Financial leverage, product quality failures, and product market effects: Evidence from product recalls[+]

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Abstract

We study the impact of financial leverage on severe product quality failures that result in product recalls. Consistent with the view that debt financing distorts the incentives to invest in product quality enhancements, we find that firms with higher financial leverage or likelihood of distress are associated with a greater likelihood of a product recall after controlling for other factors expected to affect recalls. This finding stands up to several robustness tests including the use of two quasi-natural experiments that result in exogenous negative cash flow shocks to firms. Consistent with the view that taking on high debt relative to rivals makes the firm a weaker competitor, we find that recalling firms with high relative-leverage experience more negative wealth effects to recalls while their industry rivals experience more positive wealth effects. These effects are, however, confined to the sub-sample of recalls in oligopolistic industries. Key suppliers' losses are exacerbated when they have more leverage or have committed larger relationship-specific investments.

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

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1. Introduction

Product quality failures can manifest themselves in many ways and, when severe, can result in the products being recalled from the marketplace. Often, the recalled products are associated with harmful effects such as injury, sickness, or death, and have received significant scrutiny from the media and various U.S. agencies in charge of regulating product safety.[1] Once a firm determines that a safety defect exists, federal regulation requires that firms cease selling the product immediately and report the defect to the relevant regulating agency.[2] The financial economics literature has shown that recalls are costly events for recalling firms and the costs of the recall far exceed the costs of replacing or repairing the defective products. These additional costs can include significant indirect penalties in the form of lost goodwill, tarnished brand image, lost sales, and product liability lawsuits (e.g., Jarrell and Peltzman, 1985; Hoffer, Pruitt, and Reilly, 1988; Mitchell, 1989; and Barber and Darrough, 1996).

Theoretical research has argued that the financial condition of a firm can affect its incentives to invest in initiatives such as product quality enhancements (e.g., Maksimovic and Titman, 1991; and Chevalier and Scharfstein, 1996). Thus, the firm's financial condition can influence the incidence of product recalls. In addition, contingent upon a recall, a firm's ability to recover from the recall, and the strategic actions taken by its rivals in response to the recall, can also be affected by the firm's and its rivals' financial condition (Bolton and Scharfstein, 1990; Chevalier, 1995; and Phillips, 1995). We shed light on these and related issues by examining: (i) the impact of leverage and the likelihood of financial distress on the incidence of product recalls, (ii) the role of the financial strength of the firm relative to its rivals in explaining the value consequences for the recalling firms, their industry rivals, and key suppliers, (iii) the impact of industry structure (oligopolistic vs. competitive industry) on the role of leverage in

[1] The U.S. agencies regulating safety for the different types of products are Consumer Product Safety Commission (*CPSC*), Food and Drug Administration (*FDA*), and National Highway Traffic Safety Administration (*NHTSA*).
[2] Section 15(b) of the *Consumer Product Safety Act* requires that firms report safety defects immediately to the CPSC. *Federal, Food, Drug, and Cosmetic Act*, which governs FDA related recalls, has similar provisions. In the case of automobiles, firms are required to report safety defects to the NHTSA within five business days of determining that a safety defect exists.

affecting the recall's consequences to the recalling firms and their rivals, and finally (iv) whether recalls are associated with any contagion effects for the industry rivals and the key suppliers of recalling firms.

There are several reasons why the financial condition of a firm can affect the incidence of product recalls. Maksimovic and Titman (1991) argue that debt financing can distort the incentives of a firm to invest in product quality enhancements because highly levered firms have a greater pressure to cut costs and increase current cash flows at the expense of long-term benefits in order to avoid immediate bankruptcy. The focus on the short-term cash flow needs at the expense of long-term investment may also be seen in the model of counter-cyclical markups in Chevalier and Scharfstein (1996). Some antecedents of these views are found in Jensen and Meckling (1976) and Myers (1977) who argue that financial leverage leads to underinvestment due to the debt overhang problem. Additionally, the asset substitution problem argues that due to the option-like characteristics of shareholder payoffs, shareholders of highly levered firms have incentives to undertake more speculative investments in lieu of low risk positive NPV investments. Based on the above theories, we argue that the financial health of a firm has a direct impact on the quality of the firm's products and, therefore, affects the incidence of product recalls.[3]

We additionally study the value implications of the recall on the recalling firms, their industry rival firms, and key suppliers. In particular, we examine the role of leverage of the recalling firm *relative* to its industry rivals in explaining wealth effects to the above parties. This measure allows us to test the predictions derived from Bolton and Scharfstein (1990), Phillips (1995), and Chevalier (1995) 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. Specifically, a high relative leverage for the recalling firm not only captures the potential financial difficulties faced by the firm in its efforts to recover from the recall, but also captures the ability of its rivals to take advantage of the recall by engaging in predatory pricing and market-share enhancing investment policies. To more definitively establish the link between the relative financial strengths of the

[3] Matsa (2011b) finds that supermarkets with high leverage have more severe stockouts, and Phillips and Sertsios (2012) find that airline carriers in financial distress had inferior quality as measured by baggage mishandling and poor on-time performance.

recalling firms and their rivals and the value consequences associated with recalls, we repeat the analyses by separating the firms into two subsamples based on whether the recalling firm is in an oligopolistic (high concentration) or competitive (low concentration) industry. Kovenock and Phillips (1997) and Lang and Stulz (1992) argue that industry rivals are more likely to take strategic actions in oligopolistic industries where there are more economic rents to be expropriated than in competitive industries. If high relative leverage or distress likelihood does indeed place a recalling firm at a disadvantage (and the rivals at an advantage), then the link between relative leverage and value consequences will be more apparent in the subsample of firms in oligopolistic industries. In contrast, we would expect the strategic effects of leverage to be weak in low concentration industries.

Furthermore, if a recall is associated with any negative spillover effects for the entire industry, i.e., contagion effects, then the industry rivals of recalling firms would also suffer negative value consequences from recalls. Contagion effects of recalls may be in the form of additional costly packaging restrictions for the whole industry (e.g., Tylenol), 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 (e.g., toy recalls due to unsafe lead content). 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. However, since the competitive benefits are likely to be higher in oligopolistic industries and partially or fully offset the contagion effects, we expect to be able to discern the contagion effects more clearly in the low concentration industries. That is, there should be a positive relation between the announcement period returns of the recalling firms and the rival firms in the low concentration industries subsample, i.e., bad news for the recalling firms will translate into bad news for its industry rivals too in this subsample.

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 2006–2010 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 816 recall events included in the regulating agencies' filings and with reliable announcement dates in the financial press. As control firms, we include firms that do not have a recall over our sample period but operate in the same three-digit SIC codes as the recalling firms.

Our analysis of the determinants of product recalls shows that the financial position of a firm has a tangible effect on recall incidence, even after controlling for other potential factors that may affect product quality. Consistent with the argument that firms with high financial leverage (or high distress likelihood) suffer investment distortions that negatively impact quality, we document a significant positive relation (both statistically and economically) between financial leverage/likelihood of financial distress and the probability of a product recall. Our findings reinforce those in Matsa (2011b) and Phillips and Sertsios (2012) who also report a negative relation between quality and leverage/distress likelihood but in the supermarket and airline industry, respectively. In addition, we also find that the incidence of recall is higher if the firm operates in a more unionized industry, a less competitive industry, or has a larger number of input suppliers, while it is lower if the firm is vertically integrated or has more efficient managers.

To more definitively conclude that the financial condition of a firm affects product recall incidence, we condition our tests on two exogenous negative shocks to firm cash flows – (i) sharp cuts in import tariffs that increase competition for domestic firms, and (ii) input price shocks that result in exogenous cost increases for firms' inputs. If high financial leverage and likelihood of distress do indeed constrain firms from undertaking the costs and the investments necessary to improve product quality, then such constraints should be exacerbated for these firms following the exogenous shocks. That is, we should expect the impact of leverage and distress likelihood to be more pronounced in affecting product recalls following the shocks. In addition to the above two quasi-natural experiments, we treat financial leverage as endogenous and perform two stage least squares estimation to examine the impact of leverage on product recalls. Further, to avoid any spurious contemporaneous correlation, we use lagged values of the independent variables in our tests. All the results continue to indicate that firms with high financial leverage or likelihood of financial distress are indeed more prone to producing lower quality products and, hence, are more likely to have product recalls.

Our examination of the valuation consequences across our large sample of 816 recalls indicates that these 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 an average wealth effect of –1.72% for the recalling firms over a (–5, +5) day window around the announcement date. In dollar terms this is roughly an average loss of $302 million to the firms in our sample. In our analysis of wealth effects to rivals and suppliers, we show that rival firms and key supplier firms (who are 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.

We examine the drivers of the heterogeneity in recalling firms' stock price reaction around the announcement of recalls. In this analysis, we employ the Heckman selection model to correct for the incidental truncation bias that arises because we observe the announcement returns only for the recalling firms and not the control firms (Wooldridge, 2010). Our results show that when a firm is relatively more leveraged or has higher distress likelihood than its industry rivals, the market expects these firms to suffer greater losses, perhaps due to predation or other 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 or has higher distress likelihood 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 (1995), and Chevalier (1995). In studying supplier stock price reactions to the product recall, we find that suppliers who themselves are highly levered experience more negative wealth effects. This suggests that suppliers who are financially weaker suffer more when an important customer faces a negative shock like a product recall. We also find weak evidence that the suppliers are worse off when the relative-to-industry leverage of the recalling firm is large – highlighting the consequences of relying on a customer firm which is financially weaker than its rivals. Finally, we find that their stock prices are more adversely affected if they have made more relationship-investments, thereby suggesting that the adverse consequences of a recall are greater for key supplier firms if it is more difficult for them to switch to supplying other firms.

Our rival results indicate that higher relative leverage puts recalling firms at a competitive disadvantage vis-à-vis their industry rival firms. Theory suggests that the strategic effects of debt are likely to be stronger in concentrated industries because there are more economic rents that can be expropriated by rival firms from recalling firms in these industries (e.g., Kovenock and Phillips, 1997; and Lang and Stulz, 1992). To explore this hypothesis, we examine the impact of relative leverage on the wealth effects of product recalls on recalling firms and their industry rival firms in high and low concentration industries. We find that a higher relative-to-industry leverage ratio for the recalling firm leads to lower wealth effects for recalling firms and higher wealth effects for their rival firms only in oligopolistic industries – that is, only in industries where rivals' predation-related benefits are likely to be high. We find no such benefits in the low concentration industries.

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 some negative spillover effects from the recall. We also find that this contagion effect is more apparent in low concentration industries, i.e., industries where the competitive benefits to rivals from the recall event are likely to be small. Additionally, we document a positive relation between the abnormal returns of the recalling firms and those of their key suppliers even after controlling for a variety of firm- and supplier-specific characteristics. Thus, key supplier firms' losses are larger when the recalling firm's losses are higher. Overall, these results indicate that product recalls have both horizontal (industry-wide) and vertical (supplier) contagion effects.

Our paper makes the following contributions. First, to the best of our knowledge, no other paper has examined the impact of financial leverage or likelihood of financial distress on product quality breakdowns in the context of a product recall. Our use of two exogenous negative shocks to firm cash flows and the employment of the 2SLS regression methodology allow us to make a causal argument linking financial condition to quality failures. Existing studies confine themselves to specific industries to document the effects of leverage on different aspects of quality such as product shortfalls in the supermarket industry (Matsa, 2011b) and baggage mishandling and on-time performance in the airline industry (Phillips and Sertsios, 2012). Our study of recalls encompasses a broad cross-section of industries and allows us to generalize the impact of financial leverage on quality outcomes.

Second, unlike other quality attributes such as baggage handling or supermarket stock-out rates, product recall announcements are well-defined quality failure events which can be traced back to a specific announcement date. This enables us to analyze the impact of the financial condition of the recalling firms, their rivals, and key suppliers on the value consequences associated with the product recall. Thus, we are able to materially add to the literature not only on financial condition and product quality but also to the literature on strategic product market competition where firms' actions and their financial position affect not only their own value, but also the actions and value of their rivals. This analysis provides a unique test of the arguments in Bolton and Scharfstein (1990), Phillips (1995), and Chevalier (1995) that high debt and high distress likelihood relative to industry rivals is likely to make the firm a weaker competitor in the product market.

Third, the availability of product quality failures data across multiple industries enables us to conduct a more nuanced analysis of the relation between relative financial condition of firms and the value consequences of recalls. Specifically, we are able to test the contention in the literature that the financial condition, and the resulting strategic actions, of firms has a greater impact on rivals in oligopolistic industries than in competitive industries. Fourth, our examination of the cross-sectional determinants of the announcement period wealth effects to recalling firms, their key suppliers, and their industry-rivals provides insights about whether there are horizontal and vertical contagion effects associated with product recalls. Finally, our analysis of the role of leverage and other firm- and industry-specific factors that affect recalls should be of interest to the U.S. product safety watchdogs such as the *CPSC*, *FDA*, and *NHTSA* in their regulation of product safety practices. Since these agencies have limited financial and human resources, fine-tuning their inspection strategies based on these factors can be a more effective way to marshal their limited resources.

The remainder of the paper proceeds as follows. Section 2 provides a discussion of the leverage and financial distress related factors that we posit can affect the incidence of product recalls. We also describe the control variables and associated theories here. Section 3 describes our data sources, sample selection criteria, and the salient characteristics of the sample. In Section 4, we present our univariate analysis followed by probit regressions explaining the incidence of recalls. Here, we also conduct several robustness tests to determine whether the relation between financial leverage/distress likelihood and incidence of product recalls is causal in nature. In Section 5, we present our predictions and regression results pertaining to the relation between relative leverage of the recalling firm vis-à-vis it industry rival firms and the valuation consequences of the recall to the recalling firms, their industry rivals, and the key suppliers. We examine the impact of industry structure on the relation between relative leverage and the wealth effects of product recalls on the recalling firms and their rivals in Section 6. Section 7 summarizes the results and concludes the paper.

2. Theoretical considerations for recall incidence: Hypotheses and variable description

In the section below, we provide theoretical justifications for why financial leverage/distress likelihood can influence the incidence of product recalls. We also present other variables that are hypothesized to impact product recalls. Detailed descriptions of all the variables used in this study are presented in the Appendix.

2.1. Financial leverage/distress likelihood and the propensity for a product recall

Maksimovic and Titman (1991) develop a model in which firms with high leverage (or high probability of financial distress) have incentives to cut costs and reduce the quality of their products to avoid immediate bankruptcy. Chevalier and Scharfstein (1996), using an intertemporal model with switching costs, argue that highly levered firms may be financially constrained and, hence, forced to cut investment even if the firm has positive NPV projects. Chevalier (1995) in her analysis of product prices in the supermarket industry following high-leverage transactions finds results consistent with the view that liquidity constraints make firms myopic. She shows that firms "charge short-run profit maximizing prices after the LBO" compared to the "inter-temporal profit maximizing prices prior to the LBO."

Further, debt exacerbates agency problems associated with debt overhang and asset substitution (Jensen and Meckling, 1976; Myers, 1977). The debt overhang problem arises when too much of the expected benefits from an investment accrue to the bondholders thereby making the residual payoffs received by the shareholders inadequate to compensate them for their investment. This would be the case in highly levered firms, since the number of states of nature where the firm is bankrupt is greater. So, in highly levered firms, the shareholders have the incentive to forego some investments even if they are positive NPV for the firm as a whole. In addition, shareholders being residual claimants have payoffs that exhibit option-like characteristics. As leverage increases, riskier investments are likely to be undertaken by shareholders for the resultant payoffs to exceed the required bondholder payments. Thus, shareholders of highly levered firms have incentives to undertake more speculative investments and forego low risk positive NPV investments. Again, this would suggest that highly levered firms are likely to forego investments in quality enhancements and opt for riskier choices that render products less safe and recalls more likely.

Matsa (2011b) and Phillips and Sertsios (2012) focus on the supermarket and the airline industries, respectively, and provide empirical support for the above theories. Matsa (2011b) uses retailers' product shortfalls as a measure of product quality in the supermarket industry, and finds that higher leverage is associated with greater shortfalls. Phillips and Sertsios (2012) analyze the airline industry and find that product quality, as measured by baggage mishandling and on-time performance, decreases when the airline is in financial distress.

In this paper, we use a product recall as a proxy for product quality failure, consider a broad cross-section of all industries, and analyze the link between product quality and leverage/financial distress likelihood. Based on the above theories, we argue that highly levered firms and those with high distress likelihoods, either due to liquidity constraints or distorted incentives, are less likely to undertake quality enhancements and other safeguards that will reduce the incidence of product recalls. We, therefore, expect a positive relation between the likelihood of a recall and measures of financial leverage and probability of distress. We use measures of financial leverage based on book values (*Book leverage*) as well as market values (*Market leverage*) in our tests. In addition, to control for the possibility that some firms may be able to sustain high leverage without any adverse effects because they have higher earnings or cash flows or more liquid assets in the form of working capital, we use a measure of the financial viability of the firm as another metric of its financial condition. Specifically, we use the Altman Z-score (*Altman Z*) measure developed by Altman (1968) as a measure of the likelihood of financial distress, where by construction, firms with lower financial leverage or higher cash flows or liquid assets have a higher *Altman Z,* i.e., lower likelihood of financial distress. Therefore, high Z-score firms are likely to be in a better financial condition, and consequently we expect a negative relation between *Altman Z* and the likelihood of a product recall.

2.2. Control Variables

We use a variety of control variables that capture other economic factors that are likely to affect the probability of product recalls. Below, we provide theoretical justifications for their inclusion in our empirical analysis.

2.2.1. Market power

Starting with Chamberlin (1933) and Abbott (1955), the theoretical literature has long argued that firms with greater market power have the ability to reduce product quality to maximize their profits.[4] In contrast, firms operating in more competitive industries face greater market pressures to make necessary investments in physical and labor capital to reduce their chance of product quality failures and, thus, will

[4] Mazzeo (2003) and Matsa (2011a) document a negative relation between industry concentration and product quality in the airline and supermarket industry, respectively.

have a lower likelihood of recalls. To control for this competition-related effect we use the sales-based *Herfindahl index* of the recalling firm's industry, measured at the three-digit SIC level, in the regressions.

2.2.2. Unionization

Unionization is likely to affect employees' incentives to exert effort in the following ways. On the one hand, Baldwin (1983) and Bronars and Deere (1993) show that unionized firms underinvest in physical capital and operate at an inefficient level, with higher wage costs and lower profitability. Under this view, a higher unionization rate will increase the likelihood of a product recall. On the other hand, if unionization provides greater job security and affords a level of freedom to employees which improves decision-making and, thereby, product quality, we would expect a negative relation between unionization and the likelihood of a product recall. To control for this effect, we use *Unionization* as a control variable, where we measure unionization as the percentage of employees in the industry that are unionized.

2.2.3. Supplier-related Coordination costs

Sourcing its inputs from many suppliers can make a firm less dependent on any one supplier and, thus, is a way to reduce input-related risk (e.g., Shin, Collier, and Wilson, 2000). However, in the process the firm will incur higher coordination and transactions costs such as labor and order processing costs. Further, multiple sourcing can result in the reduction of overall quality as there will be more variation in quality of inputs from suppliers due to different production processes employed (e.g., Treleven, 1987; Treleven and Schweikhart, 1988; Kekre, Murthi, and Srinivasan, 1995). Thus, the potential for supply chain coordination problems are likely to be higher if a firm sources its supplies from a larger set of suppliers, which will lead to quality problems and a higher proclivity for product recalls. To control for the above effect, we use the *Number of Suppliers* used by the firm as a control variable.[5]

[5] FASB 14 requires firms to report the names of customers that account for at least 10% their sales. This information is available on the Compustat database. We use this data to generate the number of suppliers (*Number of suppliers*) for all firms in our sample. While this database does not allow us to capture *all* the suppliers for a given customer firm, we believe that it is a reasonable proxy in the sense that if the true number of suppliers is higher, the number we compute is likely to be higher too, i.e., there is generally a monotonic relation between our proxy for the number of suppliers and the true number of suppliers.

In a related vein, it has been argued that vertical integration reduces coordination costs associated with dealing with suppliers (e.g., Klein, Crawford, and Alchian, 1978; Ross, Westerfield, and Jaffe, 2008). A vertically integrated firm is likely to source some of its inputs internally and, thus, can potentially reduce coordination costs. In contrast, a non-integrated firm in the same industry will incur greater coordination costs in its dealings with supplier firms. These coordination problems can lead to an inefficient supply chain and poor production management, possibly resulting in lower product quality and, therefore, a greater propensity to recall products. Thus, we predict that vertically integrated firms will have a lower likelihood of a product recall. We use the Compustat segment tapes and the benchmark input-output tables published by the Bureau of Economic Analysis to create an indicator variable (*Vertical integration dummy*) that equals 1 for vertically integrated firms and 0 for non-integrated firms.

2.2.4. Long-term investments in quality

Firms that continually try to innovate and improve the quality of their current and future products by making long-term investments in quality are less likely to have product recalls.[6] R&D investments can be thought of as investments in innovations and/or long-term quality. In addition, Klein and Leffler (1981) suggest that firms are more likely to deliver high quality products in the presence of significant firm-specific assets that are not salvageable outside the firm. To the extent that investments in R&D capture firm-specific assets (e.g., Allen and Phillips, 2000; and Kale and Shahrur, 2007), we expect to see a negative relation between R&D intensity and the occurrence of a product recall. The specific control variable we use in this context is *R&D intensity,* which is defined as R&D expenditures over total assets.

2.2.5. Managerial ability and efficiency of operations

A large body of research examines whether managerial ability matters for firm performance and policies (e.g., Bertrand and Schoar, 2003; Gabaix and Landier, 2008; and Chang, Dasgupta, and Hilary, 2010). We expect that firms that are better managed and have higher efficiency of operations are less likely to observe breakdowns in quality. We use total factor productivity as a measure of managerial

[6] Daughety and Reinganum (1995) derive a model in which they assume that R&D investments make products safer and conclude that the optimal level of R&D investments related to product safety will be determined by the firm's marginal cost of product safety risk.

ability. Higher total productivity indicates that the firm's managers have been more efficient in using factors of production like labor and capital in generating sales.[7] We follow Faleye, Mehrotra, and Morck (2006) and calculate total factor productivity (*Total factor productivity*) as the residual from a regression of the logarithm of the firms sales on the logarithm of the number of employees and the logarithm of property, plant, and equipment, where the regressions are estimated at the two-digit SIC industry level and year.

2.2.6. Firm Size

Larger firms will produce and sell more products than smaller firms and, as such, the likelihood of quality failure will be higher for purely mechanical reasons. Larger firms are also likely to be more complex organizations with a larger number of external contracting relationships (e.g., Coles, Daniel, and Naveen, 2008). Thus, coordination costs arising from managing interactions between various parties within the firm as well as with external constituents are likely to be higher. As a result, there is a higher probability of opportunistic behavior by various parties – suppliers, workers, managers, etc. – leading to a higher propensity for product quality failures. We use the logarithm of market value of equity (*Size*) as a proxy for firm size.

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 2006 – December 2010 from three U.S. regulatory agencies that govern product quality and safety –*FDA*, *CPSC*, and *NHTSA*. 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 volume of recall, the reason for recall, and the recall date. 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

[7] It is possible that managers can attain higher total factor productivity in the short-run by pushing their factors of production too hard in generating sales. If this is the case, in the longer-run, there will be relatively more breakdowns and greater stoppage times which will lead to a higher incidence of product quality failures.

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 announcements have to be covered by at least one of the publication or information sources in Factiva.

Table 1 provides a summary of our final sample. It comprises of 816 recall events during the 2006–2010 period. Of these, 139 events are automobile recalls from *NHTSA*, 356 are food, drug, and medical devices recalls from *FDA*, and 321 are consumer product recalls from *CPSC*. 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 60 three-digit SIC codes. Table 2 shows the industry break-up of the sample using 2-digit SIC codes (33 different industry groups). Not surprisingly, Transportation equipment had the most recalls followed by Chemical and Allied products, Food and Kindred products, and Measuring and Controlling instruments. Industries such as Lumber and Wood products, Stone, Clay, Glass, and Concrete products had nearly no recalls. Also, service industries such as Transportation Services, Business Services, and Health Services were associated with few recalls.

3.2. Is a product recall a material event?

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 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.[8]

We compute the market model announcement period abnormal returns (CARs) for a variety of windows including (–2, +2), (–5, +5), (–10, +10), (–10, +2), and (–20, +20) around day 0, the announcement date of the product recall. We use the CRSP value-weighted market index 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 slightly wider windows is that some recall announcements are preceded by 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 all the way up to twenty days prior to the event. We also report the percentage of positive abnormal returns in each of the windows and the

[8] 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. A case in point is the 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).

abnormal dollar impact of the event on the firms' stock. The abnormal dollar losses (or gains) are computed as the product of the relevant CAR and the market capitalization of the firm's equity before the recall announcement.[9] The announcement period wealth effects are reported in Table 3. For the overall sample of all recalls, the (–5, +5) event window has an announcement period return of –1.72%, which is statistically significant at the 1% level. The results also show that, for this window, nearly two-thirds of all firms exhibit negative abnormal returns to the announcement of product recalls.

Product recalls result in over $300 million average abnormal *decrease* in market capitalization for the recalling firms. The average dollar wealth effect is even more negative (over $520 million) if we focus on the larger (–10, +10) window. Since there are many small scale recalls, we also compute the abnormal dollar change for the median firm. That figure is smaller, yet significant, at over –$38 million. These results are consistent across the different windows in the overall sample of recalls, and clearly demonstrate that product recalls are very significant events in the life of a company with substantial negative wealth effects for the shareholders of recalling firms.

We also decompose the sample into its three main constituent groups – the *FDA*, *CPSC*, and *NHTSA* recalls. The *CPSC* sample shows the most negative announcement period abnormal returns, resulting in –2.42% and –3.22% abnormal returns in the (–5, +5) and (–10, +10) windows, respectively. The *FDA* sample shows negative abnormal returns of –1.57% and –1.71% in the (–5, +5) and (–10, +10) windows, respectively. The figures are all statistically significant at the 1% level of significance. Since the *FDA* recall sample has larger firms compared to the *CPSC* sample firms, the dollar wealth effects are quite large in the *FDA* sample (–$320 million) despite the smaller magnitude in percentage returns. The *NHTSA* sample also shows a similar pattern. The abnormal returns are, however, less negative and are statistically significant at the 1% level only in the longer event windows such as the (–10, +10) window.

[9] 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), (-10, +2), and (-20, +20) event windows, we use the market capitalization twenty days prior to the recall announcement date.

3.3. Salient characteristics of product recall and control firms

Table 4 presents univariate comparisons between recalling firms and control firms. The univariate statistics on the leverage/financial distress (control) variables for each of the two groups are presented in Panel A (Panel B). The sample of control firms comprises of all firms that are from the same three-digit SIC industries as the sample (recalling) firms, but have not had a product recall in any of the years in our sample period. We perform a t-test to test for the equality of means between the recalling and control firms where we use robust standard errors that are clustered by firm. We also perform a Wilcoxon rank-sum test to test for the equality of medians.

In Panel A, we observe that recalling firms have significantly higher book leverage and market leverage, and significantly lower *Altman Z* score than control firms. Specifically, the mean *Book leverage* for recalling firms is 0.267, while it is 0.155 for control firms, with the difference between the two groups of firms being significant at the 1% level. We detect a similar pattern with *Market leverage*. Finally, the mean *Altman Z* for recalling firms is 3.64, while it is 4.41 for control firms. The difference in the mean *Altman Z* between the two groups of firms is significant at the 1% level. Note that a lower value for *Altman Z* is associated with a higher likelihood of financial distress. Thus, these univariate results are consistent with the notion that firms with either higher leverage or greater likelihood of financial distress may be forced to reduce investments in product quality, thereby resulting in an increased propensity for product recalls.

Further, in Panel B, we find that the *Herfindahl index* is significantly higher for recalling firms than for non-recalling firms. This result is consistent with the view that firms operating in concentrated industries face fewer product market pressures and, therefore, are more likely to have product quality failures. We also find that *Unionization* is significantly greater for recalling firms, which is consistent with the view that rent extraction by unions force firms to operate at higher costs and inefficient levels, thus increasing the likelihood of a product recall. In addition, recalling firms have significantly more suppliers from whom they source their inputs than control firms, suggesting that the associated higher supply chain coordination costs increase the frequency of recalls. Recalling firms have significantly lower

R&D intensity and total factor productivity. The lower R&D intensity among recalling firms is consistent with the view that they spend less on long-term investments to improve product quality. The lower total factor productivity of recalling firms is consistent with the notion that managers of recalling firms are less efficient than those of non-recalling firms. Finally, recalling firms are significantly larger in size than control firms. In the next section, we analyze probit regressions to examine the incremental impact of each of the above variables in affecting recalls in a multivariate setting.

4. Empirical analysis of recall incidence

4.1. The impact of leverage/financial distress on the incidence of product recalls: Basic results

In this section, we empirically investigate our hypotheses about firm- and industry-characteristics that can impact the likelihood of a product recall in a cross-sectional regression setting using probit regression models. Specifically, our main specification is:

$$\begin{aligned} \mathit{RecallDum}_{i,t+1} = {} & \beta_0 + \beta_1 \mathit{Financial\ leverage/Distress\ likelihood}_{i,t} + \beta_2 \mathit{Number\ of\ suppliers}_{i,t} \\ & + \beta_3 \mathit{Vertical\ integration\ dummy}_{i,t} + \beta_4 \mathit{Herfindahl\ index}_{i,t} + \beta_5 \mathit{Unionization}_{i,t} \\ & + \beta_6 \mathit{R\ \&\ D\ intensity}_{i,t} + \beta_7 \mathit{Total\ factor\ productivity}_{i,t} + \beta_8 \mathit{Size}_{i,t} \\ & + \mathit{Year\ and/or\ industry\ dummies} + \varepsilon_{i,t+1} \end{aligned} \quad (1)$$

In the above model, the dependent variable, *RecallDum* is a dummy variable that takes the value 1 if a product recall takes place for firm *i* in year *t+1*. All independent variables are *lagged* by one year to help alleviate concerns regarding reverse causality. We use three alternative proxies for the financial leverage/distress likelihood variable in the estimated regressions – *Book leverage*, *Market leverage*, and *Altman Z*. The inclusion of a number of control variables, as well as industry dummies, helps us account for the others factors likely to influence product quality as hypothesized in Section 2.

The results are reported in Table 5. We include year dummies in the regressions reported in Columns (1) – (3), while we include both year- and two-digit SIC industry dummies in the regressions reported in Columns (4) – (6). The table reports marginal effects and their respective *p*-values in parentheses. These *p*-values are based on heteroskedasticity robust standard errors and are clustered by firm. The results reported in all six columns indicate that if the firm either has higher leverage or has a higher likelihood of financial distress, then the likelihood of a product recall is larger. Specifically, we find that there is a significantly positive relation between the probability of a product recall and leverage – both book and market leverage – at least at the 5% level of significance in all the estimated regressions. Further, we find that the relation between the likelihood of a recall and *Altman Z* is negative and significant at the 1% level in the estimated regressions. Note again that a higher value of *Altman Z* signifies a lower probability of financial distress. These results are consistent with the hypothesis that firms with higher leverage or at a greater risk of financial distress, either due to liquidity constraints or distorted incentives, will invest less in product quality enhancements, thereby leading to an increased propensity for product recalls.

We also find that the relation between the probability of a product recall and *Herfindahl index* is significantly positive at the 1% level. This is consistent with the hypothesis that firms that see themselves as relatively immune to product market discipline because of market power are more likely to have quality failures as evidenced by a greater propensity for product recalls.[10] We further find that a higher degree of unionization in the industry (*Unionization*) increases the propensity for a firm to have a product recall (significant at the 1% level). This result is consistent with the notion that unions offer protection to workers and, as such, their incentives to enhance quality are diminished because their job risk is lower. Alternatively, since unions negotiate employment terms including wages and benefits, the fixed claims against the firm increase, and they may have to make some compromises on product quality to manage their overall costs.

In addition, we find the incidence of recalls is higher if the *Number of suppliers* is greater. This marginal effect is significant at the 1% level. This result is consistent with the idea that it is more difficult and costly to coordinate with suppliers and monitor the quality of all its inputs if the firm sources them from a larger number of suppliers, resulting in poorer quality products. In addition, we document a

[10] *Herfindahl index* is computed based on sales of all firms in the three-digit SIC industry covered in Compustat database. As a robustness test, we compute the fitted Herfindahl index based on the methodology outlined in Hoberg and Phillips (2010). Consistent with our prior results, we find a significantly positive relation between fitted Herfindahl index and the likelihood of a recall, while the coefficients on the other variables remain qualitatively similar.

negative relation, significant at least at the 5% level, between the probability of a product recall and the *Vertical integration dummy*. This suggests that vertically integrated firms are able to reduce coordination costs across different layers in the production process resulting in better quality products. Similarly, we find that the relation between the probability of a product recall and *R&D intensity* is negative in all the estimated regressions and significant at least at the 10% level. Thus, if *R&D intensity* can be construed as a proxy for innovation and/or long-term investments in quality, our results are consistent with the notion that firms that make such investments are less likely to experience quality failures. In addition, we find that there is generally a significantly negative relation between the propensity to have a product recall and *Total factor productivity*. If higher total productivity implies more efficient use of factors of production – labor and capital – in generating sales and, thus, can be thought of as a proxy for managerial ability, our results are consistent with the view that we are less likely to observe product recalls for firms with more efficient managers. Finally, we find that larger firms are more likely to have product recalls. This result can be attributed to the fact that larger firms are likely to be more complex organizations, which produce/sell in higher volumes and, thus, either due to greater coordination problems or for purely mechanical reasons are more likely to experience quality failures.

To more intuitively assess the economic significance of our leverage-related results, we examine the change in implied probability of a product recall if the value of the leverage variable in question changes from its 10^{th} to 90^{th} percentile value, while all the other independent variables take on their median values. The change in implied probability has to be evaluated relative to the unconditional probability of a recall of 6.59% (796 recall observations from a total of 12,081 total observations). For purposes of brevity, we provide these numbers only for Models 1 – 3 of Table 5.

We find that as *Book leverage* changes from its 10^{th} to 90^{th} percentile value (Model 1), the implied probability of a product recall goes up by 0.96%. To give some perspective, this amounts to a percentage increase of about 14.6% relative to the unconditional probability of a recall (equal to 0.96/6.59). Similarly, when *Market leverage* changes from its 10^{th} to 90^{th} percentile value (Model 2), the implied probability of a product recall goes up by 1.39%; this amounts to a percentage increase of about

21.1% relative to the unconditional probability of a recall (equal to 1.39/6.59). Finally, when *Altman Z* changes from its 10th to 90th percentile value (Model 3), the implied probability of a product recall goes down by –1.54%, which is equivalent to a percentage decrease of about 23.4% relative to the unconditional probability of a recall (equal to –1.54/6.59). Thus, it appears that these leverage/financial distress variables have a significant economic impact as well on the incidence of product recalls.

4.2. Is the relation between firm leverage/financial distress and recall incidence causal in nature?

In this section, we perform several additional tests to more definitively conclude that financial leverage and distress likelihood affect the propensity for a product recall. It may be that the results in Table 5 are driven by the possibility that leverage proxies for some other factor such as inefficient management or weak industry conditions that are also correlated with low product quality, and hence, product recalls. This is partly addressed by having (i) control firms that are from the same industry as the recalling firms but do not have recalls themselves, (ii) using proxies for managerial efficiency and other control variables, and (iii) including industry and time dummies in our regressions. To address the possibility that there may be some missing latent factor that is correlated with both leverage and recalls and not fully captured by any of the above mechanisms, we perform additional tests in an attempt to more firmly establish the causal link between leverage and recalls.

First, we identify two exogenous shocks that negatively affect cash flows of the firms in the recalling industry — industry tariff cuts and industry input price increases. We then examine the impact of these shocks on the relation between firm leverage/financial distress and recall incidence. Second, we utilize a 2SLS methodology to empirically account for the possibility that some missing latent factor, e.g., managerial ability, can impact both leverage and recall incidence.[11] Finally, we further examine whether it is indeed leverage that leads to a higher propensity for product recalls by using even longer lags of the financial leverage/financial distress independent variables.

[11] Note that in all the regressions reported in Table 5 we explicitly include *Total factor productivity* as a proxy for managerial ability.

4.2.1. Quasi-natural experiments

Recent research that examines the impact of financing on product market outcomes addresses endogeneity concerns by considering shocks to either the competitive environment or financial market conditions (see, e.g., Fresard, 2010; Campello, 2003; Khanna and Tice, 2000; and Zingales, 1998). We consider the impact of two largely exogenous shocks – a significant reduction in tariffs and a large increase in industry input prices. Both shocks will have an impact on the cash flows of firms in the industry, but the impact will be felt disproportionately by firms with higher leverage. Specifically, these firms will be forced to make drastic cost cuts and substantially reduce product quality to avoid financial distress. In addition, high leverage and high distress likelihood firms will face exacerbated debt overhang and asset substitution problems compared to the low leverage firms because of the stress imposed on their profits and cash flows following the shocks. Thus, we expect the relation between leverage and recall incidence to be stronger for firms impacted by the adverse cash flow shock relative to firms unaffected by the shock.

If firms with high leverage and distress likelihood were not actually faced with greater constraints or weaker investment incentives that impact their product quality, then these exogenous shocks which affect their financial condition should not have any incremental impact on their likelihood of product recalls. As such, our empirical strategy amounts to a difference-in-differences approach – that is, we are effectively comparing the change in product recall propensity from before the shock to after the shock in high versus low leverage firms. Specifically, we estimate the following probit model to test our prediction:

$$\begin{aligned} RecallDum_{i,t+1} &= \beta_0 + \beta_1 Shock\ dummy_{i,t} + \beta_2 Financial\ leverage/Distress\ likelihood_{i,t} \\ &+ \beta_3 Shock\ dummy_{i,t} * Financial\ leverage/Distress\ likelihood_{i,t} + \beta_4 Number\ of\ suppliers_{i,t} \\ &+ \beta_5 Vertical\ integration\ dummy_{i,t} + \beta_6 Herfindahl\ index_{i,t} + \beta_7 Unionization_{i,t} + \beta_8 R\ \&\ D\ intensity_{i,t} \\ &+ \beta_9 Total\ factor\ productivity_{i,t} + \beta_{10} Size_{i,t} + Year\ and/or\ industry\ dummies + \varepsilon_{i,t+1} \qquad (2) \end{aligned}$$

Our empirical strategy is to estimate the same probit regression model detailed in Equation (1), but with the addition of the shock variable and the interaction between the shock variable and the specific financial leverage/distress likelihood variable. We expect the impact of financial leverage/distress on recall incidence to be stronger for firms impacted by the exogenous shock (i.e., $\beta_3 > 0$).

4.2.1.1. Significant cut in industry tariff rates

The first shock that we consider is a significant cut in industry tariff rates. A significant decrease in the tariff rate will increase foreign competition and, as such, represent a cash flow shock to all domestic firms in the industry. To measure significant reductions in the tariff rate, we follow an approach similar to that described in Fresard (2010). Specifically, we first obtain U.S. import data from the United States International Trade Commission (*USITC*) website. In particular, we download the annual values for *Calculated Duties* and *Imports by Custom Value* by the four-digit NAICS industry over the period 1997 – 2010.[12] The tariff rate for an industry-year is computed as *Calculated Duties* divided by *Imports by Custom Value.* Next, we compute the annual percentage change in the tariff rate for each industry-year observation. We then measure the median level of the annual percentage change for each industry across all years. Finally, an annual percentage *drop* in tariff rate for any industry-year is considered a significant tariff cut if it was at least 2.0 times the industry median level (in alternative specifications we also use thresholds of 2.5 and 3.0 times).[13] Furthermore, to ensure that large tariff cuts reflect permanent rather than transient changes in tariffs, we exclude tariff cuts if there was a comparable large percentage increase in the tariff rate the following year. Overall, the procedure likely captures exogenous changes in product market competition as measured by significant permanent cuts in tariff rates. We create an indicator variable *Tariff cut dummy* set to 1 for an industry-year that recorded a significant drop in tariff rates, and 0 otherwise.

The results from the estimated probit regressions are reported in Table 6. Note that the sample size is smaller in the reported regressions in this table because information to compute tariff rates is only

[12] *Calculated Duties* represents the estimated import duties collected which in turn are based on the applicable rate(s) of duty as shown in the Harmonized Tariff schedule. *Imports by Custom Value* is the value of imports as appraised by the U.S. Customs Service. (Source: http://dataweb.usitc.gov/).

[13] We slightly modify our procedure in cases where the industry median level is a positive number as these instances would fail to register any tariff reduction as a tariff cut. In particular, in industries where the industry median was positive, an annual percentage *drop* in tariff rate for an industry-year is considered a significant tariff cut if it was at least 2.0 times the industry median level in absolute terms.

available for manufacturing industries. We do not include industry dummies in Columns (1) - (3), but do include them in Columns (4) - (6). The financial leverage/distress likelihood variable is *Book Leverage* in Columns (1) and (4), *Market Leverage* in Columns (2) and (5), and *Altman Z* in Columns (3) and (6). In the estimated probit regressions in Columns (1), (2), (4), and (5), the marginal value related to the interaction term between *Tariff cut dummy* and either *Book leverage* or *Market leverage* is significantly positive at the 5% level. For example, the marginal value on the interaction term, *Tariff cut dummy * Book leverage* is 0.0153 in Column (4), and is significant at the 5% level. Further, the marginal value related to the interaction term between *Tariff cut dummy* and *Altman Z* is significantly negative at the 10 % level. We, thus, find that the impact of leverage/financial distress on the propensity for a product recall is significantly stronger if the firm is faced with an exogenous negative cash flow shock arising from a large decrease in import tariffs. Thus, this difference-in-difference estimation procedure is consistent with the causal impact of leverage/distress on the propensity for product quality failures.

4.2.1.2. Negative input price shocks

The second shock that we examine relates to a large increase in industry input prices. As with significant reduction in tariff rates, a sharp increase in industry input prices will also represent a cash flow shock to firms in the industry. Our process to compute significant industry input price increase is as follows. For each recalling industry in our sample, we identify the five most important supplier industries, i.e., supplier industries that the recalling industry is most heavily reliant upon to manufacture its output. We use the 2002 benchmark input-output tables of the U.S. economy published by the Bureau of Economic Analysis (*BEA*) to identify the supplier input-output (*IO*) industries. We then obtain supplier industry prices using the *Producer Price Index* (*PPI*) constructed by the Bureau of Labor and Statistics (*BLS*). The *PPI* reflects price movements for the net output of producers at the industry level. Monthly *PPI* data are adjusted for inflation by the Gross Domestic Product deflator to obtain the real *PPI (RPPI)*. Data at the six-digit NAICS level are matched to the 2002 IO industries. When finer data is not available, four-digit NAICS level data are matched to IO industries.

We compute input price shocks as follows. For each recall and control observation in our sample we use the year and month of the fiscal year end where we measure leverage and other control variables as our reference date. We obtain 60 months of monthly *RPPI* ending in the reference date for the five supplier industries associated with each recalling industry-year in our sample. For every industry-year, these five supplier monthly *RPPI* series are then aggregated into a weighted *RPPI* series where the weights are the relative importance of each supplier industry to the downstream industry. The monthly weighted *RPPI* are averaged into annual *Weighted RPPI Series* for each of the five years before the reference date. Our input price shocks are based on the *Weighted RPPI Series*. In particular, we create an indicator variable *Negative input price shock dummy* which is set to 1 if the geometric average growth rate over the three years before the recall is 5% or greater, and 0 otherwise. As an alternative, we define a similar input price shock using a five year window as well.

The results from this analysis are reported in Table 7. The structure of this table is identical to that of Table 6 with the exception that our focus is now on the impact of input price shocks, rather than tariff cuts, on the relation between firm leverage/financial distress and the propensity for a product recall. In the estimated probit regressions in Columns (1), (2), (4), and (5), the marginal value related to the interaction term between *Negative input price shock dummy* and either *Book leverage* or *Market leverage* is significantly positive at least at the 10% level. For example, the marginal value on the interaction term, *Negative input price shock dummy* * *Book leverage* is 0.0111 in Column (4), and is significant at the 5% level. Further, the marginal value related to the interaction term between *Negative input price shock* and *Altman Z* is significantly negative at the 1 % level. Here too we find that the impact of leverage/distress likelihood on the propensity for a product recall is significantly stronger if the firm is faced with an exogenous negative cash flow shock. The difference here is that the quasi-natural experiment pertains to increases in input prices and not tariff cuts. Thus, this additional difference-in-differences estimation procedure is also consistent with the causal impact of leverage/distress likelihood on the propensity for product recalls.

4.2.2. Instrumental variable approach

The relation between financial leverage and recall incidence documented in Table 5 can be due to a missing latent factor that affects both leverage and the propensity for a recall. One approach to address this issue would be to estimate firm fixed effects regressions, which would control for time invariant firm-specific factors that affect both the financial position and the recall propensity of the firm. However, firm fixed effects regressions are not possible in our setting because the data in this study do not comprise a panel since our control firms are firms from the same industry as the recalling firms, but have not had a recall during the five-year sample period. That is, recall firms do not enter the control group, and vice-versa, so there is no within-firm variation in the recall/control status of the firms in the study.

Another approach to address the possibility that both leverage and recall incidence are endogenously determined by a missing latent factor is to use a 2SLS estimation framework. This approach would control for any time varying latent factors that affect both the firm's leverage and recall likelihood. In the 2SLS method, we instrument for the specific leverage-related variable in the first stage and use a linear probability model in the second stage to model the propensity for a recall. We use industry leverage (excluding the firm) as an instrument for the firm-level financial leverage variables. We believe this is a good instrument because Leary and Roberts (2010) show that firm leverage is significantly influenced by industry leverage after controlling for other economic factors that capital structure theories would suggest and further because there is no reason to believe that industry leverage directly affects a firm's propensity for a recall other than through its effect on firm leverage. Further, we employ exactly-identified specifications because it is difficult to find good instruments and the benefits of instrument validity tests are unclear (Roberts and Whited, 2011).

The results from our analysis are reported in Table 8. In this table, we present coefficients from OLS regressions in odd numbered columns and coefficients from 2SLS regressions in even numbered columns. We use *Book Leverage*, *Market leverage*, and *Altman Z* as the measure of financial leverage/distress likelihood in the first, second, and third pair of columns, respectively. We provide OLS regression results to illustrate that our linear probability model results are similar is spirit to what we presented earlier in Table 5 using probit regression models. Specifically, in these regressions, we find that consistent with our hypothesis, *Book Leverage* (Column 1) and *Market Leverage* (Column 3) are significantly positively related, while *Altman Z* (Column 5) is significantly negatively related to the propensity for product recalls.

In all our estimated 2SLS regression models, we find that our industry leverage instrument is highly significant in the first-stage regression and the F-statistic for relevance is greater than 10 (Columns 2, 4, and 6). Further, in all models, the Kleibergen-Paap rk LM test statistic rejects the null hypothesis that the equation is under-identified indicating that the chosen instruments are highly correlated with the endogenous regressors. Our test for endogeneity indicates that, given the chosen instrument, the use of the 2SLS approach is appropriate. The coefficients on the leverage-related variables remain statistically significant (at the 1% level) in the second stage regression and in the predicted direction. For example, in Column 2, the coefficient on *Book leverage* is 0.2847, and is statistically significant at the 1% level. Thus, our instrumental variable estimations provide further support for a causal link between firm leverage/distress likelihood and quality failure events.

4.2.3. Reverse causality

As noted earlier, we lag our leverage-related variables by one year to help alleviate concerns regarding reverse causality between leverage and recall incidence. We additionally compute the average of the firm-specific independent variables in Equation (1) for the years *t-1* and *t-2* and use these as independent variables instead of their respective values for just year *t*. Our results with these *longer* lagged average leverage variables are qualitatively similar to those reported in Table 5. In the interest of brevity, we do not tabulate these results.

5. Wealth effects of recalling, rival, and supplier firms around recall announcements

5.1. Univariate wealth effects of rival and supplier firms

In Table 9, we present the stock price reaction of rivals and key suppliers of firms that announce recalls. We expect two effects to be at play. One effect is the *competitive* effect where the product recalls have a negative effect on customer perception about the company's product quality and this shifts demand to the firm's rivals. In a related vein, industry rivals will be 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 if they are financially strong relative to the recalling firm. This effect should result in positive announcement period abnormal returns for the rivals.

Another effect is the *contagion* effect. If the product recall comes with adverse effects for the industry as a whole, such as increased regulatory attention, newer packaging, or other product standards for all firms in the industry, then we should observe a negative stock price reaction for the rivals.[14] 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 9-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 cars suffered sales declines following severe automobile recalls. If both competitive and contagion effects are in play, then the effect on rival firms will depend on which one of these two effects dominates.

The results in Panel A of Table 9 show the announcement-period abnormal returns for the rivals. Rivals are 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.

In the full sample of rivals (*FDA*, *CPSC*, and *NHTSA* together), the abnormal returns for rivals in the (–5, +5) window is a statistically insignificant –0.15% (t-value = –1.62). The abnormal returns in the (–10, +10) and (–20, +20) windows are –0.35% and –0.63%, which are statistically significant at the 5% and 1% levels, respectively. The abnormal returns in the other windows tend to be negative but are

[14] Lang and Stulz (1992) and Hertzel, Li, Officer, and Rodgers (2008) examine contagion and competitive effects in the context of bankruptcy announcements.

generally statistically insignificant. We observe a pattern of mostly negative but statistically insignificant abnormal returns when we analyze the rivals of recalling firms in the three categories separately. Overall, these results are consistent with the view that both competitive and contagion effects are at play in the recalling industries, but the contagion effect dominates slightly and renders a product recall a slightly negative event for all firms in the industry.[15]

Panel B of Table 9 analyses the abnormal returns to the key suppliers of the recalling firms. Key suppliers of each firm are identified from the Compustat database based on the FASB No. 14 requirement that firms report their customers that account for at least 10% of sales. For each recalling firm, we then form an equally-weighted portfolio of the firm's key suppliers to compute the announcement-period abnormal returns 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. 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 the suppliers.

Our results are strongly consistent with the view that product recalls do have a significant negative impact on the demand for the products of the upstream firms (key suppliers). Specifically, in the overall sample of suppliers of all recalling firms, we observe negative abnormal returns in all the event windows. For example, the announcement period abnormal returns are –1.23% and –1.85% in the (–5, +5) and (–10, +10) windows, respectively. Both are statistically significant at the 1% level. Similar results are found when we analyze the suppliers in the three sub-samples, *FDA*, *CPSC*, and *NHTSA*, separately. The percentage of suppliers with negative abnormal returns is also statistically significantly different from

[15] To further explore the contagion hypothesis, we follow Hertzel, Li, Officer, and Rodgers (2008) and examine rival firms' wealth effects based on two sub-samples split by the median *Herfindahl index* of the recalling firm's industry. Lang and Stulz (1992) and Hertzel, Li, Officer, and Rodgers (2008) contend that contagion effects are likely to dominate competitive effects in low concentration industries since there are fewer economic rents to be appropriated from rivals in such (competitive) industries. Consistent with their arguments, in untabulated results, we document generally negative and significant wealth effects to the rivals of the recalling firm in the low-concentration sub-sample. In contrast, the wealth effects to the rivals are insignificant in the high-concentration sub-sample, which is consistent with the view that competitive effects more fully offset contagion effects in oligopolistic industries.

50% in all the windows and at least at the 5% level of significance. These results indicate that suppliers suffer the direct adverse consequences of a product recall by a downstream firm.[16] These results are similar in spirit to those documented in Hertzel, Li, Officer, and Rodgers (2008) who find vertical contagion effects following corporate bankruptcy events.

5.2. Determinants of wealth effects of product recall firms

In this section, we examine the determinants of the announcement-period wealth effects to recalling firms in a multivariate setting. Bolton and Scharfstein (1990) present a model of optimal financial constraints in response to agency problems and show that financial constraints lead to predation by less constrained rivals. Chevalier (1995) studies predation among supermarket stores following LBOs in the industry. She finds evidence of predation by industry rivals following leveraged buyouts by firms but only when the rivals are not themselves highly levered. In a similar vein, Phillips (1995) analyzes product pricing in four industries following highly leveraged transactions. He finds evidence of predation following large leverage increases, but again, only where the rivals are not highly levered. Both Chevalier (1995) and Phillips (1995) do not find any evidence of predation following highly leveraged transactions when the rivals are also highly levered, i.e., when the rivals are themselves too constrained to take advantage of the recalling firm's financial weakness. These findings suggest that more than own leverage, the leverage of the recalling firms *relative* to those of their industry rivals is an important indicator of the magnitude of losses a firm might suffer due to the product recall crisis. This relative leverage variable captures not only the financial weakness of the recalling 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. We, thus, predict 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.

[16] In unreported results, we also examine the wealth effects of the recall event on the key suppliers of the industry-rival firms (but who are not the key suppliers of the recalling firm) and find insignificant abnormal returns to them.

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 (*Altman Z*) to the industry average leverage (*Altman Z*) as our primary metric to capture the leverage effects.[17] Note that in the case of *Altman Z*, since larger scores indicate a lower likelihood of distress, we expect the relative *Altman Z* score to be positively related to the announcement period returns for the recalling firms. 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.

Since we can estimate the factors that affect announcement returns only for the recalling firms, we have a potential sample selection problem that arises due to this incidental truncation bias (Wooldridge, 2010). To correct for this problem, we employ a two-stage Heckman selection model. In the first stage of this approach, we model the propensity of a product recall using the variables in Equation 1. To satisfy the exclusion restrictions of the Heckman selection model, for each firm-year (year t in equation 1) we compute the proportion of firms in the industry (excluding the recalling firm) with a recall in year t, and include it as an instrumental variable in all first stage estimations. We believe that this instrument will be highly correlated with the likelihood of the firm having a recall. 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 return (other than through its effect on the likelihood of the recall modeled in the first stage). We, therefore, believe this instrument meets both the relevance criterion and the exclusion restriction.

In the second stage, we model the determinants of the stock price reaction to recalling firms. We report these results in Table 10. In all the models in the table, the announcement period abnormal returns are measured over the (–5, +5) window. Further, all reported regressions are estimated using weighted

[17] We exclude the recalling firm when we compute the average industry leverage.

least squares regressions, where the weights are the inverse of the standard deviation of market model residuals. The coefficient associated with *Firm to industry book leverage* (Model 1) and *Firm to industry market leverage* (Model 2) is negative and statistically significant at least at the 10% level in the regressions. In a similar vein, *Firm to industry Altman Z* is positive and statistically significant. These results are consistent with the view that the 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.[18]

5.3. Determinants of wealth effects of industry rival firms

In this section, we undertake a more detailed 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 using factors we expect can affect the returns in a multivariate setting. We report two regression specifications in Table 11; one where the dependent variable is the abnormal returns of the rivals measured over our main (–5, +5) window, and another where it is measured over the longer, (–10, +10) window. The reason for our considering the longer (-10, +10) window 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 such as customers and suppliers.

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 leverage and Firm to industry Altman Z,* in order 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

[18] Our inferences remain unchanged even if we directly estimate weighted least squares regressions instead of using the Heckman two-stage selection models to explain the determinants of recalling firm wealth effects.

following the recalls. Thus, we expect *Firm to industry book leverage* and *Firm to industry market leverage* measures to have a positive coefficient and *Firm to industry Altman Z* to have a negative coefficient in the rival abnormal returns regressions. We use *Size* and *Initial recall dummy* as control variables in our regressions.

The results in Table 11 indicate that the coefficient associated with *Firm to Industry Book Leverage* and *Firm to Industry Market Leverage* are positive in all the regressions and in both the (–5, +5) and the (–10, +10) announcement-period windows. However, only *Firm to industry book leverage* is statistically significant, at least at the 5% level, in all the regressions. The coefficient of *Firm to Industry Market Leverage* has a positive sign but is statistically significant in only one of the regressions across both windows. In a similar vein, *Firm to Industry Altman Z* is negative and statistically significant in all the regressions. 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 or have higher distress likelihood 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- and distress-related competitive effects that are beneficial to the rivals, 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 would also be bad news for the rivals. If there are any contagion effects, we should see a positive relation between the recalling firm CARs and the rival CARs after controlling for relative leverage or distress likelihood. The results in Table 11 indicate that recalling firm CARs are positively related to rival firm CARs measured over both the (–5, +5) and the (–10, +10) announcement-period windows. However, the coefficients are statistically significant only for the CARs measured over the (–5, +5) window. These results are weakly consistent with the view that there are contagion effects in product recalls.

The initial recall dummy has a positive coefficient in all the regressions, but is statistically significant in only the models where the rival CARs are measured over the (–5, +5) window. Again, the evidence is weakly consistent with the view that initial recalls are viewed positively for the rivals especially after controlling for any contagion effects that may be captured by the coefficient on the recalling firm CARs in the regression. 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 leverage than them.

5.4. Determinants of wealth effects of key supplier firms

In this section, we examine the determinants of the wealth effects of key supplier firms 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 12. The dependent variable is the abnormal returns of the key suppliers measured over the (–5, +5) window in Panel A and over the (-10, +10) window in Panel B.

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, its key suppliers will also be affected by its inability to fully deal with the aftermath of the product recall announcement. We, therefore, hypothesize that there should be a negative relation between the abnormal returns to the key supplier firms and measures of relative leverage of the recalling firm. This effect, however, may not be a first-order effect. On the other hand, if the key suppliers themselves are highly levered, then a negative shock like a product recall to an important customer will 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.

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 10 and 11, the *Initial recall dummy* and *Size* are control variables in Table 12 too.

We find some weak evidence of a negative relation between key suppliers' abnormal returns and relative leverage. Specifically, in both panels, the coefficient associated with the specific measure of relative leverage is always in the correct direction (negative), but it is significant at the 10% level in 3 out of 6 models in Panel A and 2 out of 6 models in Panel B. This is weakly 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. *Supplier leverage*, however, is significantly negatively related to supplier firm's *CAR* in every estimated regression at least at the 10% level, indicating that the ability of suppliers to deal with a negative shock to a key customer is hampered if their own financial position is weak. Finally, the coefficient on *Supplier R&D intensity* is significantly negative at the 1% level in all estimated models in both panels, thereby suggesting that key suppliers who make greater relationship specific investments in the recalling firm are more adversely affected by the announcement of the product recall. Essentially, this result says that suppliers who have high switching costs suffer more when their key customer endures a recall.

Finally, we include the recalling firm's abnormal returns as one of the determinants of suppliers' abnormal returns in models with odd numbers in both panels of Table 12. Including this variable allows us to address if 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 least at the 1% level in all three estimated models that include this variable (Models 2, 4, and 6) in both panels, which is consistent with the view that suppliers suffer more when recalling firms' losses are greater.

6. The effect of relative leverage on the value impact of product recalls: The role of industry structure

For our overall sample, we find that a recalling firm's relative leverage is negatively related to its announcement CARs, but is generally positively related to the rivals' CARs. We interpret these results to indicate that higher relative leverage puts recalling firms at a competitive disadvantage vis-à-vis their industry rival firms. These competitive effects, however, are likely to be stronger in concentrated industries because there are more economic rents that can be expropriated from recalling firms in these industries (Lang and Stulz, 1992). To explore this hypothesis, we examine the impact of relative leverage on the wealth effects of recalling firms and their industry rival firms separately for two sub-samples split by the median *Herfindahl index* of the recalling firm's industry. We expect our full sample results to be largely confined to product recalls by firms operating in concentrated industries. This analysis also has the additional benefit of informing us whether the impact of relative leverage is indeed confined to concentrated industries, which, theory argues is where the strategic interaction between the recalling firm and its rivals is likely to be observed. We empirically examine these issues in Tables 13 and 14.

In Table 13, we examine the relation between recalling firm CARs and measures of relative leverage in concentrated and competitive industries separately. For each of our three measures of relative leverage we estimate two regressions – the first for the sub-sample of recalling firms operating in concentrated industries and the second for the sub-sample of recalling firms operating in competitive industries. In each regression, all the explanatory variables are identical to those employed in regressions for the full sample in Table 10. Consistent with our conjecture, the relation between recalling firm wealth effects and our relative leverage/distress likelihood measures is significant and in the hypothesized direction only in the sub-sample of recalling firms operating in concentrated industries. The coefficient on these measures of relative leverage is statistically insignificantly different from zero in the sub-sample of recalling firms operating in competitive industries. Thus, it appears that recalling firms are worse off when they have a relatively higher leverage (or equivalently higher distress likelihood) than their industry rivals only in oligopolistic industries.

We conduct a similar analysis for the wealth effects of rival firms in Table 14. The explanatory variables in this table are rival firm CARs and are identical to those employed in Table 11. We examine the wealth effects to rival firms over the event window (–5, +5) in Panel A and over the event window (–10, +10) in Panel B. The independent variables of interest in these regressions are the three measures of relative leverage/financial distress. We find that leverage/distress-likelihood disparity between recalling firms and rivals is significantly positively related at least at the 5% level to the stock price reaction of rivals (in two of three estimated regressions in Panel A and in all three estimated regressions in Panel B) only in concentrated industries – that is, in industries where we expect the competitive benefits to be high. We find no such benefits in low concentration industries.

Furthermore, we find that there is a significant positive relation between the recalling firm wealth effects and rivals' wealth effects at least at the 10% level in all six estimated regressions for the sub-sample of recalls in low concentration industries. We find an insignificant relation between the two in the sub-sample of recalls in concentrated industries. These results are consistent with the arguments made in Lang and Stulz (1992) and Hertzel, Li, Officer, and Rodgers (2008) that contagion effects are more apparent in the low concentration industries as there are fewer economic rents to be appropriated from rivals (i.e., competitive benefits) in such industries.

In summary, we find: (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 *only* in the concentrated industries sub-sample as predicted by theory. 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 in concentrated industries) or more benefited by higher relative leverage (rival firms in concentrated industries).

7. Summary and conclusions

In this paper, we study the role of financial leverage and likelihood of financial distress in explaining the incidence of severe product failures that result in product recalls. Further, we examine the role of leverage and financial distress likelihood of the recalling firm *relative* to its industry rivals in explaining the value consequences of product recalls to the firms, rivals, and suppliers. We also analyze whether the nature of the product market – i.e., whether the industry is high concentration (oligopolistic) or low concentration – has an impact on the role of relative leverage in explaining the value consequences of product recalls on the recalling firms and their industry rival firms. Finally, we study whether there are any adverse contagion effects associated with recalls.

To empirically analyze the hypotheses, we use a sample of 816 product recalls campaigns announced by publicly traded firms during the period 2006 - 2010. Our sample spans multiple industries such as consumer products, automobiles, food, drug, and medical devices. Probit regressions indicate that high leverage and a greater likelihood of financial distress are associated with higher incidence of product recalls. To make a causal argument, we condition our tests on two exogenous negative shocks to firm cash flows – (i) cuts in import tariffs which increase competition for domestic firms, and (ii) input price shocks which increase input costs for firms. Additionally, we treat firm leverage/financial distress variables as endogenous in two-stage least squares regressions to examine the impact of leverage on product recalls. The results consistently indicate that firms with high financial leverage or high likelihood of financial distress are indeed more likely to suffer product recalls.

In our examination of value consequences to the recalling firms and their industry rivals, we find that the stock price reaction of recalling firms is more negative while the rival's reaction is more positive when the recalling firm is relatively more leveraged or has higher distress likelihood relative to its industry rivals. These findings suggest that there are more predation-related benefits to rivals when they are dealing with a financially vulnerable recalling firm as is predicted in Bolton and Scharfstein (1990), Phillips (1995), and Chevalier (1995). Moreover, we find that the recalling firm and rival valuation effects seen above are stronger in concentrated industries where the strategic effects of debt are expected to be more pronounced (e.g., Kovenock and Phillips, 1997; and Lang and Stulz, 1992).

In studying supplier stock price reactions to the product recall, we find that suppliers who themselves have higher leverage suffer greater value losses. We also find weak evidence that the suppliers are worse off when the relative-to-industry leverage of the recalling firm is large – highlighting the consequences of being overly reliant on a financially weak downstream customer. Furthermore, we find that the key suppliers' stock prices are more adversely affected if they have made more relationship-specific investments, suggesting that it is more difficult for these suppliers to switch to the industry rivals of the recalling firm. Finally, we document a positive relation between the abnormal returns of the recalling firms and those of their key suppliers. In a similar vein, we document a positive relation between the abnormal returns of the recalling firms and those of their industry rivals. These results indicate that there are both horizontal (industry-wide) and vertical (supplier) contagion effects from product recalls.

The contributions of this study are multifaceted. First, the study fills a gap in the financial economics literature by using the incidence of a product recall as a proxy for severe quality failure to examine the role of firm financial health in explaining quality failures. Second, since product recalls can be traced back to an exact recall date, we are able to conduct an in-depth examination of the impact of leverage/distress likelihood on the valuation consequences of recall events to the recalling firms, their rivals, and key suppliers. Earlier studies that examine the role of leverage on quality were unable to conduct such an analysis because they did not have a well-defined quality failure event such as a product recall. Third, the availability of product quality failures data across multiple industries enables us to conduct a more nuanced analysis of the relation between relative financial condition of firms and the value consequences of recalls. Specifically, we are able to test the contention in the literature that the financial condition, and resulting strategic actions, of firms has a greater impact on rivals in oligopolistic industries than in competitive industries. Fourth, the findings from this study have some public policy implications as well because it gives U.S. product safety watchdogs insights that can possibly improve their regulation of product safety practices. Finally, our findings will also help firms identify factors that affect recalls so that they can better target the highest acceptable level for the likelihood of a recall.

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, instead of dividing the numerator by *AT* we divide it 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 year of announcement.

b. *Altman Z*

Altman Z is the Altman Z-score score developed in Altman (1968). It is calculated as 3.3*(Compustat item *EBIT*/Compustat item *AT*) + (Compustat item *REVT*/Compustat item *AT*) + 1.4*(Compustat item *RE*/Compustat item *AT*) + 1.2*([Compustat item *ACT* – Compustat item *LCT*]/Compustat item *AT*) + 0.6*([Compustat item *CSHO* x Compustat item *PRCC_F*]/Compustat item *LT*). All Compustat items are measured for the year prior to year of announcement.

c. *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.

d. 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.

e. 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.

f. 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.

g. 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.

h. 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.

i. Size

It is the logarithm of the market value of equity for the recalling firm (control 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. Firm to industry Altman Z

Firm to industry Altman Z is the ratio of the Altman Z-score of the recalling firm to the Altman Z-score of the industry peers. The recalling firm itself is not considered in computing the measure for the industry peers.

c. 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.

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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 2006 – 2010. 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	*FDA*	*CPSC*	*NHTSA*	Overall
2006	58	65	39	162
2007	60	96	31	187
2008	63	57	21	141
2009	90	49	15	154
2010	85	54	33	172
Total	356	321	139	816

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 2006 – 2010. 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 Code	Description of industry	Number of recalls
1	Agricultural Production Crops	3
2	Agriculture production livestock and animal specialties	2
20	Food And Kindred Products	98
23	Apparel And Other Finished Products Made From Fabrics	4
24	Lumber And Wood Products, Except Furniture	1
25	Furniture And Fixtures	4
27	Printing, Publishing, And Allied Industries	3
28	Chemicals And Allied Products	140
29	Petroleum Refining And Related Industries	1
30	Rubber And Miscellaneous Plastics Products	8
31	Leather And Leather Products	4
32	Stone, Clay, Glass, And Concrete Products	1
34	Fabricated Metal Products, Except Machinery And Transportation Equipment	13
35	Industrial And Commercial Machinery And Computer Equipment	41
36	Electronic & Other Electrical Equipment And Components, Except Computer Equipment	41
37	Transportation Equipment	159
38	Measuring, Analyzing, And Controlling Instruments	73
39	Miscellaneous Manufacturing Industries	37
47	Transportation Services	1
48	Communications	4
50	Wholesale Trade-durable Goods	4
51	Wholesale Trade-non-durable Goods	3
52	Building Materials, Hardware, Garden Supply, And Mobile Home Dealers	4
53	General Merchandise Stores	51
54	Food Stores	40
55	Automotive Dealers And Gasoline Service Stations	1
56	Apparel And Accessory Stores	18
57	Home Furniture, Furnishings, And Equipment Stores	22
58	Eating And Drinking Places	7
59	Miscellaneous Retail	10
73	Business Services	1
80	Health Services	2
99	Non-classifiable Establishments	15

Table 3

Announcement period wealth effects for recalling firms

This table presents the announcement period wealth effects of the recall events for the recalling firms. The sample period is 2006 – 2010 and contains recalls covered by the Consumer Product Safety Commission (*CPSC*), National Highway Traffic Safety Administration (*NHTSA*), and Food and Drug Administration (*FDA*). *CAR* (%) is the average cumulative abnormal return for the recalling firm over the event window. Z statistics are used to test if the mean cumulative abnormal returns are statistically different from zero and are provided in the parentheses. *% Positive* represents the proportion of recalling firms that have positive returns. A generalized sign test is performed to test their statistical significance. *Dollars* presents the mean and median dollar wealth effect of the recall announcement and is measured in millions of dollars, with median numbers reported in square brackets. It is calculated as the product of the announcement period cumulative abnormal return and the market capitalization of the recalling firm. For the (-2, +2) and (-5, +5) windows, we use the market capitalization ten days prior to the recall announcement date while for the rest of the windows, we use the market capitalization twenty days prior to the recall announcement date..N is the number of recall events in the sample. The table report results for the overall sample of recalls, and different sub-samples such as the *FDA*, *CPSC*, and *NHTSA*, respectively. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

	Overall N=816			*FDA* N=356			*CPSC* N=321			*NHTSA* N=139		
Event windows	*CAR* (%)	*% Positive*	*Dollars* (mil)	*CAR* (%)	*% Positive*	*Dollars* (mil)	*CAR* (%)	*% Positive*	*Dollars* (mil)	*CAR* (%)	*% Positive*	*Dollars* (mil)
(-2, +2)	-0.97***	39.58***	-171.92	-0.96***	41.29**	-162.16	-1.25	36.13***	-224.89	-0.34	43.17	-74.98
	(-6.01)	(-4.82)	[-17.13]	(-4.21)	(-2.66)	[-17.52]	(-4.34)	(-4.26)	[-16.22]	(-1.25)	(-0.95)	[-20.03]
(-5, +5)	-1.72***	37.50***	-302.27	-1.57***	39.60***	-320.73	-2.42***	31.46***	-393.05	-0.36	46.04	-46.00
	(-7.87)	(-6.01)	[-37.66]	(-4.79)	(-3.29)	[-41.01]	(-6.59)	(-5.93)	[-40.53]	(-1.38)	(-0.28)	[-11.48]
(-10, +10)	-2.23***	37.62***	-521.96	-1.71***	38.48***	-638.49	-3.22***	35.20***	-499.91	-1.29***	41.00	-274.29
	(-8.25)	(-5.94)	[-68.46]	(-5.02)	(-3.72)	[-73.33]	(-6.08)	(-4.59)	[-64.08]	(-2.71)	(-1.46)	[-83.29]
(-10, +2)	-1.78***	37.38***	-339.17	-1.31***	40.44***	-309.07	-2.56***	33.02***	-475.23	-1.20**	39.57*	-103.02
	(-7.33)	(-6.08)	[-51.31]	(-4.02)	(-2.98)	[-40.31]	(-5.75)	(-5.37)	[-56.18]	(-2.58)	(-1.80)	[-62.48]
(-20, +20)	-2.82***	39.71***	-380.25	-1.84***	38.48***	-654.56	-3.92***	36.76***	-78.30	-2.81***	46.04	-372.86
	(-6.78)	(-4.75)	[-56.22]	(-4.33)	(-3.72)	[-95.59]	(-4.44)	(-4.03)	[-50.83]	(-2.70)	(-1.46)	[-23.12]

Table 4

Univariate comparisons between recalling firms and control firms

This table presents the univariate comparisons between recalling firms and control firms. The sample period is 2006 – 2010 and contains recalls covered by the Consumer Product Safety Commission (*CPSC*), National Highway Traffic Safety Administration (*NHTSA*), and Food and Drug Administration (*FDA*). 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 2006 – 2010. *Book (Market) leverage* is the book (market) value of debt divided by total assets. *Altman Z* is the Altman Z-score score used in Altman (1968) and is calculated as 3.3*EBIT/Total assets + Sales/Total assets + 1.4*Retained earnings/Total assets + 1.2*Working capital/Total assets + 0.6*Market value of equity/Total Liabilities. *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. *Firm to industry Altman Z* is the ratio of the Altman Z-Score of the recalling firm to the Altman Z-Score of the industry peers. The recalling firm is not considered in computing the industry level measures of leverage or Altman Z-Score. *Herfindahl Index* is the sales-based Herfindahl index of the three-digit SIC industry of the firm. *Unionization* is the percentage 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 (control firm). *T-Stat* provides the *t*-statistic from a t-test for the equality in means between recalling and control firms where the standard errors are robust and clustered at the firm level. *Z-Stat* provides the *z*-statistic for the equality of medians between the recalling and control firms and is based on a Wilcoxon rank-sum test for the equality of medians. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: Leverage/financial distress variables

Variable name	Recall sample			Control sample			
	N	Mean	Median	N	Mean	Median	*T (Z) Stat*
Book leverage	796	0.267	0.260	11,283	0.155	0.072	6.29*** (21.09***)
Market leverage	796	0.258	0.199	11,276	0.138	0.045	4.39*** (20.28***)
Altman Z	796	3.64	3.12	11,217	4.41	3.36	2.83*** (-1.24)
Firm to industry book leverage	794	1.382	1.251	11,283	1.058	0.471	2.23*** (16.00***)
Firm to industry market leverage	794	1.349	1.045	11,276	1.098	0.365	1.67* (15.33***)
Firm to industry Altman Z	794	0.912	0.808	11,217	1.167	0.825	-2.61*** (-0.25)

Panel B: Control variables

Variable name	Recall sample			Control sample			
	N	Mean	Median	N	Mean	Median	*T (Z) Stat*
Herfindahl index	796	0.219	0.169	11,285	0.137	0.078	4.93*** (16.70***)
Unionization	796	11.15	6.00	11,285	5.189	3.300	4.93*** (17.17***)
Number of suppliers	796	11.43	2.00	11,285	0.56	0.00	3.51*** (44.18***)
Vertical integration dummy	778	0.046	0.000	11,108	0.042	0.000	0.27 (0.50)
R&D intensity	796	0.031	0.024	11,283	0.107	0.045	-17.49*** (-12.23***)
Total factor productivity	781	-0.113	-0.132	11,107	0.021	0.067	-3.07*** (-8.65***)
Size	796	9.263	9.606	11,276	5.670	5.573	17.23*** (36.81***)

Table 5

Probit regressions: Impact of leverage and distress likelihood on recall incidence

This table presents the recall incidence estimation results for recall events by public firms during our sample period of 2006 – 2010. The sample contains recalls covered by the Consumer Product Safety Commission (*CPSC*), National Highway Traffic Safety Administration (*NHTSA*), and Food and Drug Administration (*FDA*). 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 2006 – 2010. Refer to the appendix for details on the construction of our variables. Models (1) – (3) contain estimation results when we include calendar year dummies along with our explanatory variables and Models (4) – (6) contain estimation results when we include industry dummies and calendar year dummies along with our explanatory variables. Marginal effects are reported in the table 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.

Dep. Variable: Recall incidence	(1) *RecallDum*	(2) *RecallDum*	(3) *RecallDum*	(4) *RecallDum*	(5) *RecallDum*	(6) *RecallDum*
Book leverage	0.0207***			0.0066**		
	(0.002)			(0.016)		
Market leverage		0.0301***			0.0121***	
		(0.000)			(0.000)	
Altman Z			-0.0011***			-0.0005***
			(0.000)			(0.001)
Herfindahl index	0.0477***	0.0482***	0.0470***	0.0139***	0.0142***	0.0123***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)	(0.004)
Unionization	0.0011***	0.0010***	0.0011***	0.0004***	0.0004***	0.0004***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)
Number of suppliers	0.0009***	0.0008***	0.0009***	0.0005***	0.0004***	0.0004***
	(0.001)	(0.005)	(0.001)	(0.000)	(0.000)	(0.000)
Vertical integration dummy	-0.0133***	-0.0132***	-0.0138***	-0.0030*	-0.0030**	-0.0031**
	(0.000)	(0.000)	(0.000)	(0.054)	(0.036)	(0.030)
R&D intensity	-0.0526**	-0.0396*	-0.0612***	-0.0197**	-0.0130*	-0.0216***
	(0.014)	(0.060)	(0.004)	(0.022)	(0.088)	(0.005)
Total factor productivity	-0.0061***	-0.0058***	-0.0062***	-0.0015**	-0.0012	-0.0012
	(0.003)	(0.006)	(0.005)	(0.046)	(0.100)	(0.114)
Size	0.0112***	0.0117***	0.0118***	0.0044***	0.0045***	0.0044***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	No	No	Yes	Yes	Yes
Observations	11,686	11,686	11,637	11,664	11,664	11,615

Table 6

The impact of tariff cuts on the relation between recall incidence and financial leverage or distress likelihood

This table presents the impact of tariff cuts on the relation between recall incidence and financial leverage or distress likelihood over the sample period of 2006 – 2010. 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 2006 – 2010. *Tariff cut* is a dummy variable that is set to 1 if the annual percentage drop in the tariff rate of the recalling industry was 2.0 times the industry median level and set to 0 otherwise. This definition is consistent with Fresard (2010). For all other variables, refer to the appendix for details on their construction. Models (1) – (3) contain estimation results when we include calendar year dummies along with our explanatory variables and Models (4) – (6) contain estimation results when we include industry dummies and calendar year dummies along with our explanatory variables. Marginal effects are reported in the table 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.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable: Recall incidence	*RecallDum*	*RecallDum*	*RecallDum*	*RecallDum*	*RecallDum*	*RecallDum*
Tariff cut	-0.0019	-0.0022	0.0099**	0.0013	0.0010	0.0100***
	(0.666)	(0.630)	(0.020)	(0.677)	(0.738)	(0.002)
Book leverage	0.0206**			0.0091		
	(0.022)			(0.145)		
*Tariff cut * Book leverage*	0.0245**			0.0153**		
	(0.031)			(0.045)		
Market leverage		0.0333***			0.0239***	
		(0.002)			(0.001)	
*Tariff cut * Market leverage*		0.0298**			0.0174**	
		(0.026)			(0.037)	
Altman Z			-0.0010**			-0.0008**
			(0.038)			(0.019)
*Tariff cut * Altman Z*			-0.0010*			-0.0007*
			(0.051)			(0.074)
Herfindahl index	0.0427***	0.0436***	0.0403***	0.0279***	0.0279***	0.0257***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.004)
Unionization	0.0010***	0.0009***	0.0011***	0.0009***	0.0008***	0.0009***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
Number of suppliers	0.0013***	0.0011***	0.0013***	0.0012***	0.0011***	0.0012***
	(0.000)	(0.004)	(0.001)	(0.000)	(0.000)	(0.000)
Vertical integration dummy	-0.0158***	-0.0161***	-0.0165***	-0.0062*	-0.0062*	-0.0066**
	(0.000)	(0.000)	(0.000)	(0.072)	(0.052)	(0.050)
R&D intensity	-0.0620**	-0.0425*	-0.0725***	-0.0413**	-0.0242	-0.0464***
	(0.021)	(0.096)	(0.006)	(0.035)	(0.134)	(0.010)

Total factor productivity	-0.0031	-0.0026	-0.0028	-0.0011	-0.0005	-0.0007
	(0.214)	(0.310)	(0.309)	(0.467)	(0.754)	(0.679)
Size	0.0126***	0.0136***	0.0133***	0.0084***	0.0087***	0.0087***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	No	No	Yes	Yes	Yes
Observations	7,619	7,619	7,594	7,591	7,591	7,566

Table 7
The impact of negative input price shocks on the relation between recall incidence and financial leverage or distress likelihood

This table presents the impact of negative input price shocks on the relation between recall incidence and financial leverage/distress over the sample period of 2006 – 2010. 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 2006 – 2010. *Negative input price shock* is a dummy variable that is set to 1 if the geometric average growth rate in input prices for the recalling industry over the three years before the recall was 5% or more and set to 0 otherwise. For all other variables, refer to the appendix for details on their construction. Models (1) – (3) contain estimation results when we include calendar year dummies along with our explanatory variables and Models (4) – (6) contain estimation results when we include industry dummies and calendar year dummies along with our explanatory variables. Marginal effects are reported in the table 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.

Dep. Variable: Recall incidence	(1) *RecallDum*	(2) *RecallDum*	(3) *RecallDum*	(4) *RecallDum*	(5) *RecallDum*	(6) *RecallDum*
Negative input price shock	-0.0129***	-0.0123***	-0.0050	-0.0021	-0.0020	0.0031
	(0.003)	(0.002)	(0.400)	(0.254)	(0.406)	(0.354)
Book leverage	0.0155**			0.0052***		
	(0.021)			(0.001)		
*Negative input price shock * Book leverage*	0.0520***			0.0111**		
	(0.009)			(0.046)		
Market leverage		0.0263***			0.0111***	
		(0.001)			(0.001)	
*Negative input price shock * Market leverage*		0.0444***			0.0113*	
		(0.002)			(0.070)	
Altman Z			-0.0009***			-0.0004***
			(0.001)			(0.004)
*Negative input price shock * Altman Z*			-0.0028***			-0.0007***
			(0.000)			(0.003)
Herfindahl index	0.0494***	0.0501***	0.0475***	0.0146***	0.0148***	0.0128***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.003)
Unionization	0.0011***	0.0010***	0.0011***	0.0004***	0.0004***	0.0004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)
Number of suppliers	0.0009***	0.0008***	0.0009***	0.0005***	0.0004***	0.0005***
	(0.001)	(0.004)	(0.001)	(0.000)	(0.000)	(0.000)
Vertical integration dummy	-0.0127***	-0.0128***	-0.0131***	-0.0030***	-0.0030**	-0.0031**
	(0.000)	(0.000)	(0.000)	(0.003)	(0.035)	(0.030)
R&D intensity	-0.0521**	-0.0396*	-0.0592***	-0.0175***	-0.0113	-0.0195***
	(0.013)	(0.054)	(0.004)	(0.003)	(0.118)	(0.007)

Total factor productivity	-0.0067***	-0.0064***	-0.0067***	-0.0017***	-0.0014*	-0.0015*
	(0.001)	(0.002)	(0.002)	(0.000)	(0.056)	(0.065)
Size	0.0111***	0.0117***	0.0116***	0.0044***	0.0046***	0.0044***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	No	No	Yes	Yes	Yes
Observations	11,235	11,235	11,186	11,161	11,161	11,112

Table 8

Linear probability models & two-stage least squares estimations

This table presents the recall incidence estimation results for recall events by public firms during our sample period of 2006 – 2010. The sample contains recalls covered by the Consumer Product Safety Commission (*CPSC*), National Highway Traffic Safety Administration (*NHTSA*), and Food and Drug Administration (*FDA*). 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 2006 – 2010. Models (1), (3), and (6) contain linear probability model estimation results and Models (2), (4), and (6) contain results from the second stage of the two-stage least squares estimation. All estimations in the table include industry dummies and calendar year dummies along with our explanatory variables. The Kleibergen-Paap rk LM statistic is a weak instrument test to check if the excluded instruments are correlated with the endogenous regressors. Endogeneity test examines if endogeneity is prevalent in the estimations given the chosen instruments. 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: Recall incidence	OLS	2SLS	OLS	2SLS	OLS	2SLS
Book leverage	0.0601***	1.4215***				
	(0.001)	(0.003)				
Market leverage			0.1173***	0.9867***		
			(0.000)	(0.001)		
Altman Z					-0.0027***	-0.0296***
					(0.000)	(0.002)
Herfindahl index	0.1002*	0.0880	0.1024*	0.1236**	0.0933*	0.0128
	(0.078)	(0.240)	(0.067)	(0.032)	(0.096)	(0.850)
Unionization	0.0033**	-0.0004	0.0030**	0.0000	0.0033**	0.0025
	(0.027)	(0.844)	(0.040)	(0.987)	(0.025)	(0.149)
Number of suppliers	0.0078***	0.0057**	0.0075***	0.0045**	0.0076***	0.0047**
	(0.006)	(0.017)	(0.005)	(0.016)	(0.006)	(0.019)
Vertical integration dummy	-0.0505**	-0.0609*	-0.0554**	-0.0967***	-0.0550**	-0.1036***
	(0.043)	(0.077)	(0.027)	(0.004)	(0.029)	(0.009)
R&D intensity	-0.0292	0.0320	-0.0048	0.1963**	-0.0741***	-0.4974***
	(0.210)	(0.568)	(0.844)	(0.011)	(0.002)	(0.001)
Total factor productivity	-0.0240***	-0.0041	-0.0240***	-0.0167***	-0.0251***	-0.0273***
	(0.000)	(0.695)	(0.000)	(0.005)	(0.000)	(0.000)
Size	0.0353***	0.0286***	0.0372***	0.0495***	0.0378***	0.0592***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.4809***	-0.2378***	0.4366***	-0.3470***	0.5780***	0.2455
	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.115)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,691	11,623	11,691	11,623	11,642	11,574
Kleibergen-Paap rk LM statistic	n.a.	18.22***	n.a.	25.19***	n.a.	29.94***
Endogeneity test	n.a.	8.025***	n.a.	7.474***	n.a.	7.273***

Table 9

Announcement period wealth effects for rival firms and key supplier firms of recalling firms

This table presents the announcement period wealth effects of the recall events for the rival firms and key supplier firms of recalling firms. The sample period is 2006 – 2010 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. The rival portfolio and key supplier portfolio returns are calculated as equally weighted returns for the (-2, +2), (-5, +5), (-10, +10), and (-10, +2) trading day windows around the recall announcement date. Z statistics are used to test if the mean cumulative abnormal returns (*CAR*s) are statistically different from zero and are provided in the parentheses. % positive represents the proportion of portfolios that have positive returns. A generalized sign test is performed to test their statistical significance. N is the number of portfolios of rivals or suppliers. Panel A and Panel B provide the *CAR*s for the rival firms and key supplier firms respectively. All panels in the table report results for the overall sample of recalls, and different sub-samples such as the *FDA*, *CPSC*, and *NHTSA* respectively. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: Announcement period abnormal returns of the rival firms								
	Overall (N=806)		*FDA* (N=354)		*CPSC* (N=313)		*NHTSA* (N=139)	
Event Windows	*CAR* (%)	% Positive	*CAR* (%)	% Positive	*CAR* (%)	% Positive	*CAR* (%)	% Positive
(-2, +2)	0.00	47.41	0.09	46.61	-0.06	48.89	-0.09	46.04
	(-0.31)	(-1.30)	(0.03)	(-1.34)	(-0.91)	(-0.04)	(0.55)	(-0.93)
(-5, +5)	-0.15	45.91**	-0.04	48.87	-0.14	45.36	-0.42	39.57**
	(-1.62)	(-2.15)	(-0.83)	(-0.49)	(-1.49)	(-1.28)	(-0.28)	(-2.45)
(-10, +10)	-0.35**	45.28**	-0.12	46.61	-0.44*	48.24	-0.69	35.97***
	(-2.25)	(-2.50)	(-1.17)	(-1.34)	(-1.70)	(-0.26)	(-0.93)	(-3.31)
(-10, +2)	-0.12	46.52*	0.20	47.74	-0.31	46.96	-0.47	42.44*
	(-1.02)	(-1.80)	(0.08)	(-0.92)	(-1.36)	(-0.72)	(-0.46)	(-1.78)
(-20, +20)	-0.63***	45.53**	-0.37*	43.78**	-1.08***	46.00	-0.25	48.92
	(-2.76)	(-2.36)	(-1.73)	(-2.40)	(-3.11)	(-1.05)	(-0.81)	(-0.25)

Panel B: Announcement period abnormal returns of key supplier firms								
	Overall		*FDA*		*CPSC*		*NHTSA*	
Number	(N=594)		(N=260)		(N=198)		(N=136)	
Event Windows	*CAR* (%)	% Positive	*CAR* (%)	% Positive	*CAR* (%)	% Positive	*CAR* (%)	% Positive
(-2, +2)	-0.85***	40.57***	-0.58**	42.30**	-0.82***	41.92***	-1.41***	35.29***
	(-4.89)	(-4.49)	(-2.45)	(-2.42)	(-3.11)	(-2.20)	(-3.08)	(-3.39)
(-5, +5)	-1.23***	38.72***	-0.47*	40.38***	-1.73***	37.88***	-1.96**	36.76***
	(-4.86)	(-5.39)	(-1.79)	(-3.03)	(-4.23)	(-3.33)	(-2.57)	(-3.04)
(-10, +10)	-1.85***	40.74***	-1.38**	42.69**	-1.82***	40.40***	-2.79***	37.50***
	(-5.29)	(-4.41)	(-2.47)	(-2.29)	(-4.10)	(-2.62)	(-2.65)	(-2.87)
(-10, +2)	-1.42***	39.73***	-1.25**	39.23***	-1.38***	38.38***	-1.80**	42.65*
	(-4.71)	(-4.89)	(-2.11)	(-3.41)	(-3.73)	(-3.19)	(-2.42)	(-1.67)
(-20, +20)	-1.66***	40.91***	-0.76*	43.85*	-1.40***	37.88***	-3.74***	39.71**
	(-4.68)	(-4.32)	(-1.80)	(-1.92)	(-3.53)	(-3.33)	(-3.02)	(-2.36)

Table 10

Determinants of announcement period wealth effects of recalling firms

This table presents the Heckman selection model estimation results for the determinants of the announcement period abnormal returns to recalling firms. In the first stage (unreported), we model the recall incidence where 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 2006 – 2010. In the first stage estimation, we include all variables from model (1) of Table 5. 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 the cumulative abnormal return (*Recalling firm CAR*) measured over the (-5, +5) event window around the recall announcement date and 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. *Firm to industry Altman Z* is the ratio of the Altman Z-Score of the recalling firm to the Altman Z-Score of the industry peers. The recalling firm is not considered in computing the industry level measures of leverage or Altman Z-Score. *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. *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.

Dep. Variable: *Recalling firm CAR*	(1)	(2)	(3)
Firm to industry book leverage	-0.0008*		
	(0.083)		
Firm to industry market leverage		-0.0010***	
		(0.001)	
Firm to industry Altman Z			0.0021*
			(0.082)
Size	0.0014	0.0013	0.0012
	(0.456)	(0.472)	(0.517)
Initial recall dummy	0.0038	0.0038	0.0036
	(0.494)	(0.483)	(0.512)
Inverse mills ratio	-0.0077*	-0.0079*	-0.0079*
	(0.074)	(0.066)	(0.068)
Constant	-0.0117	-0.0105	-0.0250
	(0.579)	(0.616)	(0.251)
R-squared	0.03	0.03	0.03
Observations	758	758	758

Table 11

Determinants of 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 2006 – 2010. The dependent variable is the cumulative abnormal return for the rival portfolio (*Rival firms' CAR*) measured over the (-5, +5) or (-10, +10) 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. *Firm to industry Altman Z* is the ratio of the Altman Z-Score of the recalling firm to the Altman Z-Score of the industry peers. The recalling firm is not considered in computing the industry level measures for leverage or Altman Z-Score. *Recalling firm CAR* is the cumulative abnormal return for the recalling firm over the (-5, +5) and (-10, +10) 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.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable: *Rival firms' CAR*	(-5, +5)	(-5, +5)	(-5, +5)	(-5, +5)	(-5, +5)	(-5, +5)
Firm to industry book leverage	0.0008**	0.0007**				
	(0.037)	(0.043)				
Firm to industry market leverage			0.0004	0.0004		
			(0.318)	(0.319)		
Firm to industry Altman Z					-0.0018*	-0.0018*
					(0.088)	(0.081)
Recalling firm CAR (-5, +5)		0.0393*		0.0397*		0.0400*
		(0.097)		(0.094)		(0.091)
Initial recall dummy	0.0064*	0.0065*	0.0063*	0.0064*	0.0063*	0.0064*
	(0.055)	(0.054)	(0.058)	(0.057)	(0.060)	(0.059)
Size	0.0004	0.0002	0.0005	0.0003	0.0005	0.0003
	(0.657)	(0.826)	(0.597)	(0.765)	(0.556)	(0.719)
Constant	-0.0067	-0.0038	-0.0072	-0.0043	-0.0058	-0.0028
	(0.485)	(0.707)	(0.449)	(0.668)	(0.550)	(0.783)
R-squared	0.01	0.01	0.01	0.01	0.01	0.01
Observations	790	790	790	790	790	790
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable: *Rival firms' CAR*	(-10, +10)	(-10, +10)	(-10, +10)	(-10, +10)	(-10, +10)	(-10, +10)
Firm to industry book leverage	0.0015***	0.0015***				
	(0.003)	(0.004)				
Firm to industry market leverage			0.0011*	0.0011		
			(0.097)	(0.104)		
Firm to industry Altman Z					-0.0033**	-0.0033**
					(0.027)	(0.030)
Recalling firm CAR (-10, +10)		0.0331		0.0338		0.0335
		(0.127)		(0.119)		(0.124)
Initial recall dummy	0.0056	0.0057	0.0054	0.0056	0.0053	0.0055
	(0.251)	(0.241)	(0.263)	(0.252)	(0.269)	(0.258)
Size	-0.0008	-0.0009	-0.0007	-0.0008	-0.0005	-0.0007
	(0.572)	(0.497)	(0.641)	(0.558)	(0.708)	(0.621)
Constant	-0.0160	-0.0165	-0.0175	-0.0180	-0.0142	-0.0147
	(0.278)	(0.258)	(0.234)	(0.217)	(0.340)	(0.317)
R-squared	0.01	0.02	0.01	0.02	0.02	0.02
Observations	790	790	790	790	790	790

Table 12

Determinants of 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 2006 – 2010. The dependent variable is the cumulative abnormal return for the supplier portfolio (*Supplier firms' CAR*) measured over the (-5, +5) or (-10, +10) 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. *Firm to industry Altman Z* is the ratio of the Altman Z-Score of the recalling firm to the Altman Z-Score of the industry peers. The recalling firm is not considered in computing the industry level measures for leverage or Altman Z-Score. *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 (-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.

Dep. variable: *Supplier firms' CAR*	(1) (-5, +5)	(2) (-5, +5)	(3) (-5, +5)	(4) (-5, +5)	(5) (-5, +5)	(6) (-5, +5)
Firm to industry book leverage	-0.0006*	-0.0005				
	(0.077)	(0.139)				
Firm to industry market leverage			-0.0004	-0.0003		
			(0.204)	(0.290)		
Firm to industry Altman Z					0.0027*	0.0025*
					(0.076)	(0.083)
Supplier leverage	-0.0613**	-0.0593**	-0.0603**	-0.0584**	-0.0581**	-0.0567**
	(0.031)	(0.037)	(0.035)	(0.040)	(0.031)	(0.034)
Supplier R&D intensity	-0.0757***	-0.0713***	-0.0739***	-0.0698***	-0.0774***	-0.0733***
	(0.003)	(0.007)	(0.004)	(0.007)	(0.002)	(0.005)
Recalling firm CAR (-5, +5)		0.1079**		0.1084**		0.1080**
		(0.013)		(0.013)		(0.013)
Initial recall dummy	0.0069	0.0055	0.0068	0.0054	0.0063	0.0050
	(0.216)	(0.266)	(0.225)	(0.276)	(0.269)	(0.325)
Size	-0.0016	-0.0019	-0.0018	-0.0020	-0.0020	-0.0022
	(0.318)	(0.207)	(0.280)	(0.181)	(0.236)	(0.154)
Constant	-0.0230	-0.0194	-0.0221	-0.0187	-0.0228	-0.0193
	(0.248)	(0.291)	(0.273)	(0.316)	(0.266)	(0.302)
R-squared	0.04	0.06	0.04	0.06	0.04	0.06
Observations	574	574	574	574	574	574

Dep. variable: *Supplier firm's CAR*	(1) (-10, +10)	(2) (-10, +10)	(3) (-10, +10)	(4) (-10, +10)	(5) (-10, +10)	(6) (-10, +10)
Firm to industry book leverage	-0.0006	-0.0007				
	(0.296)	(0.162)				
Firm to industry market leverage			-0.0004	-0.0006		
			(0.462)	(0.246)		
Firm to industry Altman Z					0.0057*	0.0057*
					(0.063)	(0.058)
Supplier leverage	-0.0879*	-0.0838*	-0.0868*	-0.0830*	-0.0860*	-0.0811*
	(0.063)	(0.067)	(0.067)	(0.070)	(0.056)	(0.064)
Supplier R&D intensity	-0.1080***	-0.1002***	-0.1062***	-0.0985***	-0.1165***	-0.1080***
	(0.003)	(0.007)	(0.003)	(0.008)	(0.002)	(0.006)

Recalling firm CAR (-10, +10)		0.1672***		0.1673***		0.1666***
		(0.000)		(0.000)		(0.000)
Initial recall dummy	-0.0013	0.0011	-0.0014	0.0010	-0.0024	-0.0000
	(0.897)	(0.897)	(0.890)	(0.908)	(0.815)	(0.997)
Size	-0.0038	-0.0033	-0.0040	-0.0035	-0.0044	-0.0039
	(0.265)	(0.201)	(0.249)	(0.184)	(0.211)	(0.147)
Constant	-0.0914**	-0.0947***	-0.0905**	-0.0936***	-0.0919**	-0.0951***
	(0.020)	(0.004)	(0.022)	(0.004)	(0.024)	(0.005)
R-squared	0.04	0.08	0.04	0.08	0.04	0.08
Observations	574	574	574	574	574	574

Table 13
Wealth effects of recalling firms by industry structure

This table presents the Heckman selection model estimation results for the determinants of the announcement period abnormal returns to recalling firms split by industry concentration. We sub-divide the recalling firms into two groups based on the *Herfindahl index* of the recalling industry. Firms above the sample median are considered to be in a high concentration industry (*High Conc.*) and firms below the sample median are considered to be in a low concentration industry (*Low Conc.*). In the first stage (unreported), we model the recall incidence where the dependent variable is *RecallDum*, which is set to one for firms in the recall sample and zero for control firms. In the first stage estimation, we include all variables from model (1) of Table 5. 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 the cumulative abnormal return (*Recalling firm CAR*) measured over the (-5, +5) event window around the recall announcement date and 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. *Firm to industry Altman Z* is the ratio of the Altman Z-Score of the recalling firm to the Altman Z-Score of the industry peers. The recalling firm is not considered in computing the industry level measures for leverage or Altman Z-Score. *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. 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 Conc.* (1)	*Low Conc.* (2)	*High Conc.* (3)	*Low Conc.* (4)	*High Conc.* (5)	*Low Conc.* (6)
Firm to industry book leverage	-0.0009*	0.0026				
	(0.084)	(0.500)				
Firm to industry market leverage			-0.0011***	0.0027		
			(0.004)	(0.325)		
Firm to industry Altman Z					0.0053**	0.0005
					(0.034)	(0.754)
Size	-0.0005	0.0058**	-0.0005	0.0062**	-0.0005	0.0049
	(0.865)	(0.043)	(0.871)	(0.032)	(0.874)	(0.101)
Initial recall dummy	0.0039	0.0056	0.0040	0.0055	0.0033	0.0057
	(0.616)	(0.491)	(0.611)	(0.496)	(0.676)	(0.483)
Inverse mills ratio	-0.0083	-0.0031	-0.0086	-0.0026	-0.0081	-0.0047
	(0.285)	(0.629)	(0.264)	(0.663)	(0.298)	(0.462)
Constant	0.0013	-0.0688*	0.0014	-0.0735**	-0.0060	-0.0542
	(0.968)	(0.059)	(0.966)	(0.040)	(0.858)	(0.129)
R-squared	0.03	0.05	0.03	0.05	0.03	0.05
Observations	373	385	373	385	373	385

Table 14
Announcement period wealth effects of rival firms by industry structure

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 the recalling industry concentration. We sub-divide the rival portfolios into two groups based on the *Herfindahl index* of the recalling industry. Rival portfolios above the sample median are considered to be in a high concentration industry (*High Conc.*) and rival portfolios below the sample median are considered to be in a low concentration industry (*Low Conc.*). The sample period is 2006 – 2010. The dependent variable is the cumulative abnormal return for the rival portfolio (*Rival firms' CAR*) measured over the (-5, +5) or (-10, +10) 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. *Firm to industry Altman Z* is the ratio of the Altman Z-Score of the recalling firm to the Altman Z-Score of the industry peers. The recalling firm is not considered in computing the industry level measures for leverage or Altman Z-Score. *Recalling firm CAR* is the cumulative abnormal return for the recalling firm over the (-5, +5) and (-10, +10) 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*	*High Conc.* (-5, +5)	*Low Conc.* (-5, +5)	*High Conc.* (-5, +5)	*Low Conc.* (-5, +5)	*High Conc.* (-5, +5)	*Low Conc.* (-5, +5)
Firm to industry book leverage	0.0009***	-0.0001				
	(0.005)	(0.967)				
Firm to industry market leverage			0.0008**	-0.0020		
			(0.010)	(0.328)		
Firm to industry Altman Z					-0.0015	-0.0009
					(0.550)	(0.480)
Recalling firm CAR (-5, +5)	0.0147	0.0523*	0.0164	0.0547*	0.0173	0.0514*
	(0.748)	(0.090)	(0.721)	(0.077)	(0.708)	(0.092)
Initial recall dummy	0.0044	0.0082*	0.0043	0.0080	0.0043	0.0082
	(0.304)	(0.094)	(0.316)	(0.108)	(0.324)	(0.100)
Size	-0.0003	0.0004	-0.0002	0.0002	-0.0000	0.0005
	(0.805)	(0.742)	(0.845)	(0.867)	(0.990)	(0.706)
Constant	-0.0075	0.0066	-0.0077	0.0113	-0.0068	0.0052
	(0.507)	(0.653)	(0.496)	(0.418)	(0.556)	(0.720)
R-squared	0.01	0.03	0.01	0.04	0.01	0.03
Observations	400	389	400	389	400	389
Dep. Variable: *Rival firms' CAR*	*High Conc.* (-10, +10)	*Low Conc.* (-10, +10)	*High Conc.* (-10, +10)	*Low Conc.* (-10, +10)	*High Conc.* (-10, +10)	*Low Conc.* (-10, +10)
Firm to industry book leverage	0.0019***	-0.0014				
	(0.001)	(0.745)				
Firm to industry market leverage			0.0019***	-0.0035		
			(0.005)	(0.250)		
Firm to industry Altman Z					-0.0073**	-0.0013
					(0.032)	(0.465)
Recalling firm CAR (-10, +10)	-0.0152	0.0544**	-0.0134	0.0554**	-0.0091	0.0536**
	(0.708)	(0.029)	(0.739)	(0.028)	(0.820)	(0.034)
Initial recall dummy	-0.0023	0.0110	-0.0025	0.0109	-0.0031	0.0113
	(0.721)	(0.119)	(0.692)	(0.125)	(0.626)	(0.111)
Size	-0.0023	0.0000	-0.0022	-0.0004	-0.0019	0.0001
	(0.241)	(0.993)	(0.263)	(0.851)	(0.353)	(0.949)
Constant	0.0027	0.0170	0.0024	0.0234	0.0104	0.0133
	(0.878)	(0.437)	(0.894)	(0.281)	(0.595)	(0.530)
R-squared	0.03	0.05	0.03	0.05	0.03	0.05
Observations	400	389	400	389	400	389