverage measure is *Firm-to-industry book leverage* in Models 1 and 2 and *Firm-to-industry market leverage* in Models 3 and 4.

In Table 11, we find that the coefficients associated with our two relative leverage measures are consistently positive *only* in the low *Entry Cost* sub-sample. Specifically, *Firm-to-industry book leverage* is significantly positive at the 5% level in Model 2 (low *Entry Cost* sub-sample) in Panels B and C, while *Firm-to-industry market leverage* is significant at the 1% level in Model 4 (low *Entry Cost* sub-sample) in Panels B and C, and at the 5% level in Panel A. In Table 12, we find that the coefficients associated with our two relative leverage measures are consistently positive in all the regressions estimated for the low *Differentiated* sub-sample (significantly different from zero at least at the 10% level in four of the six reported regressions for this sub-sample). In contrast, the coefficients associated with our relative leverage measures are only significantly positive (at the 10% level) in one out of the six reported regressions for the high *Differentiated* sub-sample. Finally, in Table 13, the coefficients associated with our relative leverage measures are consistently positive in the high *PM Risk* sub-sample (significantly different from zero at least at the 10% level in five of the six reported regressions for this sub-sample). Consistent with the findings in Cohen and Frazzini (2008) of a delayed market reaction of material events for focal firms on their related supply chain firms due to the information and time it may take to assess the full impact of the event on related third parties, we find that the above reported results tend to get stronger for the longer event windows. Again, in line with theoretical predictions, we find that the relative leverage of recalling firms has a positive impact on the announcement-period wealth effects for industry rival firms only in economic environments where rivals' predation-related benefits are likely to be high.

In summary, our findings show that both our main results – (i) a significant negative relation between recalling firm's relative leverage and wealth effects to the recalling firms and (ii) a significant positive relation between recalling firm's relative leverage and wealth effects to industry rivals – are confined to economic environments where theory predicts the strategic effects of debt are likely to be more important (low industry entry costs, high product substitutability, and greater product market risk). As such, these sub-sample results also provide support for a causal relation between relative leverage and value effects because it is unlikely that a spurious correlation is also selectively present for firms that are predicted by theory to be more adversely affected by higher relative leverage (recalling firms operating in economic environments where strategic effects of debt are likely to be present) *and* more favorably affected by higher relative leverage (industry rival firms of recalling firms operating in economic environments where strategic effects of debt are likely to be present).

6. Summary and conclusions

Prior research has shown that product recalls are material events in the life of a firm and they result in significant negative wealth effects for the recalling firm. In this paper we study the role of relative financial strength of a firm compared to its industry rivals on the wealth effects of firms undergoing product recalls, their industry rival firms, and their key supplier firms. We examine whether a firm being relatively highly levered compared to its industry rivals places the recalling firm at a greater competitive disadvantage. We also examine whether the competitive disadvantages of high relative leverage are exacerbated under certain product market environments for recalling firms.

We find that announcements of products recalls are associated with negative wealth effects for recalling firms. Further, we find a negative relation between the announcement-period wealth effects of recalling firms and relative leverage. This result is consistent with the view that the market expects recalling firms with higher relative leverage to suffer greater losses, perhaps due to predatory strategic actions taken in response to the recall by its financially less-constrained industry rivals. Further, we find that rivals benefit more from the recall when the recalling firm's relative leverage is higher. This is consistent with the view that there are more predation-related benefits to rivals when they are dealing with financially vulnerable recalling firms. When analyzing supplier firms' stock price reaction to the product recall, we find evidence that the suppliers are worse off when relative leverage of recalling firms is larger – highlighting the negative consequences of relying on customer firms which are financially weaker than their rivals.

We find that a higher relative leverage leads to more negative wealth effects for recalling firms and more positive wealth effects for their rivals only in economic environments where entry costs are low, product substitutability is high, or when firms face higher product market risk. These results suggest that firms experiencing product failures are vulnerable to strategic responses by industry rivals when their relative leverage is high, especially when the recalling firms operate in environments involving significant competitive threats.

Finally, once we control for the relative leverage of the recalling firm, we find evidence that the stock price reaction of industry rival firms and key supplier firms are positively related to the recalling firm's stock price reaction. Thus, bad news for the recalling firm is viewed in the market as bad news for the rivals and suppliers – alluding to negative spillover effects from the recall. These results indicate that product recalls have both horizontal (industry-wide) and vertical (supplier) contagion effects.

Our paper makes the following contributions. First, given the sample is large and is from over a 100 different 3-digit SIC code industries, we are able to provide generalizable inferences about the wealth effects of recalls for recalling firms, their industry rivals, and their key suppliers. Second, we show evidence of horizontal and vertical contagion effects associated with product recalls. Third, our paper is the first study to provide evidence that the relative financial position of a firm plays a key role in determining the valuation consequences of a recall. Finally, the availability of product recalls data across multiple industries enables us to test the contention that relative financial leverage influences strategic actions of firms only in certain product market environments. We, thus, show that firm capital structure and product market decisions are interrelated in an entirely new setting compared to what has been documented in prior studies.

Appendix

This appendix provides details on the construction of variables used in the paper.

I. Determinants of recall incidence

a. *Book* (*market*) *leverage*

Book leverage is the sum of the long-term debt and debt in current liabilities (Compustat item *DLTT* + Compustat item *DLC*) divided by total assets (Compustat item *AT*) for the year prior to the year of announcement. For *Market leverage*, we divide the numerator by the sum of the book value of debt (Compustat item *DLTT* + Compustat item *DLC*) and market value of equity (Compustat item *CSHO* x Compustat item *PRCC_F*) for the year prior to the announcement year.

b. *Herfindahl index*

The Compustat sales-based Herfindahl index for the primary three-digit SIC industry of the recalling (control) firm for the year prior to the year of recall announcement.

c. Unionization

It is the rate of unionization for the primary three-digit SIC industry of the recalling (control) firm for the year prior to the year of the recall announcement. The rates of unionization are obtained from *Union Stats* website available at http://www.unionstats.com.

d. Number of suppliers

Number of Suppliers is the number of key suppliers of the firm as identified in the Compustat segment tapes. FASB requires that firms report the names of customers that account for at least 10% of their sales and this information is available on the Compustat database. We use this Compustat data to identify the suppliers for all firms in Compustat database. Using this data, we then generate the number of suppliers for our sample firms for the year prior to the year of announcement.

e. Vertical integration dummy

Vertical integration dummy is an indicator variable that is set to 1 if any segment of the firm belongs to an industry that sources 5% or more of its inputs from another industry in which the firm also has a segment. Segment level information is obtained from Compustat segment tapes. To identify vertical relatedness between sample industries, we use the 2002 benchmark input-output tables of the U.S. economy published by the Bureau of Economic Analysis.

f. R&D intensity

It is measured as the ratio of the research & development expenditure (Compustat item *XRD*) to total assets (Compustat item *AT*). All Compustat items are measured for the year prior to year of recall announcement.

g. Total factor productivity

To calculate total factor productivity, we follow the methodology in Faleye, Mehrotra, and Morck (2006). In particular, for each two-digit SIC industry group, we regress the natural logarithm of firm sales (Compustat item *REVT*) on the natural logarithm of number of employees (Compustat item *EMP*) and the natural logarithm of net property, plant, and equipment (Compustat data item *PPENT*). *TFP* is measured as the residual from this regression for the primary two-digit SIC industry group of the firm.

h. Size

It is the logarithm of the market value of equity for the recalling firm.

II. Additional variables influencing the wealth effects of recalling firms, industry rivals, and key suppliers

a. Firm-to-industry book (market) leverage

Firm-to-industry book leverage is the ratio of the book leverage of the recalling firm to the book leverage of the recalling firm's industry peers. In a similar fashion, *Firm-to-industry market leverage* is the ratio of market leverage of the recalling firm to the market leverage of the industry peers. In both measures, the recalling firm itself is not considered in computing the measure for the industry peers.

b. Initial recall dummy

It is a dummy variable that is set to 1 for a recall event that is the first one for a firm during our sample period. All subsequent recalls by a firm are coded as 0.

III. Variables capturing product market competitiveness

a. Differentiated

Differentiated is computed as the sales over operating costs for each three-digit SIC industry-year. As per Karuna (2007), we use Compustat segment data to identify different industry segments of a firm in a year. Operating costs include cost of goods sold (Compustat COGSS), selling, general, and administrative expense (Compustat XSGAS), and depreciation, depletion, and amortization (Compustat DPS). Segment level sales are measured using Compustat item SALES.

b. Entry Cost

Entry Cost is calculated as the natural logarithm of the CPI adjusted weighted average of the gross value of cost of property, plant and equipment for firms in the three-digit SIC industry. Consistent with Karuna (2007), we use Compustat segment data to identify different industry segments of a firm in a year. Property, plant and equipment are measured based on Compustat item PPENTS. The weight is calculated based on the market share of the segment within its industry; market shares are based on Compustat item SALES.

c. PM Risk

PM Risk is the product market fluidity measure developed in Hoberg, Phillips, and Prabhala (2014). This construct uses textual descriptions of a firm's products to capture changes in rival firms' products in relation to the firm's products.

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Table 1

Frequency of recall events

This table presents the frequency of recall events by public firms during our sample period of 2003 – 2013. The table reports recalls in the food, drug, and medical device industries covered by the Food and Drug Administration (*FDA*), the Consumer Product Safety Commission (*CPSC*), and the National Highway Traffic Safety Administration (*NHTSA*).

	Number of observations			
Year of recall	*NHTSA*	*FDA*	*CPSC*	Overall
2003	53	0	10	63
2004	102	13	63	178
2005	58	8	86	152
2006	39	53	63	155
2007	30	59	91	180
2008	20	63	56	139
2009	15	88	46	149
2010	32	92	53	177
2011	63	23	59	145
2012	71	16	39	126
2013	61	22	45	128
Total	544	437	611	1,592

Table 2

Industries covered in recall sample

This table presents the different two-digit SIC industries covered in our recall sample and the number of recalls under each two-digit SIC industry. The sample period is 2003 – 2013. The table includes recalls covered by the Consumer Product Safety Commission (*CPSC*), National Highway Traffic Safety Administration (*NHTSA*), and Food and Drug Administration (*FDA*).

Two-digit SIC	Description of industry	Number of recalls
1	Agricultural Production Crops	8
2	Agriculture production livestock and animal specialties	3
13	Oil and gas extraction	1
20	Food And Kindred Products	117
22	Textile Mill Products	1
23	Apparel And Other Finished Products Made From Fabrics	13
24	Lumber And Wood Products, Except Furniture	2
25	Furniture And Fixtures	13
26	Paper And Allied Products	2
27	Printing, Publishing, And Allied Industries	4
28	Chemicals And Allied Products	178
29	Petroleum Refining And Related Industries	1
30	Rubber And Miscellaneous Plastics Products	14
31	Leather And Leather Products	6
32	Stone, Clay, Glass, And Concrete Products	4
33	Primary Metal Industries	1
34	Fabricated Metal Products, Except Machinery And Transportation Equipment	19
35	Industrial And Commercial Machinery And Computer Equipment	100
36	Electronic & Other Electrical Equipment And Components, Except Computer Equipment	64
37	Transportation Equipment	590
38	Measuring, Analyzing, And Controlling Instruments	91
39	Miscellaneous Manufacturing Industries	51
47	Transportation Services	3
48	Communications	7
50	Wholesale Trade-durable Goods	4
51	Wholesale Trade-non-durable Goods	6
52	Building Materials, Hardware, Garden Supply, And Mobile Home Dealers	4
53	General Merchandise Stores	100
54	Food Stores	46
55	Automotive Dealers And Gasoline Service Stations	4
56	Apparel And Accessory Stores	24
57	Home Furniture, Furnishings, And Equipment Stores	41
58	Eating And Drinking Places	11
59	Miscellaneous Retail	20
73	Business Services	2
80	Health Services	5
99	Non-classifiable Establishments	32

Table 3

Descriptive statistics on product recall firms

This table presents descriptive statistics for recalling firms. The sample period is 2003 – 2013 and contains recalls covered by the Consumer Product Safety Commission (*CPSC*), National Highway Traffic Safety Administration (*NHTSA*), and Food and Drug Administration (*FDA*). *Book (Market) leverage* is the book (market) value of debt divided by total assets. The recalling firm is not considered in computing the industry level measures of leverage. *Herfindahl Index* is the sales-based Herfindahl index of the three-digit SIC industry of the firm. *Unionization* is the fraction of employees in the industry that are unionized. *Number of Suppliers* is the number of key suppliers of the firm as identified in the Compustat segment tapes. *Vertical integration dummy* is an indicator variable that is set to 1 if any two segments of the firm share a vertical relation of 5% or more, and 0 otherwise based on the benchmark input-output tables of the U.S. economy. *R&D intensity* is the research & development expenditure (XRD) divided by book value of assets (AT). *Total factor productivity* is calculated as the residual from a regression of logarithm of firm sales on the logarithm of number of employees and logarithm of property, plant, and equipment where regressions are run by two-digit SIC industry and year. *Size* is the logarithm of the market value of equity for the recalling firm.

Panel A: Leverage-related variables

Variable name	N	Mean	Median	Std. Dev.
Book leverage	1,592	0.288	0.295	0.172
Market leverage	1,592	0.313	0.262	0.250
Firm-to-industry book leverage	1,591	1.088	0.892	1.440
Firm-to-industry market leverage	1,591	1.292	1.085	1.493

Panel B: Other firm and industry variables

Variable name	N	Mean	Median	Std. Dev.
Entry Cost	1560	5.56	6.381	2.294
Differentiated	1559	6.42	4.48	5.8987
PM Risk	1154	5.64	4.705	3.4912
Cash flow shock	1,578	-0.025	0.002	0.233
Herfindahl index	1,592	0.196	0.125	0.155
Unionization	1,592	0.131	0.103	0.108
Number of suppliers	1,592	15.090	4.000	26.563
Vertical integration dummy	1,553	0.078	0.000	0.268
R&D intensity	1,592	0.029	0.025	0.033
Total factor productivity	1,574	-0.137	-0.172	0.513
Size	1,592	9.409	9.908	1.831

Table 4

Announcement-period wealth effects for recalling firms

This table presents the announcement-period wealth effects of the recall events for the recalling firms (*Recalling firm CAR*), industry rival firms (*Rival firms' CAR*), and key supplier firms of recalling firms (*Supplier firms' CAR*). The sample period is 2003 – 2013 and contains recalls covered by the Consumer Product Safety Commission (*CPSC*), National Highway Traffic Safety Administration (*NHTSA*), and Food and Drug Administration (*FDA*). Rival firms are identified based on the three-digit SIC code of the recalling firm. Any firm on the Compustat database with the same three-digit SIC code as the recalling firm during the recall year is considered a rival firm except if it announced its own product recall during the event window. Key suppliers of the recalling firms are found from the Compustat database based on the FASB No.14 requirement for firms to report customers that account for at least 10% of sales. *CAR* (%) is the average cumulative abnormal return for the over the event window. The rival portfolio and key supplier portfolio returns are calculated as equally weighted returns for the (-2, +2), (-5, +5), and (-10, +10) trading day windows around the recall announcement date. Z statistics are used to test if the mean cumulative abnormal returns are statistically different from zero and are provided in the parentheses. N is the number of recall events or portfolios of rivals/ suppliers. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

	Recalling firms Column (1)	Industry rivals Column (2)	Supplier firms Column (3)
	N=1592	N=1566	N=1110
Event windows	*Recalling firm CAR* (%)	*Rival firms' CAR* (%)	*Supplier firms' CAR* (%)
(-2, +2)	-0.57***	-0.03	-0.44***
	(-4.88)	(-0.70)	(-4.01)
(-5, +5)	-1.08***	-0.20**	-0.73***
	(-7.03)	(-2.57)	(-4.43)
(-10, +10)	-1.47***	-0.40***	-1.30***
	(-7.51)	(-3.26)	(-5.75)

Table 5

The impact of relative leverage on the announcement-period wealth effects of recalling firms

This table presents results for the determinants of the announcement-period abnormal returns to recalling firms. The dependent variable in Models 1-4 is the cumulative abnormal return (*Recalling firm CAR*) measured over the (-2, +2) day event window around the recall announcement date. In Models 5-6, the dependent variable is anticipation adjusted *CAR* (*Adjusted Recalling firm CAR*) computed as *Recalling firm CAR* divided by (1 – probability of the recall), where the probability of recall is computed using the probit model specified in Appendix Table 1. In Models 3-4, we report results from the second stage of the Heckman two-stage estimation procedure. We use weighted least squares estimations in models (1)-(6) where the weights are the inverse of the standard deviation of market model residuals. *Firm-to-industry book leverage* is the ratio of the book leverage of the recalling firm to the book leverage of the recalling firm's industry peers. *Firm-to-industry market leverage* is the ratio of the market leverage of the recalling firm to the market leverage of the recalling firm's industry peers. The recalling firm is not considered in computing the industry level measures of leverage. *Size* is the lagged logarithm of the market value of equity. *Initial recall dummy* is an indicator variable set to 1 if the recall event is the first by the recalling firm during our sample period and set to 0 otherwise. In the first stage of the Heckman selection model (results reported in Appendix Table 1), the dependent variable is *RecallDum* which is set to one for firms in the recall sample and zero for control firms. Control firms are firms that belong to the same three-digit SIC industry as the recalling firm provided they did not have a recall during the period. In addition, to satisfy exclusion restrictions of the Heckman selection model, for each firm-year we compute the proportion of firms in the industry (excluding the recalling firm) with a recall that year and include it as an instrumental variable. In the second stage, the dependent variable is *Recalling firm CAR* and weighted least squares estimations are followed. *Inverse Mills Ratio* is calculated based on the first stage estimation of the likelihood of a product recall. Reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Dependent variable	*Recalling firm CAR*				*Adjusted Recalling firm CAR*	
	(1)	(2)	(3)	(4)	(5)	(6)
Firm-to-industry book leverage	-0.0006***		-0.0007***		-0.0061***	
	(0.007)		(0.008)		(0.000)	
Firm-to-industry market leverage		-0.0008***		-0.0009***		-0.0070***
		(0.000)		(0.001)		(0.000)
Size	0.0006	0.0007	-0.0000	0.0000	-0.0044	-0.0040
	(0.274)	(0.238)	(0.981)	(0.990)	(0.111)	(0.135)
Initial recall dummy	-0.0022	-0.0023	-0.0014	-0.0015	-0.0000	-0.0006
	(0.332)	(0.314)	(0.590)	(0.569)	(0.998)	(0.940)
Inverse mills ratio			-0.0022	-0.0022		
			(0.277)	(0.268)		
Constant	-0.0030	-0.0030	0.0021	0.0019	0.0822	0.0825
	(0.747)	(0.752)	(0.850)	(0.861)	(0.105)	(0.102)
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.03	0.03	0.03	0.03	0.02	0.03
Observations	1,591	1,591	1,534	1,534	1,519	1,519

Table 6

The impact of relative leverage on the announcement-period wealth effects of industry rival firms

This table presents the weighted least squares estimation results for the determinants of the announcement-period abnormal returns to rivals of recalling firms. The sample period is 2003 – 2013. The dependent variable is the cumulative abnormal return for the rival portfolio (*Rival firms' CAR*) measured over the (-2, +2), (-5, +5), or (-10, +10) day event window around the recall announcement date. *Firm-to-industry book (market) leverage* is the ratio of the book (market) leverage of the recalling firm to the book (market) leverage of the recalling firm's industry peers. The recalling firm is not considered in computing the industry level measures for leverage. *Recalling firm CAR* is the cumulative abnormal return for the recalling firm over the (-2, +2), (-5, +5), or (-10, +10) day event window. *Size* is the lagged logarithm of the market value of equity of the recalling firm. *Initial recall dummy* is an indicator variable set to 1 if the recall event is the first by the recalling firm during our sample period and set to 0 otherwise. Reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Dep. variable: *Rival firms' CAR*	(1) (-2,+2)	(2) (-2,+2)	(3) (-5,+5)	(4) (-5,+5)	(5) (-10,+10)	(6) (-10,+10)
Firm-to-industry book leverage	0.0003		0.0004		0.0009*	
	(0.187)		(0.270)		(0.066)	
Firm-to-industry market leverage		0.0004**		0.0006*		0.0010*
		(0.021)		(0.080)		(0.057)
Recalling firm CAR (-2, +2)	0.0145	0.0148				
	(0.443)	(0.433)				
Recalling firm CAR (-5, +5)			0.0512***	0.0516***		
			(0.001)	(0.001)		
Recalling firm CAR (-10, +10)					0.0522***	0.0526***
					(0.002)	(0.002)
Size	-0.0004	-0.0004	0.0001	0.0001	-0.0006	-0.0006
	(0.369)	(0.355)	(0.805)	(0.826)	(0.471)	(0.464)
Initial recall dummy	-0.0027*	-0.0026	0.0006	0.0006	0.0010	0.0011
	(0.095)	(0.100)	(0.820)	(0.805)	(0.783)	(0.774)
Constant	-0.0000	-0.0002	-0.0094	-0.0096	-0.0076	-0.0081
	(0.998)	(0.967)	(0.181)	(0.165)	(0.469)	(0.442)
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.01	0.01	0.01	0.01	0.02	0.02
Observations	1562	1562	1562	1562	1562	1562

Table 7

The impact of relative leverage on the announcement-period wealth effects of key suppliers

This table presents the weighted least squares estimation results for the determinants of the announcement-period abnormal returns to key supplier firms of recalling firms. The sample period is 2003 – 2013. The dependent variable is the cumulative abnormal return for the supplier portfolio (*Supplier firms' CAR*) measured over the (-2, +2), (-5, +5) or (-10, +10) day event window around the recall announcement date. *Firm-to-industry book (market) leverage* is the ratio of the book (market) leverage of the recalling firm to the book (market) leverage of the recalling firm's industry peers. The recalling firm is not considered in computing the industry level measures for leverage. *Supplier leverage* is the lagged supplier portfolio book leverage. *Supplier R&D intensity* is the lagged supplier portfolio research & development intensity. *Recalling firm CAR* is the cumulative abnormal return for the recalling firm over the (-2, +2), (-5, +5) and (-10, +10) event window. *Initial recall dummy* is an indicator variable set to 1 if the recall event is the first by the recalling firm during our sample period and set to 0 otherwise. *Size* is the lagged logarithm of the market value of equity of the recalling firm. Reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable: *Supplier firms' CAR*	(-2,+2)	(-2,+2)	(-5,+5)	(-5,+5)	(-10,+10)	(-10,+10)
Firm-to-industry book leverage	-0.0006***		-0.0004**		-0.0011***	
	(0.000)		(0.015)		(0.007)	
Firm-to-industry market leverage		-0.0005***		-0.0001		-0.0008*
		(0.000)		(0.600)		(0.083)
Recalling firm CAR (-2, +2)	0.1132***	0.1129***				
	(0.001)	(0.001)				
Recalling firm CAR (-5, +5)			0.1361***	0.1364***		
			(0.000)	(0.000)		
Recalling firm CAR (-10, +10)					0.1266***	0.1266***
					(0.000)	(0.000)
Supplier R&D intensity	-0.0029	-0.0013	0.0050	0.0066	-0.0204	-0.0170
	(0.826)	(0.923)	(0.792)	(0.731)	(0.391)	(0.476)
Supplier leverage	-0.0038	-0.0045	-0.0157	-0.0149	-0.0234	-0.0239
	(0.680)	(0.631)	(0.296)	(0.317)	(0.193)	(0.184)
Size	-0.0009	-0.0010	-0.0014	-0.0014	-0.0003	-0.0005
	(0.302)	(0.261)	(0.274)	(0.240)	(0.845)	(0.764)
Initial recall dummy	-0.0009	-0.0011	-0.0033	-0.0033	-0.0068	-0.0070
	(0.768)	(0.737)	(0.483)	(0.486)	(0.341)	(0.331)
Constant	0.0120	0.0131	0.0259	0.0262	0.0221	0.0239
	(0.268)	(0.223)	(0.108)	(0.104)	(0.254)	(0.229)
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.05	0.05	0.07	0.07	0.07	0.07
Observations	1108	1108	1108	1108	1108	1108

Table 8
Relative leverage and the wealth effects of recalling firms: Subsamples based on industry entry costs

This table presents results for the determinants of the announcement period abnormal returns to recalling firms split by industry entry costs. We sub-divide the recalling firms into two groups based on the industry entry costs (*Entry Cost)* as developed by Karuna (2007). Firms in the top tercile are considered to be in a high entry cost environment (*High Entry Cost*) and firms in the bottom tercile are considered to be in a low entry cost environment (*Low Entry Cost*). The dependent variable in Models 1 – 4 is the cumulative abnormal return (*Recalling firm CAR*) measured over the (-2, +2) event window around the recall announcement date. In Models 5 – 8, the dependent variable is anticipation adjusted *Recalling firm CAR* (*Adjusted Recalling firm CAR*) measured as in Kale, Kini, and Payne (2012). Weighted least squares estimations are followed. *Size* is the lagged logarithm of the market value of equity. *Firm-to-industry book (market) leverage* is the ratio of the book (market) leverage of the recalling firm to the book (market) leverage of the recalling firm's industry peers. The recalling firm is not considered in computing the industry level measures for leverage. *Initial recall dummy* is an indicator variable set to 1 if the recall event is the first by the recalling firm during our sample period, and set to 0 otherwise. *Size* is the lagged logarithm of the market value of equity of the recalling firm. *Inverse Mills Ratio* is calculated based on the first stage estimation of the likelihood of a product recall (see Appendix Table 1). Reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

	High Entry Cost	*Low Entry Cost*	*High Entry Cost*	*Low Entry Cost*	*High Entry Cost*	*Low Entry Cost*	*High Entry Cost*	*Low Entry Cost*
Dep. Variable: *Recalling firm CAR*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm-to-industry book leverage	-0.0005	-0.0005*			-0.0025	-0.0068***		
	(0.695)	(0.064)			(0.700)	(0.000)		
Firm-to-industry market leverage			-0.0021	-0.0006***			-0.0074	-0.0073***
			(0.319)	(0.007)			(0.374)	(0.000)
Size	-0.0007	-0.0001	-0.0011	-0.0001	-0.0016	-0.0058	-0.0022	-0.0049
	(0.676)	(0.925)	(0.461)	(0.944)	(0.696)	(0.141)	(0.544)	(0.127)
Initial recall dummy	0.0023	-0.0022	0.0024	-0.0023	-0.0048	-0.0082	-0.0058	-0.0095
	(0.635)	(0.589)	(0.623)	(0.574)	(0.787)	(0.424)	(0.735)	(0.340)
Inverse mills ratio	-0.0045	-0.0014	-0.0054	-0.0015				
	(0.387)	(0.687)	(0.301)	(0.665)				
Constant	0.0142	-0.0144	0.0209	-0.0145	-0.1144	0.0311	-0.1040	0.0247
	(0.439)	(0.415)	(0.236)	(0.411)	(0.229)	(0.381)	(0.263)	(0.409)
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	489	495	489	495	486	483	486	483
R-squared	0.04	0.06	0.04	0.06	0.02	0.08	0.02	0.08

Table 9
Relative leverage and the wealth effects of recalling firms: Subsamples based on industry product substitutability

This table presents results for the determinants of the announcement-period abnormal returns to recalling firms split by product market fluidity. We sub-divide the recalling firms into two groups based on industry product substitutability (*Differentiated)* as developed by Karuna (2007). Firms in the top tercile are considered to be in a low product substitutability environment (*High Differentiated*) and firms in the bottom tercile are considered to be in a high product substitutability environment (*Low Differentiated*). The dependent variable in Models 1 – 4 is the cumulative abnormal return (*Recalling firm CAR*) measured over the (-2, +2) event window around the recall announcement date. In Models 5-8, the dependent variable is anticipation adjusted *Recalling firm CAR* (*Adjusted Recalling firm CAR*) measured as in Kale, Kini, and Payne (2012). Weighted least squares estimations are followed. *Size* is the lagged logarithm of the market value of equity. *Firm-to-industry book (market) leverage* is the ratio of the book (market) leverage of the recalling firm to the book (market) leverage of the recalling firm's industry peers. The recalling firm is not considered in computing the industry level measures for leverage. *Initial recall dummy* is an indicator variable set to 1 if the recall event is the first by the recalling firm during our sample period and set to 0 otherwise. *Size* is the lagged logarithm of the market value of equity of the recalling firm. *Inverse Mills Ratio* is calculated based on the first stage estimation of the likelihood of a product recall (see Appendix Table 1). Reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Dep. Variable: *Recalling firm CAR*	*High Differentiated* (1)	*Low Differentiated* (2)	*High Differentiated* (3)	*Low Differentiated* (4)	*High Differentiated* (5)	*Low Differentiated* (6)	*High Differentiated* (7)	*Low Differentiated* (8)
Firm-to-industry book leverage	-0.0022	-0.0007***			-0.0093	-0.0065***		
	(0.572)	(0.005)			(0.429)	(0.000)		
Firm-to-industry market leverage			0.0002	-0.0009***			0.0014	-0.0075***
			(0.953)	(0.001)			(0.919)	(0.000)
Size	-0.0008	-0.0006	-0.0005	-0.0005	-0.0011	-0.0029	-0.0008	-0.0015
	(0.675)	(0.682)	(0.815)	(0.749)	(0.738)	(0.479)	(0.833)	(0.665)
Initial recall dummy	-0.0025	-0.0058	-0.0025	-0.0057	-0.0200	-0.0356**	-0.0184	-0.0347**
	(0.641)	(0.130)	(0.627)	(0.141)	(0.132)	(0.019)	(0.177)	(0.020)
Inverse mills ratio	-0.0063	-0.0038	-0.0054	-0.0038				
	(0.127)	(0.388)	(0.201)	(0.383)				
Constant	0.0180	0.0295	0.0111	0.0282	0.0039	0.0846*	-0.0129	0.0718*
	(0.472)	(0.132)	(0.667)	(0.143)	(0.931)	(0.054)	(0.799)	(0.077)
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	487	492	487	492	487	482	487	482
R-squared	0.06	0.06	0.06	0.06	0.04	0.08	0.04	0.09

Table 10
Relative leverage and the wealth effects of recalling firms: Subsamples based on recalling firm product market risk

This table presents results for the determinants of the announcement-period abnormal returns to recalling firms split by recalling firm product market fluidity. We sub-divide the recalling firms into two groups based on the *Product market fluidity* measure developed by Hoberg, Phillips, and Prabhala (2014). Firms in the top tercile are considered to be in a high product market risk environment (*High PM Risk.*) and firms in the bottom tercile are considered to be in a low product market risk environment (*Low PM Risk*). The dependent variable in Models 1 –4 is the cumulative abnormal return (*Recalling firm CAR*) measured over the (-2, +2) event window around the recall announcement date. In Models 5 – 8, the dependent variable is anticipation adjusted *Recalling firm CAR* (*Adjusted Recalling firm CAR*) measured as in Kale, Kini, and Payne. (2012). Weighted least squares estimations are followed. *Size* is the lagged logarithm of the market value of equity. *Firm-to-industry book (market) leverage* is the ratio of the book (market) leverage of the recalling firm to the book (market) leverage of the recalling firm's industry peers. The recalling firm is not considered in computing the industry level measures for leverage. *Initial recall dummy* is an indicator variable set to 1 if the recall event is the first by the recalling firm during our sample period and set to 0 otherwise. *Size* is the lagged logarithm of the market value of equity of the recalling firm. *Inverse Mills Ratio* is calculated based on the first stage estimation of the likelihood of a product recall (see Appendix Table 1). Reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

	High PM Risk	*Low PM Risk*	*High PM Risk*	*Low PM Risk*	*High PM Risk*	*Low PM Risk*	*High PM Risk*	*Low PM Risk*
Dep. Variable: *Recalling firm CAR*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm-to-industry book leverage	-0.0008***	0.0000			-0.0075***	-0.0003		
	(0.005)	(0.990)			(0.000)	(0.945)		
Firm-to-industry market leverage			-0.0008***	-0.0026			-0.0076***	-0.0075
			(0.000)	(0.117)			(0.000)	(0.143)
Size	-0.0013	0.0029**	-0.0011	0.0027*	-0.0046	-0.0032	-0.0036	-0.0033
	(0.327)	(0.044)	(0.374)	(0.056)	(0.354)	(0.433)	(0.405)	(0.413)
Initial recall dummy	-0.0002	-0.0018	-0.0002	-0.0021	0.0010	0.0086	0.0015	0.0071
	(0.965)	(0.632)	(0.967)	(0.559)	(0.929)	(0.482)	(0.898)	(0.527)
Inverse mills ratio	-0.0061*	0.0068*	-0.0061*	0.0060*				
	(0.082)	(0.053)	(0.086)	(0.071)				
Constant	0.0432***	-0.0457**	0.0425***	-0.0389*	0.2208***	0.0032	0.2163***	0.0139
	(0.001)	(0.049)	(0.001)	(0.082)	(0.000)	(0.936)	(0.000)	(0.732)
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	373	382	373	382	373	369	373	369
R-squared	0.08	0.04	0.08	0.04	0.10	0.01	0.10	0.02

Table 11

Relative leverage and the wealth effects of rival firms: Subsamples based on industry entry costs

This table presents the weighted least squares estimation results for the determinants of the announcement-period abnormal returns to rival firms split by industry entry cost measure developed by Karuna (2007). We sub-divide the rival firms into two groups based on the industry entry costs of recalling firms (*Entry Cost)*. Rival portfolios in the top tercile of *Entry Cost* are considered to be in a high entry cost environment (*High Entry Cost*) and rival portfolios in the bottom tercile are considered to be in a low entry cost environment (*Low Entry Cost*). The sample period is 2003 – 2013. The dependent variable is the cumulative abnormal return for the rival portfolio (*Rival firms' CAR*) measured over the (-2, +2), (-5, +5), and (-10, +10) event window around the recall announcement date in Panel A, Panel B, and Panel C, respectively. *Firm-to-industry book (market) leverage* is the ratio of the book (market) leverage of the recalling firm to the book (market) leverage of the recalling firm's industry peers. The recalling firm is not considered in computing the industry level measures for leverage. *Recalling firm CAR* is the cumulative abnormal return for the recalling firm over the (-2, +2), (-5, +5) and (-10, +10) event window. Control variables include *Size* which is the lagged logarithm of the market value of equity of the recalling firm and *Initial recall dummy* which is an indicator variable set to 1 if the recall event is the first by the recalling firm during our sample period and set to 0 otherwise. All models contain calendar year dummies and reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: Dependent variable is *Rival firms' CAR* computed over the (-2, +2) days event window

Dep. Variable: *Rival firms' CAR*	*High Entry Cost* (-2, +2)	*Low Entry Cost* (-2, +2)	*High Entry Cost* (-2, +2)	*Low Entry Cost* (-2, +2)
Firm-to-industry book leverage	-0.0003	0.0004		
	(0.831)	(0.148)		
Firm-to-industry market leverage			-0.0004	0.0007**
			(0.633)	(0.015)
Recalling firm CAR (-2, +2)	0.0254	0.0394	0.0253	0.0404
	(0.533)	(0.267)	(0.534)	(0.251)
Control variables	Yes	Yes	Yes	Yes
R-squared	0.04	0.03	0.04	0.03
Observations	489	506	489	506

Panel B: Dependent variable is *Rival firms' CAR* computed over the (-5, +5) days event window

Dep. Variable: *Rival firms' CAR*	*High Entry Cost* (-5, +5)	*Low Entry Cost* (-5, +5)	*High Entry Cost* (-5, +5)	*Low Entry Cost* (-5, +5)
Firm-to-industry book leverage	-0.0015	0.0010**		
	(0.668)	(0.026)		
Firm-to-industry market leverage			-0.0019	0.0014***
			(0.539)	(0.009)
Recalling firm CAR (-5, +5)	0.0426*	0.1046***	0.0427*	0.1049***
	(0.074)	(0.007)	(0.074)	(0.006)
Control variables	Yes	Yes	Yes	Yes
R-squared	0.06	0.06	0.06	0.06
Observations	489	506	489	506

Panel C: Dependent variable is *Rival firms' CAR* computed over the (-10, +10) days event window

Dep. Variable: *Rival firms' CAR*	*High Entry Cost* (-10, +10)	*Low Entry Cost* (-10, +10)	*High Entry Cost* (-10, +10)	*Low Entry Cost* (-10, +10)
Firm-to-industry book leverage	-0.0002	0.0007**		
	(0.919)	(0.020)		
Firm-to-industry market leverage			-0.0012	0.0012***
			(0.477)	(0.005)
Recalling firm CAR (-10, +10)	0.0448*	0.0979***	0.0449*	0.1000***
	(0.050)	(0.005)	(0.053)	(0.004)
Control variables	Yes	Yes	Yes	Yes
R-squared	0.04	0.05	0.04	0.06
Observations	489	506	489	506

Table 12

Relative leverage and the wealth effects of rival firms: Subsamples based on industry product substitutability

This table presents the weighted least squares estimation results for the determinants of the announcement-period abnormal returns to rivals of recalling firms split by industry product substitutability. We sub-divide rival portfolios into two groups based on product substitutability (*Differentiated)* as developed by Karuna (2007). Firms in the top tercile are considered to be in a low product substitutability environment (*High Differentiated*) and firms in the bottom tercile are considered to be in a high product substitutability environment (*Low Differentiated*). The sample period is 2003 – 2013. The dependent variable is the cumulative abnormal return for the rival portfolio (*Rival firms' CAR*) measured over the (-2, +2), (-5, +5), and (-10, +10) event window around the recall announcement date in Panel A, Panel B, and Panel C, respectively. *Firm-to-industry book (market) leverage* is the ratio of the book (market) leverage of the recalling firm to the book (market) leverage of the recalling firm's industry peers. The recalling firm is not considered in computing the industry level measures for leverage. *Recalling firm CAR* is the cumulative abnormal return for the recalling firm over the (-2, +2), (-5, +5) and (-10, +10) event window. Control variables include *Size* which is the lagged logarithm of the market value of equity of the recalling firm and *Initial recall dummy* which is an indicator variable set to 1 if the recall event is the first by the recalling firm during our sample period and set to 0 otherwise. All estimations contain calendar year dummies and reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: Dependent variable is *Rival firms' CAR* computed over the (-2, +2) days event window

Dep. Variable: *Rival firms' CAR*	*High Differentiated* (-2, +2)	*Low Differentiated* (-2, +2)	*High Differentiated* (-2, +2)	*Low Differentiated* (-2, +2)
Firm-to-industry book leverage	0.0020	0.0001		
	(0.199)	(0.389)		
Firm-to-industry market leverage			0.0031	0.0004**
			(0.133)	(0.035)
Recalling firm CAR (-2, +2)	0.0168	0.0523	0.0147	0.0533
	(0.575)	(0.174)	(0.625)	(0.164)
Control variables	Yes	Yes	Yes	Yes
R-squared	0.05	0.06	0.05	0.06
Observations	477	522	477	522

Panel B: Dependent variable is *Rival firms' CAR* computed over the (-5, +5) days event window

Dep. Variable: *Rival firms' CAR*	*High Differentiated* (-5, +5)	*Low Differentiated* (-5, +5)	*High Differentiated* (-5, +5)	*Low Differentiated* (-5, +5)
Firm-to-industry book leverage	0.0006	0.0002		
	(0.723)	(0.396)		
Firm-to-industry market leverage			0.0050*	0.0005*
			(0.080)	(0.075)
Recalling firm CAR (-5, +5)	0.0409	0.0895***	0.0403	0.0902***
	(0.120)	(0.002)	(0.116)	(0.002)
Control variables	Yes	Yes	Yes	Yes
R-squared	0.03	0.06	0.04	0.06
Observations	477	522	477	522

Panel C: Dependent variable is *Rival firms' CAR* computed over the (-10, +10) days event window

Dep. Variable: *Rival firms' CAR*	*High Differentiated* (-10, +10)	*Low Differentiated* (-10, +10)	*High Differentiated* (-10, +10)	*Low Differentiated* (-10, +10)
Firm-to-industry book leverage	-0.0013	0.0008**		
	(0.516)	(0.050)		
Firm-to-industry market leverage			0.0030	0.0008*
			(0.410)	(0.067)
Recalling firm CAR (-10, +10)	-0.0028*	0.0001	-0.0028*	0.0000
	(0.059)	(0.943)	(0.054)	(0.998)
Control variables	Yes	Yes	Yes	Yes
R-squared	0.04	0.07	0.04	0.07
Observations	477	522	477	522

Table 13

Relative leverage and the wealth effects of rival firms: Subsamples based on recalling firm product market risk

This table presents the weighted least squares estimation results for the determinants of the announcement-period abnormal returns to rivals of recalling firms split by product market fluidity of recalling firms. *Product market fluidity* is developed by Hoberg, Phillips, and Prabhala (2014). Rival portfolios in the top tercile of *Product market fluidity* are considered to be in a high product market risk environment (*High PM Risk.*) and firms in the bottom tercile of *Product market fluidity* are considered to be in a low product market risk environment (*Low PM Risk*). The sample period is 2003 – 2013. The dependent variable is the cumulative abnormal return for the rival portfolio (*Rival firms' CAR*) measured over the (-2, +2), (-5, +5), and (-10, +10) event window around the recall announcement date in Panel A, Panel B, and Panel C, respectively. *Firm-to-industry book (market) leverage* is the ratio of the book (market) leverage of the recalling firm to the book (market) leverage of the recalling firm's industry peers. The recalling firm is not considered in computing the industry level measures for leverage. *Recalling firm CAR* is the cumulative abnormal return for the recalling firm over the (-2, +2), (-5, +5) and (-10, +10) event window. Control variables include *Size* which is the lagged logarithm of the market value of equity of the recalling firm and *Initial recall dummy* which is an indicator variable set to 1 if the recall event is the first by the recalling firm during our sample period and set to 0 otherwise. All estimations contain calendar year dummies and reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: Dependent variable is *Rival firms' CAR* computed over the (-2, +2) days event window

Dep. Variable: *Rival firms' CAR*	*High PM risk* (-2, +2)	*Low PM risk* (-2, +2)	*High PM risk* (-2, +2)	*Low PM risk* (-2, +2)
Firm-to-industry book leverage	0.0003	0.0011		
	(0.300)	(0.192)		
Firm-to-industry market leverage			0.0005**	0.0008
			(0.026)	(0.519)
Recalling firm CAR (-2, +2)	0.0454	0.0052	0.0460	0.0064
	(0.133)	(0.876)	(0.128)	(0.850)
Control variables	Yes	Yes	Yes	Yes
R-squared	0.05	0.03	0.06	0.02
Observations	382	388	382	388

Panel B: Dependent variable is *Rival firms' CAR* computed over the (-5, +5) days event window

Dep. Variable: *Rival firms' CAR*	*High PM risk.* (-5, +5)	*Low PM risk.* (-5, +5)	*High PM risk.* (-5, +5)	*Low PM risk.* (-5, +5)
Firm-to-industry book leverage	0.0006*	-0.0020		
	(0.078)	(0.120)		
Firm-to-industry market leverage			0.0006**	-0.0011
			(0.040)	(0.541)
Recalling firm CAR (-5, +5)	0.0382	0.0899**	0.0384	0.0856**
	(0.161)	(0.035)	(0.158)	(0.044)
Control variables	Yes	Yes	Yes	Yes
R-squared	0.05	0.05	0.05	0.05
Observations	382	388	382	388

Panel C: Dependent variable is *Rival firms' CAR* computed over the (-10, +10) days event window

Dep. Variable: *Rival firms' CAR*	*High PM risk.* (-10, +10)	*Low PM risk.* (-10, +10)	*High PM risk.* (-10, +10)	*Low PM risk.* (-10, +10)
Firm-to-industry book leverage	0.0011***	-0.0022		
	(0.004)	(0.320)		
Firm-to-industry market leverage			0.0011***	-0.0024
			(0.009)	(0.415)
Recalling firm CAR (-10, +10)	0.0585**	0.1028***	0.0582**	0.1005***
	(0.021)	(0.009)	(0.022)	(0.009)
Control variables	Yes	Yes	Yes	Yes
R-squared	0.05	0.07	0.05	0.07
Observations	382	388	382	388

Appendix Table 1
First stage probit regressions on recall incidence

This table presents the recall incidence estimation results for recall events by public firms during our sample period of 2003 – 2013. The dependent variable is *RecallDum* which is set to one for firms in the recall sample, and zero for control firms. Control firms are firms that belong to the same three-digit SIC industry as the recalling firm provided they did not have a recall during the period. To satisfy exclusion restrictions of the Heckman selection model, for each firm-year we compute the proportion of firms in the industry (excluding the recalling firm) with a recall that year and include it as an instrumental variable. We include this variable *Proportion industry recall* in the regression. Refer to the appendix for details on the construction of our variables. Reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Dep. Variable: Recall incidence	(1)
Market leverage	0.9478***
	(0.000)
Cash flow shock	-0.1475
	(0.130)
Unionization	0.0133*
	(0.066)
Number of suppliers	0.0291***
	(0.000)
Vertical integration dummy	-0.0963
	(0.573)
R&D intensity	-1.6420**
	(0.041)
TFP	0.0456
	(0.450)
Herfindahl index	1.3543***
	(0.000)
Size	0.4372***
	(0.000)
Proportion industry recall	1.3047***
	(0.000)
Constant	-5.4879***
	(0.000)
Industry and year dummies	Yes
Observations	29507