Labor unions and product quality: Evidence from the incidence, frequency, and severity of product recalls[+]

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Abstract

We study the impact of unionization on severe product quality failures that result in product recalls. We investigate this issue using two distinct test settings. In the first setting, we use union contract data to construct a unique panel database which enables us to test the impact of firm-level unionization rates on product quality failures. Employing a variety of tests, including two exogenous industry cash flow shocks that allow us to address endogeneity issues, we find that firms that are unionized and those that have higher unionization rates have a higher probability of a product recall and experience more severe and greater frequency of quality failures. In the second setting, we exploit close union elections in a regression discontinuity design to test whether there is a causal impact of unions on product quality failures. We find that close union wins are associated with a greater frequency of product recalls. We conduct additional tests that suggest that reduced operational flexibility and increased financial pressures are potential channels through which unions impair product quality. In summary, while there can be significant benefits from unions to society and firms, our finding of a detrimental effect of unions on quality points to a critical dimension of their cost to businesses.

Keywords: Labor markets, corporate finance, unionization, product recalls, product quality failures

JEL classification: G32, G39, J51, L15, L21

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Introduction

The impact of labor unions on businesses has been the subject of considerable debate in the political arena, popular press, and academia. Unions have historically fought not only for higher wages, pension benefits, and severance payments, but also for non-pecuniary benefits such as job security, protection against arbitrary disciplining or dismissal, better work hours, safer working conditions, career development, and protection against age, gender, and other illegal discrimination. Over the years, workers have benefitted from these endeavors (Freeman and Medoff, 1984), and even employers have benefitted because of greater productivity possibly through union-supported apprenticeship training and hiring halls (Allen, 1984) and better management-labor relations (Sojourner et al., 2015). Additionally, there is the potential for community-wide positive externalities from having a higher wage workforce (Cohen, Malloy, and Nguyen, 2016).

A large number of studies, however, also point out the downside of unions by highlighting the negative association between unionization and firm profitability (e.g., Clark, 1984; Salinger, 1984; Karier, 1985; Voos and Mishel, 1986; Rose, 1987; Abowd, 1989; and Hirsch, 1991). Additionally, existing studies document substantially increased wage costs in unionized firms since union workers earn a significant premium over comparable non-union workers (e.g., Karier, 1985; Lewis, 1986; and Rose, 1987). Becker (1995) shows that beyond the wage premium, unionization is also associated with overstaffing and constraints on managerial discretion, resulting in a crippling loss of flexibility for the firms.[1] In fact, in a study of union elections, Lee and Mas (2012) find that union formation is followed by decreases in profitability and growth, and results in an equity value loss of about $40,500 per unionized worker.

In this paper, we evaluate the firm-union relationship along a novel dimension – the impact of labor unions on product quality. Production and the quality of the products a firm produces are perhaps the most

[1] Ruback and Zimmerman (1984) and Bronars and Deere (1990) find that union election wins are associated with an approximately –4% announcement period abnormal returns to the shareholders. In fact, Ruback and Zimmerman (1984) find negative abnormal returns (though of smaller magnitude) even following union election losses suggesting that the market anticipates future elections may result in union wins. Bronars and Deere (1993) find evidence consistent with the view that unionization is a transfer of wealth from shareholders to unions.

important elements of a worker's responsibility. Given that unions are central to the incentive structure of unionized workers, we expect unions to play a fundamental role in implicitly determining product quality. Since product quality may mean different things for different products we use the incidence, frequency, and severity of product recalls as our metrics of product quality (or lack thereof).

Instead of attempting to subjectively define one or more dimensions of product quality for each type of product, we focus on product recalls as a measure of product quality. A product recall is an event where a firm learns of a safety defect or a fundamental failure of the product and is obligated to recall, repair, or fully replace the product. Once a safety defect is discovered, firms are required to report the defect to the relevant regulating agency based on the product category, and they are obligated to stop selling the product and do everything reasonable to recall the defective units.[2] We, thus, believe that product recalls provide an objective measure of product failure with established guidelines from governmental agencies, which allows us to use a consistent measure of product failure over time and across industries.

There are several reasons to believe that labor unions will have an impact on product quality. One set of arguments suggests that unions will enhance product quality. Unions provide a level of job security that may help improve worker-initiative, creativity, and responsibility which can lead to better quality products. For instance, Acharya, Baghai, and Subramanian (2013, 2014) show that countries with more stringent laws protecting workers foster more innovation and economic growth. In addition, state laws that restrain employers' ability to hold up employees, spark more initiative among employees and more innovation in the firms. To the extent that unions provide some job security, and serve as a restraint on firm's control over workers, they too may serve as a commitment by the firm not to penalize workers for short run failures, thus freeing them to purse value-enhancing long-run activities that may lead to better quality products.

[2] Consumer Product Safety Commission (*CPSC*) is the relevant regulating agency for consumer products. The Food and Drug Administration (*FDA*) governs food, drug, and medical devices related products. And, finally, the National Highway Traffic Safety Administration (*NHTSA*) is the regulating agency for the recalls of automobiles, other vehicles, and related products. 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* has similar provisions for recalls pertaining to the FDA regulated products. 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.

Additionally, unions have a vested interest in ensuring the continued viability of the firm given that some members have firm-specific human capital (Chen, Kacperczyk, and Ortiz-Molina, 2012), and many members expect to receive a pension from the firm long after they have stopped working. So, workers should be especially committed to producing high quality products to improve the health of the firm. Finally, since workers often receive a fixed salary, their payments are similar to those of bondholders, and they therefore have similar incentives for risk avoidance (Chyz, Leung, Li, and Rui, 2013; and Chen, Kacperczyk, and Ortiz-Molina, 2012). This would suggest that unions would prefer companies invest in the necessary technology and follow the most stringent of industry standards and protocols to make safer products, thereby increasing the likelihood of a healthier firm.

There are several compelling counter arguments that suggest that unions may weaken product quality. Higher product quality is often a result of making the necessary investment in the design and production processes and in the maintenance of the machinery. Outdated technology and lack of automation where needed are some of the main reasons for product failures (Taylor, 2011). Dowrick and Spencer (1994) argue that when unions are concerned about layoffs they resist automation and technological advancements. One unintended consequence of such resistance may be increased human error in production, leading to product failures. In addition to worker incentives being a problem, unionized firms may themselves underinvest because they fear expropriation by unions (Baldwin, 1983; and Grout, 1984). Consistent with this view Hirsch (1992) and Abowd (1989) show evidence of underinvestment in physical capital, and Connolly, Hirsch, and Hirschey (1986) and Bronars, Deere, and Tracy (1994) show underinvestment in R&D by unionized firms. In fact, Bradley, Kim, and Tian (2017) empirically show unionization results in less innovation among firms. Underinvestment, especially in potentially quality enhancing technology and other advancements, may therefore be another reason for product failures (Kini, Shenoy, and Subramaniam, 2017; and Matsa 2011).

A third reason why unions may impede product quality is due to financial pressures they impose on firms through marked-up wages and benefits. Unions make wages sticky and employees costlier. Union contracts are often rigid multi-year contracts with lot fewer short-term, need-based flexible arrangements than seen in non-unionized firms (Mitchell, 1985; Wunnava and Okunade, 1996; and Gramm and Schnell, 2001). Overall, unions reduce firms' operating flexibility, and in effect, raise firms' operating leverage and cost of equity capital (Chen, Kacperczyk, and Ortiz-Molina, 2011). The increased financial pressures arising from operational inflexibility in unionized firms may force them to cut corners in the production process and/or stress their physical factors of production, thereby resulting in product recalls (Kini, Shenoy, and Subramaniam, 2017).

Lack of operating flexibility is further compounded by the fact that obtaining external financing may be a problem for unionized firms as they are associated with the weakening of creditor rights. Blaylock, Edwards, and Stanfield (2015) show that unions often lobby for and receive payments during liquidation even though they are behind secured creditors in the absolute priority rule. These types of events set a bad precedent for creditor rights and become a hurdle for future debt financing. In fact, Campello, Gao, Qiu, and Zhang (2017) show that union election wins result in bond value losses, and unionization is associated with longer proceedings in bankruptcy court, more bankruptcy emergences, and with higher administrative costs. Therefore, unionization may indirectly lead to a financially stressed environment, once again potentially compromising the production process and product quality.

Overall, it is an empirical question whether unions enhance or weaken product quality. To empirically answer this question, we collect data on union contracts, union collective bargaining filings, and union election results from the National Labor Relations Board (NLRB) over the period 2002-2012. We use this data to create a unique panel dataset that contains information on whether a firm is unionized, and if unionized, the percentage of employees of the firm that are part of the union (see Appendix B for details on the construction of this union panel dataset). The NLRB data also helps us ascertain when and in which firms union elections are conducted, whether the election results in a union win, and the percentage of employees in a site that voted to be part of the union. To measure product quality characteristics, 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 each year by publicly traded firms during the 2003–2013 period. Our final sample comprises of 6,735 separate recall events spread across 42 different two-digit SIC code industries.

We initially analyze the relation between the incidence of product recalls and the unionization characteristics of the firms in the year prior to the recall using probit regressions. We use lagged values of our unionization variables to alleviate concerns regarding reverse causality. Control firms are firms from the same industry (three-digit SIC code) as the recalling firms that did not have a product recall. Consistent with the view that unionization is detrimental to product quality, we find unionized firms have a greater likelihood of a subsequent product recall than do non-unionized firms. We also find that firms which have a higher percentage of unionized workers have a higher likelihood of a subsequent product recall. Our regressions control for a variety of factors previously identified as potentially important for explaining the incidence of product recalls (Kini, Shenoy, and Subramaniam, 2017).

In addition to the incidence of recalls, we also examine whether unionization has an impact on the frequency and severity of recalls. Since even well-run firms with the best of manufacturing standards may not be able to prevent all failures, we also study the frequency of recalls as another metric of product quality, one that may be indicative of a chronic problem of low product quality in the firm. We measure the total number of recalls for a firm in each year and examine whether unionization characteristics impact this frequency of recalls. Similarly, some recalls may be rather minor quality failures and may not be indicative of a systemic quality problem within the firm. Therefore, to better capture the depth of the quality problem in the firm we focus on a third metric of quality, which is based on the severity of the product failure. Since, it is difficult to uniformly and objectively assess the severity of a product failure across different product types purely from reading the news articles about the recall, we rely on the classification determined by a regulating agency. Specifically, *FDA* is the only agency that classifies recalls into one of three categories based on the severity of the product failure. We use their classification for our tests on severity of recalls.

We estimate Poisson regression models to assess the impact of unionization on the frequency of product recalls. We find a statistically significant and positive relation between unionization characteristics and the frequency and severity of recalls. Our results show that unionized firms and those with a higher percentage of unionized workers have more frequent recalls. Also, when there is a recall, unionized firms and those with a higher percentage of unionized workers have more severe recalls than other firms. Once again, the results are robust to controlling for several previously identified factors impacting product quality.

Though the above sets of results are consistent with the view that unionization is detrimental to firm quality, they do not establish a causal relation between unionization and recalls. A variety of endogeneity issues may confound our findings. For instance, it is possible that workers in poorly run firms that are heading towards financial distress may decide to unionize to protect themselves against anticipated future pay cuts and layoffs. Given the declining nature of the firms, it is not unreasonable to conjecture that these firms may suffer more product failures than other firms. Thus, there may be omitted variables or latent factors which may jointly explain both the presence of unions and the incidence of product failures in firms. If this were the case, then it is possible to see a statistical association between unionization characteristics and product quality failures, even though unionization was not actually responsible for the low product quality. So, to definitively examine whether unionization causes product failures, we undertake several additional empirical tests that make the identification clear as to whether it is the unionization characteristics that cause the quality problems in the firm.

First, we use a two stage least squares estimation procedure that uses an instrumental variable (IV) technique to obtain the predicted values of the percentage of workers that are part of the union in each firm. Our instrument for predicting the percentage of union workers in a firm is based on the arguments in Cohen, Malloy, and Nguyen (2016) who show that current day unionization patterns in the U.S. can be explained by economic factors that were set in motion decades ago during the dust bowl. Taking the lead from their study we use the percentage of unionized workers in a metropolitan statistical area (MSA) ten years ago as an instrument for the current percentage of unionized workers for each firm headquartered within that MSA. This variable would be highly correlated with current firm level unionization, but should have no direct impact on product quality of the firm now, which is a point in time a decade later. Consistent with the view that unions are detrimental to product quality, our IV regression results indicate that the fraction of unionized workers in a firm is positively and statistically significantly related to the likelihood of a product recall. Again, the results control for all the usual control variables and for time- and industry-invariant factors.

As an additional experiment that both sharpens our identification and speaks to the channel through which unionization impacts quality, we condition our tests on two exogenous negative shocks to industry 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 unionization constrains firms from undertaking the investments necessary to improve quality, then such constraints should be exacerbated following the exogenous shocks. Consistent with the view that unionization adversely impacts product quality by magnifying the financial pressures on a firm, we find the effect of unionization on product failures is more pronounced for firms exposed to the two exogenous negative cash flow shocks compared to firms not exposed to these shocks. These results reinforce our prior evidence of a possible causal link between unionization and product failures. Finally, our reverse causality tests suggest that unionization causes product recalls and not the other way around.

We also use the data on secret ballot union election results to design an independent set of empirical tests that addresses the identification issue. We compare the post-election frequency of recalls for firms whose employees vote to become unionized with those whose employees vote against forming a union. To circumvent the endogenous nature of union election results, we employ a regression discontinuity design (RDD) methodology, which implicitly compares firms with close union victories to firms with close union losses. The RDD methodology is an identification strategy that does not suffer from endogeneity concerns because for elections where the win-loss margins are narrow, the union formation or non-formation is very close to a random event that is unlikely to be correlated with any latent firm characteristics. Thus, any difference in the post-election product quality outcomes can be attributed to unionization. Our RDD methodology compares quality failures in the one-, two-, and three-years following the elections in firms with close union wins versus those in close union losses.

We first verify that firms which narrowly pass the union election are statistically similar in pre-election firm characteristics that can affect product quality to those that narrowly fail to unionize. We find this is indeed the case with none of the characteristics such as market capitalization, assets, leverage, unionization rate, total factor productivity, etc. being statistically different across the two sub-samples. In addition, we find that the density of the percentage of votes in favor of forming a union is smooth and continuous in the vicinity of the majority threshold of 50%. These tests suggest that there is a random assignment of firms to the close win and close loss groups. We then find that unionization has a statistically significant effect on a firms' frequency of recalls. The results also continue to hold in the RDD regressions from estimating polynomial models that include a local discontinuity at the majority threshold in the union elections sample, and in local regressions using both pre-specified bandwidths as well as optimal bandwidths determined by the methodology specified in Imbens and Kalyanaraman (2012). Cumulative recalls in the one-, two-, and three-years following the election are higher following union wins.

As yet another empirical affirmation of the adverse impact of unions on product quality and of the financial pressure channels through which they affect quality, our RDD results indicate cost of goods sold, which includes labor costs, is significantly higher in the post-election years for firms where unions narrowly won compared to ones where unions narrowly lost. We also find some evidence that capital and R&D expenditures, which in part determine product quality, are lower following union wins than following union losses. Finally, as yet another independent verification of the adverse impact of unions on quality, the RDD results also show that unions have a differential impact on quality depending on whether the firm is operating in a *Right to Work* (*RTW*) state. *RTW* states are ones where union power is vastly curtailed because workers in unionized firms in these states cannot be forced to pay union dues or be part of the union. Our results show that the adverse impact of unions on product quality is largely confined to firms operating in non-*RTW* states, that is, in states where regulations afford unions a greater bargaining power. Overall, when the different tests are considered together, the overwhelming nature of the evidence allows us to conclude that labor unions have a detrimental impact on product quality, and that reduced operational flexibility and increased in financial pressures are likely channels through which unions impair product quality.

This study makes the following main contributions. Our results on product quality are generalizable since our sample of quality failures is one of the largest of its kind consisting of 6,735 recalls spread over

11 years and across 42 different two-digit SIC code industries. Further, our measure of product quality is based on product failures governed by guidelines from governmental agencies, instead of it being any one person's subjective perception of quality. More importantly, if unionization affects *any* quality attribute of a product significantly, it will be reflected in the incidence, frequency, and severity of recalls. Thus, as researchers, we do not have to *ex ante* identify any one specific quality attribute that may be impacted by unionization. In addition, our tests not only reinforce the causal link between unions and quality, but also point to the channels through which unions affect quality. We confine our focus to operational flexibility and financial channels and find evidence consistent with the view that unions decrease operational flexibility and increase financial pressures, which have the potential to adversely impact product quality.

Finally, although the literature has documented the impact of unions on firm profitability, leverage, accounting practices, etc., to the best of our knowledge, our paper is the first large-scale cross-industry study that examines the impact of unions on the most fundamental of worker responsibilities – the quality of the products they produce.[3] Unions having a positive or negative impact on product quality is a significant statement on the benefits or costs to a firm from being unionized. All the more so because product recalls are very costly for firms as they not only include the direct costs of replacing or repairing the defective product, but also include substantial indirect costs such as lost goodwill, blemished brand image, lost sales, and product liability lawsuits (Jarrell and Peltzman, 1985; Hoffer, Pruitt, and Reilly, 1988; Barber and Darrough, 1996). Although there can be significant benefits from unions to society and firms, our finding of a detrimental effect of unions on quality points to a critical aspect of their cost to businesses.

The remainder of the paper proceeds as follows. Section 2 contains the hypotheses for the relation between unionization and product quality. Section 3 describes our data sources, sample selection criteria, and the salient characteristics of the sample. In Section 4, we present our panel tests that analyze the link between unionization and the propensity, frequency, and severity of product recalls. Section 5 describes the RDD methodology and discusses the related results. Section 6 concludes the paper.

[3] Krueger and Mas (2004) and Mas (2008) focus on union-management conflicts at *Bridgestone/Firestone* and *Caterpillar*, respectively, and show that product quality was compromised during periods of labor strife.

2. Why would unionization characteristics affect product quality?

Although the labor union literature does not explicitly examine the question of the linkage between unions and product quality, there are several reasons to believe that unions do play an important role in determining product quality. Labor is an important and integral part of the production process in most firms and so we would expect workers to play a central role in determining product quality outcomes. There are several theories that suggest that unions will enhance product quality. First, unions afford employees protection against arbitrary disciplining and dismissal. They provide a higher level of job security for workers than seen in non-unionized firms. This added security may help improve worker-initiative, creativity, and responsibility in their decision making during the design and production processes, which in turn may help improve product quality. For instance, Acharya, Baghai, and Subramanian (2013) show that, at the country level, more stringent laws protecting workers foster more innovation and economic growth in those countries. They argue that stringent labor laws are effectively a commitment that firms will not penalize workers for short run failures, thus freeing them to purse value-enhancing long-run activities. In a similar vein, Acharya, Baghai, and Subramanian (2014) argue that *Wrongful Discharge Laws* (*WDL*) restrain employers' ability to hold up employees, thereby sparking more initiative among employees and more innovation in firms. Given that unions mimic, to some extent, the stringent labor law and *WDL* type protections for the workers, we expect unionized workers to also be less concerned about penalties for short-run failures, and therefore, focus more on the long-run welfare of the firm. This suggests that unionized firms should have better quality outcomes, and stronger unionization characteristics should be negatively related to the incidence, frequency, and severity of product recalls.

Additionally, union members have a vested interest in ensuring that the firm is financially sound and thriving in the long-term. One reason for this is many workers have firm-specific human capital locked up in the firm and they will lose it if the firm fails (Chen, Kacperczyk, and Ortiz-Molina, 2012). Further, many workers have pension plans linked to the financial success of the firm and they expect to receive those pension benefits for several years after they have stopped working for the firm. So, workers should be especially committed to producing high quality products that ensure the long-run viability of the firm. Finally, since workers often receive a fixed salary, their payments are fixed payments similar to those of bondholders, and they therefore have similar incentives for risk avoidance as bondholders (Faleye, Mehrotra, and Morck, 2006; Chyz, Leung, Li, and Rui, 2013; and Chen, Kacperczyk, and Ortiz-Molina, 2012). In this regard unions have an incentive to monitor the firm, and unlike external bondholders, unions have a unique monitoring ability because of their members' day-to-day involvement with the firm and the production process (Schwab and Thomas, 1998). This would suggest that unions would prefer companies that invest in the necessary technology and follow the most stringent of industry standards and protocols to produce safer products, thereby increasing the likelihood of a healthier firm. These arguments suggest that unionized firms and firms with a higher unionization rate will produce higher quality products that have a lower likelihood and frequency of product recalls. Also, if there is a recall, we can expect it to be less severe than in comparable, non-unionized firms.

Running counter to the above arguments, there are several reasons why we can expect labor unions to weaken product quality. Mas (2008) argues that union-induced labor strife can cause workers to underinvest in effort and undermine product quality. Consistent with this viewpoint, he finds that labor disputes at *Caterpillar* had a measurable adverse impact on the resale prices, resale rates, and quality ratings of the construction equipment produced during the contract dispute in the 1990s. In a similar spirit, Krueger and Mas (2004) find that labor strife at the Decatur, Illinois plant of *Firestone/Bridgestone* was a major factor that contributed to the production of defective tires.

Higher product quality is often a result of making the necessary investment in the design and production process. Outdated technology and lack of automation where needed are crucial reasons for product failures (Taylor, 2011). Dowrick and Spencer (1994) argue that under certain conditions, partly pertaining to the elasticity of labor, unions are concerned about layoffs and they resist automation and technological advancements. One unintended consequence of being slow to automate where necessary is it can lead to human errors and eventually to product failures. Thus, if unions impede technological investments, they will have a negative impact on product quality.

In addition to worker incentives, unionized firms may themselves be inclined to underinvest. Baldwin (1983) and Grout (1984) argue that unionized firms suffer from underinvestment because it is optimal for the firms to underinvest in longer-term assets such as physical capital and R&D expenditures when it anticipates union will try to expropriate quasi-rents during the collective bargaining process. The firm's optimal investment decreases as the marginal returns to the investment decrease, as it would, if unions are expected to appropriate a part of the firm's surplus. Consistent with this view Hirsch (1992) and Abowd (1989), show evidence of underinvestment in physical capital, and Connolly, Hirsch, and Hirschey (1986) and Bronars, Deere, and Tracy (1994) show underinvestment in R&D expenditures.[4] In fact, using a carefully constructed study that controls for endogeneity in union formation, Bradley, Kim, and Tian (2017) show that firm unionization results in lower innovation output. Underinvestment, especially in potentially quality enhancing technology and other advancements is, therefore, another reason for product failures (Kini, Shenoy, and Subramaniam, 2017; and Matsa, 2011).

Financial burdens imposed by unions may be another channel through which unions may impede product quality. Unions may place firms under considerable financial pressure because of the higher cost structure imposed on the firms through marked-up wages and benefits and through other worker related expenses. Unions make wages sticky and employee layoffs costlier. Mitchell (1985) and Wunnava and Okunade (1996) find that employment contracts negotiated through collective bargaining agreements are often multi-year contracts with increments pre-set through escalator clauses. Gramm and Schnell (2001) find that unionized firms have fewer instances of short-term, need-based, flexible labor contracts compared to non-unionized firms. Unions resist plant closures and sometimes force inefficient continuation of firms.[5] Overall, unions reduce firms' operating flexibility, and in effect, raise firms' operating leverage and cost of equity capital (Chen, Kacperczyk, and Ortiz-Molina, 2011).[6] These financial pressures and operational

[4] In an international setting Chung, Lee, Sohn, and Lee (2012) find a significant positive relation between union strength and the level of underinvestment, especially in R&D expenditures, among Korean companies.
[5] Lemmon, Ma, and Tashjian (2009) report that unionized firms reorganizing under Chapter 11 reduce employment by 9 percentage points less than do non-unionized firms.
[6] Abraham and Medoff (1984) show that older workers enjoy more layoff protection in unionized firms than in non-unionized firms.

inflexibility may force firms to look for ways to cut costs or push their factors of production to extreme limits, to the detriment of product quality, thereby increasing the likelihood, frequency, and severity of product failures and recalls down the road.[7]

Lack of operating flexibility is especially constraining to firms during downturns (Bentolila and Bertola, 1990; Autor, Donohue, and Schwab, 2006; and Messina and Vallanti, 2007). This is further compounded by the fact that obtaining external financing may be a problem for unionized firms as they are associated with violations of the absolute priority rule. Blaylock, Edwards, and Stanfield (2015) argue that the 2009 bailout of Chrysler is one such example where secured creditors, who were above UAW (the union of automobile workers) in the pecking order for liquidation payments, received substantially less than their face value while the UAW received considerable payments for their claims. These types of events set a bad precedent for creditor rights and a serve as a hurdle for future debt financing. In fact, Campello, Gao, Qiu, and Zhang (2017) find that unionization results in losses for bondholders. Therefore, unionization may indirectly lead to a financially stressed environment, once again potentially compromising the production process resulting in a higher likelihood, frequency, and severity of product recalls.[8]

Overall, these latter arguments suggest that unions will have a negative impact on product quality and we should expect to see unionized firms experience a higher likelihood and frequency of recalls, and when recalls do occur, we should expect the failures to be more severe than in non-unionized firms. In addition, we should expect the percentage of unionized workers in a firm to be positively related to the likelihood, frequency, and severity of product failures.

[7] Financial pressures in unionized firms may be further exacerbated due to increased debt obligations in these firms. Bronars and Deere (1991) and Matsa (2010) show that unionized firms have an increased incentive compared to non-unionized firms to take on more debt as a way to shield shareholder surplus away from unions.

[8] Hilary (2006) provides yet another channel through which market monitoring of managers is eroded in unionized firms. Unionized firms have an incentive to deliberately maintain a higher level of information asymmetry (vis-à-vis the market) about their cash flow and profitability so as to shield rents and prevent expropriation by the union. As a consequence, Hilary (2006) shows that unionized firms have lower trading volume and low levels of analyst coverage – a key avenue through which capital markets are able to monitor managers.

3. Data sources, sample selection, and salient characteristics

3.1. Product recalls sample

We hand collect data on product recalls announced during the period January 2003 – December 2013 from three U.S. regulatory agencies that govern product quality and safety. Specifically, we collect information on food, drug, and medical device recalls from the *FDA* website. We collect information on consumer recalls from the *CPSC*. This sample contains recalls of a variety of goods such as children's products, household appliances, heating and cooling equipment, home furnishings, toys, nursery products, workshop hardware and tools, yard equipment among others. Finally, we collect information on automobile recalls – related to vehicle, equipment, car seat, or tire – from the *NHTSA*. To be included in our sample, we require recalling firms to be publicly traded as we need their financial information in our analysis.

Our sample comprises of 6,735 recall events during the 2003–2013 period. In Table 1, we provide the frequency of recall events during our sample period. We find that with the exception of 2003, the first year in our sample, the number of recalls is fairly evenly distributed across the years. In our sample, 1,982 recalls belong to the *NHTSA* sub-sample, 4,055 recalls belong to the *FDA* sub-sample, and 698 recalls belong to the *CPSC* sub-sample. Table 2 provides the industry distribution of our recall sample based on two-digit SIC industries. We find that our sample spans a wide range of industries – specifically, the sample covers 42 two-digit SIC industries. Transportation Equipment (1,973), Measuring, Analyzing, and Controlling Instruments (1,803), and Chemical and Allied Products (1,233) industries are the most represented two-digit SIC industries in our sample.

3.2. Firm-level union data: Union panel and elections

We obtain data on union elections and contract settlement summaries published by the National Labor Relations Board (NLRB) over 2002–2012 from *Bloomberg BNA.* This data spans a wide variety of variables pertaining to labor unions such as firm name, site location, SIC code, petition type, date of the election, number of employees eligible to vote in the election, number of votes for and against in the election, and labor contract level details. Using a combination of automated and hand matching techniques, we link each unique firm name in the union dataset to its Compustat GVKEY identifier. When required, we use the firm's headquarter location and SIC code to ensure the accuracy of our matching procedure. Using the directory of expirations and contract settlement summaries obtained from *Bloomberg BNA*, we create a variable *% Unionized workers (3 yrs)* which is the proportion of unionized employees at the firm level assuming that expired contracts have a duration of three years. Similarly, we create *% Unionized workers (5 yrs)* which is an analogous measure but assumes that expired contracts instead have a duration of five years. In addition, we replace the continuous unionization variables outlined above with an indicator variable *Unionized (3 yrs)* (*Unionized (5 yrs)*) which is set to one if the firm has unionized employees, and is set to zero otherwise. In Appendix B, we describe in detail our procedure for constructing a panel dataset of firm-level unionization rates for all Compustat firms.

In the regression discontinuity design (RDD) tests pertaining to union elections, we focus only on union certifications which are petitions in which employees seek to certify a union at a location. We are able to collect data on 1,870 unique union elections of public firms during the period 2002-2012. Our final sample of union elections is restricted to industries that have at least one recall during the sample period. This sample includes 1,144 union elections during 2002-2012. In our RDD tests, we use a variable *Union Win* which is set to one if the union wins the election, and is zero otherwise.

3.3. Characteristics of product recalling and control firms

Table 3 presents univariate differences between recalling and control firms. Control firms are all firms that belong to the same three-digit SIC industries as the recalling firms, but have not had a recall during our sample period.[9] We winsorize all variables at their 1% and 99% levels. The univariate statistics on the firm-level unionization and control variables for each of the two groups are presented in Panel A and Panel B, respectively. The control variables are chosen based on the theoretical arguments made in Kini, Shenoy, and Subramaniam (2017).

[9] Our panel regression results are robust to the following four alternative methods for forming the control sample for each calendar year. Specifically, in the four different alternate specifications, a firm is included as a control firm in a calendar year (year *t*) if it does not have a recall in: (i) year *t* and year *t+1*, (ii) year *t*, year *t+1*, and year *t+2*, (iii) year *t-1*, year *t*, and year *t+1*, and (iv) year *t-2*, year *t-1*, year *t*, year *t+1*, and year *t+2*. We do not report these results in the interest of brevity.

In Panel A, we observe that recalling firms have significantly higher mean (median) rate of unionization than control firms. For example, the mean *% Unionized workers* (*3 yrs*) is 0.057 (5.7%) for recalling firms, while it is 0.011 (1.1%) for control firms. The mean *% Unionized workers* (*5 yrs*) is 0.060 (6.0%) for recalling firms and 0.012 (1.2%) for control firms. In addition, the mean *Unionized (3 yrs)* (*Unionized (5 yrs)*) is 0.497 (0.501) for the recalling firms and 0.082 (0.087) for the control firms. These univariate results are generally consistent with the notion that unionized firms and those with a higher rate of unionization have an increased propensity for recalls. Further, based on both mean and median values reported in Panel B, we find that recalling firms have a significantly larger number of suppliers, are bigger in size, and operate in more concentrated industries.

4. Multivariate regressions on the relation between unionization and product quality failures

4.1. The impact of unionization on the incidence of product recalls

In this section, we empirically investigate how the firm-level unionization rate can impact the likelihood of a product recall by estimating probit regressions. In this analysis, we control for firm- and industry-characteristics that can affect the likelihood of a product recall. Specifically, our main regression specification is:

$$\begin{aligned} Prob(RecallDum_{i,t+1} = 1) \\ &= F(\beta_0 + \beta_1 \%Unionized\ workers\ (Unionized)_{i,t} + \beta_2 Book\ leverage_{i,t} \\ &+ \beta_3 R\&D\ intensity_{i,t} + \beta_4 Herfindahl\ index_{i,t} + \beta_5 Number\ of\ suppliers_{i,t} \\ &+ \beta_6 Total\ factor\ productivity_{i,t} + \beta_7 Vertical\ integration\ dummy_{i,t} + \beta_8 Size_{i,t} \\ &+ Year\ and\ industry\ dummies + \varepsilon_{i,t+1}) \qquad (1) \end{aligned}$$

In the above model, the dependent variable, *RecallDum* is a dummy variable that takes the value one if a product recall takes place for firm *i* in year *t+1*. $F(\cdot)$ is a cumulative distribution function of a standard normal variable. All independent variables are *lagged* by one year. As discussed in Section 3, we use one of the following alternative measures for firm-level unionization – *% Unionized workers (3 yrs)*, *% Unionized workers (5 yrs)*, *Unionized (3 yrs)*, or *Unionized (5 yrs)*. All estimations contain industry and calendar year dummies and include other control variables that can affect product quality. All regressions report *p*-values that are based on heteroskedasticity robust standard errors and are clustered by firm.

The regression results are reported in Table 4. In Models 1 and 2, we find that there is a significantly positive relation between the probability of a product recall and *% Unionized workers (3 yrs)* and *% Unionized workers (5 yrs)*, respectively. In Models 3 and 4, we find that there is a significant positive relation between the probability of a product recall and *Unionized (3 yrs)* and *Unionized (5 yrs).* The results documented in Models 1 – 4 are statistically significant at least at the 5% level. The results indicate that unionized firms and those with a higher percentage of unionized workers have a higher likelihood of a product recall. To provide additional perspective, we assess the economic significance of the results by examining the change in average probability of a recall if a non-unionized firm were to become unionized. As an example, based on the coefficients in Model 4 of Table 4, when the *Unionized* variable changes from 0 to 1, the implied probability of a recall goes up by 3.73%. If this change in implied probability is evaluated relative to the unconditional probability of a recall of 18.45%, it suggests that becoming unionized results in a 20.2% increase in the likelihood of a recall. Thus, it appears that unionization not only has a significant statistical impact, but also a significant economic impact on the incidence of recalls. These results are consistent with the hypothesis that firms with higher unionized labor force has lower product quality.

The signs on our control variables are consistent with those documented in the literature. In particular, consistent with Kini, Subramaniam, and Shenoy (2017), we document a positive relation between *Book leverage* and the likelihood of a recall suggesting that financial constraints imposed by taking on leverage are likely to impair quality investments leading to poor quality products. This relation is statistically significant at the 10% level in Models 1 and 2. The coefficients associated with *Book leverage* are, however, not significantly positive at conventional levels, with the p-values being 0.115 and 0.128 in Models 3 and 4, respectively. In addition, we find the incidence of recalls is significantly higher if the *Number of suppliers* is greater. 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, thereby resulting in poorer quality products. We find an insignificant relation between

Herfindahl index as well as *Vertical integration dummy* and the probability of a product recall. Further, we find that the relation between the probability of a product recall and *R&D intensity* is significantly negative in all the estimated regressions indicating that investments in innovation lead to a lower likelihood of experiencing quality failures. We find that there is positive and significant relation between the propensity to have a product recall and *Total factor productivity*. This finding suggests that firms that push factors of production to increase output are more likely to experience product quality failures. Finally, we find that larger firms are significantly more likely to have product recalls.

4.2. Impact of unionization on the frequency of recalls

In this section, we estimate Poisson regression models to examine the impact of unionization on the frequency of product recalls. To conduct this analysis, we aggregate multiple recall observations for each firm in a given year by counting the number of recalls. Specifically, we construct three variables labeled *CumRecalls_1yr*, *CumRecalls_2yr*, and *CumRecalls_3yr* which measure the number of recalls announced by a firm in year *t+1*, years *t+1* and *t+2*, and years *t+1*, *t+2*, and *t+3*, respectively. These variables are equal to zero for control firms if they have financial information available over the relevant fiscal years, otherwise they are treated as missing observations. The longer windows over which we measure the frequency of recalls attempt to account for the fact that sometimes several years can elapse between when unionization actually impacts product quality through, for example, a reduction in investments that impact quality, and the eventual recall announcement. We then estimate the relation between the three measures of frequency of recalls and the firm-level unionization variables outlined in Section 3 using Poisson regression models.

The regression results are reported in Table 5. In Panel A (Panel B), we report the regression results for the continuous (dummy) unionization variables. In both panels, we find that the coefficients on all four measures of unionization are significantly positive at the 1% level regardless of the choice of dependent variable (*CumRecalls_1yr*, *CumRecalls_2yr*, or *CumRecalls_3yr*). The results in this table indicate that unionized firms and firms with higher rates of unionized workers experience a greater frequency of product recalls. Thus, if frequency of recalls can be viewed as another dimension of quality failures, the results reported in Table 5 reinforce our prior finding that labor unions adversely affect product quality of firms.

4.3. Impact of unionization on the severity of recalls

In this section, we examine the impact of unionization on the severity of recalls. If labor unions constrain investments in product quality, then we should also observe that firms with higher rates of unionization would not only experience a higher likelihood of a recall, but also experience more severe product failures. We examine *FDA* recalls in this section because neither *CPSC* nor *NHTSA* classifies recalls by their severity. The *FDA* classifies recalls into one of the following three classes based on the severity of the product failure. Specifically, Class I recalls are most severe as exposure to the violative product is likely to "cause adverse health consequences or death," Class II recalls are less severe because exposure to the violative product is likely to "cause temporary or medically reversible adverse health consequences," and Class III recalls are considered to be the least severe because although the violative product may have other deficiencies, exposure to it is not likely to "cause adverse health consequences."

To analyze the impact of unionization on severity of failures, we estimate ordered probit regressions, and the results are reported in Table 6. The dependent variable in all the models is the severity of the recall. In Model 1 (Model 2), we document a positive and significant relation between *% Unionized workers (3 yrs)* (*% Unionized workers (5 yrs)*) and the severity of a recall. Similarly, in Model 3 (Model 4), we document a positive and significant relation between the dummy variable *Unionized (3 yrs)* (*Unionized (5 yrs)*) and the severity of a recall. The positive relations highlighted above are statistically significant at least at the 5% significance level. Thus, the results indicate that firms that are unionized and those that have a higher proportion of unionized employees are more likely to experience product quality failures.[10]

4.4. Product recalls and firm unionization: Two-stage least squares estimations

The relation between unionization and recall incidence documented in Table 4 can be due to an

[10] As a robustness test, we match each recalling firm with a non-recalling firm that is in the same three-digit SIC industry and closest to it in size. We then estimate conditional logit models on this sample and find that all our measures of unionization are significantly positively related at least at the 1% level to the likelihood of a recall, frequency of recalls, and severity of recalls. Due to space considerations these results are not tabulated in the paper.

omitted variable that affects both unionization and the likelihood for a recall. For example, workers in declining firms may be more likely to unionize to protect themselves against possible future pay cuts and layoffs and, at the same time, these declining firms may also be more susceptible to quality failures due to sub-optimal levels of investments to maintain quality. In this section, we address the possibility that both unionization and recall incidence are endogenously determined by a missing latent factor using two-stage least squares (2SLS) estimations.[11] In the 2SLS method, we instrument for the unionization variable in the first stage and use a linear probability model in the second stage to model the propensity for a recall.

Based on the arguments in Cohen, Malloy, and Nguyen (2016), we use ten-year lagged value of the percentage of unionized work force computed at the metropolitan statistical area (MSA) level (*% Unionized MSA (10 yr lagged)*) as an instrumental variable for firm-level unionization. Specifically, Cohen, Malloy, and Nguyen (2016) show that unionization patterns in the U.S. can be explained by factors that were set in motion decades ago during the dust bowl. Arid and famine conditions forced farmers to move to cities during the drought years and unionization was a reaction by existing city workers to the threat of the arrival of new labor. They show those unionization patterns continue to this day and explain the variation in unionization across the U.S. Therefore, for our study we use the percentage of unionized workers in an MSA ten years ago as an instrument for the current percentage of unionized workers for each firm operating within that MSA. To construct this variable, we obtain the company's headquarter county according to the historical headquarter zip code and then match the headquarter county to MSAs based on linking tables provided by the Census Bureau. Historical MSA unionization from 1986 is obtained from the *Union Stats* website available at http://www.unionstats.com. This variable is likely to be positively related to firm's unionization rate during our sample period, but it is highly implausible that unionization at the MSA level

[11] We can potentially also control for time-variant firm-specific factors by including firm fixed effects in the estimated regressions. However, firm fixed effects regressions are not possible because there is no within-firm variation in the recall/control status of the firms in the study in our setting. This is because, in our study, control firms are by definition firms from the same industry as the recalling firms, but have not had a recall during the sample period. So, recall firms do not enter the control group and control firms do not enter the recall sample. Further, we find that there is a high degree of serial correlation in each of our four unionization variables (higher than 0.9). In such scenarios, Zhou (2001) suggests that firm fixed effects should not be used.

ten years ago would directly affect the propensity for firm-level recalls a decade later. We, thus, believe that MSA level historical unionization also meets the exclusion restriction. Finally, in the absence of other good instruments, we use exactly-identified specifications as recommended in Roberts and Whited (2011).

The results from the 2SLS analysis are reported in Table 7. In this table, the dependent variable in the second-stage regression is *RecallDum*, *CumRecalls_1yr*, *CumRecalls_2yr*, and *CumRecalls_3yr* in Panels A, B, C, and D, respectively. In each panel, odd numbered models present the first-stage OLS regression estimation results, while even numbered models present the second-stage estimation results based on linear probability models. From both the first-stage regression results in each of the four panels, we find that our instrumental variable *% Unionized MSA (10 yr lagged)* is relevant for our four unionization variables (*% Unionized workers (3 yrs)* (Model 1), *% Unionized workers (5 yrs)* (Model 3), *Unionized (3 yrs)* (Model 5), and *Unionized (5 yrs)* (Model 7)). Specifically, in all of our first-stage estimations, we find that our industry MSA level unionization instrument is statistically significant almost always at the 1% significance level. In the second-stage regression models, we find that the instrumented *% Unionized workers (3 yrs)* in Model 2 and the instrumented *% Unionized workers (5 yrs)* in Model 4 are significantly positively related to *RecallDum*, *CumRecalls_1yr*, *CumRecalls_2yr*, and *CumRecalls_3yr* at the 10%, 5%, 5%, and 10% level of statistical significance in Panels A, B, C, and D, respectively. The coefficients associated with the instrumented *Unionized (3 yrs)* (Model 6) and *Unionized (5 yrs)* (Model 8) are statistically significant at the 5% level in each of the four panels. Thus, the results from the second-stage regression suggest that higher levels of unionization and firm unionization significantly increase both the propensity for recalls and the frequency of recalls, and support our earlier conclusions that unionization adversely impacts product quality. 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 instrument is highly correlated with the endogenous regressor. Our tests for endogeneity indicate that, given the chosen instrument, the use of the 2SLS approach is appropriate. Overall, our instrumental variable estimations are suggestive of a causal link between firm unionization levels and quality failure events.

4.5. Product recalls and firm unionization: Evidence from two quasi-natural natural experiments

To more conclusively establish that firm unionization affects the likelihood and frequency of recalls and to also shed light on the operating flexibility and financial pressures channels through which unionization can adversely impact product quality, we condition our previous tests on two exogenous negative shocks to industry cash flows: (1) significant import tariff cuts that increase competition for domestic firms and (2) input price shocks that result in exogenous cost increases for firm inputs. A sharp reduction in import tariffs will result in increased import penetration by foreign firms. The resulting increased competition will have negative cash flow consequences for all domestic firms in the industry. Likewise, a large increase in input prices will also represent a negative cash flow shock for all firms in the downstream industry.

We had argued earlier that unions can impede product quality through financial pressures they impose on firms through marked-up wages and benefits. Unions can also make wages sticky and employee layoffs costlier. Union contracts are often rigid multi-year contracts with fewer short-term, need-based flexible arrangements than seen in non-unionized firms (Mitchell, 1985; Wunnava and Okunade, 1996; and Gramm and Schnell, 2001). Thus, unions reduce firms' operating flexibility, and in effect, raise firms' operating leverage and cost of equity capital (Chen, Kacperczyk, and Ortiz-Molina, 2011). These financial pressures and operational inflexibility are likely to force firms to either make suboptimal investments, take shortcuts in the production process, or push their factors of production beyond optimal levels (see, e.g., Bolton and Scharfstein, 1990; Maksimovic and Titman, 1991; Chevalier, 1995; Phillips, 1995; and Chevalier and Scharfstein, 1996), thereby significantly increasing the risk of product quality failures and subsequent increases in product recalls (Kini, Shenoy, and Subramaniam, 2017).

This reduced operating flexibility is compounded by the fact that unionized firms can have difficulty obtaining external financing because the presence of unions potentially weakens creditor rights (Blaylock, Edwards, and Stanfield, 2015). Therefore, unionization may lead to a financially stressed environment, once again potentially compromising the production process and product quality. If higher rates of unionization constrain firms from undertaking the investments necessary to improve product quality either because of higher operating leverage or tighter financial constraints, then such constraints will be amplified following the above described exogenous cash flow shocks. We should, therefore, expect the impact of unionization on product recalls to be more pronounced for firms affected by the cash flow shocks.

To more definitively examine the causal role of unions on quality, we estimate a probit (or Poisson) regression model similar to Equation (1), but with the addition of the shock variable and the interaction between the shock variable and the different unionization variables.

Specifically, we estimate the following probit/Poisson model[12]:

$$Prob(RecallDum_{i,t+1} = 1)\ (CumRecalls_{i,t+1})$$
$$= F(\beta_0 + \beta_1 \%Unionized\ workers_{\ i,t}$$
$$+ \beta_2 \%Unionized\ workers_{\ i,t}\ x\ Shock\ dummy_{i,t} + \beta_3 Shock\ dummy_{i,t}$$
$$+\ \beta_4 Book\ leverage_{i,t} + \beta_5 R\&D\ intensity_{i,t} + \beta_6 Herfindahl\ index_{i,t}$$
$$+ \beta_7 Number\ of\ suppliers_{i,t} + \beta_8 Total\ factor\ productivity_{i,t}$$
$$+ \beta_9 Vertical\ integration\ dummy_{i,t} + \beta_{10} Size_{i,t} + Year\ and\ industry\ dummies$$
$$+ \varepsilon_{i,t+1}) \qquad (2)$$

The shock dummy in the above equation is measured with a lag relative to the recall year. As argued above, we expect the coefficient (β_2) on the interaction term *%Unionized workers* x *Shock dummy* to be positive.

We use the procedure detailed in Fresard (2010) and Kini, Shenoy, and Subramaniam (2017) to estimate a tariff cut dummy, *Tariff cut*, which is set to one for an industry-year that records a significant drop in tariff rates, and is set to zero otherwise. We consider an annual percentage tariff rate drop as significant for any industry year if it is at least two times the industry median level. In addition, we follow Kini, Shenoy, and Subramaniam (2017) to generate a negative input price shock dummy, *Negative input price shock*, which is set to one if the geometric average annual growth rate of the weighted average real producer price index of the five most important supplier industries to the recalling industry is 5% or higher, and is set to zero otherwise. The computational details of the two shock variables are in the Appendix.

[12] $F(\cdot)$ is an exponential function of the independent variables in the case of the Poisson model.

We report the results from our analysis in Table 8. The dependent variable is *RecallDum* in Panel A, *CumRecalls_1yr* in Panel B, *CumRecalls_2yr* in Panel C, and *CumRecalls_3yr* in Panel D. We, therefore, estimate probit regression models in Panel A and Poisson regression models in the remaining panels. In each panel, the first two models examine the impact of the negative input price shock, while the second two models examine the impact of the tariff cut shock.[13] In addition, in each panel, Models 1 and 3 use *%Unionized workers (3 yrs)* and Models 2 and 4 use *%Unionized workers (5 yrs)* as the measure of unionization rate. In Panel A, we find that coefficient on the interaction term, *%Unionized workers* x *Negative input price shock* is significantly positive at the 5% level in both Models 1 and 2. In addition, the coefficient associated with the interaction term, *%Unionized workers* x *Tariff cut* is significantly positive at least at the 10% level in Models 3 and 4. Consistent with the view that unionization adversely impacts product quality by magnifying the financial pressures faced by a firm we find incidence of product quality failures is higher when firms that are exposed to the exogenous cash flow shocks have a higher level of unionization compared to other firms exposed to the same cash flow shocks.

In Models 1 and 2 in the remaining three panels, with measures of quality based not just on incidence of recalls but on the frequency of recalls, we find that the coefficients on the interaction term, *%Unionized workers* x *Negative input price shock* are significantly positive at the 1% level when either *CumRecalls_1yr* (Panel B) or *CumRecalls_2yr* (Panel C) is the dependent variable and at the 5% level when *CumRecalls_3yr* (Panel D) is the dependent variable. Thus, when the firms are exposed negative input price shocks, higher unionization rates have a more pronounced deleterious effect on the frequency of product recalls measured over the next one-, two-, or three-years. The coefficients on the interaction term, *%Unionized workers* x *Tariff cut* are positive in all the regressions reported in Models 3 and 4, but are only significantly positive (at the 5% level) in Panel B. Thus, the results in Panels B, C, and D generally suggest that when exposed to exogenous negative cash flow shocks higher unionization rates increase the frequency of recalls. Overall, these results suggest that the relation between unionization and product quality failures

[13] The sample size is smaller in all models that use *Tariff cut* as the shock variable because the data to compute the shock is only available for manufacturing industries.

that we document earlier in the paper is likely to be causal in nature.[14] Additionally, the results from these two quasi-natural experiments suggest that reduction in operational flexibility and/or more binding financial constraints are possible channels through which unionization adversely impacts product quality failures.

5. Unions and quality failures: Regression discontinuity design (RDD) tests

In the previous section, we exploit exogenous cash flow shocks to conduct tests that suggest that the impact of unionization on product recalls is likely to be causal in nature. To further examine the claim of a plausible causal link between unionization and product recalls, in this section we adopt a regression discontinuity design to analyze product recalls following closely-contested union elections.[15] We exploit the outcome of close union elections to provide independent evidence that can help us make a stronger case for a causal relation between unions and product quality failures. We also use this research design to further examine the possible channels through which unionization can impact product quality failures.

5.1. Unions and product quality failures: Outline of the RDD methodology

The union data we collect includes information on union elections at the site level. A union needs more than 50% votes for the site to be unionized (*Union Win*). RDD methodology entails comparing the frequency of product recalls of firms subsequent to union elections that pass by a small margin relative to those that fail by a small margin. Proper identification in a RDD setting rests critically on whether there is random assignment of unionization at the site around the majority threshold of 50%. Thus, as long as there is random assignment of firms around close election, we can identify the effect of unionization on the

[14] It is possible that employees will decide to unionize after product recalls to protect themselves against anticipated future pay cuts and layoffs that can arise due to financial adversity the firm will likely face as a consequence of the recalls. Our use of lagged unionization variables in all our estimated regressions alleviates this reverse causality concern. To further reduce this concern, we additionally conduct two reverse causality tests. The first test is essentially a falsification test in which the estimated regressions include the number of recalls at time $t+1$ as the dependent variable and both lead (time $t+2$) and lag (time t) unionization variables are included as independent variables. In the estimated Poisson model, we continue to find a significant positive coefficient on our lagged unionization variables, but an insignificant coefficient on the lead unionization variables. In the second test, the dependent variable is one of our unionization variables at time $t+1$ and the independent variables are lagged number of recalls at time t and the lagged value of the same unionization variable at both time $t-1$ and $t-2$. We find that the coefficient on lagged number of recalls in the estimated OLS models is insignificantly different from zero. Both these reverse causality tests together suggest that unionization causes product recalls and not the other way around. We do not report these results in the interest of brevity.

[15] See Imbens and Lemieux (2008) for a guide to regression discontinuity designs in practice.

frequency of product recalls. Further, this random assignment feature also makes the inclusion of other explanatory variables unnecessary for identification (see, e.g., Bradley, Kim, and Tian, 2017; Flammer, 2016; and Lee and Lemieux, 2010). Specifically, we estimate the following Poisson regressions models using outcomes *only* from close elections:

$$\begin{aligned} &Frequency\ of\ a\ recall_{i,t+T} \\ &\qquad = \alpha + \beta Union\ Win_{i,t} + Industry\ dummies + Year\ dummies + \varepsilon_{i,t} \qquad (3) \end{aligned}$$

where *Union Win* is a dummy variable that takes the value of one if there is a *close* election win, and takes the value of zero if it is a *close* election loss, where percentage votes in favor of the union (*pv*) is greater (less) than 50% for a union to win (lose) the election. Further, *T* can take on the value 1, 2, or 3, that is, we investigate the impact of unions on the cumulative frequency of recalls one year (*CumRecalls_1yr*), two years (*CumRecalls_2yr*), and three years (*CumRecalls_3yr*) subsequent to the union election.

While the above approach of focusing just on close election outcomes will provide unbiased estimates of the effect of unionization on the frequency of product recalls, it loses a significant amount of information because it does not consider in the analysis elections that are not close. To provide more efficient estimates, we also use all union elections for our sample firms and approximate the continuous relation between the *Frequency of recalls* and *pv* by including a polynomial in *pv* while, at the same time, allowing for a discontinuous jump at the union win threshold of 50% (*c*). We do this by either using one global polynomial P(*pv*, *c*) or separate polynomials for observations on the left-hand side of the threshold P(pv_l, *c*) and the right-hand side of the threshold P(pv_r, *c*). Specifically, we estimate the following Poisson regression models using all union elections[16]:

$$\begin{aligned} Frequency\ of\ a\ recall_{i,t+T} &= \alpha + \beta Union\ Win_{i,t} + P(pv, c) + Industry\ dummies \\ &\quad + Year\ dummies + \varepsilon_{i,t} \qquad (4) \end{aligned}$$

[16] Wooldridge (2010, p. 957) suggests that for response variables with limited range, local versions of estimation methods like Poisson regression models can also be employed in a RDD setting.

$$Frequency\ of\ a\ recall_{i,t+T} = \alpha + \beta Union\ Win_{i,t} + P_l(pv,c) + P_r(pv,c)$$

$$+Industry\ dummies + Year\ dummies + \varepsilon_{i,t} \qquad (5)$$

We report results using polynomials of order 2 and cluster standard errors at the firm level.[17]

In all three equations 3–5, we focus on the sign and significance of the coefficient β. If β is significantly positive (negative), then we will conclude that unions result in a higher (lower) frequency of recalls and, thus, have an adverse (beneficial) impact on product quality. We do need to exercise some care in interpreting RDD estimates because although they have strong local validity, their external validity is weak (see, e.g., Lee and Lemieux, 2010; Cuñat, Gine, and Guadalupe, 2012; and Bradley, Kim, and Tian, 2017).

5.2. Validity of using RDD methodology

As mentioned earlier, the identifying assumption of RDD is that a union win is randomly assigned around the majority threshold. In this section, we conduct tests of this identifying assumption as a precursor to using the RDD methodology to investigate whether there is a causal link between unions and the frequency of recalls.

5.2.1. Discontinuity in percentage of votes for union (pv) at threshold

The implication of random assignment of votes at the threshold is that neither employees nor the employers can manipulate election votes near the majority threshold. In Figure 1, we provide a histogram of the distribution of *pv* in 30 equally spaced *pv* bins (with a bin width of 3.33%). The total number of union elections in Figure 1 is 1,144.[18] A visual inspection of the figure appears to show that the distribution of *pv*

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[17] While the regression results reported in Tables 11 – 14 employ polynomials of order 2, we find that our results are qualitatively similar if we instead use polynomials of order 3 in these regressions. We do not tabulate these results in the interest of brevity.

[18] Our sample size of union elections is significantly smaller than that in Bradley, Kim, and Tian (2017) in their study of the impact of unionization on innovation because: (i) their study includes union elections in both private and public firms, whereas our paper only includes union elections in public firms, (ii) we restrict our sample only to industries that had at least one firm with a product recall over our sample period, and (iii) their sample period is 1980-2002, which is more than twice as long as our union election sample period of 2002-2012.

is smooth and continuous around the majority threshold of 50%, thereby suggesting election votes have not been manipulated by any party around the threshold.

We next conduct the McCrary (2008) test to more formally test for the smoothness of the density function around the threshold. Figure 2 plots the density of *pv*. In this figure, the dots represent the density, i.e., the average value of the frequency of product recalls in each bin, and the solid line signifies the fitted density function of *pv*. The density appears to be smooth and there appears to be little evidence of any discontinuous jump near the threshold. Specifically, the discontinuity estimate is 0.223 and its standard error is 0.172. Thus, the null hypothesis of continuity at the 50% threshold cannot be rejected.

5.2.2. Differences in characteristics near threshold

Another implication of random assignment is that ex-ante firm characteristics just above and below the majority threshold should be similar. In other words, if the outcomes of close union elections are random, then these outcomes should be orthogonal to ex-ante firm attributes. We compare the characteristics of firms having union elections that fall either in the [42.5%, 57.5%] or [40%, 60%] band of *pv*.[19] The firm characteristics that we consider include all the determinants of product quality failures that we consider in our earlier multivariate tests. These include *Size*, *Ln(Revenues)*, *Ln(Book value of assets)*, *Book leverage*, *R&D intensity*, *Total factor productivity*, *Number of suppliers*, *% Unionized workers (3 yrs)*, and *% Unionized workers (5 yrs)*. The results from this analysis are provided in Table 9. Specifically, in Panel A, the variable *Close Win* (*Close loss*) is a dummy variable that takes the value one if *pv* is between 50% and 57.5% (42.5% and 50%), and equals zero otherwise. In Panel B, the variable *Close Win* (*Close loss*) is a dummy variable that takes the value one if *pv* is between 50% and 60% (40% and 50%), and equals zero otherwise. In each panel, we test whether the mean firm attributes are significantly different for the *Close Win* and *Close Loss* subsamples. In both panels, we do not find that the mean value of any of these attributes is significantly different between the two subsamples. Most importantly, we do not find any significant

[19] For our sample, the maximum number of firms in the [47.5%, 52.5%] and [45%, 55%] intervals are 65 and 152, respectively. We do not report the differences in firm characteristics for these narrower bands because the number of observations are too few to obtain meaningful estimates with the inclusion of industry and year dummies in our RDD regression tests.

difference in mean unionization rate (both *% Unionized workers (3 yrs)* and *% Unionized workers (5 yrs)*). Unlike earlier studies that exploit close union elections in a RDD framework, we are able to make this determination only because we build a panel database of firm-level unionization rates using union contracts settlement data. Overall, the evidence in Table 9 suggests that there is no discontinuity in firm characteristics at the majority threshold.

In summary, we do not find any evidence of manipulation of votes by either employees or employers around the 50% majority threshold. We also find that firm characteristics are similar for firms in which unions just obtained majority votes compared to those in which unions just fell short of majority votes. These results suggest that the assignment to the close win and close loss groups appears to be random and, therefore, suggests that it is appropriate to use the RDD methodology to make causal inferences about the impact of unions on the frequency of product recalls.

5.3. Main RDD results: Union wins and frequency of recalls

5.3.1. Graphical analysis

In Figure 3, we attempt to visually check the relation between the cumulative frequency of recalls over the one year (*CumRecalls_1yr*), two years (*CumRecalls_2yr*), and three years (*CumRecalls_3yr*) after the election and unionization close to the majority threshold. More specifically, the figure presents regression discontinuity plots using a fitted quadratic polynomial estimate separately for each post-election period. The *x* axis is the percentage of votes favoring unionization (*pv*). The dots depict the average of the number of recalls variables in each of the evenly spaced bins, the width of which is determined by a data driven algorithm.[20] We present fitted quadratic polynomial estimates in the figure. All the three figures that come under the heading of Figure 3 show that the cumulative frequency of product recalls increase significantly once *pv* crosses the 50% majority threshold. This observation suggests that unions are likely to increase the cumulative frequency of product recalls.

[20] We use the default option provided under the *rdplot* estimation command of Stata. This option selects bin width based on mimicking variance evenly-spaced method using spacing estimators. We arrive at similar inferences if we pre-specify the number of bins.

5.3.2. RDD regression results

In Table 10, we present results from Poisson regressions of the cumulative number of recalls over different post-election windows on *Union Win*, i.e., a dummy variable that equals one if the union wins the election, and zero otherwise, as specified in Equation (3). In these regressions, standard errors are clustered at the firm level. In Panel A, the sample consists of all union elections. We report results for two sets of three regressions models. In the first set, we only include year dummies, while, in the second set, we include both three-digit SIC industry and year dummies. In each set, the dependent variable is *CumRecalls_3yrs*, *Cum_Recalls_2yrs*, and *CumRecalls_1yr* in the first, second, and third regression model, respectively. The sample size in these tests ranges from 972 to 1,144. We find the coefficient on *Union Win* is significantly positive at least at the 5% level in all three post-election windows with and without the control for industry dummies. We cannot, however, make causal inferences from these results because these tests are potentially subject to missing latent factor and reverse causality problems as the sample here is not restricted to close elections.

In Panel B, the dependent variable is *CumRecalls_3yr*. We present results for union elections within a 7.5% range (Models 1 and 4) of the majority threshold, 10% range of the majority threshold (Model 2 and 5), and outside the 10% range (Model 3 and 6), respectively. Again, Models 1–3 include only year dummies and Models 4–6 include both three-digit SIC industry and year dummies. The only difference in Panel C (Panel D) from Panel B is that the dependent variable is *CumRecalls_2yr* (*CumRecalls_1yr*). Note that the sample size ranges from 196 – 238 for the [42.5%, 57.5%] interval, 270 – 322 for the [40%, 60%] interval, and 702 – 822 for the outside the [40%, 60%] interval. Standard errors are clustered at the firm level. In these regressions, we find a positive relation between the cumulative frequency of recalls and union wins for the close elections. The relation is statistically significant in sixteen of the eighteen estimated regressions. For example, in Panel B with *CumRecalls_3yr* as the dependent variable, the coefficient associated with *Union Win* for the [42.5%, 57.5%] interval is 1.6478 (significant at the 5% level) without industry dummies and is 1.3783 (significant at the 1% level) with industry dummies.

As discussed earlier, focusing just on close election outcomes provides unbiased estimates of the effect of unionization on the frequency of product recalls, but we do stand to lose a significant amount of information because we do not consider elections that are not close to the threshold in the analysis. To provide more efficient estimates, we also use all union elections for our sample firms and estimate global polynomial functions of *pv* with a union win/loss discontinuity around the 50% majority threshold. We do this by either using one global polynomial P(*pv*, *c*) or separate polynomials for observations on the left-hand side of the threshold P(pv_l, *c*) and the right-hand side of the threshold P(pv_r, *c*). In addition to these two approaches, we estimate non-parametric local regressions around the 50% threshold using an optimal bandwidth that minimizes mean square error rather than using fixed bandwidth values chosen by us as in Table 10 (Imbens and Kalyanaraman, 2012). Further, we report the local estimation results using a rectangular kernel.[21] The results from this analysis are in Table 11.

Table 11 presents regression discontinuity design (RDD) results from estimating Poisson models. In all three panels, the first three models include only calendar year dummies, while the second three models include both three-digit SIC industry dummies and calendar year dummies.[22] The dependent variable is either the cumulative number of recalls measured over a period of one year (*CumRecalls_1yr*), two years (*CumRecalls_2yr*), or three years (*CumRecalls_3yr*) after the union election. The independent variable of interest is *Union Win* which is a dummy variable that equals one if the union wins the election, and zero otherwise. In Panel A, we estimate RDD regression models for all union elections using one global polynomial regression (see Equation (4)) and, in Panel B, we estimate RDD regression models for all union elections using one global polynomial regression for left hand side of the 50% threshold and another for the right hand side of the 50% threshold (see Equation (5)). In Panel C, we report results from local regressions using optimal bandwidths determined by the methodology specified in Imbens and Kalyanaraman (2012). As before, we cluster standard errors at the firm level.

[21] Our results are qualitatively similar if we use a triangular kernel. In the interest of brevity, we do not tabulate these results in the paper.
[22] Our inferences are qualitatively similar if we include state and year dummies in these regressions. We do not tabulate these results in the paper for purposes of brevity.

In Panel A, the coefficient associated with *Union Win* is significantly positive at the 1% level in two out of the three models that include calendar year dummies (Models 1 and 2) and at the 1% level in all three models that include both industry and year dummies. In Panels B and C, the coefficient associated with *Union Win* is significantly positive at least at the 5% level in two out of the three models that include calendar year dummies (Models 1 and 2) and at the 1% level in all three models that include industry and year dummies. These effects are economically meaningful. For example, assessing the economic significance of our results in Model 4 of Panel B, we find that a union win is associated with an increase of 7.51 cumulative recalls over a three-year window after the union election. Overall, the evidence presented in this section suggests that unionization increases product quality failures. The results from the RDD methodology provide additional support to our earlier findings of a plausible causal link between unions and product recalls.

5.4. Additional evidence on operating flexibility channel through which unionization can impact product quality failures

In this section, in an RDD setting, we provide some additional evidence on the operating flexibility channel through which unionization can affect product quality failures. First, we examine if there are any differences in the relation between *Union Win* and the frequency of product recalls for firms with union elections in right-to-work (*RTW*) states versus firms with union elections in non-*RTW* states. Second, we examine the impact of *Union Win* on cost-of-goods-sold for the firm. Finally, we examine the impact of *Union Win* on the firm's investments in potentially quality enhancing investments such as capital expenditures and R&D expenses.

5.4.1. Union wins and the frequency of recalls: RTW versus non-RTW states

Prior literature argues that unions reduce the operating flexibility of firms by causing operating leverage to go up (either through reduced ability to fire workers and/or through higher wages and benefits) and the cost of equity to increase (Chen, Kacperczyk, and Ortiz-Molina, 2011). Further, unions may make it harder to obtain external financing because they are associated with the weakening of creditor rights (Blaylock, Edwards, and Stanfield, 2015). These financial pressures and operational inflexibility may hinder firms' discretionary investments and force firms to cut corners in the production process or run their factors of production more ragged, thereby resulting in more product quality failures. One mitigating factor may be right-to-work laws that offset some of the union power. Employees in states that have adopted right-to-work laws cannot be forced to join the union or be forced to pay union dues as a condition of employment. Thus, unions will have less influence and bargaining power in *RTW* states than in non-*RTW* states.[23] As a result, the adverse impact of unions on the operating flexibility and/or tightening of financial constraints of firms is likely to be smaller in *RTW* states than in non-*RTW* states. Thus, in our RDD setting, we expect the impact of *Union Win* on the frequency of recalls to be stronger in non-*RTW* states than in *RTW* states.

We present the results from this analysis in Table 12. In Panel A, we estimate Poisson regression models for all union elections using one global polynomial regression and, in Panel B, we estimate RDD regression models for all union elections using one global polynomial regression for left hand side of the 50% threshold and another for the right hand side of the 50% threshold. In Panel C, we report results from local regressions using optimal bandwidths determined by the methodology specified in Imbens and Kalyanaraman (2012). We cluster standard errors at the firm level. In each panel, we report two sets of three regressions each. The first set contains the results for elections held in *RTW* states and the second set contains the results for regressions held in non-*RTW* states. In each set, the dependent variable is *CumRecalls_3yr*, *CumRecalls_2yr,* and *CumRecalls_1yr* in the first, second, and third model, respectively.

In Panel A, we find that the coefficient associated with *Union Win* is significantly positive at the 1% level in all three regressions for the union elections in non-*RTW* states. In contrast, the coefficient associated with *Union Win* is significantly positive (at the 5% level) only in one of the three regressions for the union elections in *RTW* states. For each dependent variable, the coefficient associated with *Union Win* *always* has a higher magnitude in non-*RTW* states than in *RTW* states. For example, when the dependent

[23] Consistent with this argument, Bradley, Kim, and Tian (2017) find that the negative effect of union wins on innovation that they document in their overall sample of union elections is concentrated in non-*RTW* states. In a related vein, Holmes (1998) finds large, abrupt decreases in manufacturing activity when one crosses state borders from *Right to Work* (*RTW*) states to non-*RTW* states.

variable is *CumRecalls_1yr*, the coefficient associated with *Union Win* is 1.2514 for non-*RTW* states (Model 6) and 0.4227 for *RTW* states (Model 3). In Panel B, the coefficient associated with *Union Win* is significantly positive at least at the 5% level in all the reported regressions for the non-*RTW* states. In contrast, it is never significantly positive in *RTW* states. Again, for each dependent variable, the coefficient on *Union Win* is always larger in magnitude in non-*RTW* states than in *RTW* states. Finally, in Panel C, we find that the coefficient associated with *Union Win* is significantly positive at the 1% level in all three regressions for the union elections in non-*RTW* states. The coefficient associated with *Union Win* is, however, significantly positive (at the 10% level) only in one of the three regressions for the union elections in *RTW* states. As in the other two panels, for each dependent variable, the coefficient associated with *Union Win* always has a larger magnitude in non-*RTW* states than in *RTW* states. Thus, these results are consistent with the notion that union wins have an adverse impact on product quality but the finding is mostly confined to non-*RTW* states, i.e., states where unions are more likely to have high bargaining power. These results also cast doubt on any latent factors unrelated to unionization explaining the impact of firm-level unionization on product quality because those factors would also have to be confined to non-*RTW* states.

5.4.2. Union wins and cost-of-goods-sold

Unions can reduce the operating flexibility of a firm by making it more difficult to fire employees and/or by negotiating higher wages and benefits. Ideally, we would like to study this issue by directly examining the change in wages and benefits of employees after a union win. Unfortunately, we do not have access to this wages and benefits data. We can, however, indirectly address this issue by studying the impact of union wins on cost-of-goods-sold over sales (Cogs) because higher direct labor costs will be reflected in cost-of-goods-sold. The results from this analysis are reported in Table 13. The format of the table is identical to that used in Table 11 with the exception that the dependent variables are *Cogs_1yr*, *Cogs_2yr*, and *Cogs_3yr*. *Cogs_1yr* is the cost-of-goods-sold over sales for the fiscal year following the fiscal year in which the election is held and *Cogs_2yr* (*Cogs_3yr*) is the average cost-of-goods-sold over sales for the two (three) fiscal years following the fiscal year in which the election is held.

We make the following observations. The coefficient on *Union Win* is positive in all the reported regressions in the table. In the global polynomial regression results reported in Panel A, we find that the coefficient associated with *Union Win* is significantly positive at least at the 5% level in five out of the six regressions. In Panel B, where we report results of global polynomial regressions with different polynomial terms for the left hand side and right hand side of the threshold, we find that the coefficient associated with *Union Win* is significantly positive at least at the 10% level in four out of the six regressions. Finally, in Panel C, where we estimate local regressions with the Imbens and Kalyanaraman (2012) optimal bandwidth, the coefficient associated with *Union Win* is again significantly positive at least at the 10% level in four out of the six regressions. The findings suggest that a union win results in higher cost-of-goods-sold over sales for the firm. This result is consistent with the idea that unions increase operating leverage through an increase in labor costs and, as a result, impose financial pressures on the firm forcing it to cut corners elsewhere compromising product quality.

5.4.3. Union wins and investments in capital expenditures and R&D expenses

If unions have the effect of increasing operating leverage and increasing financial pressures faced by firms, then we should also see these effects manifest themselves in reduced discretionary capital investments in quality. Thus, in our RDD setting, we should observe a decrease in capital expenditures and R&D expenses after a union win.[24] The results from this analysis is reported in Table 14. The format of the table is identical to the one used in Tables 11 and 13 with the exception that the dependent variables are *CapxRD_1yr*, *CapxRD_2yr*, and *CapxRD_3yr*. *CapxRD_1yr* is the sum of capital expenditures and R&D expenses divided by total assets for the fiscal year following the fiscal year in which the election is held and *CapxRD_2yr* (*CapxRd_3yr*) is the average of the sum of capital expenditures and R&D expenses divided by total assets for the two (three) fiscal years following the fiscal year in which the election is held.

In this table, we find that the coefficient on *Union Win* is negative in all the reported regressions in the table. In the global polynomial regression results reported in Panel A, we find that the coefficient

[24] Bradley, Kim, and Tian (2017) also use a RDD setting to empirically show that there is a decrease in R&D expenses after a union win using a sample of private and public firms over the 1980 – 2002 period.

associated with *Union Win* is significantly negative at least at the 10% level in four out of the six regressions. In Panel B, where we report results of global polynomial regressions with different polynomial terms for the left hand side and right hand side of the threshold, we find that the coefficient associated with *Union Win* is significantly negative at the 5% level in three out of the six regressions. Finally, in Panel C, where we estimate local regressions with the Imbens and Kalyanaraman (2012) optimal bandwidth, the coefficient associated with *Union Win* is again significantly positive at least at the 10% level in two out of the six regressions. Thus, we find weak evidence that a union win results in smaller discretionary investments in capital expenditures and R&D expenses for the firm. This result is consistent with the notion that unions increase operating leverage and financial pressures on firms, thereby squeezing out investments in product quality.

6. Conclusions

Labor unions have been argued to affect a variety of firm-specific financial and operating characteristics. In this paper, we examine the impact of labor unions on product quality, which is a key aspect of a firm on which the firms' workers should have a first order impact. Given that unions negotiate the incentive structure enjoyed by unionized workers, we expect unions to play a fundamental role in implicitly determining product quality. We present contrasting arguments from the economics and finance literature that suggest that unions may positively or negatively affect product quality. We define quality in an objective way using data on product recalls over the 2003–2013 period. Firms recall products when they discover a significant product defect that renders the product either unsafe or unusable, and undertake the recall after the relevant regulating agency is notified. So, recalls are an objective method of determining product quality – a measure that would be broadly applicable to a wide variety of products. In addition to the incidence of recalls, we also examine the frequency and severity of product failures in order to be able to judge the extent of quality problems and the systemic nature of failures in the firm. Our data on product recalls is one of the largest in the literature spanning eleven years, covering 6,735 recall events, spread across 42 separate two-SIC code industries.

Our results indicate that unions adversely impact the incidence, frequency, and severity of product recalls. The regression results are robust to the inclusion of control variables previously identified in the literature to explain product failures. To control for the different types of endogeneity problems, such as the possibility that unionized firms may be fundamentally different from non-unionized firms in ways in which we don't adequately control or unionization more often happens in declining firms where product quality problems are also likely to occur, we undertake several steps that circumvent the endogeneity issues and make the underlying identification reliable. First we employ an instrumental variables approach where we use historical MSA-level unionization as an instrument for firm-level unionization. Historical MSA-level unionization has been shown to impact current-day unionization (Cohen, Malloy, and Nguyen, 2016), but cannot be reasonably suspected to impact future product quality unless it is through current day unionization. We find our primary results continue to hold with unionization having a significantly adverse impact on product quality.

To further sharpen our identification, we construct two exogenous cash flow shocks – (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. We argue that if unions increase the financial pressures on a firm and impede investments in quality, then the link between unionization and subsequent product quality outcomes must be more pronounced for firms subject to the exogenous negative cash flow shocks because financial constraints would be especially aggravated for these firms. Our findings reaffirm the possible causal link between unionization and product failures since the results indicate the impact of unionization on quality failures is indeed significantly greater for firms subject to either of the two shocks.

We also design a second set of independent tests that further hone in on the issue of identification. We use NLRB's union elections data and find that union election wins have an adverse impact on subsequent product failures. To address the potential endogeneity in union wins, we employ an RDD methodology where we compare firms with narrow union wins against firms with narrow union losses to see if the winner's product quality was adversely impacted in the following one-, two-, and three-years after the elections relative to firms that barely failed to unionize. The RDD methodology is an identification strategy that does not suffer from endogeneity concerns because for elections where the win-loss margins are narrow, the union formation or non-formation is very close to a random event that is unlikely to be correlated with any latent firm characteristics. We find that unionization has a statistically significant effect on a firms' frequency of recalls. We find that there are significantly more recalls over the one-, two-, and three-years following the narrow union election win compared to those in firms where the union election failed narrowly. As another telling indication that the impact of unions on quality is causal in nature, we find that the adverse impact of unions on quality is dampened in *RTW* states – precisely states where unions' bargaining power is restrained – because workers of unionized firms in *RTW* states cannot be forced to pay union dues or join the union.

Finally, we also directly study two financial channels through which unions may impact product quality and thereby offer yet another set of tests that speak to the causal impact of unions on quality. Consistent with the view that unionization results in higher costs and lower operating flexibility for firms, our RDD tests show that cost of goods sold of firms is higher following close union election wins than following close losses. This is suggestive of increased financial pressures on firms that may cause firms to reduce expenses elsewhere, potentially compromising product quality. We also find weak evidence that capital and R&D expenditures –discretionary investments that often bolster product quality – are lower following close union wins compared to close losses. Overall, we can conclude that labor unions have a detrimental impact on product quality.

Our study makes several key contributions to the literature. First, to the best of our knowledge, our paper is the first to examine the impact of unions on product quality. Unions having a negative impact on product quality is a significant cost to firms from being unionized. Second, our inferences regarding the impact of unions on quality failures are generalizable because of our large recalls sample size, the varied industries in which the recalls occur, and the fact that recalls represent an objective measure of product quality failures. Finally, our finding of an adverse impact of unions on product quality, the conditions under which unions' impact is especially damaging to quality, and the channels through which they impact quality all add to the debate on the impact of labor unions on overall firm performance.

Appendix A. Construction of variables

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

a. % Unionized workers (3 years) [*% Unionized workers (5 years)*]

Percentage of firm's employees under union contracts assuming union contracts are for a duration of 3 years (5 years). See Appendix B for construction of this variable.

b. *Unionized (3 yrs)* [*Unionized (5 yrs)]*

Dummy variable that takes the value of one if *% Unionization workers (3 years)* [*% Unionization workers (5 years)*] is greater than zero, and is zero otherwise.

c. Union Win

Dummy variable that takes the value of one if the union gets more than 50% of votes in a union election, and is zero otherwise.

d. *Book leverage*

*Book leverag*e is the sum *of th*e long-term debt and debt in current liabilities (Compustat item *DLTT* + Compustat item *DLC*) divi*ded* by total assets (C*omp*ustat item *AT*) for the year prior to the y*ea*r of announcement.

e. *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.

f. 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. 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 there is likely to be a monotonic relation between our proxy for the number of suppliers and the true number of suppliers.

g. 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.

h. 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.

i. Total factor productivity

To calculate total factor productivity, we follow Kovenock and Phillips (1997) and Faleye, Mehrotra, and Morck (2006) and assume a Cobb-Douglas production function. Thus, 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.

j. Size

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

k. Cogs_1yr

It is the ratio of cost-of-goods-sold (Compustat data item *COGS*) divided by sales (Compustat data item *SALE*) for year *t*+1 where year *t* is the year of union election. Specifically, we use the Compustat item reported immediately after the union election to compute *COGS* and *SALE*. *Cogs_2yr* and *Cogs_3yr* are the corresponding values calculated for years *t*+1 and *t*+2 respectively.

l. CapxRD_1yr

It is the ratio of capital expenditures (Compustat data item *CAPX*) plus R&D expenditures (Compustat data item *XRD*) divided by book value of assets (Compustat data item *AT*) for year *t*+1 where year *t* is the year of union election. *CapxRD_2yr* and *CapxRD_3yr* are the corresponding values calculated for years *t*+1 and *t*+2 respectively.

m. CumRecalls_1yr

It is the cumulative number of recalls measured over a one-year period after the recall announcement in our panel regressions and over a period of one year after the union election in our RDD analysis. *CumRecalls_2yr* and *CumRecalls_3yr* are the corresponding values measured over a two-year and three-year period after the recall announcement in our panel regressions and over a two-year and three-year period after the union election in our RDD analysis after the union election, respectively.

n. Negative input price shock

We follow the procedure spelled out in Kini, Shenoy, and Subramaniam (2017) to compute the *Negative input price shock* variable. We identify the five supplier industries that the recalling industry is most dependent upon to manufacture its output to compute whether there is a significant input price increase for that recalling industry. We use the 2002 benchmark input-output tables of the U.S. economy published by the Bureau of Economic Analysis to identify the supplier input-output (*IO*) industries. We obtain supplier industry prices using the *Producer Price Index* (*PPI*) constructed by the Bureau of Labor and Statistics. 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 are not available, four-digit NAICS level data are matched to IO industries. For each recall and control observation in our sample, we use the year and month of the fiscal year-end at which we measure unionization (year *t* in Equation (1)) as our reference date. We obtain thirty-six months of monthly *RPPI* ending at the reference date for the five supplier industries associated with each firm-year in our sample. 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 three years before the reference date. Our input price shocks are based on the *Weighted RPPI Series*. Finally, we define the shock variable, *Negative input price shock* as a dummy variable that is set to one if the geometric average growth rate over the three years before the recall is 5% or greater, and is set to zero otherwise.

o. Tariff cut

We follow the approach described in Fresard (2010) and Kini, Shenoy, and Subramaniam (2017) to compute significant decreases in industry tariff rates. We obtain the annual values for Calculated_Duties and Imports_by_Custom_Value by the four-digit NAICS industry over the period 2002 – 2012 to compute tariff rates, where Calculated_Duties are the estimated import duties collected and Imports_by_Custom_Value is the value of imports as assessed by the U.S. Customs Service (Source: http://dataweb.usitc.gov/). The tariff rate for an industry-year is calculated as Calculated_Duties divided by Imports_by_Custom_Value. We then compute the annual percentage change in the tariff rate for each industry-year observation. From these annual percentage changes, we estimate the median level of the annual percentage change for each industry across all years. Finally, the annual percentage reduction in tariff rate for any industry-year is considered a significant tariff cut if it is at least 2.0 times the industry median level. In addition, we try to ensure that large tariff cuts reflect permanent rather than transient changes in tariffs by excluding industry-years where the tariff cuts are followed by a comparable large percentage increase in the tariff rate the next year. Finally, we define the shock variable, *Tariff cut* as a dummy variable that is set to one for an industry-year that recorded a significant drop in tariff rates, and is set to zero otherwise.

Appendix B: Construction of panel dataset of firm-level unionization rates

We construct the union panel based on three datasets obtained from Bloomberg's BNA Labor Plus, which collects comprehensive information on union contracts, union collective bargaining filings, and union elections. The most complete dataset, "Directory of Expirations", contains detailed information on the collective bargaining units at business establishment level. BNA Labor Plus compiles this dataset from the mandatory collective bargaining filings submitted to the Federal Mediation and Conciliation Service (FMCS). The dataset is complete from 1995 onwards.[25] From the dataset, we obtain the number of unionized workers, the number of all employees in a site, and the expiration dates of the union collective bargaining contracts. Unfortunately, the dataset does not report the start dates of the union collective bargaining contracts.

We augment the establishment-level contracts with another dataset, "Contract Settlement Summaries", which contains information on major firm-level collective bargaining agreements. BNA Labor Plus compiles the information on the outcomes of collective bargaining agreements, such as the number of workers at the time of contract initiation, wages, benefits, and the length of contracts from newspapers, union publications, and direct reports from 1990. According to the dataset, the mean (median) of union contract length is 3 (3.5) years. Therefore, we assume that the length of the establishment-level collective bargaining contracts is 3 years. As an alternative, we also assume that each contract lasts for 5 years.

The establishment-level and firm-level union datasets do not report the financial identifiers such as GVKEY. Therefore, to identify the unions in the U.S. public firms, we manually search for the GVKEY identifiers of the firm names in the BNA datasets. This is necessary because the names of establishment might differ from the names of the public companies recorded in standard data sources such as Compustat. Using a combination of hand collected and automated techniques, we link each unique name in the BNA datasets to its unique GVKEY identifier.

We make three assumptions to convert the establishment-level union bargaining contracts to a firm-year panel. First, we assume that the number of unionized workers during the contract period is equal to the number reported in the year of contract expiration. Although this assumption ignores the time-series variation in establishment employment, we believe that our estimate is conservative since the rate of unionization underwent a secular decline during our sample period (Hirsch 2008, *Journal of Economic Perspectives*). It is worth noting that survivorship bias is unlikely to influence this variable because all unions are supposed to notify FMCS at least 30 days prior to contract expiration or modification. Our second assumption is that each union contract lasts either 3 or 5 years. We justify this assumption based on the length of a sample of actual firm-level contracts we obtain from BNA Labor Plus. Finally, we extend the expiration year of all contracts recorded from year 2008 onwards to year 2012 since the establishment-level contracts are not available beyond 2012.

To arrive at our main variables, we backfill the number of unionized workers reported in the establishment-level union bargaining contracts to 3 or 5 years before the expiration year of these contracts. We then aggregate the number of union workers in all subsidiaries to obtain the number of workers under collective bargaining contracts in each firm-year. For firm-level union contracts obtained through Contract Settlement Summaries, we use the numbers of workers participating in the collective bargaining negotiation as the number of unionized workers during the effective period of the contract. We do not need to make assumptions on the length of these firm-level contracts because we get exact information on the inception and expiration dates. Because some unions negotiate contracts for multiple establishments, we use the larger

[25] We initially obtained the dataset from 1985 onwards but later conversations with BNA staff suggested that only the post-1995 datasets are complete.

value of the numbers of union workers in the firm-level contracts (Contract settlement summaries) and the aggregated establishment-level (Directory of expirations) dataset to avoid double-counting.

As a final step, we use the union elections to verify the panel. The raw union election data is provided by BNA Labor Plus. We obtain data on all union elections from 1980 to 2012 for this purpose. Note that the main purpose of the union election data is to enable the regression discontinuity estimations on the post-election likelihood of product recalls. BNA Labor Plus obtains union elections from mandatory establishment-level union filings maintained by the National Labor Relations Board (NLRB). Information on union elections includes the number of workers in an establishment upon election, the number of eligible workers who voted in an election, certification and decertification type, and the election outcomes. Using this union election data, we find that the panel successfully captures the changes in unionizations due to elections. Specifically, by incorporating union election information into the construction of our panel only extends the number of unionized firm-year observations by 0.7%. Additionally, more than 80% of the elections take place in unionized firms.

We create a variable *% Unionized workers (3 years)* [*% Unionized workers (5 years)*] which is the number of firm's employees covered under a union contract assuming union contracts are for a duration of 3 years (5 years) divided by the total number of employees of the firm (Compustat item EMP). We also create a dummy variable *Unionized (3 years)* [*Unionized (5 years)*] which is set to one if at least one employee was covered by a union contract, and is set to zero otherwise. To verify the accuracy of the panel dataset created by us, we compare the percentage of unionized employees based on our database to the rate of unionization obtained from the *Union Stats* website on an annual basis. The rates of unionization on *Union Stats* website available at http://www.unionstats.com provide the percentage of private sector employees that are covered by a collective bargaining agreement. We report these numbers in Appendix B Table 1. We find that the percentage of unionized employees as reported by Unionstats is comparable to rate of unionization obtained through our hand collected dataset. For example, the mean value of *% Unionized workers (3 years)* for year 2002 is 8.7% and the comparable number from *Union Stats*, *% Union workers from Unionstat* is 8.6%.

After following the steps outlined above, we end up in our union panel which spans the period 1995 – 2012. Since the recall dataset spans the period of 2003 - 2013, in all our estimations, we are able to exploit unionization information (panel and election) from 2002 - 2012.

Appendix B Table 1. National comparison of percentage of unionized employees in the U.S. from Unionstat and our union panel data constructed from union contract data. *% Union workers from Unionstat* is the percentage of private sector employed workers who are unionized. This data is provided by Barry Hirsch and David Macpherson at www.unionstats.com. All other variables are defined in the appendix.

Year	*% Union workers from Unionstat*	*% Unionized workers (3 yrs)*	*% Unionized workers (5 yrs)*	*Unionized (3 yrs)*	*Unionized (5 yrs)*
2002	8.6	8.7	9.3	9.3	10.0
2003	8.2	8.4	9.2	9.4	10.3
2004	7.9	7.3	7.7	9.4	10.4
2005	7.8	6.0	6.7	9.4	10.2
2006	7.4	5.6	6.1	9.6	10.5
2007	7.5	5.8	6.2	9.7	10.4
2008	7.6	6.0	6.7	9.5	10.1
2009	7.2	6.0	6.4	10.0	10.1
2010	6.9	6.6	6.6	9.9	9.9
2011	6.9	6.8	6.8	9.5	9.5
2012	6.7	6.4	6.4	9.0	9.0

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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 2003 – 2013. The table reports recalls in the food, drug, and medical device industries covered by the Food and Drug Administration (*FDA*), the Consumer Product Safety Commission (*CPSC*), and the National Highway Traffic Safety Administration (*NHTSA*).

	Number of observations			
Year of recall	*NHTSA*	*FDA*	*CPSC*	Overall
2003	243	28	31	302
2004	305	170	63	538
2005	258	130	89	631
2006	225	536	76	683
2007	170	448	103	721
2008	121	503	73	697
2009	92	503	51	646
2010	79	553	62	694
2011	166	359	61	586
2012	160	473	39	672
2013	163	352	50	565
Total	1,982	4,055	698	6,735

Table 2
Industries covered in recall sample

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

Two-digit SIC Code	Description of industry	Number of recalls
1	Agricultural Production Crops	3
2	Agriculture production livestock and animal specialties	1
20	Food And Kindred Products	251
22	Textile Mill Products	1
23	Apparel And Other Finished Products Made From Fabrics	15
24	Lumber And Wood Products, Except Furniture	10
25	Furniture And Fixtures	14
26	Paper and Allied Products	38
27	Printing, Publishing, And Allied Industries	7
28	Chemicals And Allied Products	1,233
29	Petroleum Refining And Related Industries	1
30	Rubber And Miscellaneous Plastics Products	26
31	Leather And Leather Products	3
32	Stone, Clay, Glass, And Concrete Products	4
33	Primary Metal Industries	1
34	Fabricated Metal Products, Except Machinery And Transportation Equipment	28
35	Industrial And Commercial Machinery And Computer Equipment	175
36	Electronic & Other Electrical Equipment And Components, Except Computer Equipment	166
37	Transportation Equipment	1,973
38	Measuring, Analyzing, And Controlling Instruments	1,803
39	Miscellaneous Manufacturing Industries	63
47	Transportation Services	4
48	Communications	7
49	Electric, Gas, and Sanitary Services	1
50	Wholesale Trade-durable Goods	14
51	Wholesale Trade-non-durable Goods	67
52	Building Materials, Hardware, Garden Supply, And Mobile Home Dealers	4
53	General Merchandise Stores	113
54	Food Stores	89
55	Automotive Dealers And Gasoline Service Stations	5
56	Apparel And Accessory Stores	28
57	Home Furniture, Furnishings, And Equipment Stores	44
58	Eating And Drinking Places	14
59	Miscellaneous Retail	32
70	Hotels, Rooming Houses, Camps, And Other Lodging Places	1
72	Personal Services	2
73	Business Services	11
75	Automotive Repair, Services, And Parking	1
79	Amusement and Recreation Services	1
80	Health Services	32
87	Engineering, Accounting, Research, Management, And Related Services	5
99	Non-classifiable Establishments	444

Table 3

Univariate comparisons between recalling firms and control firms

Univariate comparisons between recalling firms and control firms. The recall sample period is 2003 – 2013 and contains recalls covered by the Consumer Product Safety Commission (*CPSC*), National Highway Traffic Safety Administration (*NHTSA*), and Food and Drug Administration (*FDA*). 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 2003 – 2013. All union and control variables are lagged by one year. *% Unionized workers (3 yrs)* is the proportion of unionized employees in the firm assuming that the contract length of three years. *% Unionized workers (5 yrs)* is the proportion of unionized employees in the firm assuming that the contract length of five years. *Unionized (3 yrs)* and *Unionized (5 yrs)* is a dummy variable set to one if the firm is unionized in a year, and zero otherwise assuming a contract length of three years and five years, respectively. *Book leverage* is the book (market) value of debt divided by total assets. *Herfindahl Index* is the sales-based Herfindahl index of the three-digit SIC industry of the firm. *Number of Suppliers* is the number of key suppliers of the firm as identified in the Compustat segment tapes. *R&D intensity* is the research & development expenditure divided by book value of assets. *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. *Vertical integration dummy* is set to 1 if the firm is vertically integrated and 0 otherwise. *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: Firm-level unionization variables

Variable name	Recall sample				Control sample				
	N	Mean	Median	SD	N	Mean	Median	SD	*t-stat (z-stat)*
% Unionized workers (3 yrs)	6,735	0.057	0.000	0.122	29,447	0.011	0.000	0.057	2.64***(82.35***)
% Unionized workers (5 yrs)	6,735	0.060	0.000	0.129	29,447	0.012	0.000	0.063	2.65***(81.32***)
Unionized (3 yrs)	6,735	0.497	0.000	0.500	29,447	0.082	0.000	0.275	6.78***(83.85***)
Unionized (5 yrs)	6,735	0.501	1.000	0.500	29,447	0.087	0.000	0.282	6.79***(82.81***)

Panel B: Control variables

Variable name	Recall sample				Control sample				
	N	Mean	Median	SD	N	Mean	Median	SD	
Book leverage	6,735	0.261	0.251	0.176	29,447	0.301	0.106	0.809	-1.65*(37.95***)
R&D Intensity	6,735	0.041	0.035	0.036	29,447	0.120	0.030	0.238	-19.21***(1.84***)
Herfindahl index	6,735	0.145	0.095	0.134	29,447	0.125	0.077	0.113	1.64*(10.92***)
Number of suppliers	6,735	12.205	3.000	20.121	29,447	0.445	0.000	2.690	4.58***(113.9***)
Total factor productivity	6,735	-0.090	-0.180	0.570	29,447	-0.025	0.031	0.900	-1.11(-14.83***)
Vertical integration dummy	6,735	0.060	0.000	0.237	29,447	0.051	0.000	0.220	0.47(3.01***)
Size	6,735	9.414	9.799	1.960	29,447	5.108	5.133	2.376	20.37***(105.8***)

Table 4
Impact of unionization on recall incidence: Probit regressions

This table presents the probit estimation results for recall events by public firms during 2003 – 2013. The dependent variable is *RecallDum* which is set to one for firms in the recall sample, and zero for control firms. Control firms are firms that belong to the same three-digit SIC industry as recalling firms provided they did not have a recall during 2003 – 2013. Refer to the appendix for details on the construction of our variables. All independent variables are lagged by one year. All models contain estimation results when we include three-digit SIC industry dummies and calendar year dummies along with our explanatory variables. Reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Dep. variable: *RecallDum*	Model 1	Model 2	Model 3	Model 4
% Unionized workers (3 yrs)	1.1126**			
	(0.035)			
% Unionized workers (5 yrs)		1.0774**		
		(0.027)		
Unionized (3 yrs)			0.4576***	
			(0.000)	
Unionized (5 yrs)				0.4654***
				(0.000)
Book leverage	0.1257*	0.1247*	0.1087	0.1065
	(0.067)	(0.070)	(0.115)	(0.128)
R&D Intensity	-5.1090***	-5.1057***	-4.9014***	-4.9082***
	(0.000)	(0.000)	(0.000)	(0.000)
Herfindahl index	-0.6650	-0.6691	-0.5997	-0.6110
	(0.179)	(0.176)	(0.256)	(0.248)
Number of suppliers	0.0263***	0.0263***	0.0261***	0.0262***
	(0.000)	(0.000)	(0.000)	(0.000)
Total factor productivity	0.1443***	0.1443***	0.1501***	0.1515***
	(0.002)	(0.002)	(0.001)	(0.001)
Vertical integration dummy	-0.0226	-0.0227	-0.0564	-0.0531
	(0.890)	(0.890)	(0.737)	(0.752)
Size	0.4789***	0.4790***	0.4541***	0.4536***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-4.3852***	-4.3913***	-4.2506***	-4.2450***
	(0.000)	(0.000)	(0.000)	(0.000)
Three-digit SIC and year dummies	Yes	Yes	Yes	Yes
Observations	36,182	36,182	36,496	36,496

Table 5
The impact of unionization on number of recalls: Poisson models

Poisson model estimation results for the number of recall events for our sample firms during 2003 - 2013. The dependent variable in Models 1 and 2 is *CumRecalls_1yr*. It is defined as the number of recall events for a recalling firm in year t+1. In Models 3 and 4 (Models 5 and 6), the dependent variable is *CumRecalls_2yr* (*CumRecalls_3yr*); it is computed as the cumulative number of recall events for a recalling firm over year t+1 and t+2 (year t+1, t+2, and t+3). For all control firms these variables are defined as zero if they have financial information available over the relevant fiscal years, otherwise they are treated as missing observations. *% Unionized workers (3 yrs)* is the proportion of unionized employees in year t assuming that the contract length of three years. *% Unionized workers (5 yrs)* is the proportion of unionized employees in year t assuming that the contract length of five years. *Unionized (3 yrs)* and *Unionized (5 yrs)* is a dummy variable set to one if the firm is unionized in a year, and zero otherwise assuming a contract length of three years and five years, respectively. The appendix has details on construction of our variables. All independent variables are lagged by one year. All models contain three-digit SIC industry and year dummies. Reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: Using percentage of workers who are unionized *(% Unionized workers*) as the measure of unionization

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CumRecalls_1yr*	*CumRecalls_1yr*	*CumRecalls_2yr*	*CumRecalls_2yr*	*CumRecalls_3yr*	*CumRecalls_3yr*
% Unionized workers (3 yrs)	2.0773***		2.2835***		2.5415***	
	(0.001)		(0.002)		(0.003)	
% Unionized workers (5 yrs)		1.9528***		2.1177***		2.3707***
		(0.001)		(0.002)		(0.003)
Book leverage	0.2639**	0.2616**	0.3412**	0.3387**	0.4575**	0.4497**
	(0.037)	(0.040)	(0.029)	(0.032)	(0.026)	(0.031)
R&D Intensity	-8.3011***	-8.3014***	-8.6912***	-8.7018***	-7.9334***	-7.9208***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Herfindahl index	-0.8448	-0.8638	-1.1676	-1.1995	-1.0543	-1.1085
	(0.404)	(0.387)	(0.292)	(0.273)	(0.381)	(0.348)
Number of suppliers	0.0058	0.0059	0.0046	0.0048	0.0036	0.0038
	(0.133)	(0.126)	(0.273)	(0.251)	(0.391)	(0.364)
Total factor productivity	0.2396***	0.2406***	0.2616***	0.2628***	0.2428**	0.2447**
	(0.007)	(0.007)	(0.009)	(0.009)	(0.023)	(0.022)
Vertical integration dummy	-0.1119	-0.1131	-0.1239	-0.1260	-0.1660	-0.1694
	(0.695)	(0.692)	(0.696)	(0.691)	(0.624)	(0.616)
Size	0.6889***	0.6890***	0.7455***	0.7452***	0.7742***	0.7739***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-6.3008***	-6.2853***	-7.5824***	-7.5473***	-6.3401***	-6.2868***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Three-digit SIC and year dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.54	0.53	0.58	0.57	0.61	0.61
Observations	31,242	31,242	23,499	23,499	18,457	18,457

Panel B: Using dummy variable (Unionized) as the measure of unionization

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CumRecalls_1yr*	*CumRecalls_1yr*	*CumRecalls_2yr*	*CumRecalls_2yr*	*CumRecalls_3yr*	*CumRecalls_3yr*
Unionized (3 yrs)	0.5956***		0.6134***		0.6319***	
	(0.000)		(0.000)		(0.000)	
Unionized (5 yrs)		0.5980***		0.6159***		0.6354***
		(0.000)		(0.000)		(0.000)
Book leverage	0.2533**	0.2520**	0.3473**	0.3450**	0.5205***	0.5161***
	(0.042)	(0.044)	(0.019)	(0.021)	(0.005)	(0.006)
R&D Intensity	-7.4458***	-7.4269***	-7.7349***	-7.7212***	-7.1410***	-7.1284***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Herfindahl index	-0.8323	-0.8324	-1.2574	-1.2648	-1.1593	-1.1733
	(0.420)	(0.420)	(0.264)	(0.262)	(0.332)	(0.326)
Number of suppliers	0.0086***	0.0087***	0.0085**	0.0086**	0.0080**	0.0080**
	(0.009)	(0.009)	(0.013)	(0.013)	(0.020)	(0.020)
Total factor productivity	0.2852***	0.2856***	0.3115***	0.3117***	0.2976***	0.2974***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.005)
Vertical integration dummy	-0.2317	-0.2296	-0.2804	-0.2784	-0.3527	-0.3518
	(0.437)	(0.441)	(0.419)	(0.423)	(0.368)	(0.370)
Size	0.6563***	0.6568***	0.7092***	0.7099***	0.7344***	0.7352***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-6.5887***	-6.5907***	-7.4674***	-7.4717***	-6.1522***	-6.1514***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Three-digit SIC and year dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.56	0.56	0.60	0.60	0.63	0.63
Observations	31,556	31,556	23,690	23,690	18,552	18,552

Table 6

Impact of unionization on severity of product recalls: Ordered probit estimations

This table presents the ordered probit estimation results for FDA recalls during 2003 – 2013. The dependent variable is *Recall severity* which is set to 3 for Class 1 recalls (the most severe form of recalls), 2 for Class 2 recalls, 1 for Class 3 recalls (the least severe recalls), and 0 for control firms in our sample. 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 2003 – 2013. The appendix has details on construction of our variables. All independent variables are lagged by one year. All estimations include three-digit SIC industry dummies and year dummies. 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 severity*	Model 1	Model 2	Model 3	Model 4
% Unionized workers (3 yrs)	2.2462***			
	(0.000)			
% Unionized workers (5 yrs)		2.1337***		
		(0.000)		
Unionized (3 yrs)			0.2699**	
			(0.028)	
Unionized (5 yrs)				0.2851**
				(0.022)
Book leverage	0.1463*	0.1431*	0.1847***	0.1838***
	(0.079)	(0.091)	(0.004)	(0.004)
R&D Intensity	-4.1384***	-4.1289***	-4.0697***	-4.0656***
	(0.000)	(0.000)	(0.000)	(0.000)
Herfindahl index	0.1644	0.1219	0.2012	0.1994
	(0.762)	(0.815)	(0.697)	(0.700)
Number of suppliers	0.0003	0.0001	0.0010	0.0010
	(0.954)	(0.978)	(0.848)	(0.848)
Total factor productivity	0.0971**	0.0984**	0.1076**	0.1079**
	(0.047)	(0.045)	(0.030)	(0.030)
Vertical integration dummy	-0.1199	-0.1197	-0.1361	-0.1329
	(0.541)	(0.542)	(0.491)	(0.501)
Size	0.4223***	0.4228***	0.4052***	0.4042***
	(0.000)	(0.000)	(0.000)	(0.000)
Three-digit SIC and year dummies	Yes	Yes	Yes	Yes
Observations	28,255	28,255	28,531	28,531

Table 7

Impact of unionization on recall incidence and number of recalls: Two-stage least squares estimations

This table presents the two-stage least squares estimation results. The sample consists of all recalls during our sample period of 2003 – 2013. In Panel A, 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 2003 – 2013. In Panel B, C, and D, the dependent variable is *CumRecalls_1yr*, *CumRecalls_2yr*, and *CumRecalls_3yr*, and represent the cumulative number of recall events for a recalling firm over the next one year, two years, and three years, respectively. All independent variables are lagged by one year. Odd models contain results from the first stage estimation and adjoining even models contain results from the second stage of the two-stage least squares estimation. All estimations include 3-digit SIC and calendar year dummies. The Kleibergen-Paap rk LM statistic is a weak instrument test to check if the excluded instruments are correlated with the endogenous regressors. Reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: Incidence of recalls (*RecallDum*) and unionization (*%Unionized workers* and *Unionized*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	*% Unionized workers (3 yrs)*	*RecallDum*	*% Unionized workers (5 yrs)*	*RecallDum*	*Unionized (3 yrs)*	*RecallDum*	*Unionized (5 yrs)*	*RecallDum*
% Unionized MSA (10 yr lagged)	0.0007**		0.0008***		0.0034***		0.0035***	
	(0.01)		(0.01)		(0.00)		(0.00)	
% Unionized workers (3 yrs)		3.8801*						
		(0.06)						
% Unionized workers (5 yrs)				3.5788*				
				(0.06)				
Unionized (3 yrs)						0.8434**		
						(0.02)		
Unionized (5 yrs)								0.8325**
								(0.02)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Three-digit SIC and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	28,866	28,866	28,866	28,866	29,161	29,161	29,161	29,161
Anderson Rubin Wald F-statistic	n.a.	6.936***	n.a.	6.936***	n.a.	7.112***	n.a.	7.112***
Kleibergen-Paap rk LM statistic	n.a.	6.496***	n.a.	6.804***	n.a.	8.161***	n.a.	8.033***

Panel B: Frequency of recall (*CumRecalls_1yr*) and unionization (*%Unionized workers* and *Unionized*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	*% Unionized workers (3 yrs)*	*CumRecalls _1yr*	*% Unionized workers (5 yrs)*	*CumRecalls _1yr*	*Unionized (3 yrs)*	*Cum_Recalls _1yr*	*Unionized (5 yrs)*	*CumRecalls _1yr*
% Unionized MSA (10 yr lagged)	0.0006***		0.0007***		0.0039***		0.0039***	
	(0.00)		(0.00)		(0.00)		(0.00)	
% Unionized workers (3 yrs)		14.3940**						
		(0.02)						
% Unionized workers (5 yrs)				13.0688**				
				(0.03)				
Unionized (3 yrs)						2.3199**		
						(0.01)		
Unionized (5 yrs)								2.3131**
								(0.01)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Three-digit SIC and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	25,899	25,899	25,899	25,899	26,194	26,194	26,194	26,194
Anderson Rubin Wald F-statistic	n.a.	7.418***	n.a.	7.418***	n.a.	7.485***	n.a.	7.485***
Kleibergen-Paap rk LM statistic	n.a.	14.014***	n.a.	13.458***	n.a.	26.557***	n.a.	24.577***

Table 7 (Continued)

Panel C: Frequency of recall (*CumRecalls_2yr*) and unionization (*%Unionized workers* and *Unionized*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	*% Unionized workers (3 yrs)*	*CumRecalls _2yr*	*% Unionized workers (5 yrs)*	*CumRecalls _2yr*	*Unionized (3 yrs)*	*Cum_Recalls _2yr*	*Unionized (5 yrs)*	*CumRecalls _2yr*
% Unionized MSA (10 yr lagged)	0.0007***		0.0007***		0.0040***		0.0040***	
	(0.00)		(0.00)		(0.00)		(0.00)	
% Unionized workers (3 yrs)		25.2005**						
		(0.04)						
% Unionized workers (5 yrs)				22.9123**				
				(0.04)				
Unionized (3 yrs)						4.1645**		
						(0.02)		
Unionized (5 yrs)								4.1639**
								(0.03)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Three-digit SIC and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,815	20,815	20,815	20,815	20,990	20,990	20,990	20,990
Anderson Rubin Wald F-statistic	n.a.	5.702**	n.a.	5.702**	n.a.	5.686**	n.a.	5.686**
Kleibergen-Paap rk LM statistic	n.a.	13.848***	n.a.	12.956***	n.a.	23.981***	n.a.	21.789***

Panel D: Frequency of recall (*CumRecalls_3yr*) and unionization (*%Unionized workers* and *Unionized*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	*% Unionized workers (3 yrs)*	*CumRecalls _3yr*	*% Unionized workers (5 yrs)*	*CumRecalls _3yr*	*Unionized (3 yrs)*	*Cum_Recalls _3yr*	*Unionized (5 yrs)*	*CumRecalls _3yr*
% Unionized MSA (10 yr lagged)	0.0008***		0.0007***		0.0043***		0.0043***	
	(0.00)		(0.00)		(0.00)		(0.00)	
% Unionized workers (3 yrs)		32.7372*						
		(0.06)						
% Unionized workers (5 yrs)				29.3979*				
				(0.06)				
Unionized (3 yrs)						5.7979**		
						(0.04)		
Unionized (5 yrs)								5.8004**
								(0.04)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Three-digit SIC and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,514	16,514	16,514	16,514	16,602	16,602	16,602	16,602
Anderson Rubin Wald F-statistic	n.a.	4.787**	n.a.	4.787**	n.a.	4.785**	n.a.	4.785**
Kleibergen-Paap rk LM statistic	n.a.	14.401***	n.a.	13.472***	n.a.	21.476***	n.a.	21.476***

Table 8

Impact of unionization on recall incidence and number of recalls: Effect of tariff cuts and input price shocks

The dependent variable in Panel A is *RecallDum* which is set to one for firms in the recall sample, and zero for control firms. The sample period for recalls is 2003 – 2013. 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 2003 – 2013. In Panel B, C, and D, the dependent variable is *CumRecalls_1yr*, *CumRecalls_2yr*, and *CumRecalls_3yr* representing the number of recall events for a recalling firm over the next one-year, two-years, and three-years respectively. *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 is set to 0 otherwise. *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 is set to 0 otherwise. Refer to the appendix for details on the construction of our variables. All estimations include industry dummies and calendar year dummies. Reported *p*-values in the parentheses are based on heteroskedasticity robust standard errors and are clustered by firm. ***, ** and * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: Incidence of recall (*RecallDum*) and unionization (*%Unionized workers*)

Dependent variable:	(1) *RecallDum*	(2) *RecallDum*	(3) *RecallDum*	(4) *RecallDum*
% Unionized workers (3 yrs)	1.0634*		0.6198	
	(0.058)		(0.421)	
% Unionized workers (5 yrs)		1.0189*		0.6208
		(0.050)		(0.391)
*Negative input price shock * % Unionized workers (3 yrs)*	3.0236**			
	(0.011)			
*Negative input price shock * % Unionized workers (5 yrs)*		2.5175**		
		(0.017)		
*Tariff cut * % Unionized workers (3 yrs)*			1.4014**	
			(0.045)	
*Tariff cut * % Unionized workers (5 yrs)*				1.2302*
				(0.057)
Negative input price shock	-0.3166	-0.3034		
	(0.121)	(0.137)		
Tariff cut			-0.1208	-0.1183
			(0.122)	(0.129)
Control variables	Yes	Yes	Yes	Yes
Observations	31,775	31,775	20,523	20,523

Panel B: Frequency of recall (*CumRecalls_1yr*) and unionization (*%Unionized workers*)

Dependent variable:	(1) *CumRecalls_1yr*	(2) *CumRecalls_1yr*	(3) *CumRecalls_1yr*	(4) *CumRecalls_1yr*
% Unionized workers (3 yrs)	2.0295***		1.5931**	
	(0.001)		(0.038)	
% Unionized workers (5 yrs)		1.9043***		1.4605**
		(0.001)		(0.038)
*Negative input price shock * % Unionized workers (3 yrs)*	6.7904***			
	(0.007)			
*Negative input price shock * % Unionized workers (5 yrs)*		6.7616***		
		(0.007)		
*Tariff cut * % Unionized workers (3 yrs)*			1.4670**	
			(0.036)	
*Tariff cut * % Unionized workers (5 yrs)*				1.4237**
				(0.022)
Negative input price shock	-0.5727	-0.5913		
	(0.169)	(0.158)		
Tariff cut			-0.2175***	-0.2177***
			(0.006)	(0.006)
Control variables	Yes	Yes	Yes	Yes
Observations	26,979	26,979	16,283	16,283

Panel C: Frequency of recall (*CumRecalls_2yr*) and unionization (*%Unionized workers*)				
	(1)	(2)	(3)	(4)
Dependent variable:	*CumRecalls_2yr*	*CumRecalls_2yr*	*CumRecalls_2yr*	*CumRecalls_2yr*
% Unionized workers (3 yrs)	2.2744***		2.0066**	
	(0.002)		(0.025)	
% Unionized workers (5 yrs)		2.1085***		1.8152**
		(0.002)		(0.026)
*Negative input price shock * % Unionized workers (3 yrs)*	7.9850***			
	(0.002)			
*Negative input price shock * % Unionized workers (5 yrs)*		7.7686***		
		(0.003)		
*Tariff cut * % Unionized workers (3 yrs)*			1.0090	
			(0.209)	
*Tariff cut * % Unionized workers (5 yrs)*				1.0469
				(0.147)
Negative input price shock	-0.5128	-0.5391		
	(0.206)	(0.197)		
Tariff cut			-0.1310*	-0.1331*
			(0.084)	(0.079)
Control variables	Yes	Yes	Yes	Yes
Observations	20,610	20,610	13,128	13,128

Panel D: Frequency of recall (*CumRecalls_3yr*) and unionization (*%Unionized workers*)				
	(1)	(2)	(3)	(4)
Dependent variable:	*CumRecalls_3yr*	*CumRecalls_3yr*	*CumRecalls_3yr*	*CumRecalls_3yr*
% Unionized workers (3 yrs)	2.4970***		2.1535*	
	(0.003)		(0.051)	
% Unionized workers (5 yrs)		2.3319***		1.9806*
		(0.003)		(0.055)
*Negative input price shock * % Unionized workers (3 yrs)*	6.4382**			
	(0.018)			
*Negative input price shock * % Unionized workers (5 yrs)*		6.2227**		
		(0.018)		
*Tariff cut * % Unionized workers (3 yrs)*			1.0219	
			(0.224)	
*Tariff cut * % Unionized workers (5 yrs)*				1.0408
				(0.185)
Negative input price shock	-0.3385	-0.3273		
	(0.457)	(0.473)		
Tariff cut			-0.1140	-0.1141
			(0.193)	(0.198)
Control variables	Yes	Yes	Yes	Yes
Observations	16,621	16,621	10,481	10,481

Table 9
Close union election wins vs. losses: Univariate differences in characteristics

This table shows differences in observable characteristics between firms in union elections that win by a small margin vs. those that lose by a small margin. In Panel A we present results where vote shares are within the interval of [42.5%, 57.5%] and in Panel B we present results where the vote shares are within the interval of [40%, 60%]. Union election results are from the *NLRB*. *t-stat* presents the t-statistic based on a two-sample t-test to test statistical significance of the difference between the two sub-samples.

Panel A: Union elections within [42.5%, 57.5%]

	N	Mean	N	Mean	*t-stat*
	Close wins		*Close losses*		
Size	112	8.823	105	8.735	0.34
Ln(Revenues)	120	9.286	113	8.945	1.56
Ln(Book value of assets)	120	9.318	113	8.964	1.54
Book leverage	120	0.288	113	0.311	-0.92
R&D intensity	120	0.009	113	0.009	-0.21
Total factor productivity	119	-0.037	109	-0.041	0.05
Number of suppliers	123	8.057	115	5.643	1.43
% Unionized workers (3 yrs)	119	0.162	110	0.155	0.22
% Unionized workers (5 yrs)	119	0.183	110	0.173	0.24

Panel B: Union elections within [40%, 60%]

Variable	N	Mean	N	Mean	*t-stat*
	Close wins		*Close losses*		
Size	137	8.797	154	8.812	-0.07
Ln(Revenues)	148	9.218	169	8.906	1.56
Ln(Book value of assets)	148	9.237	169	8.948	1.38
Book leverage	148	0.296	169	0.309	-0.53
R&D intensity	148	0.010	168	0.010	-0.27
Total factor productivity	146	-0.022	164	-0.043	0.30
Number of suppliers	151	8.325	171	6.006	1.58
% Unionized workers (3 yrs)	146	0.156	165	0.147	0.31
% Unionized workers (5 yrs)	146	0.175	165	0.166	0.29

Table 10
Cumulative number of recalls and union elections: Overall sample and sub-sample results

This table presents results from Poisson regressions of the cumulative number of recalls on *Union Win*, i.e., a dummy variable that equals one if the union wins the election, and zero otherwise. Cumulative number of recalls are measured in a period of one year (*CumRecalls_1yr*), two years (*CumRecalls_2yr*), and three years (*CumRecalls_3yr*) after the union election. In Panel A, the sample consists of all union elections. In Panel B the dependent variable is *CumRecalls_3yr* and we present results for union elections within a 7.5% and 10% range of the majority threshold, i.e. [42.5%, 57.5%] and [40%, 60%] respectively. In Panel C (D) the dependent variable is *CumRecalls_2yr* (*CumRecalls_1yr*) and we present results for union elections within a 7.5% and 10% range of the majority threshold, i.e. [42.5%, 57.5%] and [40%, 60%] respectively. All specifications include three-digit SIC industry dummies and calendar year dummies. Standard errors are clustered at the firm level.

Panel A: Overall sample

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*
Union Win	1.1657***	1.0483***	0.7583**	1.0524***	1.0151***	1.0266***
	(0.003)	(0.002)	(0.031)	(0.000)	(0.000)	(0.000)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	972	1,063	1,144	972	1,063	1,144

Panel B: Sub-samples of close elections: Dependent variable is CumRecalls_3yrs

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CumRecalls_3yr*	*CumRecalls_3yr*	*CumRecalls_3yr*	*CumRecalls_3yr*	*CumRecalls_3yr*	*CumRecalls_3yr*
	[42.5%, 57.5%]	[40%, 60%]	Others	[42.5%, 57.5%]	[40%, 60%]	Others
Union Win	1.6478**	1.3780***	1.1078***	1.3783***	0.8976**	1.0512***
	(0.036)	(0.003)	(0.006)	(0.008)	(0.048)	(0.000)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	196	270	702	196	270	702

Panel C: Sub-samples of close elections: Dependent variable is CumRecalls_2yrs

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CumRecalls_2yr*	*CumRecalls_2yr*	*CumRecalls_2yr*	*CumRecalls_2yr*	*CumRecalls_2yr*	*CumRecalls_2yr*
	[42.5%, 57.5%]	[40%, 60%]	Others	[42.5%, 57.5%]	[40%, 60%]	Others
Union Win	1.3428*	1.1160***	1.0598***	1.1590***	0.6496	1.0575***
	(0.068)	(0.004)	(0.004)	(0.004)	(0.159)	(0.000)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	218	297	766	218	297	766

Panel D: Sub-samples of close elections: Dependent variable is CumRecalls_1yr

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CumRecalls_1yr*	*CumRecalls_1yr*	*CumRecalls_1yr*	*CumRecalls_1yr*	*CumRecalls_1yr*	*CumRecalls_1yr*
	[42.5%, 57.5%]	[40%, 60%]	Others	[42.5%, 57.5%]	[40%, 60%]	Others
Union Win	0.7013	0.8799**	0.8114**	1.0279**	0.8043*	1.0163***
	(0.238)	(0.043)	(0.015)	(0.020)	(0.092)	(0.000)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	238	322	822	238	322	822

Table 11
Cumulative number of recalls and union elections: Global and local regression discontinuity estimations

This table presents regression discontinuity design (RDD) results based on all union elections over 2002-2012. The dependent variable is cumulative number of recalls measured over a period of one year (*CumRecalls_1yr*), two years (*CumRecalls_2yr*), or three years (*CumRecalls_3yr*) after the union election. The independent variable of interest is *Union Win* which is a dummy variable that equals one if the union wins the election, and zero otherwise. All estimations are Poisson models and contain calendar year dummies. Models (4), (5), and (6) also contain three-digit SIC industry dummies. In Panel A, we estimate RDD regression models for all union elections using one global polynomial regression (see Equation (4)) and, in Panel B, we estimate RDD regression models for all union elections using one global polynomial regression for left hand side and another for the right hand side of the threshold (see Equation (5)). In Panel C, we estimate local regressions based on the optimal bandwidth as in Imbens and Kalyanaraman (2012). Results based on rectangular kernel estimations are reported. Standard errors are clustered at the firm level.

Panel A: Global polynomial regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*
Union Win	1.3156***	1.1781***	0.9131	1.4267***	1.2958***	1.2647***
	(0.008)	(0.008)	(0.112)	(0.000)	(0.000)	(0.000)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Polynomial terms	2	2	2	2	2	2
Polynomial (right and left of threshold)	No	No	No	No	No	No
Observations	972	1,063	1,144	972	1,063	1,144

Panel B: Global polynomial regressions with different polynomial terms for left hand side and right hand side of the threshold

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*
Union Win	1.6929**	1.3637**	0.7513	1.5769***	1.3694***	1.1971***
	(0.011)	(0.030)	(0.325)	(0.001)	(0.003)	(0.002)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Polynomial terms	2	2	2	2	2	2
Polynomial (right and left of threshold)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	972	1,063	1,144	972	1,063	1,144

Panel C: Local regressions using optimal bandwidth following Imbens and Kalyanaraman (2012)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*
Union Win	1.9737**	1.5845**	0.8206	1.4964***	1.1711***	1.2745***
	(0.014)	(0.033)	(0.295)	(0.001)	(0.004)	(0.002)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	508	561	625	508	561	625

Table 12
Cumulative number of recalls and union elections: Effect of right-to-work laws

This table presents regression discontinuity design results based on union elections for firms in states with right-to-work laws (Models 1, 2, and 3) vs. firms in states with no right-to-work laws (Models 4, 5, and 6). The dependent variable is cumulative number of recalls measured over a period of one year (*CumRecalls_1yr*), two years (*CumRecalls_2yr*), or three years (*CumRecalls_3yr*) after the union election. The main independent variable *Union Win* which is a dummy variable that equals one if the union wins the election, and zero otherwise. All estimations are Poisson models and contain three-digit SIC and calendar year dummies. In Panel A, we estimate regression models for all union elections using one global polynomial regression (see Equation (4)) and, in Panel B, we estimate regression models for all union elections using one global polynomial regression for left hand side and another for the right hand side of the threshold (see Equation (5)). In Panel C, we estimate local regressions based on the optimal bandwidth as in Imbens and Kalyanaraman (2012). Results based on rectangular kernel estimations are reported. Standard errors are clustered at the firm level.

Panel A: Global polynomial regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*
	Right-to-work laws			No Right-to-work laws		
Union Win	0.3257**	0.1484	0.4227	1.3792***	1.2718***	1.2514***
	(0.015)	(0.647)	(0.306)	(0.002)	(0.003)	(0.002)
Three-digit SIC dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Polynomial terms	2	2	2	2	2	2
Polynomial (right and left of threshold)	No	No	No	No	No	No
Observations	214	237	259	758	826	885

Panel B: Global polynomial regressions with different polynomial terms for left hand side and right hand side of the threshold

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*
	Right-to-work laws			No Right-to-work laws		
Union Win	-0.2388	-0.9717**	0.2566	1.5267***	1.3056**	1.0816**
	(0.545)	(0.017)	(0.741)	(0.009)	(0.026)	(0.014)
Three-digit SIC dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Polynomial terms	2	2	2	2	2	2
Polynomial (right and left of threshold)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	214	237	259	758	826	885

Panel C: Local regressions using optimal bandwidth following Imbens and Kalyanaraman (2012)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*	*CumRecalls_3yr*	*CumRecalls_2yr*	*CumRecalls_1yr*
	Right-to-work laws			No Right-to-work laws		
Union Win	-0.0917	-0.3584	0.4185*	1.8758***	1.6006***	1.3005***
	(0.782)	(0.103)	(0.064)	(0.003)	(0.001)	(0.007)
Three-digit SIC dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	115	132	124	334	375	477

Table 13

Cost of goods sold and union elections: Global and local regression discontinuity estimations

This table presents regression discontinuity design results based on all union elections during 2002-2012. The dependent variable is the cost of goods sold divided by revenues for year t+1 (*Cogs_1yr*), year t+2 (*Cogs_2yr*), and year t+3 (*Cogs_3yr*), where year t is the year of union election. The independent variable of interest is *Union Win* which is a dummy variable that equals one if the union wins the election, and zero otherwise. All estimations are Poisson models and contain calendar year dummies. Models 4, 5, and 6 also contain three-digit SIC industry dummies. In Panel A, we estimate RDD regression models for all union elections using one global polynomial regression (see Equation (4)) and, in Panel B, we estimate RDD regression models for all union elections using one global polynomial regression for left hand side and another for the right hand side of the threshold (see Equation (5)). In Panel C, we estimate local regressions based on the optimal bandwidth as in Imbens and Kalyanaraman (2012). Results based on rectangular kernel estimations are reported. Standard errors are clustered at the firm level.

Panel A: Global polynomial regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*Cogs_1yr*	*Cogs_2yr*	*Cogs_3yr*	*Cogs_1yr*	*Cogs_2yr*	*Cogs_3yr*
Union Win	0.0474**	0.0559***	0.0450**	0.0269**	0.0287***	0.0157
	(0.017)	(0.007)	(0.039)	(0.011)	(0.010)	(0.173)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Polynomial terms	2	2	2	2	2	2
Polynomial (right and left of threshold)	No	No	No	No	No	No
Observations	1,122	1,047	963	1,122	1,047	963

Panel B: Global polynomial regressions with different polynomial terms for left hand side and right hand side of the threshold

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*Cogs_1yr*	*Cogs_2yr*	*Cogs_3yr*	*Cogs_1yr*	*Cogs_2yr*	*Cogs_3yr*
Union Win	0.0327	0.0418*	0.0361	0.0385***	0.0360**	0.0273*
	(0.171)	(0.085)	(0.166)	(0.004)	(0.011)	(0.067)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Polynomial terms	2	2	2	2	2	2
Polynomial (right and left of threshold)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,122	1,047	963	1,122	1,047	963

Panel C: Local regressions using optimal bandwidth following Imbens and Kalyanaraman (2012)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*Cogs_1yr*	*Cogs_2yr*	*Cogs_3yr*	*Cogs_1yr*	*Cogs_2yr*	*Cogs_3yr*
Union Win	0.0437*	0.0459**	0.0356	0.0275**	0.0212*	0.0121
	(0.057)	(0.040)	(0.137)	(0.033)	(0.091)	(0.380)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	698	679	634	698	679	634

Table 14

Capital and R&D expenditures and union elections: Global and local regression discontinuity estimations

This table presents regression discontinuity design results based on all union elections during 2002-2012. The dependent variable is the sum of capital and R&D expenditures divided by total assets for year t+1 (*CapxRD_1yr*), year t+2 (*CapxRD_2yr*), and year t+3 (*CapxRD_3yr*), where year t is the year of union election. The independent variable of interest is *Union Win* which is a dummy variable that equals one if the union wins the election, and zero otherwise. All estimations are Poisson models and contain calendar year dummies. Models (4), (5), and (6) also contain three-digit SIC industry dummies. In Panel A, we estimate RDD regression models for all union elections using one global polynomial regression (see Equation (4)) and, in Panel B, we estimate RDD regression models for all union elections using one global polynomial regression for left hand side and another for the right hand side of the threshold (see Equation (5)). In Panel C, we estimate local regressions based on the optimal bandwidth as in Imbens and Kalyanaraman (2012). Results based on rectangular kernel estimations are reported. Standard errors are clustered at the firm level.

Panel A: Global polynomial regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CapxRD_1yr*	*CapxRD_2yr*	*CapxRD_3yr*	*CapxRD_1yr*	*CapxRD_2yr*	*CapxRD_3yr*
Union Win	-0.0132	-0.0177*	-0.0117**	-0.0087	-0.0157*	-0.0098*
	(0.216)	(0.085)	(0.049)	(0.375)	(0.078)	(0.067)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Polynomial terms	2	2	2	2	2	2
Polynomial (right and left of threshold)	No	No	No	No	No	No
Observations	1,106	1,041	957	1,106	1,041	957

Panel B: Global polynomial regressions with different polynomial terms for left hand side and right hand side of the threshold

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CapxRD_1yr*	*CapxRD_2yr*	*CapxRD_3yr*	*CapxRD_1yr*	*CapxRD_2yr*	*CapxRD_3yr*
Union Win	-0.0256**	-0.0247**	-0.0136**	-0.0165	-0.0183	-0.0053
	(0.040)	(0.050)	(0.050)	(0.249)	(0.166)	(0.361)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Polynomial terms	2	2	2	2	2	2
Polynomial (right and left of threshold)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,106	1,041	957	1,106	1,041	957

Panel C: Local regressions using optimal bandwidth following Imbens and Kalyanaraman (2012)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	*CapxRD_1yr*	*CapxRD_2yr*	*CapxRD_3yr*	*CapxRD_1yr*	*CapxRD_2yr*	*CapxRD_3yr*
Union Win	-0.0297**	-0.0214	-0.0151*	-0.0225	-0.0147	-0.0038
	(0.030)	(0.102)	(0.057)	(0.170)	(0.204)	(0.629)
Three-digit SIC dummies	No	No	No	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	664	718	345	664	718	345

Figure 1

Distribution of union election votes

This figure plots a histogram of the distribution of the number of elections with the percentage of votes for unionization in our sample across 30 equally spaced bins (with a 3.33% bin width). Union election results are from the NLRB over 2002–2012.

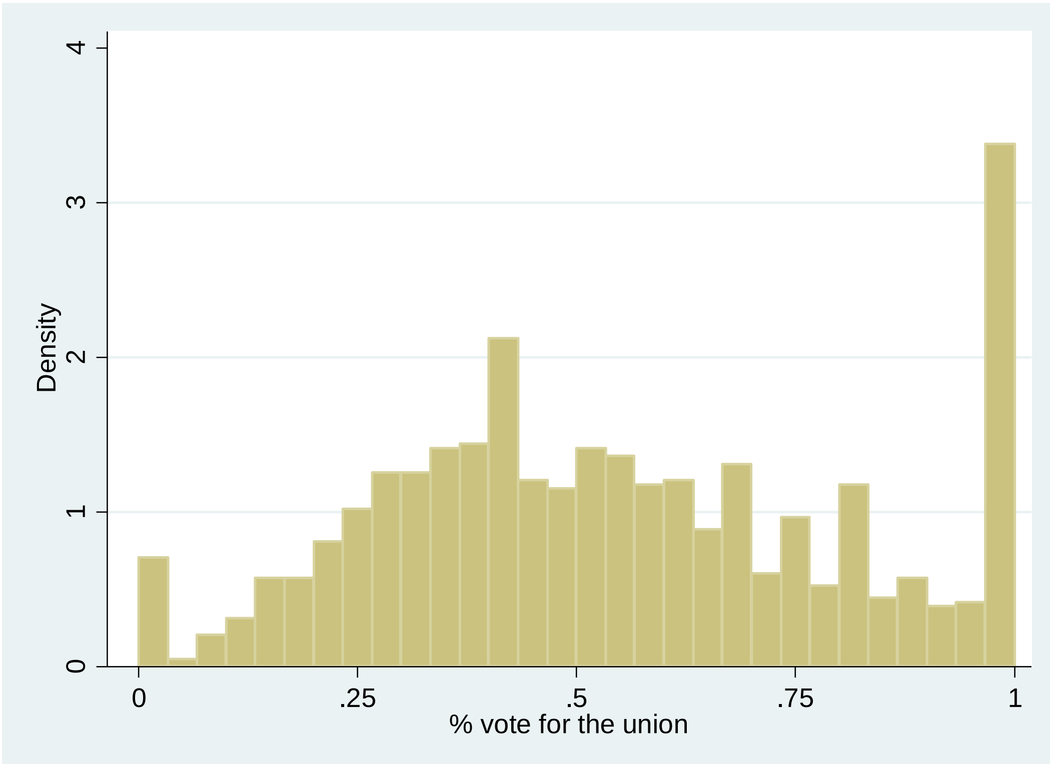


Figure 2

McCrary test for density of union vote shares

Union election results are from the NLRB over 2002–2012.This figure plots the density of union vote shares in favor of unionization based on the test outlined in McCrary (2008). The x axis is the proportion of votes favoring unionization. The dots depict the density estimate. The solid line represents the fitted density function of the forcing variable (the number of votes) with a 95% confidence interval around the fitted line.

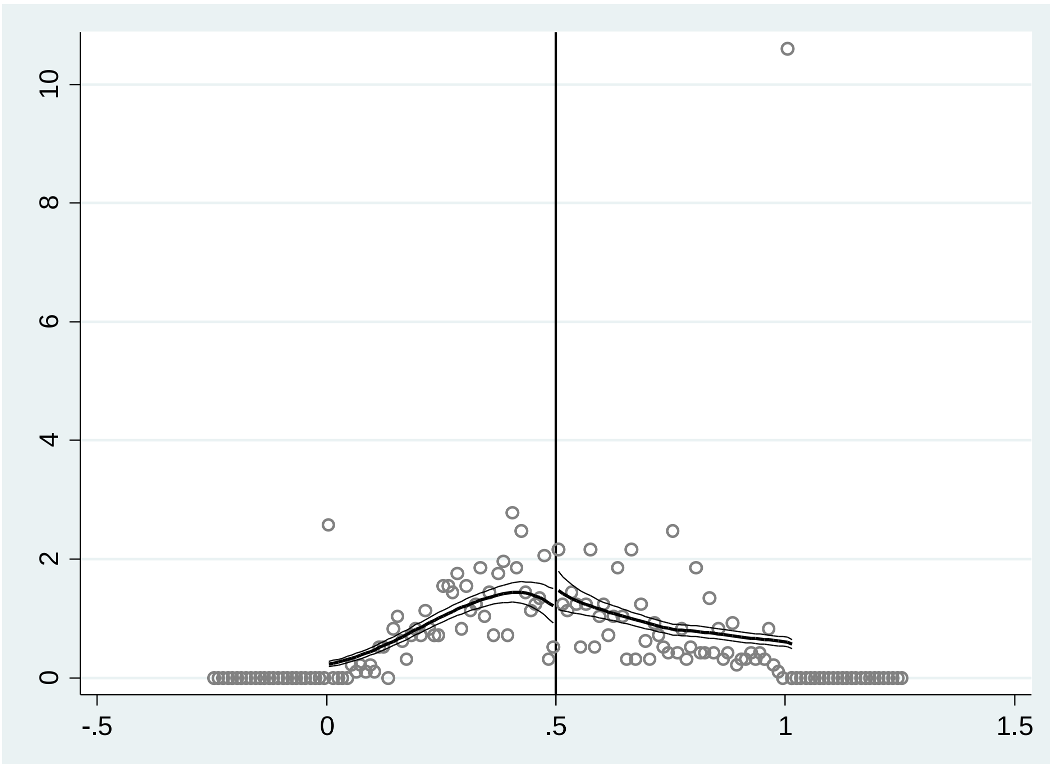
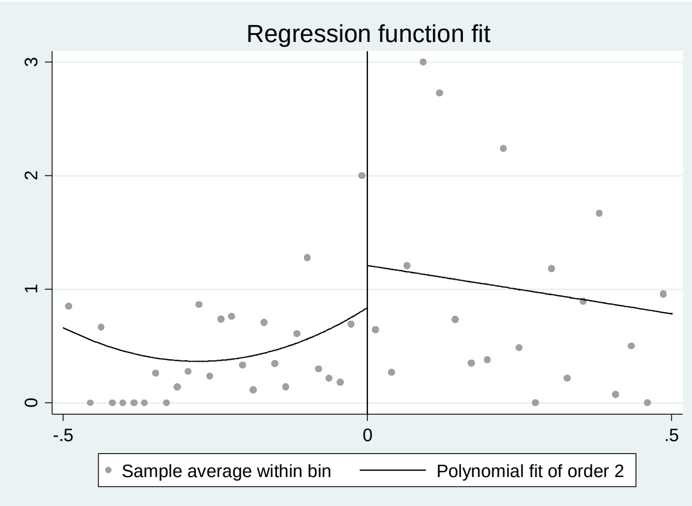


Figure 3

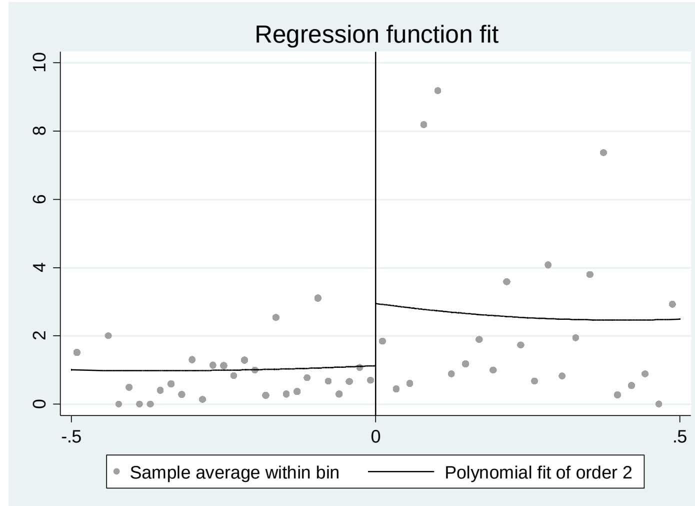
Regression discontinuity plots

Regression discontinuity plots using a fitted quadratic polynomial estimate. The x axis is the percentage of votes favoring unionization. The dots depict the average of the cumulative number of recalls in each of the equally spaced bins, the width of which is selected based on the mimicking variance evenly spaced method using spacing estimators (default option of rdplot command of Stata). Union elections are over 2002–2012 for which we have recalls information in the 1-year, 2-year, and 3-year post-election period.

Cumulative number of recalls in a one-year period post-election



Cumulative number of recalls in a two-year period post-election



Cumulative number of recalls in a three-year period post-election