Syncing Innovation to Avoid Sinking: Supplier Response to Customer Covenant Violations

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Abstract

When customers face financing frictions, they can retain suppliers through nonmonetary incentives, such as sharing their technology, thereby fostering supplier innovation. Using customer-supplier pairs in the U.S., we find that suppliers of customers who violate covenants become more innovative, specialize in niche areas, and exhibit greater tendencies to cite and coordinate with customer innovation. Additionally, supplier innovation increases when suppliers have greater financing flexibility and customers are highly specialized, stakeholder-friendly, and trustworthy. Such innovation positively influences customer relationships, supplier performance, and supplier-firm survival. Overall, our findings illustrate that nonmonetary channels motivate suppliers' relationship-specific investments.

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Keywords: Innovation, Customer-Supplier Relationship, Debt Covenant Violations, Firm Performance

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Introduction

Why do suppliers commit a substantial amount of resources to their relationship with large customers, even when they are not bound by formal contracts? The lower profitability of the supplier relative to its customers (Banerjee, Dasgupta, and Kim (2008)) and the long duration involved in recouping relationship-specific investments (hereafter, *RSI*) (Irvine, Park, and Yıldızhan (2016)) suggest that suppliers that do not obtain substantial monetary benefits from their *RSI* should refrain from committing a large amount of *RSI* in the first place. However, we continuously observe that suppliers invest in *RSI* (Joskow (1987), Crawford (1990)), which raises the question of whether there can be valuable nonpecuniary benefits in investing in and maintaining an ongoing relationship with a key customer. For example, the suppliers may obtain access to technology that they do not possess or obtain opportunities to collaborate on innovation, which can improve the competitiveness of the supplier. To understand this further, in this paper, we examine whether and to what extent suppliers learn from their customers about innovation and the consequences of such learning.

The effect of the interactions with customers on supplier innovation is important for several reasons. Suppliers and other small businesses form the backbone of the economy in terms of output and employment; hence, their innovation, which affects their competitiveness and survival, is a central issue for the economy (Porter (1992)). Furthermore, the increasing role of suppliers in new product development (e.g., Clark and Fujimoto (2003), Walter (2003)) and the salience of supplier innovation in cementing product market relationships (Pisano (1990)) make supplier innovation essential to the entire value chain of vertical industries where they operate. Moreover, the potential for supplier innovation to decrease the operational costs of a customer (Wagner and Bode (2014) introduces innovation as a key criterion in selecting a supplier, while cost reduction benefits incentivize customers to facilitate ongoing supplier innovation by sharing their technological expertise, thus suggesting a strong association between product market interactions and supplier innovation.

Due to the broad gamut of factors that influence interactions between trading partners, we focus on situations where customers' preferences for using nonmonetary incentives with suppliers are greater, namely, when there are financing frictions that decrease the attractiveness of traditional monetary incentives. Under such circumstances, to examine how supplier innovation is affected, we propose two competing hypotheses, the *bonding* and *dissociation* hypotheses, both of are carefully developed herein.

The *bonding* hypothesis is based on the premise that financing frictions incentivize *bonding* between customers and suppliers, with the increased interdependence being mutually beneficial. Financially troubled customers increasingly rely on suppliers to relieve some financial burden such as encouraging suppliers to increase *RSI* or provide more flexible trade credit. However, to entice suppliers to undertake such risky actions despite the customer's adversity, the customer should offer more nonmonetary incentives, such as inputs on innovation and close collaboration opportunities for the supplier. Any reduction in contracting frictions between customers and suppliers reduce customers' insecurities in sharing confidential information, encourage suppliers to commit more resources to the relationship, and enable suppliers to receive more nonmonetary benefits, all of which benefit supplier innovation. The close working arrangement eases financial frictions of the customer, such as through the co-investment of suppliers in customer innovation (i.e., a substitution effect), which can benefit both trading partners in the future.

The dissociation hypothesis is built on the view that suppliers are more likely to take actions to minimize damage or exposure to financially troubled customers to preserve their own interests with subsequent implications for supplier innovation. Supplier innovation will be negatively affected when 1) hold-up problems exacerbate, 2) a contagion effect of customer financial distress exists, and 3) supplier innovation complements customers' shrinking innovation activities. However, supplier innovation may benefit from necessity when the suppliers strive to diversify their customer base and undertake risky actions to minimize the costs of inaction considering customer financial difficulties, i.e., supplier innovation can improve without necessarily increased cooperation with the customer. Thus, the *dissociation* hypothesis predicts that by altering supplier incentives to maintain customer relationships and the ability of customers to finance innovation, supplier innovation will be positively or negatively affected.

We empirically resolve the tension between these two competing hypotheses. To overcome endogeneity concerns, we examine the existing customer-supplier relationships that are subject to an exogenous shock in the form of a customer's debt covenant violation.[1] Using the

[1] When customers violate their loan covenants, creditors obtain the rights to accelerate or restructure the loan. Although such covenant violations do not cause an outright default in all cases, it increases the bargaining power of the creditors and their say in the day-to-day operations of the firms. Prior studies have found that increases in creditor rights affects the financial policies of firms, such as the reduction in net debt issuance (Roberts and Sufi (2009)), increase in pledging of assets (Mann (2014)), and lower investments (Chava and Roberts (2008), Christensen, Macciocchi, and Nikolaev (2019)); they also cause large employment cuts (Falato and Liang (2016)); and encourage bondholders to adopt dual ownership (Hamilton, Irlbeck, and McKee (2018)).

customer-supplier and syndicated loan data from the Compustat Business Segment and DealScan, respectively, we identify the current ratio and net worth covenant violations of customers by comparing covenant thresholds set out in the loan agreement and quarterly financial reports. Using the identified covenant violations, we perform an RDD analysis by focusing on customers who are close to covenant violation thresholds based on the distance to the threshold, measured as the difference between the reported measure and the covenant threshold.

Using the RDD sample and innovation data from Kogan et al. (2017), we find that suppliers of customers who just violate their covenants increase their innovation output as measured by the number of patents (quantity) as well as citations (quality), supporting the *bonding* hypothesis. With respect to economic magnitude, after controlling for the standard determinants of innovation, a supplier whose principal customer faces a covenant violation produces 21.2% and 27.6% additional patents in the first two supplier fiscal years, respectively, following the covenant violation compared with suppliers whose customers have not violated covenants in the RDD sample. The patents of the former suppliers also receive 5.7% and 6.9% more citations per patent in the first two supplier fiscal years following the covenant violation, suggesting that the spillover from customer financing problems to supplier innovation is nontrivial. We also find that these suppliers increase their search depth in their patenting activity (i.e., repeat more of the citations from their past patenting behavior), which indicates that they are developing expertise in a narrower area. Through additional tests, we also rule out potential alternative explanations of our findings related to the relationship-survival bias and cost-reducing innovation strategies of suppliers.

To further determine whether the increase in supplier innovation has a *bonding* or *dissociation* motivation, we examine the propensity of suppliers to cite their customer patents following covenant violations. We find that suppliers whose customers have violated their covenants show an increased likelihood of citing their customer patents and cite them more often than suppliers whose customers have not violated their covenants. These results are also economically meaningful. For example, ceteris paribus, a supplier is 2.3% and 10.4% more likely to cite their customer patent when the customer violates a covenant in the fiscal year immediately and two years following the covenant violation, i.e., year t and year t+2, respectively. Additionally, in year t, suppliers cite their customers 4.1% more frequently.

By examining the cross-sectional variations in our baseline findings, we observe that supplier innovation is more sensitive to the financial shock to their customers when the suppliers are less leveraged, more profitable, and more likely to offer their goods on credit. All of these findings illustrate that the suppliers with the financial flexibility to pursue more innovation experience more "*bonding*". We also find that the innovation sensitivity of suppliers is higher when the customers are more innovative, have more expertise, are more trust-worthy (i.e., when the trading partners are located in counties with high societal trust levels), and are more stakeholder-oriented (i.e., when customers are incorporated in states that offer increased director discretion with regard to stakeholder interests). With all of these findings, our results illustrate that the supplier innovation is more responsive when suppliers have greater opportunities or incentives to learn and when they trust their customers to recognize the *RSI* made during turbulent times and preserve their margins when the conditions improve. The propensity of suppliers to cite customer patents also show similar cross-sectional variation patterns to supplier innovation quantities.

Although the higher propensity to cite customer patents after a covenant violation leans towards the *bonding* hypothesis, it does not completely rule out the possibility that suppliers strive to *dissociate* with customers while still citing customer patents due to familiarity. To explore this possibility, we examine the coordination of innovation activities between customers and suppliers in the post-covenant-violation period. We find that covenant violation increases contemporaneous coordination while decreasing the lead-lag coordination between customer and supplier innovation, which suggests that customers become more willing to readily coordinate with their suppliers when they face more financing frictions. All of these findings lend further support to the *bonding* hypothesis.

Examining other product market consequences of supplier innovation following customers' covenant violations, we find that innovative suppliers are able to increase their sales to the customer, unlike noninnovative suppliers, and are also able to make the customer relationship last longer. Additionally, we find that customers benefit from their innovative suppliers by being able to purchase more goods using credit, which allows them to sell more goods to their consumers on credit. At the firm level, innovative suppliers are also able to lower their leverage and increase their profitability after a covenant violation. Furthermore, innovative suppliers also have lower bankruptcy risks and higher odds of survival as a public firm for up to 5 years following the covenant violation. These findings suggest that despite the

risks of increasing engagement with a financially weakened customer, suppliers tend to benefit by increasing their bonds with such customers.

This paper makes the following contributions. First, our results help explain why small suppliers with low bargaining power willingly invest in costly relationship-specific investments with their large customers, which may potentially take advantage of them. Our findings illustrate that there could be significant nonmonetary benefits from maintaining good relationships with customers, such as technology and expertise spillovers. Our results complement various studies that examine the determinants of *RSI*, such as having positive economic spillovers (Kang, Mahoney, and Tan (2009)), reliable contract enforcement systems (Nunn (2007)), higher average life-cycle profitability despite initial losses (Irvine, Park, and Yıldızhan (2016)), social connections between managers or board members of customers and suppliers (Dasgupta, Zhang, and Zhu (2015)), lower takeover defenses (Johnson, Karpoff, and Yi (2015), Cen, Dasgupta, and Sen (2016)), and geographic proximity between customers and suppliers (Chu, Tian, and Wang (2019), Dasgupta et al. (2020)).[2] Specifically, by showing that covenant violations can facilitate innovation diffusion along the supply chain, we complement the findings of Banerjee, Dasgupta, and Shi (2019), who document a negative effect due to customer fraud, thereby highlighting the heterogeneity in supplier innovation responses to negative customer specific events.

Second, our study enables us to examine whether supplier innovation is a substitute or complement to customer innovation. Understanding whether supplier innovation substitutes or complements innovation by the customer has important implications for policymaking and economic growth. If supplier innovation largely complements innovation by the customer, then an increase in creditor rights for customers can lead to a substantial drop in innovative activity, affecting the economy's overall competitiveness and highlighting the dark side of increased creditor rights. On the other hand, as our results show, supplier innovation substitutes for customer innovation and increases knowledge sharing across the supply chain. These are

[2] Our paper is closely related to Chu, Tian, and Wang (2019) and Banerjee, Dasgupta, and Shi (2019), who document positive and negative factors for innovation diffusion along the supply chain, respectively. Although complementing the findings of both studies using a different setting, our paper differs in important ways. First, by making use of a shock to the use of nonmonetary incentives by customers, our study permits an examination of the larger question of whether supplier innovation substitutes or complements customer innovation, with evidence favoring the former. Second, while Chu, Tian, and Wang (2019) establish geographic proximity as a key channel that facilitates knowledge transfer between customers and suppliers, what motivates customers to share knowledge is left unexplored. Our study shows that financing frictions could be a potential motivator for customers to collaborate with suppliers in innovation, whereas Banerjee, Dasgupta, and Shi (2019) document customer fraud as having a negative influence on collaboration for the supplier.

positive externalities of increased creditor rights, consistent with Gu, Mao, and Tian (2017), who document more focused innovation despite an overall reduction when creditor rights increase. Our findings complement their study and indicate that suppliers address the slack in innovation quantity and prevent creditors from distorting the equilibrium in innovation output in the economy.

2. Hypotheses Development

The *bonding* perspective suggests that an increase in financing frictions of a customer will positively affect supplier innovation for two reasons: 1) increase in incentives for both customers and suppliers to work together and 2) increase in substitution of customer innovation by suppliers.

Both trading partners face greater incentives to collaborate and work closely together. Customers can relieve some of the financing pressures imposed by covenant violations by relying on suppliers, e.g., by obtaining increased trade credit, seeking a higher amount of *RSI*, and obtaining better prices on supplier's goods and services. By lending a helping hand to their principal customers who face financial difficulties, the suppliers also benefit. For example, they can strengthen their ties with the customer, improve their bargaining power, and obtain access to their customers' intellectual property, which, in turn, enhances their degree of innovation. However, if this customer fails or the relationship becomes economically unviable, the increased supplier innovation and knowledge obtained from the failed customer can increase the odds of the supplier landing a new and attractive customer, as potential customers deem innovation an important criterion to select suppliers (e.g., Ellram (1990), Pisano (1990), Tracey and Tan (2001)). Thus, suppliers are more incentivized to work closely with their customers who face financing constraints.

Meanwhile, to maintain their supplier base, customers who face financing frictions are also more willing to provide nonmonetary benefits such as knowledge sharing, which can allow suppliers to innovate more. Although customers have a large repertoire of nonmonetary incentives for suppliers, e.g., sharing information with supply-chain lenders (Cen et al. (2016)), timely sharing of demand information to decrease supplier inventories (Bourland, Powell, and Pyke (1996)), initiating strategic collaborations (Johnson and Houston (2000), a sudden increase in financing frictions makes these alternatives financially more expensive and

unattractive than sharing knowledge with respect to innovation. For example, lenders may not be keen to increase exposure to trading partners when one is constrained, even though more private information is provided by the customer to the supplier. In addition, customer incentives to minimize their inventory, which is more important when facing financing frcitions, often come at the cost of higher levels of supplier inventory. Thus a financially constrained customer may be less willing to provide more timely demand information to decrease supplier inventory as doing so would conflict with their own inventory policies. In addition, when faced with financing frictions, customers may rely more on flexible trade credit and be unable to establish joint ventures that require new investments, thus making such nonmonetary options unattractive.

Gu, Mao, and Tian (2017) show that creditors that receive control rights from financially distressed customers are less inclined to finance investment in long-term and inherently risky innovative activities. To continue to remain competitive in their product markets, such customers likely encourage their suppliers to innovate more or encourage them to co-invest in their innovation projects. In other words, customers facing financing frictions will seek to substitute some or part of their innovation through their suppliers. Thus, the *bonding* hypothesis predicts that customer financing frictions increase the pace of customer knowledge transfers to suppliers, which increases supplier innovation and strengthens ties with the supplier.

A competing perspective, which we call the *dissociation* hypothesis, suggests that the financial difficulties of a customer decrease the innovation activity of its supplier for the following reasons. First, the nature of incomplete contracting between trading partners (Macleod and Malcomson (1993)) increases the vulnerability of past investment of the suppliers by increasing the probability of appropriation by the customers who face financial difficulties (Williamson (1975), Klein, Crawford, and Alchian (1978), Shleifer and Vishny (1989)). Past *RSI* made by suppliers are not governed by any type of formal contract. Therefore, when creditors receive the control rights of customers, they more likely have an adverse effect on the claims of the suppliers (Zhang (2019)).[3] Such opportunistic creditor behavior discourages suppliers from making further investment in activities such as innovation, which may benefit their large customers or be exploited by them, which increases the levels of hold-

[3] For example, a supplier could have constructed a factory next to a customer location with the understanding that any parts manufactured at the facility could be sold at a constant profit margin to the customer in exchange for facilitating just-in-time inventory for the customer. However, following covenant violations when creditors receive control rights, they might attempt to improve the operating performance by revisiting the profit margin of the supplier or by asking the supplier to sell parts at cost prices to support the customer.

up problems in the relationship. This issue is similar to other underinvestment problems, such as those induced by equity-debtholder conflicts (e.g., Becker and Strömberg (2012)) or debt overhang problems (e.g., Hennessy (2004)). Additionally, suppliers with weaker bargaining power in the relationship may express these incentives by making irreversible decisions, which obviates any benefits that the customer can eke out of the supplier. For example, suppliers may respond to the financial troubles of their customers by increasing their own financial leverage to reduce the surplus that the customer can bargain away (Oliveira, Kadapakkam, and Beyhaghi (2017)).[4]

Second, the loss of financial flexibility of a customer can worsen the financial health of its supplier, especially when the relationship ties are stronger (Lian (2017)). For example, a financially troubled customer can fail to fulfill its payment obligations to suppliers and decrease future demand for the products or services of the supplier (Hertzel et al. (2008), Luo and Nagarajan (2015)). Subsequently, the worsening of supplier financial health due to contagion from customers decreases the supplier's ability to invest in innovation. Furthermore, Gong and Luo (2018) find that lenders commonly lend across the supply chain and use information obtained from the customers to tailor their lending decisions to the suppliers. Such coordinated activities in the external capital markets can hasten the propagation of financing shocks across the supply chain, which increases financing frictions for the supplier sooner.

Finally, when supplier innovation complements the innovation activity of their main customers, the financing frictions of a major customer likely decrease the innovation speed for both trading partners. For example, if most supplier innovation accompanies the new product development of a customer, then a covenant violation by transferring control to creditors will reduce risky new product development, which also reduces the explorative innovation of the suppliers.

However, even when the suppliers take actions to minimize negative externalities from the customer that faces financing frictions, supplier innovation may sometimes benefit. The increased concerns about diversifying the customer base and lack of technology sharing from the affected customer can spur supplier innovation. Although supplier innovation may unintentionally benefit from the dissociation with the customer, future supplier innovation will

[4] Although the increased borrowings can be used to finance innovation, which can increase both supplier innovation output and their attractiveness to potential customers, prior studies show that highly levered suppliers make unattractive trading partners due to their high probability to fail (Titman (1984), Maksimovic and Titman (1991)). Furthermore, supplier innovation activity can be dampened to the extent that it benefits the financially troubled customer.

not be coordinated with that of the customer. Thus, the *dissociation* hypothesis predicts that by altering supplier incentives to maintain customer relationships and customers' ability to finance innovation, the financing frictions of customers weaken the supplier relationship ties and consequently positively or negatively affect supplier innovation.[5]

3. Data, Sample Selection, and Key Variables

Our primary sources of data include the Loan Pricing Corporation's DealScan database for syndicated loans and covenants, the Compustat Business Segment File for customer-supplier relationships,[6] and Kogan et al. (2017) for utility patents and citations data for patents filed with the United States Patents and Trademark Office (USPTO).

We construct our sample in the following manner. We begin with all Compustat firms incorporated in the United States that have one or more loans covered by the DealScan database between 1994 and 2010.[7] We then merge this initial sample with the customers in the customer-supplier relationships dataset constructed using the Compustat Business Segment File. The Financial Accounting Standards Board's Statement of Financial Accounting Standards No. 14 (SFAS No. 14 - "Financial Reporting for Segments of Business Enterprise") requires a firm to disclose sales to its customers if the revenue generated exceeds 10% of the firm's total revenue or if the customer is vital to its business.[8] However, firms are only required to report the names of customers. We identify these customers by matching their names in the Business Segment File with the historical names in the CRSP/Compustat merged data file using a fuzzy name-

[5] The contrasting predictions of the dissociation hypothesis on supplier innovation can be empirically resolved by examining the effects of customer covenant violations on ongoing research coordination between customers and suppliers, rate of relationship survival and relationship longevity, and rate of trade credit provision by the suppliers, which we discuss in Section 5 while discussing the results.

[6] Both our hypotheses rely on the argument that incentives of both customers and suppliers are altered following a covenant violation, which is readily justifiable when the trading partners are similarly sized. However, the Compustat Segment Customer database generally consists of large customers and relatively smaller suppliers, which may affect the incentives of both customers and suppliers differently. Thus, to generalize our predictions, we check the sensitivity of our findings among large suppliers alone. In untabulated tests, we find that our results remain robust when we split our sample according to the median ratio of supplier size to customer size, measuring size as the market value of equity.

[7] Our sample period begins in 1994 to coincide with the reliable availability of covenants data in DealScan (Chava and Roberts (2008) and ends in 2010 to coincide with the availability of innovation data (Kogan et al. (2017)).

[8] In 1997, SFAS 131 superseded SFAS 14, which allowed firms to report sales to significant customers without revealing their identity. However, firms are still required to disclose their customers' identity when they account for more than 10% of overall sales or if the loss of a customer would have a material adverse impact on the firm under the Securities and Exchange Commission (SEC) Regulation S-K (Ellis, Fee, and Thomas (2012), Banerjee et al. (2014)).

matching algorithm (Cohen and Frazzini (2008), Cen et al. (2017)) supplemented by manual verification (Fee and Thomas (2004), Banerjee, Dasgupta, and Kim (2008)).[9]

To obtain information on innovation, we merge the combined dataset of customers (with at least one loan in DealScan) and their suppliers with firm-level utility patents and citations data from Kogan et al. (2017). The utility patents that are eventually granted are measured at the firm-year level according to the filing date with the USPTO. The patent filing date provides a more timely measure of innovation activity than the grant date because there is a significant lag between the two dates as a result of delays at the USPTO (Griliches, Pakes, and Hall (1986)). We also complement the patent measures with a measure of citations. Although the number of patents captures the extent of firm innovation activity, it fails to capture the quality or importance of innovation. Therefore, in the spirit of Fang, Tian, and Tice (2014), we construct a measure based on the number of nonself-citations received by each patent in the future.

Additionally, to examine the type of innovation, following Katila and Ahuja (2002), we compute search scope and search depth measures based on the types of citations included in the patent. Search depth and search scope are firm-year measures based on the repetition rate and novelty of citations, respectively, among patents filed by the firm in the previous five years. A higher rate of repetition implies higher search depth and suggests exploitative innovation, i.e., the firm develops expertise or focuses on a narrow domain in its patents. The higher use of new and previously unused citations indicates higher search scope and suggests exploratory innovation, i.e., the firm is exploring new horizons in its innovation activity.

All the variables used in the study are defined in the Appendix.

4. Research Design

Examining the effect of customer financing constraints using any proxy for supplier innovation is subject to severe endogeneity concerns. Thus, for identification, we use an

[9] When matching is not possible, we make use of SEC filings to help determine a customer's true identity; information concerning large customers is typically disclosed in the Management Discussion and Analysis section of the 10-K, as well as in the business description and the risk sections of the prospectus. We further supplement our search with the Lexis/Nexis Academic Universe and Factiva databases and company websites to further ascertain customer identities. In cases where the customer name refers to a public firm's subsidiary, then the parent firm in CRSP/Compustat is used as the matched firm.

exogenous event that alters financing constraints and amends the preferences of customers towards using nonmonetary incentives with suppliers, without the confounding effect of other economic drivers of supplier innovation.[10] Violating a covenant, termed a 'technical default', accelerates the debt obligations. Although in most cases, the debt is not repaid immediately and is often renegotiated (Roberts and Sufi (2009)), a covenant violation paves the way for the transference of control rights to the creditor. Such covenant violations by customers present an ideal setting to examine the effect of customers on supplier innovation for the following two reasons.[11]

First, by transferring control rights to creditors, the existing implicit contract environment between customers and suppliers is reset, and customers need to revitalize their relationship to maintain the renewed commitment of the supplier. Alternatively, customers can use this reset to engage in rent-seeking behavior with regard to already committed *RSI* but at the risk of experiencing more severe hold-up problems. Offering economic incentives to the supplier is subject to creditor review and hence is insufficient to assuage supplier concerns about the future. Without the power of economic incentives, the customer faces altered incentives to offer nonmonetary benefits in their trading relationships.

Second, the prevalence of covenants between borrowers and creditors (Smith and Warner (1979), Bradley and Roberts (2015)) does not affect supplier contracting decisions. Additionally, covenants' binary nature allows us to use a regression discontinuity design that mitigates the concern about endogeneity between customer financial health and supplier innovation activity. In particular, the distance between the covenant threshold of the customer and their accounting variables provides an exogenous source of variation in customer financing frictions, thereby allowing us to identify the effect of covenant violations on supplier

[10] Furthermore, customers and suppliers self-select their trading partners, which introduces an additional twin-matching problem. Thus, we focus on existing relationships where customers and suppliers have maintained ties in the past, thereby limiting the effect of selection among trading partners.

[11] Financial covenants, being set ex ante, incentivize borrowers to avoid violating them, even through manipulation if need be. Such actions can imply that violators are substantially different from nonviolators, even when both are close to the violation thresholds. This will violate the exogeneity assumption in the RDD framework, making it unsuitable. However, as argued by other studies that rely on covenant violations for identification (e.g., Chava and Roberts (2008)), lenders also well aware of such concerns. Therefore, lenders spell out the precise definition and computation of covenant-based measures to reduce manipulation and also choose a reporting frequency that minimizes such actions. Furthermore, since corporate lending is a repeated game, even reputational concerns can discourage manipulation. Finally, Chava and Roberts (2008) also find that accounting-based measures such as accruals are not systematically different around the covenant thresholds, suggesting that concerns about manipulation are limited. Finally, we also perform McCrary density tests to examine whether there is manipulation of narrow bandwidths around the covenant thresholds and plot the distribution in the Internet Appendix, which shows no remarkable discontinuity.

innovation. By focusing on a small range of distances between the covenant thresholds and accounting variables, we can homogenize the violation and nonviolation firms by restricting the analyses to highly similar firms in most aspects except for the covenant violation (Chava and Roberts (2008)). Thus, this process helps us to isolate the effect of covenant violations on supplier innovation.

Our empirical specification closely follows Chava and Roberts (2008) and Falato and Liang (2016). First, we use a treatment variable, *Customer covenant violation*$_{jt}$, as a dummy variable for covenant violation, defined as follows:

$$Customer\ covenant\ violation_{jt} = \begin{cases} 1 & z_{jt} - z_{jt}^{0} < 0 \\ 0 & z_{jt} - z_{jt}^{0} \geq 0 \end{cases}$$

where *j* indexes the firm (i.e., customer) and *t* indexes time (year).[12] z_{jt} is the actual accounting measure (current ratio and net worth), and z_{jt}^{0} is the threshold specified by the covenant in the loan agreement. We restrict our attention to the current ratio and net worth covenants, as they frequently appear in the DealScan data (Chava and Roberts (2008), Dichev and Skinner (2002)). Furthermore, these two accounting measures that determine whether these covenants are violated are straightforward to identify. Other covenants, such as those based on debt, leverage, or coverage ratios, can vary widely in the definitions of these measures and thus do not allow precise identification of covenant violations (Falato and Liang (2016)).[13] However, to mitigate concerns about focusing on only two types of covenants, we also perform additional tests based on text-based covenant violations, following Nini, Smith, and Sufi (2012). The text-based covenant violations are inferred from filings and are much more comprehensive in capturing potential covenant violations. The results of the analyses using text-based violations are described in the Internet Appendix. Our results remain robust and thus do not seem to be driven by choice of covenants, allowing us to generalize our findings to all covenants beyond just the current ratio and net worth covenants.

[12] To match customers debt covenant violations information to the frequency of the customer-supplier information, we follow Falato and Liang (2016) and convert quarterly violations information to annual violations information.
[13] In the DealScan database during our sample period, approximately 11.75% and 40.92% of loans have current ratio and net worth covenants, respectively. Thus, a combined 45.80% of DealScan loans have one of these covenants that we examine. Furthermore, other quantitative covenants that use numerical thresholds may be subject to interpretation and based on custom defined measures that are not observable from public information (e.g., Chava and Roberts (2008)). For example, debt-based ratios rely on the lender's definition of debt, such as inclusion/exclusion of short-term liabilities. Given these constraints, the current ratio and net worth covenants are reasonable proxies to identify covenant violations in our setup.

Our baseline regression specification using $Customer\ covenant\ violation_{jt}$ as the key explanatory variable is specified as follows:

$$Innov_{i,j,t+0,1,2} = \alpha + \beta Customer\ covenant\ violation_{j,t} + \gamma Customer\ default\ distance_{j,t} + \sigma X_{i,t} + \varphi_i + \theta_t + \epsilon_{i,j,t} \quad (1)$$

where *i* indexes the supplier and $Innov_{i,j,t}$ is a measure of innovation using patenting activity. Patenting activity is broadly measured in the following two ways: (1) the logarithm of the number of supplier patents filed that are eventually granted and (2) the logarithm of the number of supplier citations received for successful patents. Additionally, we also use measures of search scope and search depth, as described in Section 3. We control for supplier characteristics (*X*) to control for the determinants of firm-level innovation activity identified from prior studies (e.g., Fang, Tian, and Tice (2014)), supplier industry fixed effects (φ), and year fixed effects (θ). Including industry and year fixed effects for suppliers allows β to capture within-industry and time-independent variation in supplier innovation due to a covenant violation by their largest principal customer, thus mitigating the concern that industry or time trends in the supplier industry or the economy may drive our findings, respectively.

To capture the effect of customer covenant violation in a timely manner, we focus on the supplier fiscal years immediately following the covenant violation. Due to the unobservability of the exact time of the customer covenant violation and the misalignment in customer and supplier fiscal years, the supplier can reasonably be assumed to have had sufficient time to react to their customers' covenant violations. To further account for a lag between investment in innovation and patent application (Hall, Griliches, and Hausman (1984)), we measure the dependent variable in the subsequent two years following the covenant violation as well. Thus, we examine supplier innovation in the immediate three fiscal years of suppliers following the customer's covenant violation.

The coefficient of interest is β, the treatment effect, which represents the effect of customer covenant violation on supplier innovation outcomes. The nonlinear relationship at the covenant threshold in equation (1) allows for the identification of the treatment effect under mild conditions. As long as the unobserved component of innovation $\epsilon_{i,j,t}$ does not have an identical discontinuity at the covenant threshold, the treatment effect is well identified (Chava and Roberts (2008), Falato and Liang (2016)). Therefore, β is unbiased even if $\epsilon_{i,j,t}$ is correlated

with the distance from the customer covenant threshold, i.e., $z_{jt} - z_{jt}^{0}$, but not with $Customer\ covenant\ violation_{j,t-1}$.

To make a causal interpretation of the estimation of equation (1), the following two conditions need to be satisfied. First, the local continuity assumption needs to hold, i.e., all factors other than the treatment variable need to be continuous at the covenant threshold. To verify whether this assumption has been met in our setting, we examine the difference between the treatment (customers who violate their covenants) and control (customers who do not violate their covenants) firms within a narrow bandwidth of covenant thresholds and discuss those findings in Section 5.1. Second, firms should not be able to manipulate themselves into treatment and control groups precisely, i.e., covenant violations should be random. In our setting, customers are unlikely to be able to precisely manipulate the reported ratios for the following three reasons: (1) private reporting standards with lenders can be stricter than regular SEC reporting requirements, hence reducing managerial discretion; (2) lenders can closely monitor the customers; and (3) reputational costs in the syndicated loan market can be high if any manipulation is detected by lenders (Chava and Roberts, 2008). Furthermore, the ability of customers to influence the choice of threshold in the loan contract is itself weak because these thresholds are set at the initiation of the loan agreement, while actual violations can happen much later. Additionally, the incidence of covenant violations and creditor renegotiations are fairly common but nontrivial, suggesting that these customers either have a lower ability to manipulate covenant violations or lower willingness to influence covenant thresholds that prevent such violations than other customers. We also explore whether customers precisely manipulate their reported ratios graphically using McCrary density tests, which are detailed in the Internet Appendix. We find no results that suggest precise manipulation around the covenant thresholds.

As the discontinuity at the covenant threshold is the source of identification, following Chava and Roberts (2008), we also include the smoothing functions of the distance (*Customer default distance*) from the technical default boundary in our baseline specification. Specifically, for the current ratio and net worth covenants, we include the product of an indicator function that takes the value of one if the loan agreement has a current ratio (net worth) covenant and the difference between the latest current ratio (net worth) and the threshold specified in the covenant separately. The inclusion of these variables helps to isolate the treatment effect to the point of discontinuity and mitigates the concern that the distance to the covenant threshold contains information relevant to future customer-supplier innovation that is not captured by the

other controls, such as supplier characteristics. We estimate equation (1) using a sample of supplier-year observations that are close to the point of discontinuity, where we define closeness as the absolute value of the relative distance between the accounting variable and the corresponding covenant threshold of the customer, which is less than 0.20 (Chava and Roberts (2008)).[14] To remove the arbitrariness in choosing a numerical bandwidth, we also define closeness by estimating the optimal bandwidth using a nonparametric density function (Silverman (2018)). The optimal bandwidth is defined as $0.79Rn^{-1/5}$, where R is the interquartile range of the distance to the covenant threshold and n is the number of observations. The results using the optimal bandwidth are reported in Internet Appendix IA Table 1.

5. Results

5.1. Summary Statistics

Table 1 presents the summary statistics of a supplier's innovation and the relationship to its customers. Panel A shows how firm innovation varies according to whether the firm has a concentrated customer or not. On average, we find that firms that have one or more concentrated customers generate more innovation output than firms that do not have any concentrated customers. These trends are observable in terms of innovation quantity (i.e., patent counts) and innovation quality (scientific value such as citations and economic value such as patent value) of innovation. Even when we examine the type of innovation activity based on the scope and depth (or whether it is explorative or exploitative) (e.g., Lin, Liu, and Manso (2020)), we find that both dimensions of innovation are greater for firms with concentrated public customers than those that do not have public customers. The differences across all our innovation measures are statistically significant at the 1% level of significance. These findings oppose the common perception that large consumer-facing firms (i.e., at the end of the supply chain) might be more innovative in order to differentiate themselves from their rivals and suggest that firms in the supply chain play a disproportionately large role in innovation, raising questions as to suppliers' motivation to innovate. Next, we examine whether

[14] We also check the frequency distribution of the assignment variable and find no evidence suggesting precise manipulation by customers around the bandwidth of 0.2 as the relative distance between the accounting variable and the corresponding covenant threshold. The assignment variable density function (McCrary (2008)) shows that there is no precise manipulation around the debt covenant violation threshold, i.e., no significant discontinuity around the thresholds. The figure is presented in Internet Appendix Figure 1.

the suppliers' levels of innovation varyby industry and how the level of innovation affects suppliers' product market relationships.

[Insert Table 1 about here]

Panel B of Table 1 provides univariate comparisons by industry of patent and citation counts of firms with and without concentrated customers. As illustrated in the panel, for the most part, the number of patents (citations) is significantly higher for firms with concentrated customers across all industries, especially in consumer durables, manufacturing, business equipment and healthcare, medical equipment, and drugs, all of which are regarded as sectors that produce both socially and economically valuable innovation. Thus, the role played by suppliers in innovation is not only quantitatively superior but also more prominent in industries that are vital to economic development. In Panel C of Table 1, we examine whether being innovative will help a supplier in its product-market relationships. We find that innovative suppliers, which are defined as those filing one or more patents that year, have more concentrated customers and sell cumulatively more to such concentrated customers on average. Additionally, innovative suppliers sell more on a relative (to supplier total sales), and absolute basis to each individual concentrated customer as well and have longer-lasting durable relationships with their concentrated customers.

In Table 2, we show the difference in firm characteristics between public customers who face a covenant violation and those that do not. We present evidence using a full sample of customers and using a subsample of customers who are within a narrow bandwidth of covenant thresholds, i.e., customers who are either very close to covenant violation or have just violated the covenant by a small margin. As discussed earlier, examining customers who are very near the covenant thresholds will ensure that we are focusing on customers who are similar in most aspects, i.e., local continuity. This local continuity will then allow us to isolate the effect of covenant violations on our main outcome variable: innovation performance.

To graphically examine the covariate balance in the entire sample of customer covenant violations and within the RDD sample that is restricted to a bandwidth of 0.2 from covenant thresholds, we plot the standardized differences among the covariates between customers who violate and those that do not in Figure 1. The standardized differences in the full sample are quite large. However, within the RDD sample presented in the right panel, we find that the differences are quite small, preliminarily suggesting that customers near the covenant violation thresholds are relatively similar.

[Insert Figure 1 about here]

Panel A of Table 2 indicates that the RDD samples of customers who violate covenants and those that do not violate covenants seem statistically similar, thus implying that observable firm characteristics are indistinguishable in the RDD sample compared to the differences in the full sample. Specifically, in the full sample, customers facing covenant violations have higher R&D expenditures, ROA, and Tobin's *q* but lower leverage levels, capital expenditures, and asset tangibility, with the differences being significant at the 1% level of significance. Such differences suggest that examining the effect of covenant violations in the full sample will confound our findings due to the vast dissimilarities among the customers (i.e., sample selection problem). However, the differences in these variables (except for market capitalization and Tobin's *q*) are no longer statistically and significantly different from zero when we focus on the RDD sample, further improving the credibility of our RDD research design, which requires the covariates to be balanced.

[Insert Table 2 about here]

Panel B presents the univariate analysis of the effect of customer covenant violations on supplier innovation. Consistent with the *bonding* hypothesis, the univariate *t*-tests reveal that suppliers of firms that violate their covenants are more likely to increase their innovation, such as patents and citations in the RDD sample. Additionally, the suppliers show an increased propensity to cite the patent of the customer who has violated the covenant. When examining the difference between various kinds of innovation, we find that suppliers of firms that violate their covenants are more likely to increase their exploitative innovation, i.e., leverage their specialization to become more innovative. All these univariate differences are statistically significant at least at the 5% level of significance.

5.2 Effect of Customer Covenant Violation on Supplier Innovation

To graphically explore the discontinuity in supplier innovation around the covenant violation thresholds of their customers, in Figure 2, we plot the average measures of supplier innovation, including patent and citation counts, and the search depth of the supplier as a function of the distance from the covenant threshold of their principal customer. We use the sample of supplier-year observations where their principal customers are close to covenant violations using the bandwidth of 0.2 on either side of the covenant thresholds. We also include fitted lines and the 95% confidence interval on both sides of the thresholds that are smoothed

by including a polynomial function of order four. Distance from the covenant threshold standardized by dividing by the standard deviation of either the current ratio or net worth is shown on the x-axis. Negative values of the distance indicate violation, whereas positive values indicate that the covenants are not violated. Figure 2 indicates that suppliers of customers who violate covenants have a discontinuous jump in the number of patents, the number of citations, and search depth. Therefore, Figure 2 presents graphical evidence of discontinuity in supplier innovation around customer covenant violatons.

[Insert Figure 2 about here]

To test our hypothesis in a multivariate setting, we investigate the effect of customer covenant violation on supplier innovation by using the RDD sample and specification in equation (1). Table 3 presents the regression results with three different measures of innovation and an indicator for customer covenant violation and the control variables.[15] From Columns (1) to (3), the innovation measures are calculated in year *t*, while in Columns (4) to (6) and Columns (7) to (9), they are measured one and two year(s) following the debt covenant violation, respectively (denoted as year *t*+1 and year *t*+2). The coefficients on each customer covenant violation indicator (i.e., *Customer covenant violation*) are positively significant at the 5% significance level in Columns (1), (2), (4), (5), and (9) and at the 10% significance level in Column (7). These findings suggest that customer covenant violation is more likely to increase suppliers' innovation, both in terms of quantity and quality of innovation, which also supports the prediction of our *bonding* hypothesis. Our results are also economically significant. For example, in Columns (1) and (4), the coefficients on *Customer covenant violation* show that after customers experience a covenant violation, their number of patents increases by 21.2%= $e^{0.192}$-1 and 27.6%= $e^{0.244}$-1 in the year of and year next to covenant violation, respectively. Given that the mean number of patents in the RDD sample is 1.64, these results suggest an additional 0.34 and 0.45 patents per supplier in the first two years following their customer covenant violation.

[Insert Table 3 about here]

In terms of citations, Columns (2) and (5) show that after customers commit a covenant violation, the citations of their suppliers' patents increase by 5.7% (or $e^{0.056}$-1) and 6.9% (or

[15] We also use average patent value and search scope as additional measures of innovation but find that our results do not suggest that they are affected by customer covenant violations, and hence we do not report the findings for the sake of brevity.

$e^{0.069}$-1) in the year and subsequent year of customer covenant violation, respectively. Given that the mean number of citations per patent in the RDD sample is 0.14, the 5.7% and 6.9% increases are economically meaningful.[16] Although we find strong evidence of an increase in innovation quantity and marginal evidence of innovation quality, these findings do not indicate whether these suppliers explore or diversify to new innovation areas or build on their existing specialization strengths. Therefore, we move our focus to the results for search scope and search depth to illustrate such drivers.

The coefficient on customer covenant violation is mostly insignificant when using search depth as the dependent variable and always insignificant with search scope (untabulated results). The only exception is in Column (9), when we examine the search depth in year *t*+2 following the covenant violation shock; the coefficient on customer covenant violation is positive and statistically significant at the 5% level. This finding suggests that these suppliers rely more on their core innovation areas or expertise to file new patents rather than exploring new or less familiar areas. Additionally, to the extent that innovation comes from knowledge sharing with customers, this finding may suggest that developing expertise or specialization from acquired knowledge is time-consuming and may show up later rather than sooner.[17] Furthermore, the results on search depth also help rule out the diversification motivation for supplier innovation, i.e., when their principal customer faces trouble, suppliers may want to diversify by exploring new innovation areas to minimize the cost of inaction, which may intensify financial contagion. However, the increase in search depth (with no increase in search scope as found in untabulated tests) following covenant violations suggests that suppliers are not engaging in the diversifying innovation behavior into less explored areas; instead, they rely on their existing knowledge and expertise.

Since our estimation of innovation at the supplier firm level includes suppliers with both terminated and ongoing relationships with customers, relationship survival bias is less of a

[16] Innovation is usually a long-term process, and therefore we are biasing against ourselves in finding significant results within shorter time periods. However, in our customer-supplier dataset, the average relationship duration of a customer-supplier pair is 5.16 years, which confounds our ability to find a lasting effect of customer covenant violations on supplier innovation in longer time periods. Nevertheless, we examine our results on supplier patents in years *t*+3 to *t*+5 and find a weakly positive coefficient on *Customer covenant violation* that is insignificant.

[17] However, the finding that suppliers engage in more exploitative innovation (i.e., greater search depth) cannot rule out the possibility that suppliers decide to protect trade secrets already available through patents because of the higher possibility of customer failure. In Section 5.6, we examine the coordination among the patenting behavior of customers affected by covenant violations and their suppliers and find evidence that supports the view that these affected suppliers' innovation inputs and outputs are more synchronous with their customers' innovation in the post-covenant-violation period. This finding partially mitigates the concern that the observed increase in innovation might be a simple decision to patent existing knowledge.

concern. However, to mitigate this concern further, in untabulated tests, we split the sample into those that are terminated and those that are not within two years following the covenant violation and find that our results remain the same in both subsamples, although weaker in the sample of terminated relationships (the coefficient on *Customer covenant violation* becomes insignificant at year *t*+2 in the terminated sample). These findings may also be consistent with the *dissociation* hypothesis prediction of an unintended positive effect on supplier innovation. We further examine the effect on supplier innovation using the sample of suppliers that face an immediately terminated relationship (i.e., the same year as covenant violation) and do not find any significant increase in innovation in any of the future years, which rejects the *dissociation* hypothesis with a predicted positive effect on innovation. Thus, in addition to mitigating relationship survival bias, these tests further support the *bonding* hypothesis.

5.3. Propensity to Cite Customer Patents

To establish whether the uptick in supplier innovation occurs through their learning from the customer facing financing frictions or independent of them, we perform further tests. Table 4 presents the results for the probability that a supplier is likely to cite its customer patents in its newly filed and granted patents following the covenant violation. We find that customer covenant violation increases the likelihood of citing customer patents. Specifically, when we use a linear probability model with supplier fixed effects in Panel A and an indicator for citing any customer patent as the dependent variable, the coefficients on *Customer covenant violation* are statistically significant at the 5% significance level for the regressions in year 0 and year 2 in Columns (1) and (3), respectively. These results show that suppliers are more likely to cite their customer patents when the latter has violated debt covenants than when they have not. For robustness, we rerun our tests with an OLS regression with the logarithm of the number of customer patents cited by the supplier as the dependent variable in Panel B. We also replace supplier fixed effects with supplier industry fixed effects. Our OLS results are similar to the results from the linear probability model.

[Insert Table 4 about here]

5.4. Dynamic Effects

To examine the time-series variation in supplier innovation around a customer's covenant violation, in Figure 3, we plot the average number of patents, citations per patent, citations of affected customers, and the search depth of the supplier in the seven-year window around a

customer's covenant violation using all customer-supplier pairs in which the customer has violated a covenant. There is a clear uptick in supplier innovation in the postcovenant violation period that is observable in all of the measures of innovation. Moreover, we also notice that the increasing trends coincide with the supplier fiscal year immediately following the year of covenant violation. If there is a long lag between an investment in innovation and innovation output, the quick response of supplier patents to covenant violations may seem less plausible. However, such quick innovation responses of firms are supported both anecdotally and in prior studies. For example, de Rassenfosse and Guellec (2009), in their survey of firm innovation, find that the lag between R&D expenditures and patent applications, on average, is ten months.[18]

[Insert Figure 3 about here]

Table 5 presents a dynamic analysis of the effect of customer covenant violation on supplier innovation using only the violation sample (i.e., *Customer covenant violation (indicator)* equals 1). In Panel A, we summarize the mean supplier innovation measures during the seven-year window (*t*-3; *t*+3) around customer covenant violation, with *t* being the year of debt covenant violation by customers. Across both patents and citations, we find that innovation increases in the postcovenant violation period. Additionally, we also find that the search depth, although dipping during the year of covenant violation, comes back strong later in the postcovenant violation years. We observe an increase in number of customer covenants cited by the supplier in the postcovenant violation period, especially in the year of violation. Thus, at least some of the innovation can be attributed to learning from customers. These findings suggest that customer covenant violations play a crucial role in increasing suppliers' innovation activities. Furthermore, these findings also rule out the concern that our findings may be driven by some kind of information leakage in the years before the covenant violation.

[Insert Table 5 about here]

Panel B provides the coefficient estimates of the dynamic effect of covenant violation on firm innovation, where we use indicators for the years surrounding the customer covenant violation year. The key variable of interest is the coefficient on *Post* (indicator that takes the

[18] Anecdotally, in innovative industries such as pharmaceuticals, patent applications are made at a very early stage in the drug development, particularly by small- and medium-size firms, which need the patent protection to secure financing for clinical trials (Whenman and Matveenko (2020)). For example, in an effort to develop a vaccine for the Covid-19 in 2020, a leading contender Moderna Inc. made three patent applications between February and June of 2020 related to the vaccine under development, while their human trials started in March/April 2020 with commencement of phase 3 trials in July 2020 (Silbersher (2020)).

value of one for years after the covenant violation, i.e., years t+1, t +2, and t +3, respectively, and zero otherwise). The coefficient on *Post* in Column (1) is marginally significant (0.093) when examining a supplier's patents, while those in Columns/ (2)–(4) are insignificantly different from zero when examining the impact on suppliers' citations, search depth, and probability of citing customer patents, respectively. More interestingly, in Column (5), when we replace *Post* with multiple indicators for different years, we find that although the coefficient on *Current* is not statistically meaningful, the other coefficients of interest on year dummies such as $After^{1}$ and $After^{2,3}$ (0.154 and 0.139) are positively significant at the 5% and 10% significance levels, respectively. In Columns (6)–(8), $After^{1}$ and $After^{2,3}$ are significant at the 10% level when examining search depth, while citations and probability of citing customer patents do not have any notable patterns. These multivariate analysis results are consistent with the univariate means presented in Panel A, suggesting that customers who violate their covenants have a positive impact on supplier innovation for a few subsequent years. The insignificant coefficient on $Before^{1}$ indicates that there is no pretrend; hence, the parallel assumption is met.

5.5. Cross-sectional Tests

5.5.1 Variation according to suppliers' abilities to innovate

To examine the robustness of our findings, we examine whether our results are more pronounced among suppliers with a better ability to innovate following a shock to their principal customer. Therefore, we perform cross-sectional analyses of our main findings by adding several interaction terms along two major dimensions of supplier ability: 1) suppliers' financial flexibility and 2) suppliers' abilities to help their customers. Table 6 reports the findings.

[Insert Table 6 about here]

First, to measure suppliers' financial flexibility, we use measures of financial leverage and operating performance. i.e., industry-adjusted ROA. Panel A of Table 6 reports the cross-sectional variation in the effect of covenant violation according to these two measures on supplier innovation. The coefficients on *Customer covenant violation* are all positively significant in all regressions except Column (9) for innovation measures in year t and year $t+1$, consistent with our previous findings in Table 3. Using supplier innovation measures as the dependent variable, the coefficients on the interaction term between *Customer covenant*

violation (*a*) and our moderating variable (*b*): $a \times b$ are significant at least at the 10% significance level in seven out of the twelve specifications and in all specifications using search depth. These results weakly support the notion that suppliers with lower leverage and higher profitability are more likely to increase innovation and pursue more exploitative innovation.

Panel B demonstrates how the baseline results vary according to suppliers' ability to help their customers facing financing frictions. We measure the ability of the supplier to help by using proxies for the operating cycle and receivable ratios of the supplier. These two measures are computed as the ratio of net receivables minus net payables and net receivables to the total sales of the supplier, respectively. A higher value of these two ratios suggests that the suppliers often extend credit to their customers on more relaxed terms. Thus, when facing higher financing frictions, customers can count on trade financing from these suppliers to alleviate some of the pressure. Using these two measures as the moderating variables, the results show that the coefficients on the interaction terms (between *Customer covenant violation* and each of these two ratios) are positive and significant at least at the 10% level of significance in six of the twelve specifications, and focusing on year t+1, they are significant at least at the 10% level of significance in four of the six specifications. These results indicate that the innovation of suppliers with a greater ability to extend trade credit to their customers is most sensitive to covenant violations by customers. In other words, these results suggest that there might be some reciprocity between customers and suppliers in the sense that suppliers lend a helping hand to a customer during the crisis, and, in return, suppliers can learn more from customers about how to innovate in the future. To examine this situation much more directly, in the next set of tests, we focus on the sensitivity of supplier innovation according to customer innovation strategies.

5.5.2 Variation according to suppliers' incentives to innovate

We also expect that our baseline results will be more pronounced among suppliers with the appropriate incentives to innovate. Again, we examine their incentives from two specific dimensions: 1) when suppliers have more opportunities to learn from their customers and 2) when suppliers believe that their assistance will be reciprocated by the customer. Therefore, we perform cross-sectional analyses of our main findings by adding an interaction term between the *Customer covenant violation* variable and different measures of these incentives of suppliers.

[Insert Table 7 about here]

Panel A of Table 7 presents the results using measures of supplier opportunities to learn from customers as the moderating variable. Specifically, we use customer R&D expenditures (scaled by total assets) and customer search depth (a measure of exploitative innovation by customers) as the moderating variables (*b*). Using year *t*+1 measures of supplier innovation, the coefficient estimates of *a*×*b* are positive in all but one specification and significant in five of six specifications. These results indicate that when customers are more innovative and especially when they are specialists in their area as proxied by a greater search depth in their patenting activity, suppliers have more things to learn from these customers. Therefore, by sticking with customers subject to more financing frictions through tough periods, these suppliers can exhibit strong commitment (Johnson, Karpoff, and Yi (2015)), and their innovation mutually benefits from it through the sharing of customer technological know-how.

Panel B of Table 7 presents the results using measures of societal trust between customers and suppliers.[19] Trust plays an important role in opaque information environments (Guiso et al. (2008)) such as between trading partners. Suppliers usually face an information asymmetry problem with respect to the financial health of their customers, as evidenced by common underinvestment and hold-up problems in trading relationships. The existence of information asymmetry between major trading partners is also strongly supported by the literature (Titman (1984), Shleifer and Summers (1988), Goffin, Szwejczewski, and New (1997), Raman and Shahrur (2008), Trkman and McCormack (2009)). Thus, to examine the variation in our findings according to levels of trust between trading partners, we construct a firm-year measure of societal trust based on the Rupasingha, Goetz, and Freshwater (2006) index.

Based on the societal trust index, we first construct a variable defined as the absolute difference between the trust indexes of the customer and supplier, which forms our first moderating variable (i.e., *b*). This measure allows us to examine whether any distrust in the relationship (irrespective of the party) affects our findings. Second, we use the individual customer and supplier trust indexes as separate moderating variables (i.e., *c* and *d*), which we interact with the indicator for *Customer covenant violation* (*a*), which allows us to examine whose credibility is more important for supplier innovation.

In the first six specifications, the coefficients on the interaction term between *Customer covenant violation* (*a*) and the absolute difference in trust indexes (*b*), *a*×*b,* are significant at

[19] Following Guiso et al. (2004), we regard social capital as the level of mutual trust between the managers representing the customers and the suppliers and operationalize the concept by using the prevailing level of social trust in the headquarter locations of the customer and supplier.

the 10% significance level or better in five out of six specifications, suggesting that higher dissonance in trust lowers the sensitivity of supplier innovation to the covenant violation.

In the last six specifications of Panel B, we split the trust measure further into the measures for customer (*c*) and supplier (*d*) separately. We find that the interaction terms $a \times c$ and $a \times d$ are significant at the 5% level when examining patents in the year $t+1$ following the covenant violation. $a \times c$ remains significant when examining citations in Column (11), while $a \times d$ remains significant when examining search depth in Column (12).[20] However, we find no significant coefficient on the interactions in year *t*. These findings suggest that suppliers' innovation is more responsive when both suppliers and customers can trust each other more.

Panel C of Table 7 presents the results using a measure for the state-level adoption of customers' stakeholder orientation statutes. The enactment of state-level constituency statutes by customers' states of incorporation allows their directors to consider stakeholders' interests, such as those of employees and suppliers (e.g., Flammer and Kacperczyk (2016)). Cremers, Guernsey, and Sepe (2019) find that the increased director discretion offered by constituency statutes reduce firms' contracting frictions with their stakeholders and improves firm value. Thus, in our setting, such explicit legal protections for customers' directors could ease supplier concerns about customers' self-dealing behaviors and thus facilitate the increased commitment of resources. Similarly, explicit legal protections might increase the rate of knowledge transfer to suppliers from customers, as the protections allow directors to relax oversight on management in their collaborative activities with suppliers, as considering stakeholder interests no longer breaches their fiduciary obligations to their shareholders.

Therefore, to examine the variation in our findings, we make use of an indicator variable that takes the value of one for customer-years in which the state of incorporation of the customer has adopted a constituency statute, and zero otherwise. In Panel C, we estimate the regressions with customer state fixed effects (based on the state of incorporation) and year fixed effects, which accommodates the staggered adoption of these statutes and allows us to estimate the coefficient on customer stakeholder orientation (*b*) as a difference-in-differences estimate. We find that the interaction term between *Customer covenant violation* (*a*) and the

[20] In year $t+1$, the coefficients on the moderating variables, i.e., measures of customer and supplier trust levels individually, are negative and significant in Columns (10)–(12) in Panel B of Table 7, which suggests that suppliers might innovate less if either trading partner operates in an area with high trust. A potential explanation for these counter-intuitive findings is that the RDD sample is restricted to a sample of customers in financial difficulty, and therefore the trading partners in high trust areas might share innovation sooner rather than wait until the period of financial difficulty. Furthermore, the reduced supply chain capability to invest in innovation following customer distress could have a negative effect on supplier innovation.

customer stakeholder orientation (*b*), *a*×*b,* are significant at the 10% significance level or better in Columns (3), (4), and (6), suggesting that the stakeholder orientation of customers magnifies the predictions of the *bonding* hypothesis.

Overall, the findings in Tables 6 and 7 indicate that supplier innovation has a stronger reaction to customer covenant violation when suppliers have higher financing flexibility and use trade financing as a core strategy with customers, when the customers are innovative and exhibit higher levels of expertise, when mutual trust between the trading partners is higher, and when customers are more stakeholder friendly. These results add further support to the '*bonding*' hypothesis by suggesting that suppliers who are able and willing to lend a hand to troubled customers can receive greater nonmonetary benefits from their customer facing more financing frictions.

5.5.3 Variation in the propensity to cite customer patents

We also run cross-sectional analyses similar to the two previous subsections to pinpoint when exactly suppliers learn more from their customers' innovation. Similar to Tables 6 and 7, in Table 8, we interact the *Customer covenant violation* variable with the measures for suppliers' financing flexibility, trade credit provisions, the opportunity to learn from the customer, the difference in mutual trust levels, and customers' stakeholder orientation using the indicator for citing any customer patent as the dependent variable and a linear probability model specification.

[Insert Table 8 about here]

In Panel A, we find that the interaction term between *Customer covenant violation* and supplier leverage is negative and significant in years *t+1* and *t+2* (Columns (2) and (3) show that the coefficient estimates on *a* × *b* are -0.356 and -0.343, respectively, which are statistically significant at the 5% significance level), whereas the interaction terms using supplier industry-adjusted ROA are not statistically meaningful (Columns (4)–(6)). These results suggest that less levered suppliers with the financial flexibility to innovate show a higher likelihood of citing customer patents when their customers violate debt covenants. Similarly, the results in specifications seven to twelve support our prior findings that suppliers that are more likely to offer trade credits, showing a greater propensity to cite their customer patents in the

postcovenant violation years (positive and significant interaction term at least at the 10% level of significance in five of six specifications in Columns (7)–(12)).

Further, in Panel B, we find that when customers are large R&D spenders and specialize in niche innovation areas, suppliers show a greater willingness to file patents citing such customers after covenant violations in Columns (1)–(6). Finally, in Columns (7)–(12), we find that the interaction variable is negative and significant at the 10% level in Column (9) and positive and significant at the 5% level in Column (11), suggesting that when there is a large gap in mutual trust or customers are less stakeholder oriented, suppliers are less likely to cite their customers. However, in all the other specifications in Columns (7)–(12), the interactions are insignificant, suggesting a likely weak association between supplier incentives to bond and the propensity to cite customer patents. In summary, the findings in Table 8 clearly illustrate that suppliers learn from their customers, which are more willing to share their expertise with suppliers when facing financial frictions, especially when the supplier has the ability and willingness to help the customer and innovate.

5.6. Innovation Coordination between Trading Partners

Table 9 reports the innovation coordination between suppliers and customers by regressing measures of supplier innovation on customers' contemporaneous and lagged innovation. In addition to the measures of innovation used in previous tables, we also use an indicator variable for whether the supplier has a patent and the ratio of supplier R&D expenditures to sales as additional dependent variables. Using a logit specification in Columns (1) and (2), we find a significantly positive coefficient (significantly negative coefficient) on the interaction between *Customer covenant violation* and an indicator for a contemporaneous (lagged) customer patent. These findings suggest that there is a stronger contemporaneous effect rather than a lead-lag effect on innovation coordination between the supplier and customer following a customer covenant violation.

[Insert Table 9 about here]

The rest of the specifications produce similar results. For example, when we use an OLS specification rather than a logit specification and include supplier (and customer) industry fixed effects in Column (3) (Column (4)), we find qualitatively similar results that there is stronger contemporaneous innovation coordination between the trading partners after a customer covenant violation. In Columns (5)–(8), when we replace the dependent variable with four

different innovation measures used in previous tables, we still find that patents and search scope produce similar results. Specifically, Columns (5) and (7) show that contemporaneous (lagged) customer innovation has a positive (negative) effect on supplier innovation when customers violate their covenants. Finally, in Column (9), replacing the dependent variable with the R&D-to-sales ratio, we find that contemporaneous customer R&D expenditure is related to supplier R&D expenditure upon customer debt covenant violation.[21]

Overall, the findings in Table 9 show that when customers violate their covenants, the contemporaneous relationship between supplier and customer innovation becomes stronger, while the lead-lag relationship becomes weaker. These findings demonstrate that customer debt covenant violations facilitate customer-supplier coordination in innovation. For example, generally, customers may tend not to share much information regarding their upcoming innovation with their suppliers. However, when customers violate debt covenants, suppliers' trade credit provision may become more important; hence, customers can be more willing to offer nonmonetary incentives, such as offering their technical know-how to their suppliers, thereby improving the innovation output of their suppliers. Furthermore, the findings refute the *dissociation* hypothesis with a prediction of a positive effect on innovation. The ongoing coordinated knowledge transfer strongly refutes the view that suppliers that dissociate themselves from customers might innovate to survive.

5.7. Consequences of Supplier Innovation Following Customer Covenant Violations

To examine how customer covenant violation influences their interactions with suppliers, we use a difference-in-differences (DiD) approach in which we consider customer covenant violation as the treatment and examine the measures of supplier relationships in the pre- and postcovenant violation periods. We present the univariate DiD estimates in Table 10. In Panel A, we provide DiD estimates of customer-supplier relationship measures, including measures of sales to the affected customers (i.e., customers in either the treated or the control group), sales to nonprincipal customers, and the length of future relationships with the affected customers. Furthermore, we also examine the DiD estimates among the subsample of suppliers

[21] However, Koh and Reeb (2015) find that firms still file patents even when they do not report any R&D expenditures, suggesting that the patent measure might be the broadest approach to capture innovation. Furthermore, using innovation measures rather than R&D as our dependent variables, our study is not subject the criticism that cautious CEOs tend to under report their R&D but without exhibiting less innovation than overconfident CEOs do (Koh, Reeb and Zhao (2018)).

with a patent and those without in the postcovenant violation period.[22] The DiD estimates are computed from the perspective of years *t+1* and *t+2*, where *t* is the year of customer covenant violation.[23]

[Insert Table 10 about here]

As reported in Panel A, compared to the precovenant violation period, the postviolation period witnesses a reduction in supplier sales to the affected customer both on a relative basis (i.e., the fraction of the supplier's total sales) and on an absolute basis (i.e., the logarithm of the supplier's sales to the affected customer), as the coefficients of these sales variables are all negative and mostly significant at least at the 10% level of significance. However, when we split the results into suppliers with and suppliers without patents in the postviolation period, interestingly, we find that all the decreases are significant only among those suppliers without a patent. Therefore, it appears that suppliers that become more innovative in the postcovenant violation period continue to see similar sales volumes relative to the precovenant violation period and to periods in which customers do not violate covenants. Examining the sales growth to customers, we find that compared to suppliers without patents, those with patents are able to sell more to their affected customers in year *t*+2. On the other hand, we find that suppliers without patents substitute their lost sales to the affected customer by increasing their sales to other nonprincipal customers, suggesting that suppliers do not bond with the customer engaging in a covenant violation. Finally, in Panel A, we find that the DiD estimates for the full sample and the subsample of suppliers with patents for *Future relationship duration* are significantly positive, suggesting that these innovative suppliers further strengthen their relationship with their customers facing covenant violations. These findings, while strongly supporting the *bonding* hypothesis, also refute the *dissociation* hypothesis with a predicted positive effect on supplier innovation.

Panel B provides the DiD estimates of the customer operating cycle. We use customers' net account payables, net account receivables, and net accounts receivables minus net accounts

[22] Although splitting DiD estimates according to presence of patents in the postcovenant violation period produces balanced sample that allows us to meaningfully estimate the treatment effect of covenant violation, it need not necessarily divide the sample of suppliers into those with and without an increase in innovation. Therefore, in untabulated tests, we split the sample into those suppliers that file more patents in the postcovenant violation period than before violation, and those suppliers that file same or lesser number of patents in the postcovenant violation than before violation and reestimate the DiD analyses. Our results, especially of Panel A of Table 10 remain qualitatively similar. However, Panel B DiD estimates of the two subsamples show insignificant trends.

[23] Since we are interested in the combined consequence of customer financing frictions and supplier innovation, we measure the variables of interest in year *t*+1 instead of *t*.

payables (i.e., operating cycle), all scaled by total customer sales. Finally, we also provide DiD estimates for the ratio of customers' sales to the cost of goods sold (COGS). Using the full sample, only the receivables in year t+1 and the sales-to-COGS ratio in year t+2 are positively significant. However, when we view them by subsamples of supplier patents in the postcovenant violation period, we find that customers of suppliers without patents obtain much less trade financing from suppliers. Additionally, customers' receivables decrease because their precarious financial position does not allow them to extend their operating cycle without an extension of credit from their suppliers. However, when we look at the customers of suppliers with a patent, we find that these customers can obtain more credit from their suppliers and sell more on credit downstream without any significant change in their operating cycle, suggesting that these customers tend to pass on the benefits they obtain from their suppliers to their customers and thus achieve higher sales when including the portion sold on credit. Finally, we also find that for a given level of purchasing from suppliers, customers can sell more when their suppliers are innovative following debt covenant violations. In summary, the findings in Table 10 show that suppliers that pursue innovation following their customer's debt covenant violation improve the strength of their relationship with the affected customer, as shown by a lack of a decline in sales and a more durable relationship, thereby also helping the customer to improve its sales. Taken together, these findings are consistent with the *bonding* hypothesis that benefits both the customer and the supplier.

Next, we turn our attention to the effect of customer covenant violations on supplier performance according to their innovation decisions. Restricting our attention only to the covenant-violating customers as used in Table 4 and using the specification as in Panel B of Table 4, we examine supplier leverage, profitability, and financial distress probabilities. Table 11 provides the results using supplier performance measured by one-year ahead leverage, ROA, the profit margin, and the Altman Z-score. Columns (1), (3), (5), and (7) show the regression results for the postviolation period, while the others present dynamic analyses of the effect of covenant violation. We find that in general, there is a relatively similar pattern for how covenant violation affects supplier performance over the years. For example, suppliers that have customers with violated covenants experience lower profitability and higher bankruptcy risks in the postcovenant violation period (negative and significant coefficients in Columns (3) and (7) on *Post*). However, there is a different picture for suppliers with patents. Looking at the interaction between the year dummies and the indicator for supplier patents, we find that innovative suppliers experience a lower level of leverage in 3 years following the

violation, with the coefficients on $e \times f$ being -0.107. Columns (4) and (6) show that suppliers' future performance, such as ROA and the profit margin, increases significantly following customers' covenant violation when the suppliers are innovative, with coefficients on $e \times f$ of 0.084 and 0.335, respectively. Column (8) also shows that the financial distress probability (Altman Z-score) is decreasing for innovative suppliers every year.

[Insert Table 11 about here]

Although extending a helping hand to a customer facing more binding financing frictions and pursuing more innovation appears to be a risky strategy, there are likely some benefits of having a committed relationship with a large customer. Therefore, we investigate whether such actions by a supplier affect its future survival. We proxy the survival likelihood using the following two indicators: (1) whether the supplier remains a public firm in the future and (2) whether the supplier files for Chapter 11 bankruptcy. We present the regression results in Table 12. The results show that in the three and five years following their customer's covenant violation, becoming more innovative (i.e., *Supplier patent indicator* in year t+1) increases the probability of the supplier remaining public and reduces the probability of a Chapter 11 filing. Unsurprisingly, these effects dissipate over a long time window (i.e., seven years). In short, our analysis suggests that by being a more innovative supplier, suppliers increase their survival probability relative to other noninnovative suppliers.

[Insert Table 12 about here]

An alternative explanation of our findings is that when key customers face financial frictions, they might bargain harder on price and seek price concessions from suppliers, forcing the latter to innovate to sustain the low demanded prices from the customer. In additional untabulated tests, using the same specification as in Table 12, we estimate the effect of supplier innovation on the fraction of COGS in total sales of the supplier. We find that the coefficient on *Supplier patent indicator* is insignificant in each of the three years after the customer covenant violation. Since the entire surplus from innovation cannot be captured by the customer, these findings suggest that this innovation is not motivated by cost savings.

6. Additional Tests

In this section, we provide a brief description of additional tests that are performed and reported in the Internet Appendix. Specifically, 1) we report the robustness of our findings to an alternate data-driven optimal bandwidth, 2) results of the placebo analyses, 3) effect on the

supplier innovation input, 4) cross-sectional variation in our findings according to the common lender and customer financial constraints, and 5) results based on the alternative measures of customer covenant violations.

First, to mitigate the concern that our findings may be specific to our specific definition of bandwidth in arriving at the RDD sample, we use alternate methods to arrive at the sample. Specifically, we use a data-driven optimal bandwidth based on the mean square error (MSE) algorithm. The findings are reported in Internet Appendix Table IA1. In the MSE-based sample, we find that customer characteristics are mostly similar among customers who violate covenants and those that do not. The RDD estimates of supplier innovation using this sample show that suppliers of customers who violate the covenant are more innovative than those suppliers whose customers have not violated a covenant, supporting the *bonding* hypothesis.

Second, we perform placebo analyses by assuming that a customer covenant violation happens either five years before the actual estimated covenant violation or that it happens randomly (by defining a random uniformly distributed variable in the sample and assuming covenant violation when the variable is above the sample median). Neither analysis reported in Internet Appendix Table IA2 yields any significant effect of customer covenant violation on supplier innovation.

Third, to examine the underlying mechanism through which the customer covenant violations increase supplier innovation, we examine the sensitivity of supplier investment in innovation as measured by R&D expenditure to customer covenant violations (Internet Appendix Table IA3). Consistent with the view that innovation strategies are long-term and time-consuming in nature, we find that customer covenant violations increase the supplier R&D expenditure not in the year of violation but in the two subsequent years. However, our findings in Table 3 on patents suggest a contemporaneous relationship between supplier innovation and customer covenant violation. Although we follow the innovation literature to focus on the patent filing date instead of the grant date to measure the supplier innovation, the contemporaneous relationship suggests a shorter innovation development cycle, if all innovation only stems from organic R&D investment. However, Cohen, Nelson, and Walsh (2000) find that firms rely on various mechanisms to protect their intellectual capital, such as patenting, secrecy, lead time differentials, and marketing strategies. In this context, our findings suggest that supplier innovation increases due to the increases in both propensity to patent and investment in innovation. By hedging against customer failure, the increased patenting tendency of the supplier may appear at odds with the *bonding* hypothesis. However, our other results demonstrate a stronger future customer-supplier relationship after the covenant

violations of customers, the change in patenting decisions may be a sort of insurance, which is akin to generic insurance contracts, where the insured does not necessarily seek the adverse event while seeking protection.

Fourth, we examine the cross-sectional variation in our main findings according to the presence of common lenders and customer financial constraints, and we present the results of the analyses in Internet Appendix Tables IA4 and IA5. Common lenders face greater incentives to magnify the spillover effect of customers on supplier innovation, either positively or negatively. Since promoting the supplier innovation reduces wastage and increases efficiency (e.g., hold-up problems), common lenders may permit it. Meanwhile, if incremental innovation increases the risk of their concentrated portfolios, common lenders may discourage any innovation from both trading partners. We examine such predictions on supplier innovation and find that common lenders magnify the positive effect on the supplier innovation, especially in terms of patents and search depth. However, the propensity to cite customer patents is unaffected by the presence of common lenders.

From the perspective of customer financing constraints, our two hypotheses have different predictions. Specifically, the *bonding* hypothesis predicts that lower supplier incentives to bond with financially constrained customers lead to a weaker effect on supplier innovation and a lower propensity to cite customer patents. The *dissociation* hypothesis suggests that suppliers who are further incentivized to hedge away from a financially constrained customer might dissociate sooner with two predictions. First, to the extent that supplier innovation complements customers' innovation, the negative effect on supplier innovation might be stronger with a lower propensity to cite customer patents. Second, *dissociation* might also predict a stronger positive effect on supplier innovation and a greater propensity to cite financially constrained customers' patents when suppliers rely on innovation to improve their outcomes and begin an innovation journey with what they have learned from customers. Examining the results, we find that the positive effect on supplier innovation of customer covenant violation does not vary by customer financial constraints. However, the propensity to cite customer patents is lower under customer financial constraints, weakly supporting the *bonding* hypothesis further.

Finally, we use a text-based covenant violation that is likely to be comprehensive, as it captures most types of covenant violations, and precise, as it is based on the ex post reporting of violations in annual reports. This approach mitigates concerns about the misestimation of covenant violations based on DealScan loan data on covenant thresholds and quarterly values of the current ratio and net worth. Using data from Nini, Smith, and Sufi (2012) about text-

based covenant violations, we present the results in Internet Appendix Table IA6. We find a strong (weak) effect of customer covenant violation on supplier patenting in year t (year t+1), where year t corresponds to customer covenant violation. Furthermore, in year t+1, we also find that customer covenant violation increases the supplier's propensity to cite their customer patents in their innovation. These results are consistent with our arguments that the RDD setting used in this paper provides a clean test to examine our bonding hypothesis. Furthermore, to mitigate the concern that suppliers might be disincentivized or show lower financing ability when their customers face financial ruin, we examine the variation in our findings according to customers' future bankruptcies. To the extent that covenant violations signal future customer firm failures, suppliers should show reduced willingness to increase innovation. Consistent with these predictions, we find that future customer bankruptcies within a period of seven years moderate the effect of customer covenant violation on supplier innovation as measured through patents in Panel C of Table IA6. These results suggest that supplier innovation increases following customer covenant violation only when the violations are less severe and do not signal imminent failure.[24]

7. Conclusion

In this study, we develop two competing views, the *bonding* and *dissociation* hypotheses, to explain the effect of customer financing frictions on supplier innovation. The *bonding* hypothesis states that financially troubled customers prioritize retaining their suppliers. However, customers are unable to offer additional monetary incentives, which encourages them to share more nonmonetary benefits, such as technological know-how, with their suppliers. Additionally, the customers decreased ability to invest in innovation enables them to encourage their suppliers to substitute capital for innovation investment. Therefore, suppliers collaborate more with their financially constrained customers to learn from them and improve supplier innovation that might be able to attract new customers and, in the process, develop a natural hedge against a concentrated customer base. This hypothesis predicts that customer financing frictions increase supplier innovation and foster strong relationships. On the other hand, the *dissociation* hypothesis suggests that customers take advantage of their suppliers, especially when they face financial difficulties. Customers with increased creditor rights appropriate past supplier *RSI*, which increases hold-up problems and disincentivizes the

[24] We are unable to perform such tests using the RDD discontinuity sample, as there is not an estimable amount of customer bankruptcies that happen within seven years in the small RDD sample.

supplier from further investing in the relationship. This view predicts that suppliers decrease innovation when their customers are financially troubled both due to a lack of incentives to work alongside the customer and due to a fear of customer free-riding on any innovation output. The *dissociation* view also predicts a positive spillover of customer financing frictions on supplier innovation when that innovation is born out of the necessity of the supplier to thrive. However, such supplier innovation is less likely to be in collaboration with or coordinated by a troubled customer.

Using data on customer-supplier relationships from Compustat and loan data from DealScan, we find that following customer covenant violations in the RDD sample, suppliers produce more innovation outputs. For example, they produce 0.34 and 0.45 additional patents each in the first two years following their customer's covenant violation. We also find that these main results are more pronounced in the following five situations: (1) suppliers with higher profitability and lower leverage; (2) suppliers who offer more trade credit as evidenced by longer operating cycles and longer receivable collection cycles; (3) suppliers whose customers are more innovative and specialized; (4) suppliers who enjoy higher levels of trust with the customer; and (5) suppliers whose customers are more stakeholder-oriented exhibit greater sensitivity to their customer covenant violations. Furthermore, suppliers show an increased propensity to cite the patents of their financially troubled customers, confirming the learning channel, and the contemporaneous coordination among customers and suppliers with respect to innovation inputs and outputs increases when the customers have violated a covenant. Finally, we also find evidence that suggests that customer-supplier relationships strengthen, customers enjoy more trade credits, and innovative suppliers become more sustainable following customer covenant violations. Our findings help explain the motivation and mechanisms of supplier innovation activity and provide a plausible explanation for why suppliers invest extensively in *RSI* even when the immediate monetary benefits are not very apparent.

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Table 1: Summary of Innovation and Product Market Relationships with Customers

This table presents summary statistics of firm innovation categorized by product market customer relationships in Panel A, by industry in Panel B and by product market customer relationships according to measures of firm innovation in Panel C. In Panels A and B, the sample consists of 185,797 Compustat firm-years during the sample period of 1994 to 2009 obtained by merging firms in Compustat with firm-specific Google patent data (Kogan et al., 2017) and with product market relationships based on the Compustat segment database. In Panel C, the sample consists of a subsample of 26,022 supplier-years and 41,060 supplier-customer-years in Compustat, where the suppliers have one or more publicly listed customers. The test of the difference in means (medians) is computed as a simple *t*-test (median test). All variables are defined in the appendix.

Panel A: Firm Innovation According to Whether Firms Have a Public Customer

	Full sample		Firms that have one or more concentrated customers		Firms that do not have a concentrated customer		Test of difference in mean	
	Mean	Median	Mean	Median	Mean	Median	Difference	*t*-statistic
Measures of innovation	Obs. = 185,797		Obs. = 26,022		Obs. = 159,775			
No. of patents	1.10	0.00	2.37	0.00	0.90	0.00	1.47	(39.07)
No. of citations	0.09	0.00	0.20	0.00	0.07	0.00	0.13	(56.19)
Avg. patent value	0.45	0.00	0.89	0.00	0.38	0.00	0.51	(34.39)
Search scope (or explorative)	0.07	0.00	0.15	0.00	0.06	0.00	0.09	(60.70)
Search depth (or exploitative)	0.07	0.00	0.17	0.00	0.06	0.00	0.11	(50.64)

Panel B: Firm Innovation (mean) According to Whether Firms Have a Public Customer by Industry

	Full sample		Firms that have one or more customers		Firms that do not have a customer		Test of difference in mean	
Industry	No. of patents [no. of citations]	Obs.	No. of patents [no. of citations]	Obs.	No. of patents [no. of citations]	Obs.	Difference	*t*-statistic
Consumer Nondurables	0.67 [0.07]	7,981	0.74 [0.07]	2,000	0.64 [0.07]	5,981	0.10 [0.00]	(1.00) [(0.05)]
Consumer Durables	2.96 [0.19]	3,774	3.97 [0.23]	1,145	2.52 [0.17]	2,629	1.45 [0.06]	(4.49) [(3.82)]
Manufacturing	2.54 [0.17]	15,060	3.05 [0.25]	3,178	2.40 [0.15]	11,882	0.65 [0.10]	(3.92) [(11.46)]
Oil, Gas, and Coal	0.66 [0.03]	8,978	0.33 [0.02]	1,760	0.75 [0.03]	7,218	-0.42 [-0.01]	(-3.31) [(-2.90)]
Chemicals	4.49 [0.20]	3,485	3.15 [0.23]	632	4.79 [0.19]	2,853	-1.64 [0.04]	(-3.17) [(2.25)]
Business Equipment	2.70 [0.21]	30,547	3.87 [0.32]	7,921	2.29 [0.18]	22,626	1.58 [0.14]	(13.65) [(19.77)]
Telephone and TV Transmission	0.62 [0.05]	6,474	0.43 [0.11]	874	0.66 [0.04]	5,600	-0.23 [0.07]	(-1.47) [(6.83)]
Utilities	0.05 [0.01]	5,433	0.06 [0.02]	418	0.04 [0.01]	5,015	0.02 [0.01]	(0.71) [(1.31)]
Wholesale and Retail	0.11 [0.02]	14,156	0.19 [0.06]	950	0.11 [0.02]	13,206	0.08 [0.04]	(1.50) [(7.10)]
Healthcare, Medical Equipment, and Drugs	2.00 [0.22]	16,530	3.55 [0.35]	3,019	1.66 [0.19]	13,511	1.89 [0.16]	(13.76) [(14.30)]
Finance	0.05 [0.01]	45,425	0.51 [0.03]	1,302	0.04 [0.01]	44,123	0.47 [0.02]	(14.93) [(8.91)]
Others	0.18 [0.02]	27,954	0.30 [0.05]	2,823	0.17 [0.02]	25,131	0.13 [0.03]	(3.01) [(9.66)]

Panel C: Effect of Innovation on Trading Relationships of Suppliers with One or More Public Customers

	Full sample		Suppliers that have one or more patents		Suppliers that do not have a patent		Test of difference	
Relationship measures	Mean [median]	Obs.	Mean [median]	Obs.	Mean [median]	Obs.	Difference	*t*-statistic [χ^2-statistic]
	Aggregate customer relationships							
Customer concentration ratio	0.10 [0.03]		0.11 [0.04]		0.10 [0.03]		0.01 [0.01]	(3.79) [(33.86)]
Cumulative sales to all customers	0.28 [0.21]	26,022	0.30 [0.23]	5,857	0.27 [0.20]	20,165	0.03 [0.03]	(8.83) [(43.04)]
Count of all customers	1.90 [1.00]		1.89 [1.00]		1.90 [1.00]		-0.01 [0.00]	(-0.61) [(2.31)]
	Existing individual customer relationships							
Supplier sales fraction	0.18 [0.13]	41,060	0.19 [0.14]	9,259	0.17 [0.13]	31,801	0.02 [0.01]	(9.92) [(133.50)]
Log (supplier sales)	3.14 [2.97]	37,165	3.68 [3.52]	8,758	2.97 [2.81]	28,407	0.71 [0.71]	(33.00) [(507.54)]
Future relationship duration	5.16 [4.00]	35,226	5.76 [4.00]	8,268	4.98 [3.00]	26,958	0.78 [1.00]	(19.94) [(72.44)]

Table 2: RDD Sample and Univariate Analysis of the Effect of Customer Covenant Violations on Supplier Innovation

This table presents summary statistics of the regression discontinuity design (RDD) samples of customer firm characteristics (Panel A) and supplier innovation (Panel B). The sample in Panel A consists of 4,091 customers identified from the Compustat segment database merged with loan data from DealScan from 1994 to 2009. The sample is restricted to the customers in the Compustat segment database that have a current loan outstanding with one or more quantitative covenants (i.e., either current ratio or net worth covenants). Covenant violations are identified as those firms that have fallen below the covenant specified threshold of the current ratio or net worth during the life of one of their outstanding loans. In Panel B, the sample consists of 3,387 suppliers identified from the Compustat segment database as being the suppliers of the customers in Panel A. The supplier data are merged with firm-specific Google patent data (Kogan et al., 2017). In Columns (5)–(9) of Panel A and Columns (4)–(7) of Panel B, the sample is restricted to the customers and suppliers where the customers are within a bandwidth of 0.2 of the covenant threshold (discontinuity sample), i.e., 853 customer-years and 687 supplier-years, respectively. The test of the differences in means in Panels A and B is computed as a simple *t*-test. The standardized difference in Panel A is computed as the standardized imbalance in firm characteristics to assess covariate balance. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Tests of Covariate Imbalance Among Customers With and Without Covenant Violations

	Using Full Sample				Using Discontinuity Sample			
	Customer facing covenant violations	Customer not facing covenant violations	Mean difference (*p*-value)	Standardized difference	Customer facing covenant violations	Customer not facing covenant violations	Mean difference (*p*-value)	Standardized difference
Firm characteristics	Obs. = 603	Obs. = 3,488			Obs. = 539	Obs. = 314		
Ln (market equity)	9.74	9.54	0.19 (0.56)	-21.82	9.24	9.55	-0.31 (0.00)	36.61
R&D/assets	0.03	0.02	0.00 (0.00)	-10.79	0.01	0.02	0.00 (0.15)	6.50
ROA	0.08	0.03	0.06 (0.00)	-51.27	0.04	0.02	0.02 (0.33)	-15.64
Leverage	0.50	0.52	-0.01 (0.00)	8.76	0.52	0.52	0.00 (0.47)	1.25
Tobin's *q*	1.85	1.44	0.42 (0.00)	-40.21	1.27	1.40	-0.13 (0.00)	17.40
Capex/assets	0.05	0.06	-0.01 (0.00)	13.10	0.06	0.06	0.00 (0.55)	4.11
PPE/assets	0.24	0.33	-0.09 (0.00)	36.49	0.32	0.33	-0.01 (0.47)	2.58
Herfindahl index	0.01	0.01	0.00 (0.97)	20.95	0.01	0.01	0.00 (0.65)	16.03

Panel B: Effect of Covenant Violation on Supplier Innovation Univariate Analysis

		Using Full Sample		Using Discontinuity Sample		Test of the Difference in Means in the Discontinuity Sample	
	Full sample	Suppliers of customer facing covenant violations	Suppliers of customers not facing covenant violations	Suppliers of customer facing covenant violations	Suppliers of customers not facing covenant violations		
Innovation measures	Obs. = 3,387	Obs. = 473	Obs. = 2,914	Obs. = 413	Obs. = 274	Difference	*t*-statistic
No. of patents	2.651	2.258	2.714	2.199	0.792	1.407	(2.69)
No. of citations	0.203	0.179	0.207	0.169	0.092	0.077	(2.21)
Avg. patent value	1.081	0.602	1.159	0.603	0.369	0.234	(1.30)
Probability of citing customer patent	0.038	0.044	0.037	0.041	0.000	0.041	(3.42)
No. of citations of customer patent	0.724	1.072	0.667	1.128	0.000	1.128	(1.88)
Search scope (or explorative)	0.148	0.113	0.154	0.114	0.078	0.036	(1.72)
Search depth (or exploitative)	0.183	0.149	0.189	0.149	0.060	0.089	(2.54)

Table 3: Baseline Regressions of the Effect of Customer Covenant Violations on Supplier Innovation

This table presents regression estimates of supplier innovation on customer covenant violation and control variables using the RDD sample. The RDD sample begins with 3,387 supplier-years identified from the Compustat segment database as being the suppliers of customers from the Compustat segment database merged with loan data from DealScan during 1994 to 2009. The sample is restricted to the customers in the Compustat segment database that have a current loan outstanding with one or more quantitative covenants (i.e., either current ratio or net worth covenants). Customer covenant violation is an indicator for customer covenant violations identified as those customers who have fallen below the covenant specified threshold of the current ratio or net worth during the life of one of their outstanding loans. The supplier data are merged with firm-specific Google patent data (Kogan et al., 2017). The sample of suppliers is restricted to the suppliers whose customers are within a bandwidth of 0.2 of the covenant threshold (discontinuity sample), i.e., 687 supplier-years. Industry fixed effects based on the Fama-French 30 industry classification are included and *t*-statistics based on standard errors clustered by firm are reported in parentheses. Constants are included in all the regressions but not reported. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth
Independent variables		Year *t*			Year *t*+1			Year *t*+2	
Customer covenant violation	0.192**	0.056**	0.063	0.244**	0.069**	0.116	0.208*	0.037	0.185**
(indicator)	(2.155)	(1.985)	(1.079)	(2.374)	(2.153)	(1.529)	(1.732)	(0.974)	(2.158)
Customer default distance (CR)	1.186	0.686**	0.150	0.863	0.082	0.472	0.377	-0.216	0.487
	(1.364)	(2.075)	(0.376)	(0.923)	(0.280)	(0.922)	(0.370)	(-1.088)	(0.937)
Customer default distance (NW)	-0.000	-0.000	-0.000	-0.000	-0.000**	-0.000	-0.000	-0.000	-0.000
	(-1.164)	(-1.271)	(-0.808)	(-1.113)	(-2.097)	(-0.917)	(-0.719)	(-1.352)	(-1.081)
Supplier characteristics									
Ln (market equity)	0.116***	0.023***	0.035**	0.099***	0.011	0.033*	0.110***	0.014	0.040*
	(3.392)	(2.863)	(2.083)	(2.885)	(1.402)	(1.724)	(2.754)	(1.558)	(1.785)
R&D/assets	0.788*	0.427**	0.744***	0.844**	0.336**	0.853**	0.749	0.281*	0.544
	(1.837)	(2.431)	(2.735)	(1.985)	(2.444)	(2.401)	(1.594)	(1.820)	(1.412)
ROA	-0.088	-0.032	-0.024	-0.174*	-0.027	-0.076	-0.279**	-0.031	-0.200**
	(-0.851)	(-1.139)	(-0.320)	(-1.677)	(-1.041)	(-0.829)	(-2.038)	(-0.986)	(-2.035)
Leverage	0.104	-0.011	0.042	0.043	-0.012	0.084	-0.011	-0.018	-0.046
	(1.254)	(-0.457)	(0.605)	(0.536)	(-0.564)	(0.946)	(-0.127)	(-0.760)	(-0.932)
PPE/assets	-0.090	-0.000	-0.145	-0.091	0.001	-0.160	-0.354	-0.025	-0.334**
	(-0.479)	(-0.001)	(-1.470)	(-0.470)	(0.023)	(-1.401)	(-1.588)	(-0.349)	(-2.351)
Capex/assets	0.542	-0.081	0.391*	-0.023	0.009	0.223	0.181	0.030	0.067
	(1.165)	(-0.768)	(1.662)	(-0.061)	(0.080)	(0.926)	(0.401)	(0.262)	(0.256)
Herfindahl index	-9.508	-9.833***	-5.298	-13.904*	-5.328**	-0.522	-8.319	-0.590	-7.030
	(-1.196)	(-3.151)	(-0.921)	(-1.909)	(-2.014)	(-0.076)	(-0.964)	(-0.189)	(-0.903)
Herfindahl index square	63.433	62.253***	31.473	91.359**	26.856	0.981	51.037	-10.119	51.454
	(1.405)	(2.911)	(0.935)	(2.094)	(1.532)	(0.023)	(0.986)	(-0.492)	(0.924)
Tobin's *q*	-0.006	0.003	0.016	0.007	0.001	0.020	-0.013	-0.001	-0.005

	(-0.334)	(0.515)	(1.245)	(0.376)	(0.275)	(1.410)	(-0.668)	(-0.176)	(-0.513)
Whited-Wu index	-1.609*	-0.554**	-1.178**	-2.838***	-0.720***	-1.988***	-2.952**	-0.496	-2.317**
	(-1.889)	(-2.480)	(-2.054)	(-3.008)	(-3.160)	(-2.993)	(-1.981)	(-1.523)	(-2.260)
Ln (age)	0.155	0.051	0.103	0.095	-0.034	0.062	0.042	-0.014	0.044
	(0.980)	(1.424)	(1.305)	(0.608)	(-1.072)	(0.781)	(0.256)	(-0.400)	(0.459)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	602	602	602	525	525	525	455	455	455
Adj. R-sq	0.276	0.182	0.199	0.289	0.143	0.243	0.269	0.130	0.170

Table 4: Effect of Customer Covenant Violations on Supplier Propensity to Cite Customer Patents
This table presents regression estimates of the likelihood of a supplier citing its customer's patent (Panel A) and an OLS regression of the number of citations of the customer made by the supplier (Panel B) on customer covenant violation and control variables using customer-supplier pairs. The sample consists of 4,424 customer-supplier pair-years identified from the Compustat segment database as being the suppliers of customers with an outstanding loan with a quantitative covenant as identified in DealScan between 1994 and 2009. The supplier data are merged with firm-specific Google patent data (Kogan et al., 2017). The sample is further restricted to the suppliers whose customers are within a bandwidth of 0.2 of the covenant threshold (discontinuity sample), i.e., 1,048 customer-supplier pair-years. Customer covenant violation is an indicator for customer covenant violations identified as those customers who have fallen below the covenant specified threshold of the current ratio or net worth during the life of one of their outstanding loans. In Panel A, all the models are estimated as a linear probability model with firm (i.e., supplier) fixed effects. In Panel B, all the models are estimated as OLS models with industry fixed effects based on the Fama-French 30 industry classification being included. t-statistics based on robust standard errors (clustered by firm) are reported in parentheses in Panel A (Panel B). Constants are included in all the regressions but not reported. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Linear Probability Model of Propensity to Cite Customer Patents

	(1)	(2)	(3)
	Citing covenant violated customer (indicator)		
Independent variables	Year *t*	Year *t*+1	Year *t*+2
Customer covenant violation (indicator)	0.023**	0.045	0.104**
	(2.455)	(0.812)	(2.013)
Other controls in Table 3	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	878	878	878
Adj. R-sq	0.722	0.248	0.351

Panel B: OLS Regressions of Customer Patent Citations

	(1)	(2)	(3)
	Ln (no. of citations) of covenant violated customer		
Independent variables	Year *t*	Year *t*+1	Year *t*+2
Customer covenant violation (indicator)	0.040*	0.022	0.001
	(1.954)	(1.181)	(0.078)
Other controls in Table 3	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Observations	878	878	878
Adj. R-sq	0.076	0.038	0.030

Table 5: Dynamic Analysis of the Effect of Customer Covenant Violations on Supplier Innovation
This table presents summary statistics and regression estimates of innovation among a subsample of suppliers whose customer(s) witness a covenant violation in Panels A and B, respectively. The sample consists of 2,570 supplier-years corresponding to 603 customer covenant violations. Customers are identified from the Compustat segment database as those with an outstanding loan with a quantitative covenant as identified in DealScan between 1994 and 2009. The sample is restricted to the customers in the Compustat segment database that have a current loan outstanding that specifies a quantitative covenant (i.e., either current ratio or net worth covenants). Customer covenant violations are identified as those customers who have fallen below the covenant specified threshold of the current ratio or net worth during the life of one of their outstanding loans. In Panel B, Post, Before[1], After, and After[2,3] are indicator variables for years constructed relative to the year of covenant violation (i.e., year *t*), and supplier innovation is measured in year *t*+1. In Panel B, industry fixed effects based on the Fama-French 30 industry classification are included and *t*-statistics based on standard errors clustered by firm are reported in parentheses. Constants are included in all the regressions but not reported. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Dynamic Effect of Covenant Violation on Supplier Innovation Univariate Analysis

	Year *t*					
Covenant violation year	No. of patents	No. of citations	Citing covenant violated customer (indicator)	No. of citations of covenant violated customer	Search depth	Obs.
Year *t* -3	1.989	0.182	0.843	0.035	0.136	357
Year *t* -2	1.873	0.152	0.814	0.045	0.129	393
Year *t* -1	1.767	0.152	0.768	0.079	0.105	408
Year *t*	2.306	0.164	0.153	0.615	0.138	648
Year *t*+1	2.555	0.160	0.699	0.241	0.166	299
Year *t* +2	2.613	0.190	0.748	0.101	0.185	253
Year *t* +3	2.778	0.187	0.764	0.215	0.190	212
Total	2.208	0.167	0.716	0.289	0.143	2,570

Panel B: Dynamic Effect of Covenant Violation on Supplier Innovation Using Full Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Independent variables	Ln (no. of patents)	Ln (no. of citations)	Search depth	Citing covenant violated customer (indicator)	Ln (no. of patents)	Ln (no. of citations)	Search depth	Citing covenant violated customer (indicator)
Post	0.093*	0.016	0.050	0.024				
	(1.805)	(1.021)	(1.533)	(1.315)				
Before[1]					0.047	0.008	0.032	0.016
					(1.112)	(0.498)	(1.052)	(0.690)
Current					0.094	0.005	0.041	-0.023
					(1.453)	(0.259)	(1.031)	(-0.813)
After[1]					0.154**	0.023	0.087*	-0.003
					(2.101)	(1.059)	(1.722)	(-0.097)
After[2,3]					0.139*	0.017	0.066	0.030
					(1.737)	(0.727)	(1.287)	(1.182)
Supplier characteristics in Table 3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,931	1,931	1,931	1,839	1,931	1,931	1,931	1,839
Adj. R-sq	0.335	0.182	0.229	0.121	0.335	0.180	0.229	0.122

Table 6: Cross-sectional Variation According to Supplier Ability

This table presents regression estimates of supplier innovation on customer covenant violation and control variables using the RDD sample according to suppliers' abilities to innovate. Specifically, Panel A (B) reports the cross-sectional variation in the effect of covenant violations on supplier innovation according to (1) suppliers' financial flexibility and (2) suppliers' abilities to help their customers. The RDD sample begins with 3,387 supplier-years identified from the Compustat segment database as being the suppliers of customers from the Compustat segment database merged with loan data from DealScan during 1994 to 2009. The sample is restricted to the customers in the Compustat segment database that have a current loan outstanding with one or more quantitative covenants (i.e., either current ratio or net worth covenants). Customer covenant violation is an indicator for customer covenant violations identified as those customers whp have fallen below the covenant specified threshold of the current ratio or net worth during the life of one of their outstanding loans. The supplier data are merged with firm-specific Google patent data (Kogan et al., 2017). The sample of suppliers is restricted to the suppliers whose customers are within a bandwidth of 0.2 of the covenant threshold (discontinuity sample), i.e., 687 supplier-years. In both the panels, industry fixed effects based on the Fama-French 30 industry classification are included, and *t*-statistics based on standard errors clustered by firm are reported in parentheses. Constants are included in all the regressions but not reported. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Variation in Findings According to Supplier Financing Flexibility

	(1) Ln (no. of patents)	(2) Ln (no. of citations)	(3) Search depth	(4) Ln (no. of patents)	(5) Ln (no. of citations)	(6) Search depth	(7) Ln (no. of patents)	(8) Ln (no. of citations)	(9) Search depth	(10) Ln (no. of patents)	(11) Ln (no. of citations)	(12) Search depth
	Moderating variable: Supplier leverage						Moderating variable: Supplier industry-adjusted ROA					
Independent variables	Year *t*			Year *t*+1			Year *t*			Year *t*+1		
Customer covenant	0.287**	0.073**	0.186**	0.333**	0.075*	0.269***	0.222**	0.057**	0.081	0.251**	0.068**	0.139*
violation (indicator): a	(2.409)	(2.034)	(2.202)	(2.446)	(1.813)	(2.597)	(2.453)	(2.056)	(1.339)	(2.390)	(2.171)	(1.820)
Moderating variable: b	0.192*	0.011	0.178*	0.138*	-0.006	0.223**	1.096	0.257	0.964	1.654	-0.060	0.681
	(1.796)	(0.410)	(1.721)	(1.715)	(-0.273)	(1.972)	(0.695)	(0.518)	(0.847)	(0.938)	(-0.134)	(0.520)
a × b	-0.156	-0.038	-0.237**	-0.190*	-0.018	-0.293***	0.198*	0.047	0.225**	0.148*	0.034	0.246**
	(-1.332)	(-1.197)	(-2.307)	(-1.765)	(-0.564)	(-2.585)	(1.919)	(1.338)	(2.077)	(1.736)	(1.122)	(1.975)
Other controls in Table 3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	602	602	602	525	525	525	602	602	602	525	525	525
Adj. R-sq	0.288	0.188	0.209	0.291	0.154	0.257	0.289	0.187	0.211	0.292	0.153	0.254

Panel B: Variation in Findings According to Supplier Trade Credit Provision

	(1) Ln (no. of patents)	(2) Ln (no. of citations)	(3) Search depth	(4) Ln (no. of patents)	(5) Ln (no. of citations)	(6) Search depth	(7) Ln (no. of patents)	(8) Ln (no. of citations)	(9) Search depth	(10) Ln (no. of patents)	(11) Ln (no. of citations)	(12) Search depth
	Moderating variable: Supplier operating cycle						Moderating variable: Supplier receivables					
Independent variables	Year *t*			Year *t*+1			Year *t*			Year *t*+1		
Customer covenant	0.188**	0.043	0.042	0.202*	0.051*	0.095	0.179*	0.034	0.036	0.164	0.036	0.081
violation (indicator): a	(2.010)	(1.565)	(0.672)	(1.899)	(1.652)	(1.193)	(1.747)	(1.140)	(0.563)	(1.464)	(1.111)	(0.978)
Moderating variable: b	0.005	0.001	0.005	0.009	-0.001	0.015	0.043	0.007	0.032	0.028	0.000	0.029
	(0.235)	(0.112)	(0.363)	(0.442)	(-0.248)	(1.058)	(1.476)	(0.913)	(1.348)	(1.022)	(0.029)	(1.317)
a × b	0.063	0.030**	0.049**	0.090**	0.034**	0.046	0.027	0.022	0.020	0.075*	0.032**	0.029
	(1.601)	(2.217)	(2.010)	(2.518)	(2.379)	(1.531)	(0.547)	(1.377)	(0.612)	(1.680)	(2.029)	(0.819)
Other controls in Table 3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	586	586	586	511	511	511	586	586	586	511	511	511
Adj. R-sq	0.300	0.224	0.218	0.308	0.172	0.256	0.302	0.223	0.219	0.310	0.170	0.257

Table 7: Cross-sectional Variation According to Supplier Incentives

This table presents regression estimates of supplier innovation on customer covenant violation and control variables using the RDD sample according to supplier incentives to innovate. Panel A presents the results using measures of supplier opportunities to learn from customers as the moderating variable. Panel B presents the results using measures of societal trust between customers and suppliers. Panel C presents the results using an indicator for the enactment of stakeholder orientation statutes in the customer's state of incorporation. The RDD sample begins with 3,387 supplier-years identified from the Compustat segment database as being the suppliers of customers from the Compustat segment database merged with loan data from DealScan during 1994 to 2009. The sample is restricted to the customers in the Compustat segment database that have a current loan outstanding with one or more quantitative covenants (i.e., either current ratio or net worth covenants). Customer covenant violation is an indicator for customer covenant violations identified as those customers who have fallen below the covenant specified threshold of the current ratio or net worth during the life of one of their outstanding loans. The supplier data are merged with firm-specific Google patent data (Kogan et al., 2017). The sample of suppliers is restricted to the suppliers whose customers are within a bandwidth of 0.2 of the covenant threshold (discontinuity sample), i.e., 687 supplier-years. In both panels, the moderating variables are measured on the basis of customers who have outstanding covenants that are within the bandwidth of 0.2 of the covenant thresholds. In both panels, industry fixed effects based on the Fama-French 30 industry classification are included, and *t*-statistics based on standard errors clustered by firm are reported in parentheses. Constants are included in all the regressions but not reported. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Variation in Findings According to Customer Expertise in Innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth
	Moderating variable: Customer R&D/Assets						Moderating variable: Customer search depth					
	Year *t*			Year *t*+1			Year *t*			Year *t*+1		
Customer covenant violation (indicator): a	0.143	0.038	0.059	0.185*	0.051	0.103	0.174*	0.051*	0.049	0.195*	0.055*	0.088
	(1.458)	(1.260)	(0.878)	(1.682)	(1.524)	(1.252)	(1.939)	(1.831)	(0.803)	(1.862)	(1.752)	(1.106)
Moderating variable: b	-1.498	-0.205	-0.287	-0.278	-0.333	-0.339	-0.005	-0.002	0.016	0.032	0.002	0.012
	(-1.080)	(-0.476)	(-0.229)	(-0.160)	(-1.056)	(-0.244)	(-0.072)	(-0.109)	(0.295)	(0.373)	(0.132)	(0.200)
a × b	3.837	1.061	-0.197	4.648*	1.137*	0.947	0.210*	0.011	0.083	0.297**	0.070**	0.206*
	(1.536)	(1.422)	(-0.127)	(1.706)	(1.672)	(0.569)	(1.818)	(0.333)	(1.106)	(2.359)	(2.008)	(1.954)
Other controls in Table 3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	602	602	602	525	525	525	602	602	602	525	525	525
Adj. R-sq	0.292	0.192	0.196	0.302	0.159	0.242	0.295	0.185	0.203	0.317	0.169	0.273

Panel B: Variation in Findings According to Societal Trust

	(1) Ln (no. of patents)	(2) Ln (no. of citations)	(3) Search depth	(4) Ln (no. of patents)	(5) Ln (no. of citations)	(6) Search depth	(7) Ln (no. of patents)	(8) Ln (no. of citations)	(9) Search depth	(10) Ln (no. of patents)	(11) Ln (no. of citations)	(12) Search depth
	Moderating variable: Absolute difference in societal trust between customer and supplier (b)						Moderating variable: Customer societal trust (c) and supplier societal trust (d)					
	Year *t*			Year *t*+1			Year *t*			Year *t*+1		
Customer covenant violation (indicator): a	0.778**	0.115	0.549***	0.998***	0.229***	0.783***	0.435	0.034	0.304*	1.148**	0.293**	0.863**
	(2.258)	(1.183)	(2.655)	(2.840)	(2.600)	(3.067)	(1.515)	(0.413)	(1.718)	(2.481)	(2.221)	(2.562)
Moderating variable: b	0.367*	0.080	0.293***	0.639***	0.139***	0.474***						
	(1.825)	(1.364)	(2.588)	(3.266)	(3.013)	(3.019)						
Moderating variable: c							-0.173	-0.033	-0.099	-0.545**	-0.144**	-0.355**
							(-1.133)	(-0.748)	(-1.109)	(-2.276)	(-2.028)	(-2.072)
Moderating variable: d							0.090	0.026	-0.010	-0.453**	-0.074	-0.375**
							(0.546)	(0.520)	(-0.102)	(-2.066)	(-1.099)	(-2.262)
a × b	-0.408*	-0.082	-0.333**	-0.640***	-0.106*	-0.507***						
	(-1.680)	(-1.174)	(-2.233)	(-2.912)	(-1.767)	(-3.038)						
a × c							0.283	0.028	0.163	0.575**	0.141*	0.321
							(1.473)	(0.497)	(1.348)	(2.128)	(1.924)	(1.546)
a × d							-0.113	-0.044	0.021	0.489**	0.109	0.400**
							(-0.646)	(-0.853)	(0.195)	(2.083)	(1.589)	(2.462)
Other controls in Table 3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	143	143	143	120	120	120	143	143	143	120	120	120
Adj. R-sq	0.403	0.266	0.338	0.524	0.231	0.532	0.387	0.247	0.307	0.506	0.214	0.501

Panel C: Variation in Findings According to Customer Stakeholder Orientation

	(1) Ln (no. of patents)	(2) Ln (no. of citations)	(3) Search depth	(4) Ln (no. of patents)	(5) Ln (no. of citations)	(6) Search depth
	Moderating variable: Customer stakeholder orientation (b)					
	Year *t*			Year *t*+1		
Customer covenant violation (indicator): a	0.035	0.020	-0.106	0.050	0.030	-0.062
	(0.307)	(0.582)	(-1.258)	(0.364)	(0.925)	(-0.638)
Moderating variable: b	-0.503**	-0.057	-0.335***	-0.424**	-0.034	-0.284**
	(-2.292)	(-0.992)	(-2.830)	(-2.213)	(-0.655)	(-2.129)
a × b	0.260	0.036	0.289**	0.350*	0.042	0.304**
	(1.512)	(0.639)	(2.480)	(1.839)	(0.879)	(2.222)
Other controls in Table 3	Yes	Yes	Yes	Yes	Yes	Yes
Customer state of incorporation fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	388	388	388	331	331	331
Adj. R-sq	0.276	0.185	0.201	0.305	0.186	0.284

Table 8: Effect of Customer Covenant Violations on Supplier Propensity to Cite Customer Patents

This table presents regression estimates of the likelihood of a supplier citing its customer's patent on customer covenant violation and control variables along the following two dimensions of suppliers. First, Panel A reports the cross-sectional variation based on supplier ability to innovate, such as suppliers' financial leverage, suppliers' industry-adjusted ROA, suppliers' operating cycle and suppliers' receivables). Second, Panel B reports the cross-sectional variation based on suppliers' incentives to innovate, such as customers' R&D/assets, customers' search depth, the differences in social trust between customers and suppliers, and customers' stakeholder orientation. The sample consists of 4,424 customer-supplier pair-years identified from the Compustat segment database as being the suppliers of the customers with an outstanding loan with a quantitative covenant as identified in DealScan between 1994 and 2009. The supplier data are merged with firm-specific Google patent data (Kogan et al., 2017). The sample is further restricted to the suppliers whose customers are within a bandwidth of 0.2 of the covenant threshold (discontinuity sample), i.e., 1,048 customer-supplier pair years. Customer covenant violation is an indicator for customer covenant violations identified as those customers who have fallen below the covenant specified threshold of the current ratio or net worth during the life of one of their outstanding loans. In both panels all models are estimated as a linear probability model with firm (i.e., supplier) fixed effects. In Panel B, the moderating variables are measured on the basis of customers who have outstanding covenants that are within the bandwidth of 0.2 of the covenant threshold. *t*-Statistics based on robust standard errors are reported in parentheses. Constants are included in all the regressions but not reported. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Cross-sectional Variation in the Likelihood of Citing Customer Patents According to Supplier Ability

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Citing covenant violated customer (indicator)											
	Moderating var: Supplier Leverage			Moderating var: Supplier Industry-adjusted ROA			Moderating var: Supplier Operating Cycle			Moderating var: Supplier Receivables		
	Year *t*	Year *t*+1	Year *t*+2	Year *t*	Year *t*+1	Year *t*+2	Year *t*	Year *t*+1	Year *t*+2	Year *t*	Year *t*+1	Year *t*+2
Customer covenant violation (indicator): a	0.025*	0.189**	0.244***	0.023**	0.042	0.103**	0.011	-0.053	-0.015	0.008	-0.034	0.007
	(1.721)	(2.263)	(3.117)	(2.474)	(0.766)	(1.984)	(0.920)	(-0.782)	(-0.240)	(0.606)	(-0.464)	(0.097)
Moderating variable: b	0.005	0.306*	0.291*	0.010	-0.175	-0.176	-0.014	-0.365***	-0.345***	-0.009	-0.173***	-0.164***
	(0.156)	(1.674)	(1.696)	(0.202)	(-0.612)	(-0.659)	(-0.725)	(-3.308)	(-3.358)	(-0.855)	(-2.929)	(-2.961)
a × b	-0.004	-0.356**	-0.343**	-0.023	0.006	0.023	0.027*	0.171**	0.201***	0.020**	0.082	0.095*
	(-0.151)	(-2.315)	(-2.375)	(-0.593)	(0.028)	(0.111)	(1.941)	(2.125)	(2.671)	(1.997)	(1.439)	(1.793)
Other controls in Table 3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	878	878	878	878	878	878	858	858	858	858	858	858
Adj. R-sq	0.722	0.255	0.358	0.721	0.245	0.349	0.723	0.272	0.377	0.723	0.268	0.372

Panel B: Cross-sectional Variation in the Likelihood of Citing Customer Patents According to Supplier Incentives

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Citing covenant violated customer (indicator)											
	Moderating variable: Customer R&D/Assets (b)			Moderating variable: Customer search depth (b)			Moderating variable: Absolute difference in societal trust between customer and supplier (b)			Moderating variable: Customer stakeholder orientation (b)		
	Year *t*	Year *t*+1	Year *t*+2	Year *t*	Year *t*+1	Year *t*+2	Year *t*	Year *t*+1	Year *t*+2	Year *t*	Year *t*+1	Year *t*+2
Customer covenant violation (indicator): a	-0.000	0.017	0.049	0.012	0.006	0.059	0.061*	0.111	0.367**	0.040***	-0.070	0.045
	(-0.004)	(0.270)	(0.822)	(1.153)	(0.098)	(1.057)	(1.676)	(0.689)	(2.273)	(2.856)	(-0.974)	(0.653)
Moderating variable: b	-1.441	-0.930	-5.443	-0.067**	-0.255	-0.331*	0.015	0.147	0.234	0.033	-0.048	-0.467**
	(-1.445)	(-0.156)	(-0.976)	(-2.111)	(-1.369)	(-1.897)	(0.436)	(0.957)	(1.516)	(0.851)	(-0.244)	(-2.457)
a × b	3.133***	3.558	7.240*	0.095***	0.298	0.353**	-0.021	-0.052	-0.246*	-0.038	0.293**	0.176
	(4.424)	(0.840)	(1.828)	(3.022)	(1.616)	(2.047)	(-0.657)	(-0.367)	(-1.739)	(-1.622)	(2.447)	(1.524)
Other controls in Table 3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Customer state of incorporation fixed effects	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Observations	878	878	878	878	878	878	206	206	206	206	206	206
Adj. R-sq	0.733	0.245	0.353	0.727	0.248	0.355	0.799	0.355	0.398	0.800	0.356	0.367

Table 9: Effect of Customer Covenant Violations on Customer-Supplier Investment Coordination

This table presents regression estimates of supplier innovation on customer's contemporaneous and lagged innovation. The sample consists of 4,424 customer-supplier pair-years identified from the Compustat segment database as being the suppliers of customers with an outstanding loan with a quantitative covenant as identified in DealScan between 1994 and 2009. The supplier data are merged with firm-specific Google patent data (Kogan et al., 2017). The sample is further restricted to the suppliers whose customers are within a bandwidth of 0.2 of the covenant threshold (discontinuity sample), i.e., 1,048 customer-supplier pair years. Customer covenant violation is an indicator for customer covenant violations identified as those customers who have fallen below the covenant specified threshold of the current ratio or net worth during the life of one of their outstanding loans. Industry fixed effects based on the Fama-French 30 industry classification are included. In columns (1) and (2), *z*-statistics based on standard errors adjusted for heteroskedasticity clustered by firm are reported in parentheses. In Columns (3)-(9), *t*-statistics based on standard errors adjusted for heteroskedasticity clustered by supplier industry and year are reported in parentheses. Constants and customer default distance for current ratio and net worth covenants are included in all the regressions but not reported. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Logit		OLS						
	Supplier patent (indicator)$_{t+1}$				Supplier ln (no. of patents)$_{t+1}$	Supplier ln (no. of citations)$_{t+1}$	Supplier search scope$_{t+1}$	Supplier search depth$_{t+1}$	Supplier R&D/sales$_{t+1}$
Customer covenant violation (indicator): a	-0.843**	-0.738	-0.040*	-0.044**	-0.028	0.004	-0.032*	-0.004	0.037
	(-2.108)	(-1.529)	(-1.908)	(-2.089)	(-0.535)	(0.238)	(-1.727)	(-0.091)	(1.056)
Customer patent (indicator)$_t$: b	16.757***	15.876***	0.208**	0.227**	0.353**	0.075	0.148*	0.193	
	(11.742)	(12.169)	(2.071)	(2.025)	(2.130)	(1.332)	(1.748)	(1.580)	
Customer patent (indicator)$_{t+1}$: c	-14.636***	-15.138***	-0.123*	-0.115*	-0.261*	-0.051	-0.111**	-0.090	
	(-13.090)	(-16.036)	(-1.837)	(-1.669)	(-1.950)	(-1.346)	(-2.107)	(-1.158)	
Supplier patent (indicator)$_t$	4.673***	4.320***	0.600***	0.592***	1.409***	0.321***	0.387***	0.719***	
	(10.336)	(8.776)	(13.636)	(13.414)	(10.228)	(7.711)	(9.955)	(7.272)	
Customer R&D/sales$_t$: d									0.102
									(0.334)
Customer R&D/sales$_{t+1}$: e									-0.066
									(-0.154)
Supplier R&D/sales$_t$									0.784***
									(3.186)
a × b	-16.674***	-16.559***	-0.220**	-0.209*	-0.360*	-0.073	-0.159*	-0.224	
	(-8.992)	(-10.669)	(-2.012)	(-1.719)	(-1.711)	(-1.069)	(-1.703)	(-1.492)	
a × c	15.858***	16.426***	0.186**	0.172**	0.354*	0.055	0.135*	0.103	
	(10.004)	(13.645)	(2.261)	(2.073)	(1.803)	(1.068)	(1.902)	(0.743)	
a × d									-1.526
									(-1.485)
a × e									2.430*
									(1.931)
Customer distance from thresholds	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Supplier industry fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Customer industry fixed effects	No	No	No	Yes	No	No	No	No	No
Observations	748	470	781	779	746	746	746	746	779
Pseudo/Adj. R-sq	0.510	0.524	0.623	0.624	0.520	0.316	0.371	0.374	0.540

Table 10: Effect of Customer Covenant Violations on Trading Relationships and Operating Cycle
This table presents difference-in-differences (DiD) estimates of how covenant violation by a customer affects existing supplier relationships (Panel A) and customer operating cycle (Panel B) in a seven-year window around the covenant violation using a sample of customers identified from the Compustat segment database and with an outstanding loan with a quantitative covenant as identified in DealScan between 1994 and 2009. The sample consists of 4,424 customer-supplier pair-years identified from the Compustat segment database as being the suppliers of the customers with an outstanding loan with a quantitative covenant as identified in DealScan between 1994 and 2009. The supplier data are merged with firm-specific Google patent data (Kogan et al., 2017). Additionally, the sample is restricted to the suppliers whose customers are within a bandwidth of 0.2 of the covenant threshold (discontinuity sample), i.e., 1,048 customer-supplier pair years. Customer covenant violations are identified as those customers who have fallen below the covenant specified threshold of the current ratio or net worth during the life of one of their outstanding loans. In Panel A, customers identified from the Compustat segment database are labeled as PC or principal customers. Affected PC refers to customers within a bandwidth of 0.2 of the covenant threshold. Differences between total sales and sales to customers identified from the Compustat segment database are denoted as sales to non-PC or nonprincipal customers. Standard errors are reported in parentheses. All the variable definitions are in Appendix A1. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Implications of Customer Covenant Violation on Existing Supplier Product Market Relationships

	Mean difference during precovenant violation	Mean difference during postcovenant violation	DiD estimator	DiD estimator for subsamples of suppliers	
	(Treatment - control)	(Treatment - control)	(After - before)	without patents	with patents
Supplier sales fraction$_{t+1}$	0.006	0.150	-0.074***	-0.094***	-0.008
	(0.011)	(0.150)	(0.022)	(0.027)	(0.032)
Supplier sales fraction$_{t+2}$	0.004	0.138	-0.096***	-0.116***	-0.041
	(0.013)	(0.138)	(0.026)	(0.031)	(0.029)
Log (supplier sales)$_{t+1}$	0.016	3.042	-0.282	-0.415*	0.309
	(0.117)	(3.042)	(0.243)	(0.250)	(0.581)
Log (supplier sales)$_{t+2}$	0.205	3.117	-0.487*	-0.301	-0.931
	(0.135)	(3.117)	(0.280)	(0.286)	(0.754)
Sales growth to affected PC$_{t+1}$	0.091	0.451	0.066	0.138	-0.171
	(0.110)	(0.451)	(0.228)	(0.287)	(0.235)
Sales growth to affected PC$_{t+2}$	-0.023	0.635	0.575**	0.242	2.154*
	(0.136)	(0.635)	(0.284)	(0.235)	(1.160)
Sales growth to Non-PC$_{t+1}$	0.073	0.270	0.074	0.121	-0.056
	(0.052)	(0.270)	(0.113)	(0.138)	(0.171)
Sales growth to Non-PC$_{t+2}$	0.010	0.289	0.186	0.289**	-0.259
	(0.054)	(0.289)	(0.119)	(0.140)	(0.188)
Future relationship duration	-1.333	4.004	1.176***	0.959	0.754*
	(0.193)	(4.004)	(0.370)	(0.586)	(0.384)

Panel B: Implications of Customer Covenant Violation on Their Operating Cycle

	Mean difference during precovenant violation	Mean difference during postcovenant violation	DiD estimator	DiD estimator for subsamples of suppliers	
	(Treatment - control)	(Treatment - control)	(After - before)	without patents	with patents
Customer payables$_{t+1}$	0.145	0.337	0.029	-0.055***	0.090**
	(0.010)	(0.337)	(0.019)	(0.021)	(0.038)
Customer payables$_{t+2}$	0.164	0.328	0.000	-0.054**	0.022
	(0.012)	(0.328)	(0.023)	(0.024)	(0.048)
Customer receivables$_{t+1}$	0.109	0.425	0.049**	-0.034	0.063**
	(0.010)	(0.425)	(0.019)	(0.026)	(0.031)
Customer receivables$_{t+2}$	0.129	0.411	0.005	-0.072***	0.022
	(0.011)	(0.411)	(0.021)	(0.027)	(0.034)
Customer operating cycle$_{t+1}$	-0.050	0.070	0.016	0.029	-0.034
	(0.011)	(0.070)	(0.020)	(0.021)	(0.041)
Customer operating cycle$_{t+2}$	-0.050	0.065	0.005	-0.009	-0.003
	(0.013)	(0.065)	(0.024)	(0.024)	(0.052)
Customer sales/COGS$_{t+1}$	0.354	1.703	0.082	-0.237**	0.253**
	(0.039)	(1.703)	(0.074)	(0.106)	(0.118)
Customer sales/COGS$_{t+2}$	0.305	1.798	0.194**	-0.132	0.445***
	(0.040)	(1.798)	(0.079)	(0.109)	(0.129)

Table 11: Dynamic Analysis of the Effect of Customer Covenant Violations on Supplier Performance

This table presents regression estimates of supplier performance among a subsample of suppliers whose customers witness a covenant violation. The sample consists exclusively of suppliers with one or more customers with covenant violations in a seven-year window around the covenant violation based on the 603 customer covenant violations in Table 2 and those with nonmissing supplier information. Customers are identified from the Compustat segment database as those with an outstanding loan with a quantitative covenant as identified in DealScan between 1994 and 2009. The sample is restricted to the customers in the Compustat segment database that have a current loan outstanding that specifies a quantitative covenant (i.e., either current ratio or net worth covenants). Customer covenant violations are identified as those customers who have fallen below the covenant specified threshold of the current ratio or net worth during the life of one of their outstanding loans. In all columns, Post, Before1, After, and After23 are indicator variables for years constructed relative to the year of covenant violation. Industry fixed effects based on the Fama-French 30 industry classification are included, and *t*-statistics based on standard errors clustered by firm are reported in parentheses. Constants are included in all the regressions but not reported. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Leverage		ROA		Profit margin		Altman Z	
	Year *t*+1							
Post: a	0.060		-0.030*		0.017		-1.219***	
	(1.301)		(-1.765)		(0.432)		(-2.619)	
Before[1]: b		0.033		-0.026*		-0.013		-0.603**
		(1.024)		(-1.815)		(-0.325)		(-2.061)
Current: c		0.060		-0.018		0.097*		-0.719
		(1.213)		(-0.743)		(1.831)		(-1.444)
After[1]: d		0.082		-0.038		0.082		-1.347**
		(1.543)		(-1.414)		(1.425)		(-2.430)
After[23]: e		0.096**		-0.049*		0.057		-1.930***
		(1.977)		(-1.675)		(0.814)		(-2.784)
Supplier patent (indicator)$_{t+1}$: f	-0.055***	-0.008	-0.031	-0.049	-0.203	-0.273*	0.818	0.002
	(-2.580)	(-0.253)	(-0.772)	(-0.990)	(-1.598)	(-1.663)	(1.081)	(0.003)
a × f	-0.036		0.050		0.199**		0.561	
	(-0.705)		(1.500)		(2.257)		(0.845)	
b × f		-0.043		0.022		0.129		1.026**
		(-0.479)		(0.711)		(1.186)		(2.286)
c × f		-0.100		0.036		0.106		1.570**
		(-1.412)		(1.021)		(0.858)		(2.251)
d × f		-0.045		0.044		0.167		1.006
		(-0.723)		(0.985)		(1.235)		(1.322)
e × f		-0.107**		0.084*		0.335**		1.620*
		(-1.995)		(1.711)		(2.239)		(1.786)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,918	1,918	1,918	1,918	1,903	1,903	1,733	1,733
Adj. R-sq	0.085	0.083	0.116	0.114	0.117	0.118	0.101	0.101

Table 12: Effect of Customer Covenant Violations on Supplier Survival According to Innovation

This table presents probit regression estimates of whether suppliers continue to remain as publicly listed firms following their customer's covenant violations and their innovation decisions. The sample consists exclusively of suppliers with one or more customers with covenant violations based on the 603 customer covenant violations in Table 2 and those with nonmissing supplier information. Customers are identified from the Compustat segment database as those with an outstanding loan with a quantitative covenant as identified in DealScan between 1994 and 2009. The sample is restricted to the customers in the Compustat segment database that have a current loan outstanding that specifies a quantitative covenant (i.e., either current ratio or net worth covenants). Customer covenant violations are identified as those customers who have fallen below the covenant specified threshold of the current ratio or net worth during the life of one of their outstanding loans. The dependent variable in Columns (1)–(3) is an indicator variable that takes the value of one when the supplier continues to remain a publicly listed firm in the Compustat database at the end of years t+3, t+5, and t+7, respectively, where year t corresponds to the year of customer covenant violation. The dependent variable in Columns (4)–(6) is an indicator variable that takes the value of one when the supplier has made a Chapter-11 filing according to the UCLA-LoPucki Bankruptcy Research Database until years t+3, t+5, and t+7, respectively. t-Statistics based on standard errors clustered by Fama-French 30 industry classification are reported in parentheses. Constants are included in all the regressions but not reported. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Indicator for whether supplier remains a public firm until			Indicator for whether supplier files for bankruptcy until		
	Year t+3	Year t+5	Year t+7	Year t+3	Year t+5	Year t+7
Supplier patent (indicator)$_{t+1}$	0.349**	0.324*	0.074	-0.344**	-0.341*	-0.098
	(2.172)	(1.660)	(0.382)	(-2.089)	(-1.668)	(-0.504)
Ln (market equity)	0.060	0.073	0.125**	-0.051	-0.062	-0.107**
	(1.087)	(1.350)	(2.337)	(-0.946)	(-1.204)	(-2.136)
ROA	0.171	0.072	0.098	-0.136	-0.010	0.004
	(0.760)	(0.271)	(0.258)	(-0.622)	(-0.039)	(0.009)
Leverage	-0.002**	-0.000	-0.000	-0.001	-0.028	-0.018
	(-2.516)	(-0.159)	(-0.041)	(-0.965)	(-1.441)	(-1.240)
Tobin's q	0.011	0.080***	0.042	-0.007	-0.073***	-0.034
	(0.313)	(3.099)	(1.230)	(-0.198)	(-2.954)	(-0.989)
Altman Z	-0.013	0.013	0.020	0.009	-0.017	-0.030
	(-0.970)	(1.076)	(0.856)	(0.693)	(-1.493)	(-1.074)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	435	447	447	435	447	447
Pseudo R-sq	0.056	0.059	0.084	0.041	0.067	0.079

Appendix

This appendix provides a detailed description of all the variables in the tables.

Variables	Definition
Altman Z	The sum of 3.3 times pretax income, sales, 1.4 times retained earnings, and 1.2 times net working capital all divided by total assets, i.e., (3.3 × pi + revt + 1.4 × re + 1.2 × wcap)/at (Chava and Roberts, 2008)
Avg. patent value	Product of the estimate of the stock return due to the value of the patent and market capitalization of the firm divided by number of patents granted on the same day and multiplied by 2.27 (1 / (1-0.56), where 0.56 is the unconditional probability of a successful patent application (Kogan et al., 2017)
Capex/assets	Ratio of capital expenditure to total assets, i.e., capx/at
Cumulative sales to all customers	Sum of the ratio of sales to customer to total sales across all identified publicly disclosed principal customers
Customer default distance (CR)	Difference between latest current ratio and current ratio threshold specified in the current ratio covenant, and zero if the loan does not have a current ratio covenant
Customer default distance (NW)	Difference between latest net worth and net worth threshold specified in the net worth covenant, and zero if the loan does not have a net worth covenant
Future relationship duration	The number of continuous future years the customer-supplier link is observed in the Compustat segment database
Herfindahl index	Sum of the squares of the market shares of all firms in the same industry, where industry is defined according to the Fama-French 30 industry classification
Industry-adjusted ROA	Difference between firm-specific ROA and industry median ROA, where industry is defined based on the Fama-French 30 industry classification
Leverage	Sum of long-term and short-term debt divided by total assets, i.e., (dltt+lct)/at
Ln (market equity)	Natural logarithm of market value of equity, i.e., ln (csho × prccf)
Ln (no. of citations)	Natural logarithm of one plus the total number of non-self adjusted citations received on the firm's patents filed and eventually granted, scaled by the number of patents filed and eventually granted. Adjusted citations are the total number of citations divided by average number of citations in the industry (Mudambi and Swift, 2014), where industry is defined at the three digit SIC code level.
Ln (no. of patents)	Natural logarithm of one plus the number of patents filed by the firm that are eventually granted
Operating cycle	Net accounts receivable minus net accounts payable, scaled by total revenue, i.e., (act - lct)/revt
PPE/assets	Ratio of fixed assets to total assets, i.e., ppent/at
Profit margin	Ratio of operating income after depreciation to total sales, i.e., oiadp/revt
R&D/assets	Maximum (0, Research & Development expenditures/total sales)
Risky patent	A patent with a ratio of new citations to total citations in the patent being greater than 0.6
ROA	Ratio of operating income after depreciation to total assets, i.e., oiadp/at
Routine patent	A patent with a ratio of repeated citations to total citations in the patent being greater than 0.6
Sales/COGS	Ratio of total sales to cost of goods sold, i.e., revt/cogs
Search depth	Ratio of repeated citations to total citations made by a firm in patents filed and eventually granted, where citation repetition is computed by looking at the firm's historical patent filings
Search scope	Ratio of new citations to total citations made by a firm in patents filed and eventually granted
Societal trust	County level measure of social capital index assigned to each firm based on the headquarter location in each firm-year. The index is based on Rupasingha, Goetz, and Freshwater (2006), who construct it using a principal component analysis for each county based on the number of social and civic associations, the voter turnout in the presidential election, the census response rate, and the number of nongovernment organizations. Based on data from the Northeast Regional Center for Rural Development in the College of Agricultural Sciences at Pennsylvania State University, this index is computable for the years 1990, 1997, 2005, and 2009. For missing years, the index is interpolated (Huang and Shang (2019))
Supplier sales fraction	Ratio of sales to customer to total assets
Tobin's *q*	[Total assets + market value of equity - book value of equity]/total assets, i.e., (at + prcc_f × csho - bkvlps × csho)/at
Whited-Wu index	Computed as −0.091× [(income before extraordinary items + depreciation and amortization)/total assets] – 0.062 × [indicator for dividends for common shares or preferred shares] + 0.021× [long-term debt/total assets] – 0.044 × [log (total assets)] + 0.102 × [average industry sales growth (two-digit SIC)] – 0.035 × sales growth (Whited and Wu, 2006)

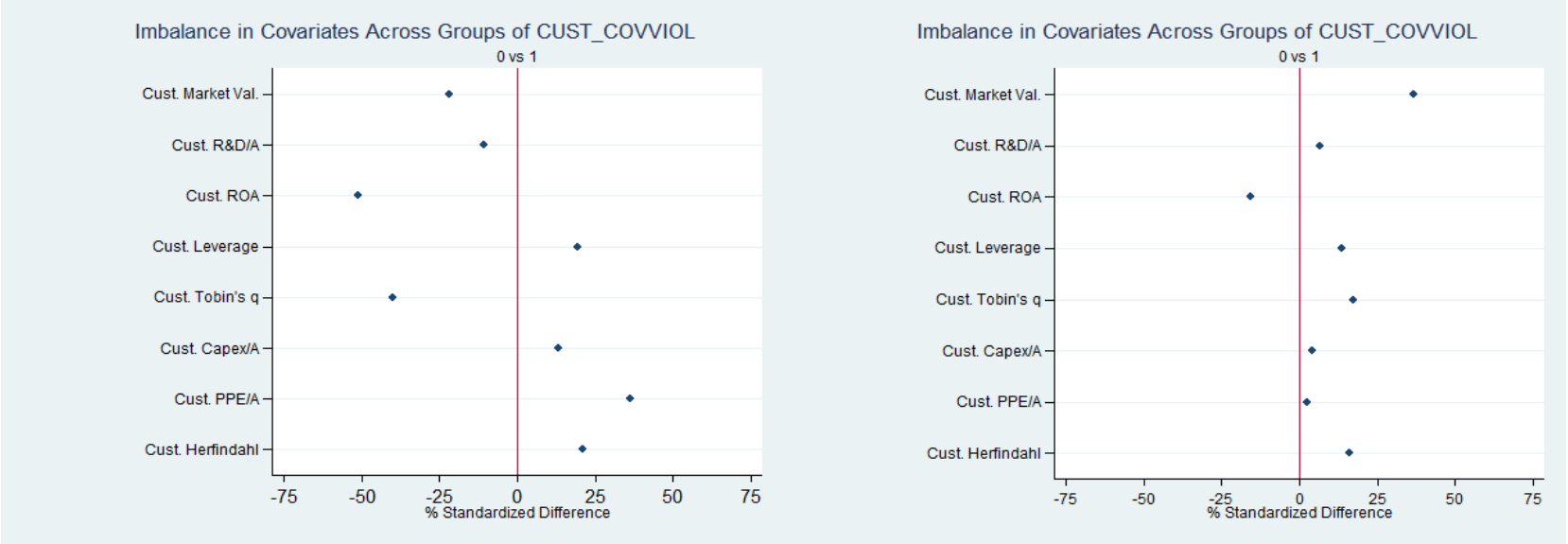

Figure 1: Covariate imbalance according to key customer characteristics in the full sample (left panel) of customers including those that have violated a covenant and those that have not between the years of 1994 and 2009. In the right panel, the sample is restricted to the customers who are within a bandwidth of 0.2 from the covenant threshold.

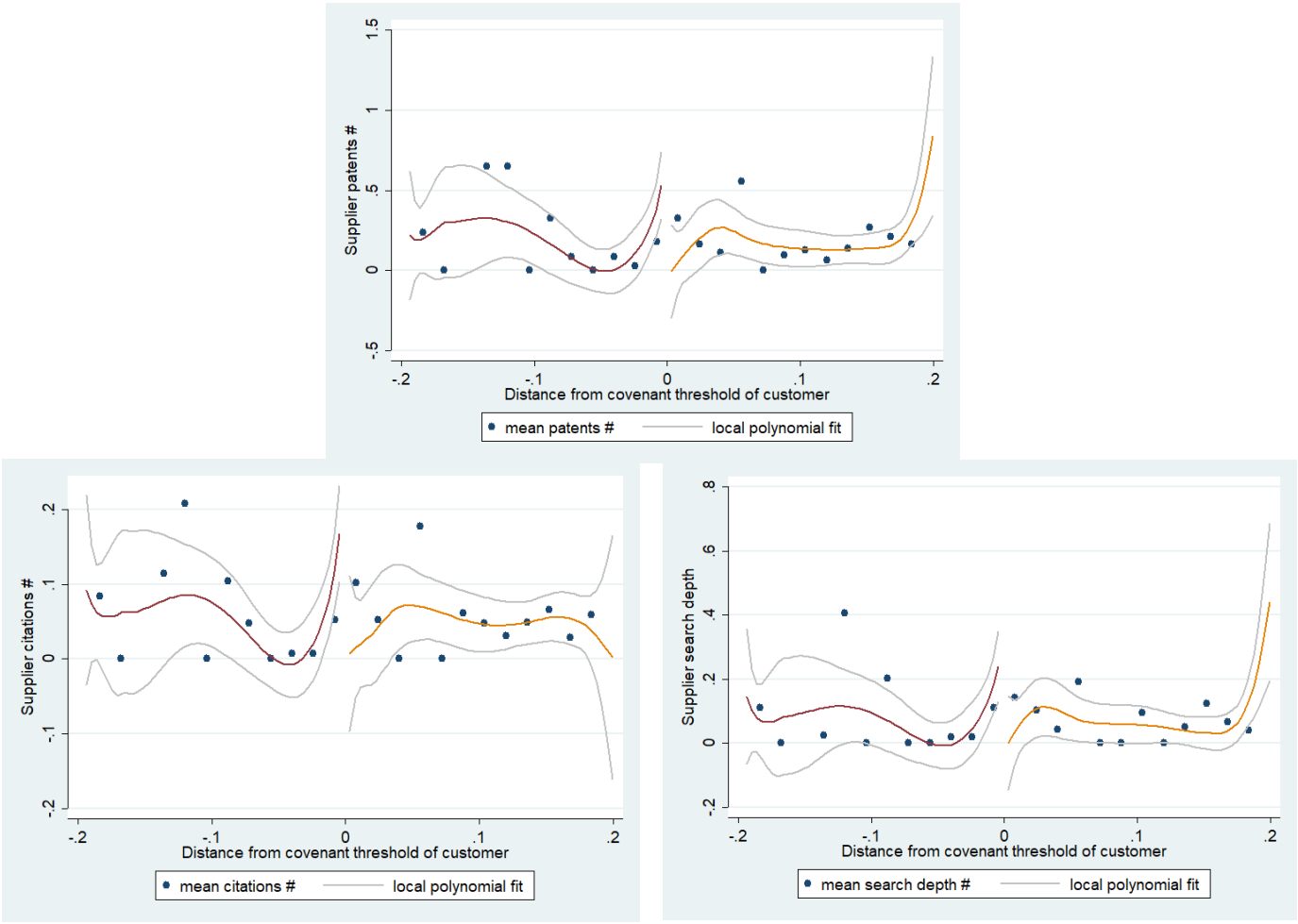

Figure 2: Regression discontinuity of supplier innovation measures according to distance from covenant threshold of their principal customer according to a fitted polynomial of order four with a 95% confidence interval. The RDD sample consists of 687 supplier-years with customers identified from the Compustat segment database. The customers are merged with loan data from DealScan between 1994 and 2009, and the sample is restricted to customers who have a current loan outstanding with one or more quantitative covenants (i.e., either current ratio or net worth covenants), which is within a bandwidth of 0.2 of the covenant threshold (i.e., discontinuity sample). The x-axis is the distance from the covenant threshold, which is standardized by the standard deviation of the relevant measure (i.e., current ratio or net worth according to the type of financial covenant). A negative distance implies a covenant violation. The dots represent the average measures of supplier innovation, including the number of patents (top), number of citations (bottom-left), and search depth (bottom-right) around the covenant threshold of their principal customer.

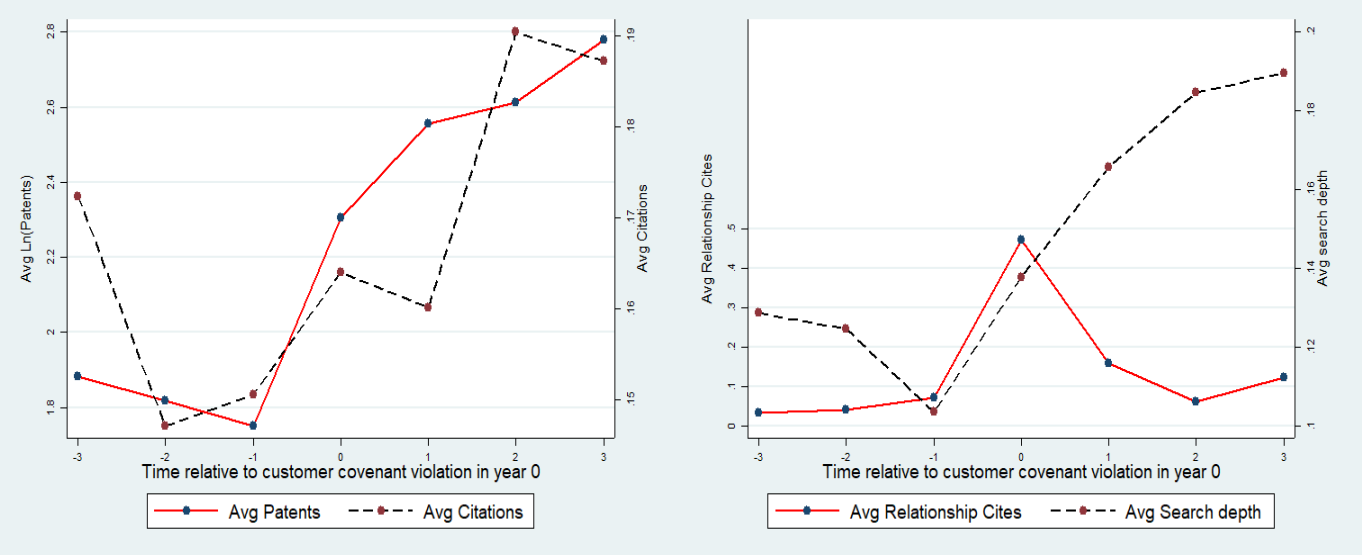

Figure 3: Time trend in supplier innovation around the years of customer covenant violation using the sample of 2,570 supplier-years corresponding to 603 customer covenant violations between 1994 and 2009.

Internet Appendix for
"Syncing Innovation to Avoid Sinking: Supplier Response to Customer Covenant Violations"

Srinivasan Selvam and Kelvin Jui Keng Tan

This appendix presents tables for additional analyses that are discussed but not reported in the main manuscript. Section 1 presents the regression discontinuity design (RDD) findings of the effect of customer covenant violation on supplier innovation using a data-driven optimal bandwidth. Section 2 presents the findings of placebo tests, where the customer covenant violation is assumed to have occurred five years before the actual violation or is assumed to have occurred randomly. Section 3 presents the effect of customer covenant violation on supplier innovation inputs. Section 4 presents the variation in our baseline findings according to the presence of common lenders to both customers and suppliers and the levels of customers' financial constraints. Section 5 presents the findings of the effect of text-based covenant violations of customers on supplier innovation.

Specifically, the appendix includes

- IA Table 1: RDD Estimates of Supplier Innovation using a Data-driven Optimal Bandwidth
- IA Table 2: Effect of Customer Covenant Violations on Supplier Innovation Placebo Analysis
- IA Table 3: Regressions of the Effect of Customer Covenant Violations on Supplier Innovation Input
- IA Table 4: Cross-sectional Variation According to Common Supply Chain Lenders
- IA Table 5: Cross-sectional Variation According to Customer Financial Constraints
- IA Table 6: Supplier Innovation and Text-based Customer Covenant Violations

1. Robustness of RDD estimation to alternate bandwidths

IA Table 1 presents regression discontinuity design (RDD) univariate estimates of supplier innovation using a data-driven optimal bandwidth based on the mean square error algorithm. In Panel A, we compare the firm characteristics of the suppliers in the RDD sample using this bandwidth and find that the only significant coefficient is *Ln (market equity)* (0.446), while the

other ex ante supplier characteristic RDD estimates are not statistically and significantly different from zero. Panel B presents the impact of covenant violation on supplier postviolation innovation. The RDD estimates show that suppliers of customers who violate the covenant are more innovative than suppliers whose customers do not violate their covenants in years *t*, *t*+1, and *t*+2, where *t* refers to the year of customer covenant violation. These robustness test results are consistent with our main results showing that following a debt covenant violation by customers, suppliers are more likely to be more innovative.

[Insert IA Table 1 about here]

2. Placebo analyses

IA Table 2 presents the placebo analyses of the effect of customer covenant violation on supplier innovation. Panel A shows the effect of a pseudo customer covenant violation, which we assume to have occurred five years before the actual estimated covenant violation, on supplier innovation using a full sample of customers with one or more outstanding loans with a covenant in the DealScan database. Consistent with our expectation, the pseudo covenant violation indicator has no association with supplier innovation in the full sample, which is not tabulated for the sake of brevity. We repeat the same placebo analysis with the discontinuity sample (those within a bandwidth of 0.2 from covenant threshold in year *t*) rather than the full sample and report the results in Panel A. Panel A shows a similar finding, i.e., the past five-year period prior to a customer covenant violation cannot predict supplier innovation activities in the subsequent years. In Panel B, we randomize the effect of customer violation using a discontinuity sample. Specifically, we create a random variable and assign the *Pseudo covenant violation* indicator, the key variable of interest, to be one if it is greater than the sample median. The *Pseudo customer covenant* violation indicator appears to be not significantly related to supplier innovation activities, which confirms that our main results are not due to chance.

[Insert IA Table 2 about here]

3. Response of supplier innovation input to customers' covenant violations

The long-term and time-consuming nature of innovation implies that there is a substantial lag between investment and eventual commercial success, which biases against us in finding a significant effect on supplier innovation in our short-term analyses following customer covenant violations. Although we record patents when they are filed and not when they are

granted, as it is the common practice in the literature, there still could be a lag between investment in innovation and a stage when patents are ready to be filed. Thus, our findings, although robust, suggest shorter innovation development cycles for the suppliers. To investigate this further, in this section, we examine the responsivity of supplier investment in innovation to customer covenant violations, by focusing on their innovation input, i.e., research and development (R&D) expenditures. IA Table 3 presents the results of the analyses.

[Insert IA Table 3 about here]

To further drill down the exact timing of the effect on innovation inputs, we examine supplier R&D in a five-year window around customer covenant violation. Using both the ratio of R&D expenditure to assets and R&D expenditure to sales as dependent variables in IA Table 3, we employ a specification similar to Table 3 in the main manuscript. We find that the coefficient on *Customer covenant violation* indicator is significant only in the year (i.e., t+1) and two years (i.e., t+2) after the violation, and insignificant in all prior years. These findings suggest that suppliers slowly increase their investment in innovation following the covenant violation of their customers. Additionally, these findings, when combined with those in Table 3 in the main manuscript that document an immediate effect (i.e., year t) on patents filed, suggest that the increase in supplier innovation arises from both a change in patenting behavior (e.g., rely on patents more than secrecy (Cohen, Nelson, and Walsh, 2000) and an organic investment fueled innovation. Or in other words, it implies that the increase in supplier innovation arises both from a higher propensity to patent intellectual property and a higher investment in innovation, and unsurprisingly the former reacts quickly rather than the latter.

4. Cross-sectional variation according to common lenders and customers' financial constraints

The predictions of both the *bonding* and *dissociation* hypotheses are likely to vary according to 1) the presence of common lenders and, 2) customers' ex-ante financial constraints. First, common lenders who lend to firms along the supply chain can collect better information (Cen et al. (2016)), modify loan terms accounting for their trading partners' fortunes (Houston, Lin, and Zhu (2016)), and also face higher default risk due to their concentrated portfolios. Thus, receiving control rights following the covenant violations, common lenders might exaggerate the predictions for both the *bonding* and *dissociation* hypotheses. To the extent that *bonding* can reduce transaction costs and reduce hold-up problems between trading partners, it is in the

common lender's interest to promote closer ties between customers and suppliers. However, if customer's problems are emblematic of future woes, the common lender can also encourage the supplier to diversify its customer base sooner, prodding them towards *dissociation*.

IA Table 4 presents the variation in the main findings presented in Tables 3 and 4 of the main manuscript according to the presence of a common lender. We identify a common lender in a syndicate (coded as one) who is exposed to both the customer and supplier through outstanding loans. Any customer-supplier pair where we cannot identify such a common lender, we code the indicator as zero. Panel A shows the variation in supplier innovation with the key explanatory variable being the interaction between *Customer covenant violation* and *Common lender* (indicator). In columns (1), (4), and (6), we find that the interaction is positive and significant, which suggests that the positive effect of customer covenant violation on supplier innovation, especially on patents filed, is greater when there is a common lender to the customer-supplier pair. In Panel B of IA Table 4, we present the variation in the propensity of suppliers to cite customer patents following covenant violation but do not find any significant findings.

In sum, the findings in IA Table 4 support the view that supplier innovation benefits more when there is a common lender, who is in a better position to coordinate the innovation of the trading partners.

[Insert IA Table 4 about here]

Second, similarly the effects of customer covenant violations on supplier innovation and propensity to cite customer patents may be weaker due to lower future expectations of benefits from financially constrained customers, which supports the *bonding* hypothesis. In addition, to the extent that financially constrained customers would have used nonmonetary incentives earlier, incentives to '*bond*' after covenant violation might be weaker. Alternatively, according to the *dissociation* hypothesis, suppliers might be further incentivized to hedge away from the financially constrained customer, whom they would regard as having a higher probability of ruin, which predicts a stronger negative effect on supplier innovation and a lower propensity to cite customer patents, especially when the majority of supplier innovation complements the customer, i.e., *dissociation* with negative supplier innovation prediction. *Dissociation* might also predict a stronger effect on supplier innovation and a greater propensity to cite financially constrained customer's patents when suppliers pivot away from their customers but take advantage of existing knowledge to innovate.

IA Table 5 presents the variation in the main findings presented in Tables 3 and 4 of the main manuscript according to levels of customers' financial constraints. Customer financial constraints are measured in two ways: the Whited-Wu index (Whited and Wu, 2006) and as customer firm size, where firm size is measured as the natural logarithm of the customer's market value of equity. Panel A shows the variation in supplier innovation using subsamples of customers split according to the sample median of financial constraints using the two measures. The key explanatory variable is the interaction between *Customer covenant violation* and the measure of financial constraint. In all columns except column (12), we find that the interaction is insignificantly positive, suggesting that the positive effect of customer covenant violation on supplier innovation does not systematically vary by customer financial constraints. The significant interaction term in column (12) suggests that following covenant violation by the customer, suppliers engage in more exploitative innovation in year t+1 following covenant violation.

In Panel B of IA Table 5, we present the variation in the propensity of suppliers to cite customer patents following covenant violation. The interaction term is significantly negative in columns (1) and (4), which indicates that, using both measures of financial constraints, suppliers are less likely to cite their customer's patents in the year of covenant violation (i.e., year t) if the customer is financially constrained.

In summary, the findings in IA Table 5 weakly support the *bonding* hypothesis, as they suggest that the supplier innovation does not necessarily benefit more from the covenant violation of a financially constrained customer.

[Insert IA Table 5 about here]

5. Text-based covenant violations

In the main manuscript, our customer covenant violation measure is based on the quantitative threshold of debt covenants, i.e., estimated debt covenant violations. We repeat our customer covenant violation using a text-based covenant violation, which is likely more comprehensive as it captures most types of covenant violations and with greater precision as it is based on ex post reporting of the violations in annual reports. Using data from Nini, Smith, and Sufi (2012) on text-based covenant violations, we present the results in IA Table 6. Panel A reports the univariate tests, which are similar to Panel B of Table 2 of the main manuscript, except Panel

A uses a text-based covenant violation method. According to the presence of public customers, firms with one or more customers are more innovative than their corresponding counterparts. Similarly, Panel B (corresponding to Table 3 and Table 4) reports the multivariate regression results. The coefficient estimates on *Customer covenant violation* are positively significant at least at the 10% significance level in the regressions of *Ln (no of patents)* in year *t* and year *t*+1. Furthermore, the propensity of suppliers to cite customer patents in year *t*+1 is also positively associated with customer covenant violation. However, citations and search depth of suppliers appear unrelated to customer covenant violations. These results provide further support for our main finding that financially troubled customers incentivize their primary suppliers to be more innovative.

A concern with our main findings is that to the extent that severe financial distress spills over to the supply chain, suppliers might be unable to finance innovation or unwilling to work along with a doomed customer. However, covenant violations are fairly common (Chava and Roberts (2008)) and do not necessarily spell financial doom. Thus, we reexamine our baseline findings by interacting the *Customer covenant violation* indicator with an indicator for customer bankruptcy that happens in the subsequent seven years as a proxy for severe financial distress. To the extent that suppliers face reduced incentives and ability to work with severely distressed customers, we should expect to see a moderation in their innovation activity following customer covenant violations that lead subsequently to bankruptcy. We report the findings in Panel C. Consistent with the predictions, we find that the interaction term between *Customer covenant violation* and *Customer bankruptcy within t+7* is negatively significant at the 5% level of significance in the regressions of *Ln (no of patents)* in year *t*. However, other specifications are insignificant. Thus, these findings suggest that as long as the covenant violation of the customer does not signal extreme distress, supplier innovation responds positively, allowing mutual benefits.

[Insert IA Table 6 about here]

Internet Appendix Figure 1 presents the frequency distribution of the covenant violation variable around the violation thresholds (McCrary (2008)). The figure does not support the view that there is a precise manipulation by the customers around the violation thresholds within both the data-driven optimal bandwidth based on the mean square error algorithm of 0.75 (in the left panel) and a bandwidth of 0.20 (in the right panel) on each side of the covenant thresholds. The distance from covenant violation thresholds is measured as the standardized

relative distance from violation for both the current ratio and the net worth covenant thresholds. We do not find any remarkable discontinuity around the thresholds. Specifically, the 95% confidence bands overlap in both graphs, indicating the densities of the distribution on either side of the thresholds are not significantly different.

Internet Appendix Figure 2 presents the regression discontinuity plots of the measures of supplier innovation according to the data-driven optimal bandwidths estimated as in IA Table 1 using the "rdplot" command and an evenly spaced default number of bins of distance from the covenant thresholds within the data-driven optimal bandwidth based on the mean square error algorithm of 0.75 on each side of the covenant thresholds.[27] Specifically, we plot the average measures of supplier innovation, including patent and citation counts, and the search depth of the supplier as a function of the distance from the covenant threshold of their principal customer. The distance from the covenant threshold standardized by dividing the standard deviation of either the current ratio or net worth is shown on the x-axis, with negative values indicating covenant violations. Dots correspond to binned means based on default bin widths, and lines correspond to linear regressions. As in the main manuscript, we find a significant discontinuous jump in the number of patents and smaller jumps in citations and search depth, even when we use the sample of firms within a data-driven bandwidth.

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[27] The package and documentation for rdplot are available at https://grf-labs.github.io/grf/

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IA Table 1: RDD Estimates of Supplier Innovation using a Data-driven Optimal Bandwidth

This table presents the regression discontinuity estimates of the effect of customer covenant violation on supplier ex ante characteristics (Panel A) and supplier postviolation innovation (Panel B) for a sample of customer-suppliers between 1994 and 2009. The treatment effect is computed for an optimal data-driven bandwidth. To aid interpretation, the distance from the covenant threshold is multiplied by –1 to designate positive and negative distances as violation and non-violation, respectively. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: RDD estimates of supplier control variables

	Year -1
Ln (market equity)	0.446*
	(1.88)
Profit margin	0.120
	(0.57)
Leverage	-0.011
	(-0.22)
PPE/assets	0.001
	(0.04)
Capex/assets	-0.019
	(-1.42)
Herfindahl index	0.003
	(0.82)
Tobin's *q*	-0.257
	(-1.14)
Whited-Wu index	-0.001
	(-0.16)
Ln (age)	0.048
	0.446*

Panel B: RDD estimates of supplier innovation according to the distance from the covenant thresholds

	Year *t*	Year *t*+1	Year *t*+2
No. of patents	2.538**	2.378**	2.340**
	(2.58)	(2.14)	(2.05)
No. of citations	0.095*	0.033	0.030
	(1.91)	(0.76)	(0.59)
Search depth	0.154***	0.076	0.085
	(2.68)	(1.28)	(1.24)

IA Table 2: Effect of Customer Covenant Violations on Supplier Innovation Placebo Analysis

This table presents regression estimates of different types of supplier innovation on customer covenant violation and control variables. The customer covenant violation is assumed to have occurred five years prior to the actual violation in Panel A. In Panel B, covenant violation is randomly assigned in the sample. The sample consists of 2,998 suppliers identified from the Compustat segment database as being the suppliers of customers with an outstanding loan with a quantitative covenant as identified in DealScan between 1994 and 2009. The supplier data are merged with firm-specific Google patent data (Kogan et al., 2017). The sample of suppliers is restricted to the suppliers whose customers are within a bandwidth of 0.2 of the covenant threshold (discontinuity sample). *Customer covenant violation* is an indicator for customer covenant violations in Panel A, identified as those customers who have fallen below the covenant-specified threshold of the current ratio or net worth during the life of one of their outstanding loans. In Panel A, other control variables are lagged with respect to the year of innovation. In Panel B, *Customer covenant violation* is randomized by generating a random number that is uniformly distributed between 1 and 0. *Pseudo customer covenant violation* is defined as an indicator variable that takes the value of one for customer-supplier pairs when the random variable is greater than the sample median and zero otherwise. In both panels, industry fixed effects based on the Fama-French 30 industry classification are included, and *t*-statistics based on standard errors clustered by firm are reported in parentheses. Constants are included in all the regressions but are not reported. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Effect of Customer Covenant Violation (at year *t*+5)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth
Independent variables		Year *t*			Year *t*+1			Year *t*+2	
Customer covenant violation (indicator)	-0.060	-0.001	-0.085	-0.018	-0.015	-0.108	0.081	0.033	-0.060
	(-0.601)	(-0.034)	(-1.418)	(-0.167)	(-0.455)	(-1.403)	(0.701)	(0.969)	(-0.818)
Customer default distance (CR)	1.457	0.069	-0.599	3.411**	0.675**	-0.337	3.848**	1.015**	2.654*
	(0.809)	(0.213)	(-1.544)	(2.187)	(2.063)	(-0.802)	(2.574)	(2.284)	(1.698)
Customer default distance (NW)	-0.000	-0.000*	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(-0.932)	(-1.782)	(0.064)	(-0.846)	(-1.202)	(-0.533)	(-1.064)	(-1.316)	(-0.811)
Supplier characteristics									
Ln (market equity)	0.087**	0.019*	0.008	0.114***	0.029***	0.007	0.138***	0.029**	0.010
	(2.450)	(1.702)	(0.412)	(3.005)	(2.622)	(0.301)	(3.470)	(2.467)	(0.493)
R&D/assets	1.769***	0.827***	0.785***	1.733***	0.660***	0.980***	1.558**	0.456*	0.849**
	(3.683)	(3.493)	(3.237)	(2.971)	(2.614)	(2.991)	(2.186)	(1.957)	(2.374)
ROA	-0.137	-0.035	-0.070	-0.127	-0.025	-0.074	-0.171*	-0.035	-0.061
	(-1.467)	(-1.112)	(-1.573)	(-1.330)	(-0.778)	(-1.286)	(-1.658)	(-1.290)	(-1.056)
Leverage	0.037	0.011	0.028	0.057	0.019	0.020	0.058	0.025**	0.010
	(0.854)	(0.785)	(1.470)	(1.266)	(1.521)	(0.998)	(1.229)	(1.984)	(0.412)
PPE/assets	-0.378*	-0.158**	-0.258**	-0.324	-0.094	-0.265**	-0.322	-0.073	-0.142
	(-1.812)	(-2.434)	(-2.039)	(-1.524)	(-1.485)	(-2.117)	(-1.511)	(-1.165)	(-1.094)
Capex/assets	0.506	0.223	0.213	0.391	0.124	0.456	0.294	0.068	0.435
	(1.079)	(1.614)	(0.828)	(0.766)	(0.818)	(1.489)	(0.635)	(0.484)	(1.331)

Herfindahl index	-13.985	-5.216*	-0.362	-10.646	-0.867	-4.884	-15.037	-4.886*	-5.611
	(-1.466)	(-1.900)	(-0.063)	(-1.080)	(-0.286)	(-0.782)	(-1.539)	(-1.785)	(-1.098)
Herfindahl index square	75.486*	28.264**	3.775	62.914	9.256	25.502	77.115*	23.567**	27.214
	(1.862)	(2.404)	(0.156)	(1.481)	(0.748)	(0.925)	(1.847)	(2.022)	(1.171)
Tobin's *q*	0.014	0.003	0.005	0.009	0.002	0.008	0.005	-0.002	0.012
	(1.103)	(0.914)	(0.987)	(0.737)	(0.413)	(1.414)	(0.414)	(-0.532)	(1.474)
Whited-Wu index	-2.237**	-0.758**	-1.518**	-1.682*	-0.441	-1.660**	-1.609	-0.443	-1.416**
	(-2.297)	(-2.300)	(-2.310)	(-1.680)	(-1.505)	(-2.495)	(-1.583)	(-1.485)	(-2.165)
Ln (age)	0.381***	0.112***	0.198**	0.341**	0.079*	0.224**	0.361**	0.081*	0.202**
	(2.697)	(2.594)	(2.216)	(2.302)	(1.784)	(2.300)	(2.487)	(1.927)	(2.250)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	378	378	378	378	378	378	378	378	378
Adj. R-sq	0.423	0.352	0.222	0.388	0.307	0.239	0.405	0.289	0.236

Panel B: Effect of Randomized Customer Covenant Violation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth
		Year *t*			Year *t*+1			Year *t*+2	
Pseudo customer covenant violation (indicator)	-0.014	0.013	-0.003	0.029	0.018	-0.006	-0.003	-0.004	-0.042
	(-0.242)	(0.665)	(-0.096)	(0.453)	(0.897)	(-0.142)	(-0.050)	(-0.193)	(-0.778)
Supplier characteristics									
Ln (market equity)	0.115***	0.023***	0.034**	0.100***	0.011	0.033*	0.113***	0.015	0.042*
	(3.359)	(2.801)	(2.056)	(2.896)	(1.476)	(1.716)	(2.788)	(1.644)	(1.835)
R&D/assets	0.834*	0.457**	0.749***	0.869**	0.335**	0.866**	0.721	0.259*	0.525
	(1.956)	(2.571)	(2.778)	(2.078)	(2.386)	(2.506)	(1.550)	(1.678)	(1.376)
ROA	-0.097	-0.032	-0.028	-0.178*	-0.028	-0.078	-0.292**	-0.034	-0.213**
	(-0.958)	(-1.124)	(-0.377)	(-1.762)	(-1.060)	(-0.872)	(-2.142)	(-1.091)	(-2.195)
Leverage	0.088	-0.015	0.037	0.023	-0.017	0.074	-0.037	-0.024	-0.071
	(1.083)	(-0.639)	(0.538)	(0.289)	(-0.787)	(0.848)	(-0.438)	(-0.985)	(-1.438)
PPE/assets	-0.038	0.021	-0.131	-0.037	0.014	-0.132	-0.318	-0.024	-0.299**
	(-0.201)	(0.335)	(-1.367)	(-0.194)	(0.211)	(-1.184)	(-1.435)	(-0.336)	(-2.084)
Capex/assets	0.475	-0.113	0.380	-0.045	0.015	0.204	0.222	0.050	0.078
	(1.006)	(-1.066)	(1.602)	(-0.116)	(0.124)	(0.804)	(0.465)	(0.423)	(0.269)
Herfindahl index	-6.848	-8.721***	-4.603	-9.759	-4.246	1.422	-5.926	-0.500	-4.760
	(-0.845)	(-2.703)	(-0.802)	(-1.247)	(-1.478)	(0.205)	(-0.656)	(-0.158)	(-0.621)
Herfindahl index square	52.168	56.819**	28.793	69.478	21.029	-8.990	40.002	-10.136	41.958

	(1.115)	(2.551)	(0.867)	(1.486)	(1.093)	(-0.208)	(0.755)	(-0.486)	(0.771)
Tobin's *q*	-0.007	0.002	0.016	0.006	0.001	0.019	-0.014	-0.001	-0.007
	(-0.410)	(0.474)	(1.237)	(0.332)	(0.213)	(1.421)	(-0.789)	(-0.196)	(-0.658)
Whited-Wu index	-1.529*	-0.534**	-1.146**	-2.595***	-0.638***	-1.877***	-2.723*	-0.432	-2.146**
	(-1.779)	(-2.360)	(-1.999)	(-2.801)	(-2.843)	(-2.830)	(-1.861)	(-1.361)	(-2.116)
Ln (age)	0.144	0.044	0.102	0.073	-0.039	0.055	0.025	-0.012	0.033
	(0.930)	(1.231)	(1.336)	(0.479)	(-1.259)	(0.706)	(0.154)	(-0.351)	(0.352)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	602	602	602	525	525	525	455	455	455
Adj. R-sq	0.270	0.171	0.199	0.281	0.136	0.239	0.266	0.127	0.163

IA Table 3: Regressions of the Effect of Customer Covenant Violations on the Supplier Innovation Input

This table presents the regression estimates of the supplier innovation input in five years around the customer covenant violation using the RDD sample. The RDD sample begins with 3,387 supplier-years identified from the Compustat segment database as being the suppliers of customers from the Compustat segment database merged with loan data from Dealscan during 1994-2009. The sample is restricted to customers in the Compustat segment database with a current outstanding loan with one or more quantitative covenants (i.e., current ratio or net worth covenants). A customer covenant violation in year *t* is an indicator of customer covenant violations that are identified as customers who have fallen below the covenant specified threshold of the current ratio or net worth during the life of one of their outstanding loans. The supplier data are merged with firm-specific Google patent data (Kogan et al., 2017). The sample of suppliers is restricted to the suppliers whose customers are within a bandwidth of 0.2 of the covenant threshold (discontinuity sample), i.e., 687 supplier-years. Industry-fixed effects based on Fama-French 30 industry classification are included, and *t*-statistics based on standard errors clustered by the firm are reported in parentheses. Constants are included in all regressions but not reported. All variables are defined in the appendix. ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	R&D/assets	R&D/sales	R&D/assets	R&D/sales	R&D/assets	R&D/sales	R&D/assets	R&D/sales	R&D/assets	R&D/sales
Independent variables	Year *t*-2		Year *t*-1		Year *t*		Year *t*+1		Year *t*+2	
Customer covenant violation (indicator)	0.009	0.057	0.016	0.071	0.003	0.071	0.032**	0.157**	0.027*	0.072*
	(0.745)	(0.899)	(1.295)	(1.537)	(0.270)	(1.623)	(2.106)	(2.159)	(1.802)	(1.777)
Customer default distance (CR)	0.024	0.444	0.267	0.318	0.138	0.302	0.159	0.047	0.068	0.034
	(0.252)	(1.018)	(1.245)	(1.083)	(1.342)	(1.457)	(1.036)	(0.191)	(0.551)	(0.242)
Customer default distance (NW)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(-0.042)	(-0.924)	(-1.042)	(-1.165)	(-0.110)	(-1.032)	(-1.110)	(-0.868)	(-1.146)	(-1.017)
Supplier characteristics										
Ln (market equity)	-0.003	-0.028	-0.005	-0.026*	0.002	0.009	0.005	0.013	0.005	0.019*
	(-1.050)	(-1.433)	(-1.485)	(-1.774)	(0.705)	(0.969)	(1.490)	(0.897)	(1.574)	(1.848)
ROA	-0.070***	-0.585***	-0.067**	-0.422***	-0.111***	-0.210***	-0.034	-0.113*	-0.038**	-0.101*
	(-3.205)	(-2.942)	(-2.422)	(-3.116)	(-4.022)	(-3.338)	(-1.355)	(-1.676)	(-2.273)	(-1.917)
Leverage	-0.043**	-0.292**	-0.014	-0.190***	-0.018	-0.123***	-0.014	-0.018	-0.033**	-0.076**
	(-2.177)	(-2.448)	(-0.569)	(-2.800)	(-1.070)	(-2.751)	(-0.676)	(-0.205)	(-2.530)	(-2.374)
PPE/assets	-0.004	-0.034	0.014	-0.035	0.011	-0.080	-0.020	-0.194*	-0.027	-0.069
	(-0.183)	(-0.277)	(0.659)	(-0.466)	(0.539)	(-1.086)	(-1.041)	(-1.806)	(-1.392)	(-1.202)
Capex/assets	-0.088*	-0.493	-0.083	-0.258	-0.007	-0.169	0.022	-0.158	0.027	-0.049
	(-1.838)	(-1.573)	(-1.632)	(-1.176)	(-0.125)	(-1.258)	(0.533)	(-1.403)	(0.848)	(-0.755)
Herfindahl index	-1.027	-7.533	-0.761	-7.200*	1.339	-3.400	5.224**	13.245	3.538*	8.553
	(-0.553)	(-1.549)	(-0.403)	(-1.946)	(0.819)	(-1.483)	(2.023)	(1.378)	(1.664)	(1.231)

Herfindahl index square	10.493	47.517	8.747	48.343**	-2.946	29.567**	-20.890	-51.769	-13.092	-35.375
	(0.996)	(1.572)	(0.789)	(2.036)	(-0.330)	(2.002)	(-1.562)	(-1.096)	(-1.214)	(-1.048)
Tobin's *q*	0.008**	0.020	0.008*	0.013	0.000	-0.003	0.002	-0.004	0.002	0.003
	(2.269)	(1.036)	(1.963)	(1.205)	(0.121)	(-0.385)	(0.599)	(-0.427)	(0.875)	(0.455)
Whited-Wu index	-0.204*	-1.784**	-0.113	-1.418**	0.107	-0.088	0.264**	0.011	0.193*	0.371
	(-1.784)	(-2.244)	(-1.138)	(-2.436)	(1.036)	(-0.402)	(2.026)	(0.035)	(1.803)	(1.257)
Ln (age)	-0.028**	-0.118*	-0.023*	-0.102**	-0.005	-0.072**	-0.009	-0.080*	0.001	-0.001
	(-2.129)	(-1.890)	(-1.796)	(-2.191)	(-0.635)	(-2.210)	(-0.773)	(-1.823)	(0.058)	(-0.040)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	595	595	602	602	602	602	546	544	498	493
Adj. R-sq	0.396	0.288	0.424	0.415	0.575	0.351	0.410	0.210	0.444	0.461

IA Table 4: Cross-sectional Variation According to Common Supply Chain Lenders

This table presents the regression estimates of supplier innovation (Panel A) and regression estimates of the likelihood of a supplier citing its customer's patents (Panel B) on customer covenant violation and control variables using the RDD sample according to common lenders to the supply chain partners. The indicator variable *Common Lender* takes the value of one if we identify a common creditor in the lending syndicate who has been a creditor to both supplier and customer in the current or historical years covered by Dealscan. The RDD sample begins with 3,387 supplier-years (4,424 customer-supplier pair-years) identified from the Compustat segment database merged with loan data from Dealscan during 1994-2009. The sample is restricted to customers in the Compustat segment database with a current outstanding loan with one or more quantitative covenants (i.e., current ratio or net worth covenants). A customer covenant violation is identified as a customer that has fallen below the covenant-specified threshold of the current ratio or net worth during the life of one of their outstanding loans. The supplier data are merged with firm-specific Google patent data (Kogan et al., 2017). The sample of suppliers is restricted to the suppliers whose customers are within a bandwidth of 0.2 of the covenant threshold (discontinuity sample), i.e., 687 supplier-years in Panel A (i.e., 1,048 customer-supplier pair-years in Panel B). In Panel A, industry-fixed effects based on Fama-French 30 industry classification are included, and t-statistics based on standard errors clustered by the firm are reported in parentheses. In Panel B, all models are estimated as a linear probability model with the firm (i.e., supplier) fixed effects, and t-statistics based on robust standard errors are reported in the parentheses. Constants are included in all regressions but not reported. All variables are defined in the appendix. ***, **, and * denote the significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Variation in Supplier Innovation According to the Presence of Common Lenders

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth
	Moderating variable: Common Lender (indicator)					
Independent variables	Year *t*			Year *t*+1		
Customer covenant violation (indicator): a	0.200**	0.052*	0.058	0.229**	0.065**	0.113
	(2.218)	(1.879)	(0.936)	(2.191)	(2.027)	(1.423)
Moderating variable: b	-0.648***	-0.130**	-0.333***	-0.824***	-0.047	-0.449**
	(-3.072)	(-2.117)	(-2.800)	(-3.132)	(-0.795)	(-2.385)
a × b	0.480**	0.087	0.265	0.554*	0.007	0.393*
	(2.030)	(1.325)	(1.624)	(1.897)	(0.105)	(1.884)
Other controls in IA Table 2	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	602	602	602	525	525	525
Adj. R-sq	0.285	0.185	0.196	0.288	0.152	0.242

Panel B: Cross-sectional Variation in the Likelihood of Citing Customer Patents According to Presence of Common Lenders

	(1)	(2)	(3)
	Citing covenant violated customer (indicator)		
	Moderating variable: Common Lender (indicator)		
	Year *t*	Year *t*+1	Year *t*+2
Customer covenant violation (indicator): a	0.024**	0.051	0.117**
	(2.474)	(0.916)	(2.242)
Moderating variable: b	0.016	-0.084	0.287
	(0.190)	(-0.166)	(0.605)
a × b	-0.038	-0.438	-0.871
	(-0.340)	(-0.672)	(-1.426)
Other controls in IA Table 2	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Observations	878	878	878
Adj. R-sq	0.721	0.247	0.352

IA Table 5: Cross-sectional Variation According to Customer Financial Constraints

This table presents regression estimates of supplier innovation (Panel A) and regression estimates of the likelihood of a supplier citing its customer's patents (Panel B) on customer covenant violation and control variables using the RDD sample according to customer financial constraints. Panel A reports the cross-sectional variation in the effect of covenant violations on supplier innovation according to (1) customers' Whited-Wu index and (2) customers' firm size measured as the natural logarithm of market value of equity. The RDD sample begins with 3,387 supplier-years (4,424 customer-supplier pair-years) identified from the Compustat segment database merged with loan data from Dealscan during 1994 to 2009. The sample is restricted to customers in the Compustat segment database that have a current loan outstanding with one or more quantitative covenants (i.e., either current ratio or net worth covenants). Customer covenant violation is identified as a customer that has fallen below the covenant-specified threshold of the current ratio or net worth during the life of one of their outstanding loans. The supplier data are merged with firm-specific Google patent data (Kogan et al., 2017). The sample of suppliers is restricted to the suppliers whose customers are within a bandwidth of 0.2 of the covenant threshold (discontinuity sample), i.e., 687 supplier-years in Panel A (i.e., 1,048 customer-supplier pair-years in Panel B). In Panel A, industry fixed effects based on the Fama-French 30 industry classification are included, and t-statistics based on standard errors clustered by firm are reported in parentheses. In Panel B, all models are estimated as a linear probability model with firm (i.e., supplier) fixed effects, and *t*-statistics based on robust standard errors are reported in parentheses. Constants are included in all regressions but are not reported. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Variation in Findings According to Customer Financial Constraints

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth	Ln (no. of patents)	Ln (no. of citations)	Search depth
	Moderating variable: Financially Constrained Customer (indicator) (using Whited-Wu Index)						Moderating variable: Financially Constrained Customer (indicator) (using Firm size)					
Independent variables	Year *t*			Year *t*+1			Year *t*			Year *t*+1		
Customer covenant violation	0.181*	0.049	0.025	-0.023	0.036	0.043	0.229**	0.049	0.021	0.007	0.047	-0.001
(indicator): a	(1.825)	(1.509)	(0.365)	(-0.306)	(1.030)	(0.505)	(2.312)	(1.594)	(0.334)	(0.101)	(1.491)	(-0.012)
Moderating variable: b	0.087	0.028	0.022	-0.030	0.006	0.048	0.130	0.030	0.033	-0.026	-0.008	-0.008
	(0.970)	(1.037)	(0.443)	(-0.480)	(0.215)	(0.764)	(1.504)	(1.097)	(0.597)	(-0.457)	(-0.292)	(-0.122)
a × b	0.021	0.002	0.050	0.139	0.043	0.103	-0.061	0.002	0.057	0.095	0.029	0.185*
	(0.182)	(0.050)	(0.648)	(1.624)	(0.976)	(1.085)	(-0.480)	(0.046)	(0.636)	(1.169)	(0.735)	(1.730)
Other controls in IA Table 2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	602	602	602	525	525	525	602	602	602	525	525	525
Adj. R-sq	0.288	0.188	0.198	0.290	0.157	0.251	0.288	0.188	0.200	0.287	0.153	0.255

Panel B: Cross-sectional Variation in the Likelihood of Citing Customer Patents According to Supplier Ability

	(1)	(2)	(3)	(4)	(5)	(6)
	Citing covenant-violating customer (indicator)					
	Moderating variable: Financially Constrained Customer (indicator) (using Whited-Wu Index)			Moderating variable: Financially Constrained Customer (indicator) (using Firm size)		
	Year *t*	Year *t*+1	Year *t*+2	Year *t*	Year *t*+1	Year *t*+2
Customer covenant violation (indicator): a	0.047***	0.018	0.140	0.059***	0.099	0.160*
	(2.903)	(0.189)	(1.560)	(3.970)	(1.123)	(1.940)
Moderating variable: b	-0.007	0.161*	0.137*	0.006	0.237***	0.247***
	(-0.484)	(1.918)	(1.738)	(0.431)	(2.672)	(2.975)
a × b	-0.035*	0.041	-0.048	-0.054***	-0.140	-0.143
	(-1.856)	(0.374)	(-0.462)	(-2.821)	(-1.235)	(-1.351)
Other controls in IA Table 2	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	878	878	878	878	878	878
Adj. R-sq	0.727	0.260	0.354	0.729	0.257	0.362

IA Table 6: Supplier Innovation and Text-based Covenant Violation

This table presents summary statistics of supplier innovation using a text-based covenant violation customer sample (Panel A) and regression estimates of supplier innovation on customer covenant violation and control variables (Panels B and C). Customer-supplier relationships are identified from the Compustat segment database and merged with text-based covenant violations of Compustat firms obtained from Amir Sufi's website for a sample of customer-suppliers between 1994 and 2009. Text-based covenant violations are identified by Nini, Smith, and Sufi (2012) based on keywords mentioned in the reported filings. These data are merged with firm-specific Google patent data (Kogan et al., 2017). In Panel C, an indicator for customer bankruptcy within *t*+7 years is defined based on whether the customer has made a Chapter 11 filing according to the UCLA-LoPucki Bankruptcy Research Database until years *t*+7. In Panel A, the test of the difference in means is computed as a simple *t*-test. In Panels B and C, industry fixed effects based on the Fama-French 30 industry classification are included, and *t*-statistics based on standard errors clustered by firm are reported in parentheses. Constants are included in all the regressions but not reported. All variables are defined in the appendix. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Firm Innovation According to Presence of Customer and Customer Covenant Violation

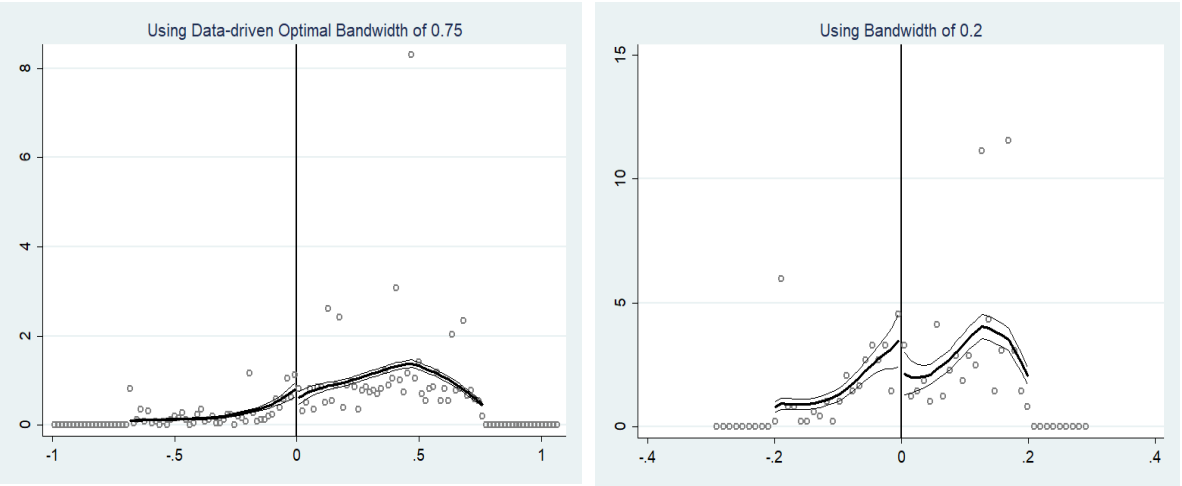
	Full sample	Firms that have one or more customers	Firms that do not have a customer	Suppliers of customer facing covenant violations	Suppliers of customers not facing covenant violations	Test of difference in mean			
	Obs. = 185,797	Obs. = 24,698	Obs. = 161,099	Obs. = 563	Obs. = 11,678	Difference	*t*-statistic	Difference	*t*-statistic
Measures of innovation	(1)	(2)	(3)	(4)	(5)	(2)-(3)	(2)-(3)	(4)-(5)	(4)-(5)
No. of patents	1.104	2.482	0.893	2.213	3.133	1.589	(41.20)	-0.920	(-2.34)
No. of citations	0.089	0.213	0.070	0.200	0.239	0.143	(58.97)	-0.039	(-1.64)
Avg. patent value	0.453	0.939	0.378	0.619	1.130	0.561	(37.29)	-0.511	(-3.63)
Probability of citing customer patent	0.028	0.207	0.000	0.034	0.037	0.207	(485.63)	-0.003	(-0.35)
No. of citations of customer patent	0.006	0.047	0.000	0.054	0.064	0.047	(4.37)	-0.010	(-0.60)
Search scope (or explorative)	0.070	0.157	0.056	0.151	0.177	0.101	(65.10)	-0.026	(-1.86)
Search depth (or exploitative)	0.071	0.177	0.055	0.146	0.221	0.122	(52.12)	-0.075	(-2.99)

Panel B: Multivariate Analysis of Supplier Innovation Following Text-based Customer Covenant Violation

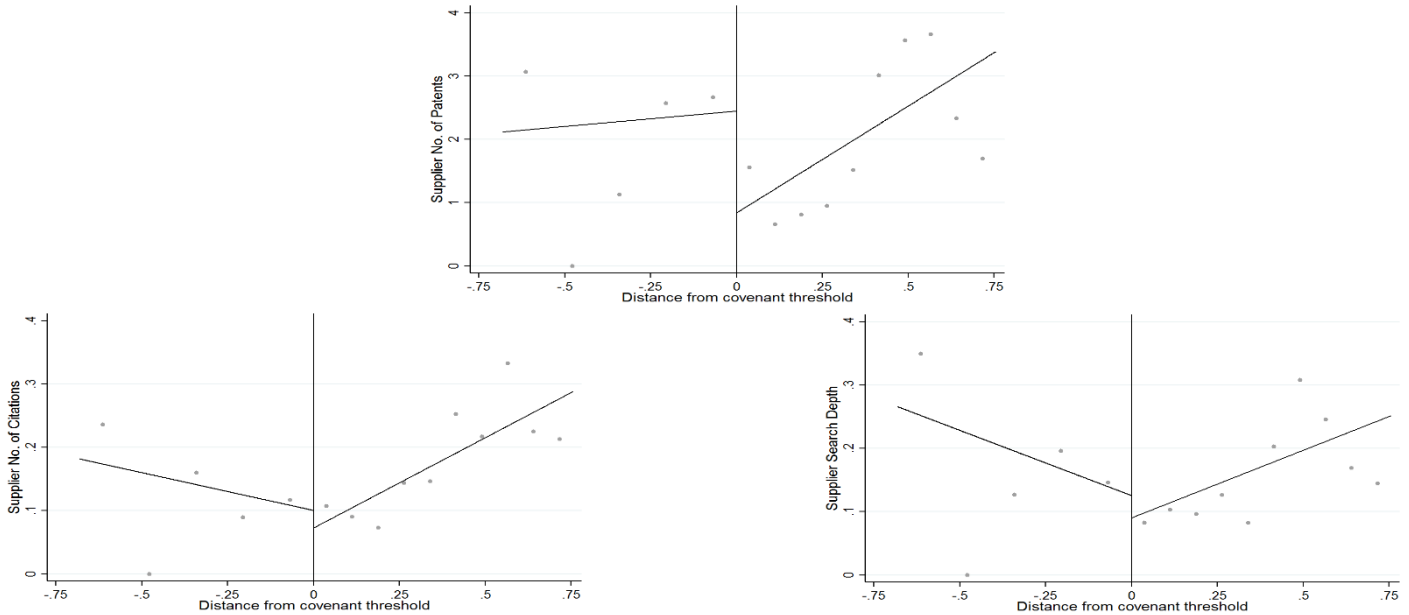
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ln (no. of patents)	Ln (no. of citations)	Search depth	Citing covenant violated customer (indicator)	Ln (no. of patents)	Ln (no. of citations)	Search depth	Citing covenant violated customer (indicator)
	Year *t*				Year *t*+1			
Customer covenant violation (indicator)	0.055**	0.018	0.003	0.011	0.047*	0.015	0.015	0.093***
	(2.291)	(1.184)	(0.227)	(0.986)	(1.841)	(1.149)	(0.797)	(3.711)
Ln (market equity)	0.058***	0.005	0.020***	0.007***	0.039***	-0.008**	0.017**	-0.012
	(4.941)	(1.361)	(2.770)	(2.795)	(3.185)	(-2.196)	(2.182)	(-1.554)
R&D/assets	0.043	-0.013	-0.028	-0.055	-0.002	-0.016	0.078	0.163
	(0.426)	(-0.228)	(-0.284)	(-1.582)	(-0.013)	(-0.271)	(0.600)	(1.642)
ROA	-0.038	0.018	0.001	-0.024***	-0.043	0.000	-0.024	-0.058*
	(-1.617)	(1.459)	(0.024)	(-2.919)	(-1.479)	(0.025)	(-0.971)	(-1.955)
Leverage	0.026*	-0.011	0.015	0.008*	-0.004	-0.016**	0.009	0.048**
	(1.699)	(-1.637)	(1.108)	(1.839)	(-0.190)	(-2.443)	(0.601)	(2.425)
PPE/assets	0.068	0.005	0.090	0.002	0.121	0.021	0.105	-0.135
	(0.695)	(0.126)	(1.269)	(0.097)	(1.085)	(0.408)	(1.223)	(-1.501)
Capex/assets	-0.249**	0.077	-0.157	-0.007	0.024	0.167**	-0.067	0.148
	(-2.488)	(1.359)	(-1.533)	(-0.176)	(0.210)	(2.550)	(-0.715)	(1.129)
Herfindahl index	-1.939	-0.050	2.576	0.051	-5.073**	0.058	1.552	-6.549***
	(-0.751)	(-0.062)	(1.632)	(0.068)	(-2.070)	(0.064)	(0.970)	(-3.208)
Herfindahl index square	4.365	-1.896	-13.457*	-1.678	16.446	-3.178	-11.004	33.555***
	(0.243)	(-0.477)	(-1.647)	(-0.360)	(0.919)	(-0.718)	(-1.268)	(3.171)
Tobin's *q*	-0.013**	0.004**	-0.010**	-0.003**	0.001	0.006***	-0.006	-0.003
	(-2.532)	(2.104)	(-2.374)	(-2.452)	(0.170)	(4.010)	(-1.390)	(-0.861)
Whited-Wu index	-0.029	-0.013	0.071	-0.073	-0.414***	-0.264***	-0.145	-0.050
	(-0.203)	(-0.203)	(0.564)	(-1.480)	(-2.775)	(-3.466)	(-1.210)	(-0.334)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,032	11,032	11,032	11,032	10,185	10,185	10,185	10,185
Adj. R-sq	0.011	0.003	0.003	0.002	0.009	0.006	0.001	0.008

Panel C: Multivariate Analysis of Supplier Innovation Following Text-based Customer Covenant Violation According to Future Customer Bankruptcy

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ln (no. of patents)	Ln (no. of citations)	Search depth	Citing covenant violated customer (indicator)	Ln (no. of patents)	Ln (no. of citations)	Search depth	Citing covenant violated customer (indicator)
	Year *t*				Year *t*+1			
Customer covenant violation (indicator): a	0.057**	0.022*	0.005	0.024**	0.063	0.036	0.036	0.106***
	(2.601)	(2.016)	(0.369)	(2.165)	(1.551)	(1.624)	(0.996)	(3.782)
Customer bankruptcy within *t*+7: b	-0.029	-0.013	0.034	-0.019	-0.036	0.020	0.026	-0.054
	(-1.160)	(-1.211)	(1.047)	(-0.723)	(-1.438)	(1.117)	(0.933)	(-1.169)
a × b	-0.098***	-0.023	-0.043	-0.012	0.039	-0.027	-0.041	-0.005
	(-2.875)	(-0.933)	(-1.325)	(-0.520)	(0.411)	(-0.680)	(-0.906)	(-0.027)
Controls in Panel B	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,017	9,017	9,017	9,017	8,352	8,352	8,352	8,352
Adj. R-sq	0.010	0.003	0.002	0.002	0.010	0.006	0.001	0.008



Internet Appendix Figure 1: The McCrary Test of density around the customer covenant violation threshold examines whether there is any discontinuity around the threshold boundary that would suggest significant manipulation by firms. The sample consists of customers identified from the Compustat segment database merged with loan data from Dealscan from 1994 to 2009 and is restricted to the customers in the Compustat segment database who have a current loan outstanding with one or more quantitative covenants (i.e., either current ratio or net worth covenants) with distance from the covenant threshold being within a data-driven bandwidth of 0.75 in the left panel and a bandwidth of 0.20 in the right panel, respectively. The x-axis is the distance from the covenant threshold, which is standardized by the standard deviation of the relevant measure, i.e., the current ratio or net worth according to the type of financial covenant. A negative distance implies a covenant violation. The y-axis is the estimated density. The dots represent the average estimated density of the sample binned by default. The solid lines represent the fitted lines. The lighter solid lines represent the 95% confidence interval.



Internet Appendix Figure 2: Regression discontinuity of supplier innovation measures according to distance from covenant threshold of their principal customer using average of evenly spaced bins and the 95% confidence interval for the means within each bin. The RDD sample consists of 4,485 supplier-years with customers identified from the Compustat segment database. The customers are merged with loan data from DealScan for the period 1994 to 2009, and the sample is restricted to the customers who have a current loan outstanding with one or more quantitative covenants (i.e., either current ratio or net worth covenants) that is within a data-driven bandwidth of 0.75 of the covenant threshold (i.e., discontinuity sample). The x-axis is the distance from the covenant threshold, which is standardized by the standard deviation of the relevant measure, i.e., the current ratio or net worth according to the type of financial covenant. A negative distance implies a covenant violation. The dots represent the average measures of supplier innovation, including the number of patents (top), number of citations (bottom left), and search depth (bottom right) around the covenant threshold of their principal customer.