The Supply Chain Effects of Bankruptcy

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This paper examines how a firm's financial distress and the legal environment regarding the ease of bankruptcy reorganization can alter product market competition and supplier–buyer relationships. We identify three effects—predation, bail-out, and abetment—that can change firms' behavior from their actions in the absence of financial distress. The predation effect increases competition before potential bankruptcy as the nondistressed competitor behaves as if it has some first-mover advantage that could benefit a supplier with price control. The bail-out effect reflects the supplier's incentive to grant the distressed firm concessions to preserve competition, improving supply chain efficiency and providing support for the exclusivity rule in Chapter 11 of the United States Bankruptcy Code when the supplier and the distressed firm are financially linked. The abetment effect is that the supplier may deliberately abet the competitor's predation, leading to increased operational disadvantages for the distressed firm before bankruptcy. Together these effects stress that a firm's bankruptcy potential can hurt its competitors and benefit its suppliers/customers. They also provide guidelines for firms' operational decisions in such situations, a rationale for observed firm actions surrounding bankruptcies, and motivation for policies supporting reorganization and relaxing broad enforcement of nondiscriminatory pricing regulations.

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1. Introduction

Bankruptcy is a critical business decision in which firms declare their inability to meet their financial obligations and obtain protection from creditors. Contrary to public opinion, bankruptcy is not the demise of the filing company. Instead, many jurisdictions around the world offer two alternatives to bankrupt firms: liquidation and reorganization. Although liquidation indeed brings the bankrupt company to an end, bankruptcy reorganization is a process designed to provide operationally sound firms with relief from their financial burdens and to continue operating. As an example, bankruptcy in the United States is largely governed by The Bankruptcy Reform Act of 1978, which includes Chapter 7 that governs the process of liquidation and Chapter 11 that focuses on corporate reorganization. The U.S. bankruptcy code is debtor-oriented, allowing the management of the bankrupt firm to stay in control and to continue operating the firm during reorganization. As a result, the majority of firms that filed for Chapter 11 reorganization (95% according to Gilson 1990 and more than 75% according to Morse and Shaw 1988) were rehabilitated under Chapter 11 and emerged from bankruptcy. Successful examples include many U.S. legacy airlines,

General Motors, Chrysler, and Kmart. However, some bankrupt companies, such as Circuit City and Borders, were eventually liquidated after failed attempts to reorganize. As with all other laws, bankruptcy law varies from country to country. In contrast to the U.S. bankruptcy code, some other jurisdictions provide more protection for creditors, who normally prefer a quick liquidation, thus leading to less reorganization (Franks et al. 1996, Ravid and Sundgren 1998).

Given its significant economic and social impact, bankruptcy has been an important research topic among scholars in law and economics, who mainly focus on the behavior of different stakeholders within the bankrupt firm. However, bankruptcy not only concerns the firm facing bankruptcy risk but also other parties in its supply chain. The interaction between bankruptcy and supply chain dynamics is a two-way street: not only could one firm's (potential) bankruptcy have a profound influence on the decisions and performance of other parties in its supply chain, supply chain interactions can also affect the distressed firm's risk of bankruptcy and the bankruptcy outcome.

In danger of losing a major customer because of bankruptcy liquidation, a supplier often grants

significant concessions to its customer to reduce bankruptcy risk or increase the chance of reorganization. For example, as documented by (Gilson 2010, p. 95), Cardinal Health, "which supplied Kmart with most of its prescription drugs and account for $3 billion in sales in 2002," was forced to "provide more favorable pricing and terms" as Kmart was reorganized under Chapter 11. Similarly, (Bower and Gilson 2003, p. 21) claims that United Airlines "have reduced its aircraft lease payments by 50% through reorganization." In addition to companies that supply physical products to the downstream firm, one can also view labor unions as suppliers, a perspective used in the labor economics and industrial organization literature because most labor negotiation concerns a fixed wage contract (Davidson 1988, Horn and Wolinsky 1988). Indeed, the outcome of labor negotiation often significantly influences whether a heavily unionized company can be sufficiently reorganized. For example, having more than 90% of its employees belonging to two unions, Hostess filed for bankruptcy twice since 2009 mainly because of conflict with the labor unions. The company was eventually liquidated when an agreement with the unions could not be reached (Palank et al. 2012, Feintzeig 2013). American Airlines, on the other hand, was able to successfully reorganize partially thanks to the "deep concession from labor unions that helped it cut about $1 billion in annual labor costs" (Palank 2014).

One company's bankruptcy may have a mixed impact on its competitors. On one hand, industry experts argue that Best Buy enjoyed market share gains when its rival Circuit City went bankrupt and was eventually liquidated in 2009 (Reagan 2013). On the other hand, better terms offered by suppliers in reorganization could potentially put a bankrupt firm in an advantageous position in competition. For example, Esterl (2010) reports that the labor cost per available seat mile for American Airlines, the only U.S. legacy airline that had not filed for Chapter 11 by that time, was 4.30¢ in 2010, whereas its main rivals that had been successfully reorganized in bankruptcy had reduced their costs to 3.30–3.60 cents per available seat mile through bankruptcy reorganization. This cost disadvantage eventually led to the bankruptcy of American Airlines in November 2011. Similarly, Zhang (2010) provides empirical evidence that a bankrupt firm normally re-emerges as a stronger competitor after being successfully reorganized. These impacts are also likely to influence market competition before bankruptcy. For example, Chevalier (1995) finds that highly levered supermarkets face more intense competition as competitors attempt to benefit from the levered firms' financial vulnerability.

Furthermore, in some concentrated industries, distressed and nondistressed competitors commonly share some important suppliers. For example, both Borders and Barnes and Noble relied on the same major publishing houses for books. Similarly, Circuit City and Best Buy both sourced from electronics manufacturers such as Hewlett-Packard and Samsung. In addition, the United Automobile Workers (UAW) provides workforces to General Motors, Ford, and Chrysler. Similar relationships exist between U.S. legacy airlines and their unions.

Motivated by the aforementioned phenomenon, this paper focuses on *the supply chain effects of bankruptcy*, that is, how the bankruptcy potential of one firm affects the operational strategies and performance of all parties in its supply chain through supply chain interactions. To achieve this goal, we build a two-period supply chain model with three strategic players: two competing downstream firms and a common supplier. Different from the classic supply chain models, one of the downstream firms is financially distressed and may file for bankruptcy at the end of the first period. In the event of bankruptcy, we abstract away from modeling the conflict between the firm and its creditors and emphasize the operational implications of reorganization by modeling bankruptcy reorganization as an instantaneous process with a random cost. The distribution of the random cost of reorganization can be seen as a proxy of the friendliness of a jurisdiction toward reorganization and/or the complexity of the bankrupt firm's debt structure.

Using this model, we identify three supply chain effects of bankruptcy: the predation effect, the bail-out effect, and the abetment effect. Depending on the cost of reorganization and supply chain interactions, these effects alter the ex ante and ex post behavior of different firms in the supply chain, and hence influence the firms' profitability and consumer surplus.

Originating from its incentive to gain the monopoly position, the predator effect induces the nondistressed firm to compete aggressively before bankruptcy, hurting the distressed firm. The competitor benefits from this effect when facing passive suppliers. As the supplier gains more pricing power, the supplier extracts this benefit and the nondistressed competitor may be hurt.

The supplier's fear of losing one sales channel motivates the bail-out effect. The supplier hence grants concessions to the distressed firm both before and after bankruptcy. This effect essentially redistributes the cost related to bankruptcy among different parties, benefiting the distressed firm and harming the supplier and possibly the nondistressed firm.

Finally, the abetment effect comes from the supplier's incentive to profit more from the nondistressed firm. This effect pushes the distressed firm

into bankruptcy, benefiting the nondistressed firm but harming the distressed firm and consumers.

This work carries important managerial and policy implications. It alerts managers that when facing a distressed competitor or buyer, it is important to understand how supply chain effects can alter firms' competitiveness and profitability before and after bankruptcy and take advantage of the financial situation when possible. From the competitor's perspective, facing a distressed competitor may not be beneficial. Similarly, a distressed firm may actually benefit the supplier when there is downstream competition. From the distressed firm's perspective, although this model assumes that the distressed firm's financial situation is public information, it may not always be the case in practice. Therefore, managers of a distressed firm should downplay or disclose the firm's financial situation depending on the supply chain dynamics and the legal environment it operates in.

For the policy perspective, this paper stresses that supply chain interactions play a crucial role in the effectiveness of bankruptcy law. It shows that firms in a country with more reorganization-friendly bankruptcy laws have a competitive advantage over their international competitors. A carefully designed bankruptcy mechanism improves supply chain efficiency. Imposing a uniform pricing constraint when downstream firms are in different financial situations can hurt consumers, which may justify relaxing pricing regulations such as the Robinson–Patman Act.

The remainder of the paper is organized as follows. Related literature is summarized in §2. We set up the model in §3. Sections 4 to 6 introduce the three supply chain effects and analyze their influences on the operational decisions and performances of different parties in the chain. We discuss the implication of the constraint of uniform pricing in §7. Section 8 summarizes the managerial insights and discusses policy implications and possible further research. The appendix includes a list of notation and all proofs.

2. Literature Review

Aiming to examine how supply chain interactions influence the ex ante and ex post impact of bankruptcy on operational decisions and supply chain performance, we build on a diverse literature that explores corporate bankruptcy in different disciplines. For details of the current U.S. bankruptcy code and the changes in legal status that take place during the bankruptcy process, we refer to White (1989), Gilson (1990), Senbet and Seward (1995), Kordana and Posner (1999), and the references therein. In addition, Weiss and Wruck (1998) and Gilson (2010) provide excellent case studies of both successful and failed reorganizations.

In the operations management literature, operational decisions of firms that are financially constrained have received increased attention recently. For single firms' operational decisions with financing concerns, see Buzacott and Zhang (2004), Xu and Birge (2004), Caldentey and Haugh (2006), Boyabatlı and Toktay (2011), Alan and Gaur (2015), and references therein. Foley et al. (2012) and Craig and Raman (2013) discuss the current practice of retail liquidation and propose several operational improvements based on sophisticated mathematical programming techniques. In the context of the influence of the downstream firm's financial distress on supply chain performance, to which this paper is closely related, most papers study single-period supply chain models with one upstream party and one downstream party. Zhou and Groenevelt (2008) and Kouvelis and Zhao (2010) examine supply chain performance when the downstream firm is financially constrained and only bank financing is available. Lai et al. (2009) compare different trade modes when both supply chain parties are financially constrained. Kouvelis and Zhao (2012) and Yang and Birge (2009) show supply chain efficiency can be improved when a distressed firm receives financing from its supplier. Federgruen and Wang (2010) examine different supplier financing mechanisms in a multiperiod supply chain model. In contrast to this literature's emphasis on interactions between operational decisions and financing choices, we take financing as given with a downstream firm in financial distress and focus on the impact of bankruptcy driven by supply chain interactions.

Researchers have also studied supply chain models in which the buyer mitigates its supplier's default risk via operational and financial means. Swinney and Netessine (2009), for example, studies a model where one buyer sources from two ex ante identical suppliers who are prone to bankruptcy. They show that long-term commitments induce the buyer to pay a higher price to the supplier, hence lowering the supplier's default risk. Using a multiperiod model with one supplier and one manufacturer, Babich (2010) shows that when sourcing from a distressed supplier, the manufacturer's capacity reservation and financial subsidy decisions can be independently made and that the financial subsidy follows a classic up-to structure. In a similar vein, we find that the supplier may bail out the distressed firm both before and after bankruptcy. However, by modeling downstream competition, we find the supplier may also have the incentive to abet the competitor's predation and push the distressed firm into bankruptcy.

Our paper is also related to the line of research on the impact of supply chain structure on operational decisions and supply chain efficiency. Netessine

and Zhang (2005) study the implication of externalities among different retailers on supply chain design and inventory management. Babich et al. (2007) show that in a supply chain with unreliable suppliers, when wholesale prices are endogenously determined by suppliers, retailers may prefer suppliers with high default correlations because of more intense price competition. Similarly, we find that a distressed buyer can become a positive externality for the supplier in the presence of downstream competition. Swinney et al. (2011) find that when competing with a risk-neutral established firm, a startup firm whose objective is to maximize its survival probability may enter an uncertain market earlier. This work, which is also based on asymmetry downstream competition, finds the nondistressed firm could benefit from its rival's financial distress even before bankruptcy. Wadecki et al. (2012) find that the subsidy the manufacturers provide to their distressed suppliers depends on the supply chain structure. Our paper also shows that supply chain interactions play an important role in the profitability of all firms in the supply chain both before and after bankruptcy.

Scholars in law and economics have provided in-depth analyses of different bankruptcy rules that affect firm operations. Baird and Picker (1991), Bebchuk and Chang (1992), and Kordana and Posner (1999) use different game-theoretical models to capture the bargaining process between manager-shareholders and creditors in the bankruptcy process and examine various rules in the current U.S. bankruptcy code such as automatic stay and exclusivity.[1] The focus of these papers is mainly the distributional effect of bankruptcy, that is, how the value of the bankrupt firm is distributed between shareholders and different classes of creditors. However, our paper argues that costly bankruptcy induces different operational strategies and may even create value in some circumstances. In this sense, we show that the operational efficiency of a supply chain could actually be improved by introducing a financial inefficiency, namely the cost of reorganization.

Economists have also studied the supplier's role when facing a buyer with bankruptcy risk. Among these studies, Perotti and Spier (1993) shows that firms can use leverage to gain bargaining power against labor unions. Wilner (2000) argues that trade creditors may be willing to grant more concessions when the debtor is in financial distress. The supplier in our model could play a similar role. However, by including downstream competition into the

model, we find that the supplier may be better off when facing a distressed buyer and that the supplier may push the distressed firm into bankruptcy. Finally, recent papers, including François and Morellec (2004) and Broadie et al. (2007), explicitly capture the impact of reorganization and liquidation and use structural default models to assess default probability, as well as debt and equity values. Although also modeling reorganization and liquidation options explicitly, our paper focuses on endogenous operational decisions and supply chain interactions that are not discussed in the previous papers.

3. The Model

Consider a supply chain with two competing downstream firms with a common supplier that operate over two periods. All firms are risk-neutral and their objectives in the first period are to maximize their long-run profits, that is, their total expected profits over the two periods. Without loss of generality, the risk-free interest rate is normalized to zero. One novelty of the model is that one of the downstream firms (the *distressed* firm, with superscript d) faces bankruptcy risk.[2] More specifically, when its first-period cash flow is sufficiently low, it files for bankruptcy and faces the choice of reorganization or liquidation. In the following, we first model the process of bankruptcy, and then introduce supply chain interactions and establish some benchmark results.

### 3.1. The Financial Distress and Bankruptcy Process

The distressed firm's road to bankruptcy is illustrated in Figure 1. At the beginning of the first period (the prebankruptcy period), the firm has *net asset* (asset minus liability) A. Its cash flow during the first period consists of two components. First, the operational profit π_1^d that is determined by the operational decisions of the distressed firm and other firms in its supply chain;[3] and second, a random shock $\tilde{\alpha} \in (-\infty, +\infty)$ that captures the firm's profit from other lines of business, uncertainties in fixed operational cost (legal liability, trading loss, etc.) and/or

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[1] In the U.S. bankruptcy law, *automatic stay* is an automatic injunction that halts actions by creditors to collect debts from a debtor who has declared bankruptcy. *Exclusivity* dictates that within a certain period, the debtor has the exclusive rights to propose a reorganization plan. The latter rule will be discussed in detail in §5.1.

[2] We model the asymmetry between the two downstream firms as dispersion of capital structures among firms within an industry, which is commonly observed and empirically documented. For example, Almazan and Molina (2005) find that industries that are older and more concentrated exhibit greater intraindustry dispersion.

[3] Because we mainly focus on large bankrupt companies that have some market power, we assume that although the firm faces bankruptcy risk, it has sufficient cash to support its operations in either period. Indeed, in its letter to suppliers, American Airlines (2011) states that "(it) is going into Chapter 11 process with what it anticipates to be more than sufficient liquidity in cash and short term investments, as well as cash generated from operations."

Figure 1 Sequence of Events
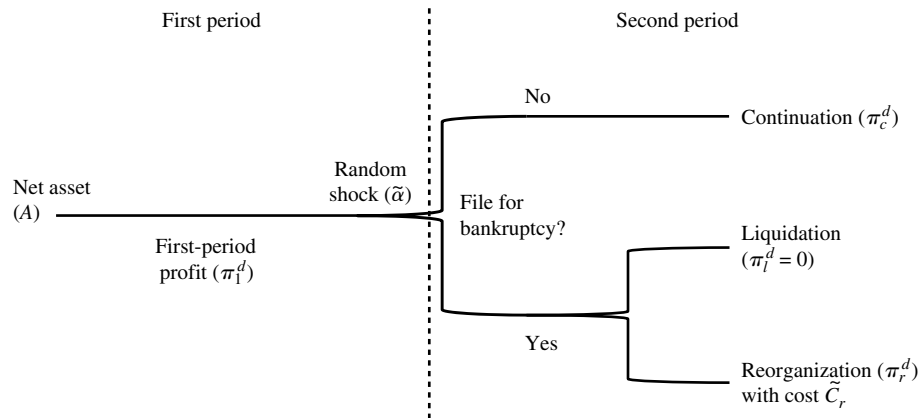
random movement of the firm's asset value. Similar assumptions on random shocks are used by Babich (2010), Hortaçsu et al. (2011), and Tanrisever et al. (2012) to model firms' financial distress. The shock $\tilde{\alpha}$ follows cumulative distribution function (CDF) $F(\cdot)$ and probability density function (PDF) $f(\cdot)$. Because bankruptcy is associated with the low realization of $\tilde{\alpha}$, we assume that $F(\cdot)$ is convex in the region that we are interested in.[4]

After π_1^d and $\tilde{\alpha}$ are realized, the firm makes the bankruptcy decision. Specifically, assuming that the firm could obtain additional financing against its second-period profit without bankruptcy π_c^d (the subscript c represents *continuation*), it files for bankruptcy if and only if the firm's total net liability at the end of the first period, $-(A + \alpha + \pi_1^d)$, is greater than π_c^d.[5] Equivalently, $\alpha < \alpha_b$, where $\alpha_b = -(A + \pi_1^d + \pi_c^d)$ is the bankruptcy threshold. The *probability of bankruptcy* $\Psi = F(\alpha_b)$.

In bankruptcy, the firm first attempts to negotiate with other stakeholders, including creditors and suppliers, in a costly reorganization process. This cost associated with reorganization includes refinancing cost, legal costs, the costs to coordinate creditors, losses incurred in asset sales used to fund operations, and so forth. Empirical evidence suggests that these costs are significant and highly variable. For example, Weiss (1990) reports that the direct cost of bankruptcy ranges from 2.0% to 63.6% of the market value of equity. Finally, it is known that reorganization is an extremely complicated and involved process controlled by the management of the firm, making it

difficult for other parties to observe the exact cost. To capture these features, we assume that to be successfully reorganized (with subscript r), the bankrupt firm incurs a random *cost of reorganization* $\tilde{C}_r \in [0, +\infty)$, following CDF $G(\cdot)$ and PDF $g(\cdot)$. The distribution of $\tilde{C}_r$ is influenced by factors such as whether a jurisdiction is friendly to reorganization and the complexity of the firm's debt structure. For example, firms filing for bankruptcy in the United States should face a stochastically smaller reorganization cost than firms in many European countries. Although the distribution of $\tilde{C}_r$ is known to all parties, only the management of the bankrupt firm receives an accurate signal of the realized cost of reorganization C_r before the second period operational decisions are made by all parties.[6] The firm decides to reorganize or liquidate depending on whether C_r is smaller than the firm's operating profit under reorganization π_r^d. Therefore, the probability of reorganization $\Phi = G(\pi_r^d)$, and the firm's expected net profit in bankruptcy (operating profit minus reorganization cost) is $\pi_b^d = \int_0^{\pi_r^d} (\pi_r^d - x) dG(x)$.

Facing bankruptcy risk, what is the distressed firm's reaction in the first period? As its long-run profit, $\Pi^d = \pi_1^d + (1 - \Psi)\pi_c^d + \Psi \pi_b^d$, decreases in Ψ, and hence increases in π_1^d, the distressed firm should simply maximize its first-period profit π_1^d.[7] In this sense, the distressed firm's first-period decision is independent of its bankruptcy risk. Although this is an abstraction from reality, it is a desirable property in the model, as it allows us to attribute all deviations of the firm's decision from the benchmark without

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[4] This is a common assumption used to model the lower tail of a distribution. As shown later, this property ensures that the predation effect and the abetment effect have the same sign, which we believe is a more realistic case.

[5] Alternatively, assuming that the firm cannot obtain financing against its future profit, the firm then files for bankruptcy when $A + \pi_1^d + \alpha < 0$. However, as the two conditions only differ by a constant π_c^d, all qualitative insights remain valid.

[6] The qualitative results remain the same if $\tilde{C}_r$ increases (stochastically) in the amount of debt forgiven in bankruptcy, and that the realization of $\tilde{C}_r$ is observable to all parties. See §§C.1 and C.2 in Online Appendix C (available as supplemental material at http://dx.doi.org/10.1287/mnsc.2014.2079) for technical details.

[7] This result continues to hold if the distressed firm maximizes its equity value $\Pi_e^d = \int_{\alpha_b}^{+\infty} (\pi_1^d + \pi_c^d + \alpha + A) dF(\alpha)$ as α_b decreases in π_1^d. See Lemma B.1 in the appendix for the statements and proofs of both the profit and equity maximization cases.

bankruptcy, which we characterize in §3.3, to supply chain interactions, hence isolating the supply chain effect of bankruptcy.

3.2. Supply Chain Interactions

The distressed firm does not exist in a vacuum. Instead, it earns profits while interacting with competitors that influence the demand faced by the distressed firm, and suppliers that influence the distressed firms' input prices. Anticipating the impact of bankruptcy and the cost of reorganization on them, competitors and suppliers adjust their operational decisions, which in turn influence the distressed firm's operational decisions and profits of all firms in the supply chain.

We consider both horizontal and vertical supply chain interactions. Horizontally, we introduce a nondistressed firm that engages in Cournot competition with the distressed firm in the same product market (with superscript n) for both periods.[8] As argued by Kreps and Scheinkman (1983), Cournot competition is appropriate when modeling competition between firms who have to precommit quantities. In the examples that motivate this study, most quantities, including labor, long-term leases, and inventory, need to be precommitted. In the first period, facing wholesale prices w_1^d and w_1^n, the two downstream firms decide their quantities q_1^d and q_1^n to maximize their long-run profits respectively in anticipation of the subgame perfect strategies played in the second period. q_1^d and q_1^n lead to market-clearance price $p_1 = \mu_1 - q_1^d - q_1^n$ and the corresponding first-period operational profits $\pi_1^j = (p_1 - w_1^j)q_1^j$ for $j = n, d$.

Along the vertical dimension, we introduce a supplier (with superscript s) that sells to both downstream firms and consider three scenarios based on the supplier's pricing power. In the first scenario (*passive supply*), the supplier is passive in the sense that the wholesale prices are exogenously determined and independent of the firms' financial situations. That is, $w_r^j = w_c^j = w_l^j$ for $j = n, d$. This case proxies for the situation when the wholesale prices are determined by a relatively competitive supply market. For example, the input the two firms use are commodities such as jet fuel in the airline industry. This case allows us to isolate the interaction between competitors and serves as a benchmark for the following two cases.

The second scenario (*endogenous differentiated pricing*) assumes that, as the Stackelberg leader, the supplier makes a take-it-or-leave-it offer of different wholesale prices w_i^d and w_i^n to the two downstream firms depending on their financial situation.[9] This setting equips the supplier with the greatest pricing flexibility.

Last, we consider the scenario with *endogenous uniform pricing*, where the supplier maintains its power to offer different prices across different financial situations, but the same price is offered to both downstream buyers, that is, $w_i^d = w_i^n$ for $i = 1, c, r, l$. This scenario can be seen as an intermediate case in which the supplier has limited pricing power.

For both endogenous pricing scenarios, in the second period, the supplier maximizes its corresponding profit by choosing wholesale prices depending on whether the distressed firm files for bankruptcy or not. In bankruptcy, it maximizes its expected profit $\pi_b^s = \Phi \pi_r^s + (1 - \Phi)\pi_l^s$ by first offering w_r^d and w_r^n for the bankrupt firm to reorganize and then w_n^l to the nondistressed firm in the event of liquidation. In the first period, in anticipation of the uncertainties and the subgame perfect strategies played in the second period, the supplier chooses w_1^d and w_1^n to maximize $\Pi^s = \pi_1^s + (1 - \Psi)\pi_c^s + \Psi \pi_b^s$.

Admittedly, in practice, firms interact with suppliers with and without pricing powers simultaneously. For example, in the airline industry, airlines purchase fuel from a competitive market, in which the price is not influenced by the companies' financial situation, and also contract with labor unions that have strong bargaining power over the company. Similarly, in the automobile industry, the manufacturers purchase from smaller suppliers and contract with unionized labor. In the retail industry, retailers share large suppliers such as P&G and contract from small local suppliers. By examining three representative scenarios, our model sheds light on these practical cases.

Finally, note that although the paper assumes that the market demand function, or equivalently, customers' valuation, is not influenced by the firms' financial situation, it does measure the impact of bankruptcy on consumer welfare by evaluating expected consumer surplus that also illuminates the efficiency of different bankruptcy mechanisms and other policies.

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[8] In the paper, we assume the products the two firms produce are perfect substitutes. Additional analysis in §C.3 in Online Appendix C shows that all qualitative insights remain valid when we adopt a differentiated Cournot model as in Singh and Vives (1984).

[9] Offering different prices to different buyers may be perceived as a violation of the price discrimination provisions under the Robinson–Patman Act. However, price differentiation is a form of antitrust violation only if it harms consumer welfare. Furthermore, recent research on antitrust law (Antitrust Modernization Commission 2007) suggests that restricting price discrimination is seen as being less and less effective. It does not protect small businesses, as was its initial aim. Also, it is seen as inconsistent with other antitrust law as it restricts price and other forms of competition. Empirical evidence (Luchs et al. 2010) also shows that the likelihood that a court finds a defendant guilty of violating the Robinson–Patman Act has dropped dramatically in recent years. Interestingly, comparing results in §§6 and 7, we find that allowing price differentiation may benefit consumers.

3.3. The No-Distress Benchmark

As discussed at the beginning of the section, a key driver in the model is the distressed firm's bankruptcy risk. To quantify the impact of bankruptcy, we first establish a benchmark in which the distressed firm's bankruptcy risk is zero, which we call the *no-distress benchmark*. To simplify the notation, we use the subscript a to represent first-period quantities under this benchmark. For example, π_a^d is the distressed firm's first-period profit under the no-distress benchmark.

It is obvious that under this benchmark, the two periods can be decomposed. Simple analysis shows that facing w_1^d and w_1^n in the first period, the downstream firms' quantities are $q_a^d = \frac{1}{3}(\mu_1 - 2w_1^d + w_1^n)$ and $q_a^n = \frac{1}{3}(\mu_1 - 2w_1^n + w_1^d)$. Similarly, in the second period, as the firm has no bankruptcy risk, only the continuation scenario is relevant, therefore, $q_c^d = \frac{1}{3}(\mu_2 - 2w_c^d + w_c^n)$ and $q_c^n = \frac{1}{3}(\mu_2 - 2w_c^n + w_c^d)$. When prices are endogenously determined by the supplier (the endogenous differentiated pricing and uniform pricing cases), $w_a^d = w_a^n = \mu_1/2$ in the first period, with profits $\pi_a^d = \pi_a^n = \mu_1^2/36$ and $\pi_a^s = \mu_1^2/6$. Similarly, in the second period, $w_c^d = w_c^n = \mu_2/2$, leading to profits $\pi_c^d = \pi_c^n = \mu_2^2/36$ and $\pi_c^s = \mu_2^2/6$.

Furthermore, we note that the above benchmark can also be achieved when the cost of reorganization is zero, that is, $\Pr(C_r = 0) = 1$.

PROPOSITION 1. *When reorganization is costless, all decisions under any supply chain structure are the same under the no-distress benchmark.*

Because the cost of reorganization is the only source of financial market imperfection, the previous result is consistent with the seminal irrelevance result of Modigliani and Miller (1958), which states that a firm's value is independent of its capital structure in a perfect financial market.

4. The Predation Effect with Passive Supply

Starting with the scenario with passive supply, we conduct the analysis backward in time. When the distressed firm is in bankruptcy, it first tries to reorganize. Under wholesale prices w_r^d and w_r^n, the two downstream firms' order quantities are

$$q_r^d = \frac{\mu_2 - 2w_r^d + w_r^n}{3} \quad \text{and} \quad q_r^n = \frac{\mu_2 - 2w_r^n + w_r^d}{3}, \quad (1)$$

which lead to the corresponding operational profits $\pi_r^i = \frac{1}{9}(\mu_2 - 2w_r^i + w_r^{-i})^2$ for $i = n, d$. Since $w_r^i = w_c^i$, $\pi_r^i = \pi_c^i$. Therefore, the bankrupt firm is liquidated and stops operating if and only if $C_r > \pi_c^c$, leading to $q_r^d = 0$ and $\pi_r^d = 0$. In the event of liquidation, the nondistressed firm becomes a monopoly, making a

profit $\pi_l^n = \frac{1}{4}(\mu_2 - w_l^n)^2$. Combining the two possibilities, the expected net profits in bankruptcy of the two firms are $\pi_b^d = \Phi \pi_c^d - \int_0^{\pi_c^d} x \, dG(x)$ and $\pi_b^n = \pi_c^n + \Phi(\pi_l^n - \pi_c^n)$. Since $\pi_l^n < \pi_c^n$, we have $\pi_b^n > \pi_c^n$, that is, the nondistressed firm benefits from its competitor's bankruptcy.

In the first period, the two firms face wholesale prices w_1^d and w_1^n, respectively, and decide their order quantities q_1^d and q_1^n to maximize their respective long-run payoffs. As shown in §3.2, the distressed firm's goal in the first period is to maximize π_1^d. Therefore, its best-response quantity $q_1^d = \frac{1}{2}(\mu_1 - w_1^d - q_1^n)$. On the other hand, the nondistressed competitor maximizes $\Pi^n = \pi_1^n + \pi_2^n$, where $\pi_1^n = (p_1 - w_1^n)q_1^n$ and $\pi_2^n = \pi_c^n - \Psi\Phi(\pi_l^n - \pi_c^n)$. As shown, π_2^n is a function of the probability of bankruptcy Ψ, and hence also a function of q_1^n. Defining $\delta^n = -\partial \pi_2^n / \partial \pi_1^d$ as the *(marginal) competitor impact*, we note that $\delta^n = f(\alpha_b)\Phi(\pi_l^n - \pi_c^n) > 0$; that is, the nondistressed firm has an incentive to push the distressed firm into bankruptcy, creating what we call the *predation effect*. Furthermore, $\partial \pi_2^n / \partial q_1^n = \delta^n q_1^d > 0$, revealing that with the predation effect, the nondistressed competitor should compete more aggressively in the first period.

Combining the impact of q_1^n on both periods' profits, the nondistressed firm's best-response quantity is $q_1^n = \frac{1}{2}[\mu_1 - w_1^n - (1 - \delta^n)q_1^d]$, revealing that the nondistressed firm is less sensitive to the distressed firm's quantity as δ^n increases. This is because, as q_1^d increases above the no-distress benchmark, it *reduces* the distressed firm's first-period profit, hence increases its bankruptcy probability, and benefits the nondistressed competitor in the second period. Alternatively, q_1^n can be seen as a (convex) linear combination of the quantity from a simultaneously move game $((\mu_1 - w^n - q_1^d)/2)$ and that from a game where the nondistressed firm is the Stackelberg leader or a monopolist seller $((\mu_1 - w^n)/2)$. That is, as bankruptcy risk increases or reorganization becomes more costly, the nondistressed firm behaves more and more like a monopolist seller or as if it has the first-mover advantage. In this sense, the predatory behavior seeking to benefit from possible liquidation can actually become a competitive advantage for the nondistressed firm before bankruptcy.

Further analysis shows that, because of the predation effect, the distressed firm's order quantity (q_1^d) and its first-period profit (π_1^d) in equilibrium are less than the no-distress benchmark and that this damage may be more significant than the actual bankruptcy.[10] On the other hand, in equilibrium, the nondistressed firm produces more than the no-distress benchmark,

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[10] For brevity of exposition, we refer the readers to Proposition B.1 and Corollaries B.1 and B.2 for the technical details of the results summarized in this paragraph.

Figure 2 (Color online) Long-Run Expected Consumer Surplus with Passive Supply
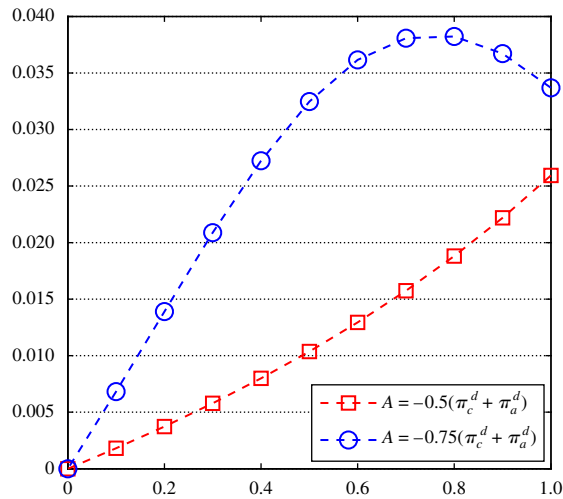
Notes. $\mu_1 = \mu_2$, $w_i^j = 0$ for $i = 1, c, l, r$, and $j = n, d$; $\tilde{\alpha}$ follows normal distribution with $\mathbb{E}[\tilde{\alpha}] = 0$ and $\sigma = \pi_a^d / 2$. The x axis is the probability of liquidation $(1 - \Phi)$, which is endogenously determined by the cost of reorganization.

consistent with the empirical findings in Chevalier (1995) that highly levered supermarkets face more intense competition as competitors attempt to benefit from the levered firms' financial vulnerability. The increase in q_1^n overcompensates for the decrease in q_1^d, leading to a higher aggregated supply to customers, and the previous deviations grow as reorganization becomes more costly. Moreover, the nondistressed firm's first-period profit may be greater than the no-distressed benchmark. This confirms that even though the predation effect originates from the nondistressed firm's motive to increase profit *after* bankruptcy, it can also benefit the nondistressed firm even *before* bankruptcy.

The predation effect has a mixed impact on consumers. Although consumers are hurt in the event of liquidation, they benefit in the first period from more intense competition. As shown in Figure 2, when bankruptcy risk is low, the first-period benefit dominates; hence, consumers benefit more from more costly reorganization. As bankruptcy risk grows, the second-period damage grows and less costly reorganization becomes favorable.

The aforementioned dynamics can also be interpreted in a different setting. Imagine two firms based in two different countries competing in a global market. For example, both American Airlines and Virgin Atlantic operate the same transatlantic routes. Although both could be financially distressed, they are homed in jurisdictions with different costs of reorganization. As an approximation, suppose one operates in a jurisdiction where reorganization is costless; the other in a jurisdiction where reorganization is more costly. As our model suggests, the firm with

costless reorganization behaves as the nondistressed competitor, and the previous results suggest that it has a competitive advantage over the other firm. In this sense, a country that is more friendly toward reorganization could provide its companies with a legal advantage in global competition.

5. The Bail-Out Effect and Negative Externality

As shown in the previous section, when the supply prices do not depend on the firms' financial situation, the distressed firm's bankruptcy always hurts itself and benefits the competitor. However, do these results continue to hold as the supplier has more pricing power and can adjust the wholesale prices in response to the firm's financial situation? Further, how is the supplier's profitability affected when one of its customers faces bankruptcy risk? The next two sections answer these questions under the endogenous differentiated pricing case, focusing on the in-bankruptcy decisions in this section and prebankruptcy decisions in §6.

When the distressed firm is in bankruptcy, to decide the wholesale contracts offered in reorganization, the supplier needs to evaluate its outside option, that is, its profit when the bankrupt firm is liquidated: $\pi_l^s = w_l^d q_l^d$. Anticipating the nondistressed firm's quantity response $q_l^n = \frac{1}{2}(\mu_2 - w_l^n)$, the supplier offers $w_l^n = \mu_2/2$, leading to its profit in liquidation $\pi_l^s = \mu_2^2/8$, which is also the profit up to which the supplier is willing to grant concessions to keep the bankrupt firm alive. On the other hand, in reorganization, the supplier's profit is $\pi_r^s = w_r^d q_r^d + w_r^n q_r^n$, where the downstream firm's quantities are governed by (1).

PROPOSITION 2. *In bankruptcy, to help the bankrupt firm reorganize, the supplier offers w_r^d and w_r^n that maximize $G(\pi_r^d)(\pi_r^s - \pi_l^s)$. The resulting wholesale prices in reorganization are*

$$w_r^d = \frac{3}{4}(\mu_2 - 2\sqrt{x^*}) \quad and \quad w_r^n = \frac{\mu_2}{2}, \qquad (2)$$

where $x^* = \arg\max_{x \in [\mu_2^2/36, \, \mu_2^2/9]} G(x)(\mu_2\sqrt{x} - 3x)$. When $G(x)$ is concave for $x \in [\mu_2^2/36, \mu_2^2/9]$,

$$x^* = \frac{\mu_2^2}{36}\left[1 + \frac{x^* g(x^*)}{G(x^*) + x^* g(x^*)}\right]^2. \qquad (3)$$

Note that, as revealed by the supplier's maximand $G(\pi_r^d)(\pi_r^s - \pi_l^s)$, the fundamental trade-off the supplier faces is between its own profit under reorganization (π_r^s), which decreases in π_r^d within the relevant region, and the probability that the reorganization is successful $G(\pi_r^d)$, which obviously increases in π_r^d. Even though the supplier is still the Stackelberg leader, its maximand $G(\pi_r^d)(\pi_r^s - \pi_l^s)$ shares some similarities

with the Nash product in a Nash bargaining solution where π_r^s is the payoff to the supplier when reorganization succeeds, and π_l^s is its outside option, and $G(\pi_r^d)$ can be seen as the bankrupt firm's "utility." In this sense, the uncertainty in reorganization gives the bankrupt firm more "bargaining power" against its supplier, leading to higher supply chain efficiency as measured by total quantity in reorganization. Indeed, Proposition 2 dictates that $w_r^d \leq \mu_2/2 = w_c^d$. That is, to reduce the probability of being left with a monopsony buyer, the supplier is willing to lower the bankrupt firm's wholesale price, creating the *bail-out* effect. On the other hand, note that $w_r^n = \mu_2/2 = w_c^n = w_l^n$. That is, the second-period wholesale price offered to the nondistressed firm is independent of the financial situation of the distressed firm. Therefore, its competitor's bankruptcy does not influence the nondistressed firm's wholesale price directly. However, $w_r^d \leq w_r^n$ does highlight that after a successful reorganization, the re-emerged firm has a cost advantage over its competitor, exactly as observed in the airline industry. This disadvantage is reflected in the firm's profits as $\pi_r^n = \mu_2^2/16 + (\pi_r^d - \mu_2\sqrt{\pi_r^d})/4 \leq \pi_r^d$. In other words, one firm's bankruptcy can become a negative externality to its competitor in the presence of the bail-out effect.

COROLLARY 1. *As the random reorganization cost $\tilde{C}_r$ increases (according to the monotone likelihood ratio property), π_r^d increases; w_r^d, π_r^s, π_r^n, and π_b^s decrease.*

Figure 3(a) shows that the probability of reorganization decreases in the cost of reorganization, suggesting that even though the supplier grants more concessions as reorganization becomes costly, the growth of these concessions does not keep pace with the reorganization cost. Further, Figure 3(b) confirms that because of the negative externality, the competitor could actually be worse off compared with the no-distress benchmark, particularly when reorganization is less costly. The reason is as follows. Note that π_r^s is concave in π_r^d; that is, the marginal cost of offering concession is low to the supplier when the concession is small. Therefore, when reorganization is less costly, the supplier can ensure a low probability of liquidation at a small cost, limiting the benefit to the nondistressed firm. On the other hand, as the nondistressed firm profit in reorganization, π_r^n, is decreasing and convex in π_r^d, the nondistressed firm is hurt (marginally) the most when the supplier grants less in concession. Combining the two effects, the harm to the nondistressed firm dominates the benefit when reorganization is less costly although, as the cost of reorganization increases (stochastically), the benefit becomes the dominating force.

5.1. Exclusivity and Suppliers as Creditors

Within industries where bankruptcy appears frequently, it is common that a major supplier is also a major creditor of the distressed firm. For example, in the retail industry, Circuit City relied on important electronics manufacturers such as Hewlett-Packard, Samsung, and Sony to supply both goods and financing.[11] The relationship between Borders and large publishers was similar. In addition, labor unions also tend to be large creditors of bankrupt firms. For instance, the UAW was one of the most important creditors in the bankruptcy of General Motors. Motivated by these examples, this section examines how the interaction of the operational and financial linkages between the supplier and the distressed firm influences the outcome of the reorganization. We focus on a specific rule in Chapter 11: exclusivity, which dictates that only the bankrupt firm can propose a reorganization plan which includes the amount paid to each creditor.[12]

Assume that at the time of bankruptcy, the bankrupt firm owes the supplier L^s. Obviously, the payment received by the supplier cannot exceed L^s. On the other hand, bankruptcy law requires that, in reorganization, all creditors need to receive no less than what they would receive in liquidation, which is normalized to zero without loss of generality. Therefore, when proposing a reorganization plan, the bankrupt firm chooses $y_r^s \in [0, L^s]$ to (partially) repay the supplier's claim. The supplier accepts the offer as long as its total (operational and financial) payoff exceeds what it receives in liquidation.

PROPOSITION 3. *When the supplier and the bankrupt firm make their decisions independently, the bankrupt firm chooses $y_r^s = 0$.*

Proposition 3 suggests that the supplier does not receive one penny more than what it would receive in liquidation and that the supply contract offered by the supplier is identical to the one when the supplier is not a creditor. This mutual hold-up outcome is obviously not desirable to either party. Indeed, although the supplier maintains the pricing power, it may want to give up part of this power in exchange for the bankrupt firm's concession on financial payment as exclusivity gives the bankrupt firm a weapon to fight back with when the supplier is also a creditor. This results in more balanced power between the two

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[11] According to Circuit City Stores, Inc. (2008), Hewlett-Packard, Samsung, and Sony were the three biggest unsecured creditors of Circuit City when Chapter 11 was filed.

[12] Strictly speaking, there is an initial exclusivity period of 120 days in Chapter 11. However, in practice, this period can be extended multiple times by the court. For simplicity, in this paper we assume the exclusivity period can be extended indefinitely.

Figure 3 (Color online) Probability of Reorganization and Net Profits in Bankruptcy Under Endogenous Differentiated Pricing
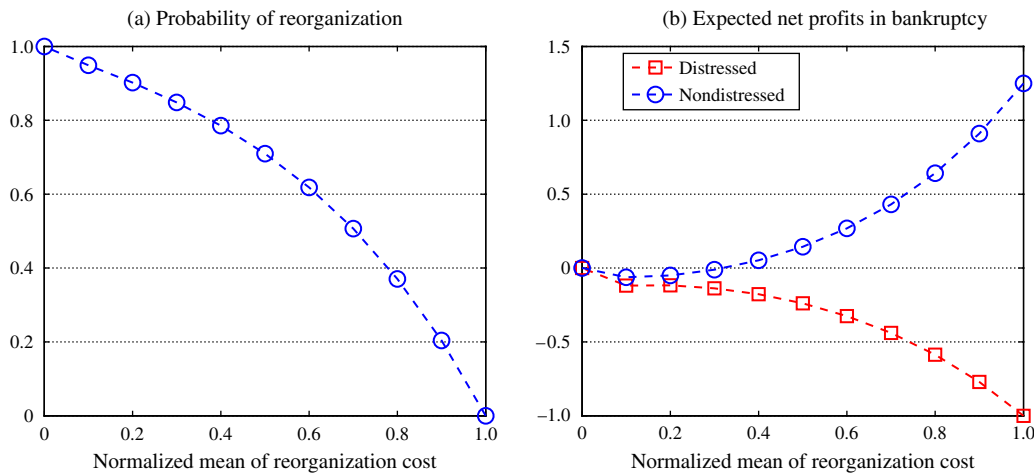
Notes. The cost of reorganization $\tilde{C}_r$ follows an exponential distribution with mean $c_r \in [0, +\infty)$. The x axes are normalized to $1 - \exp(-\pi_c^d / c_r) \in [0, 1)$. Costless reorganization corresponds to 0, and 1 represents the scenario when the cost of reorganization is prohibitively high, and hence bankruptcy only leads to liquidation. The y axis in panel (b) represents the relative differences from the no-distress benchmark.

supply chain parties, leaving room for further efficiency enhancement. For example, instead of making two independent offers to each other, the two parties could jointly negotiate the wholesale price contract and financial payment. To distinguish this case from the previous one, all quantities have a second subscript b, which represents *bargaining*. For example, $y_{r,b}^s$ represents the recovery amount received by the supplier relative to liquidation (or equivalently, the no-bargaining case). If the negotiation on $\pi_{r,b}^d$ and $y_{r,b}^s$ breaks down, each firm returns to the case where π_r^d and y_r^s are determined independently. Therefore, the disagreement points in the Nash bargaining are the payoffs in the no-bargaining case.

PROPOSITION 4. *When $y_{r,b}^s$ and $w_{r,b}^d$ are determined jointly in Nash bargaining, either $w_{r,b}^d = 0$ or $y_{r,b}^s = L^s$.*

The previous result reveals that when the supplier is also a creditor of the bankrupt firm, the optimal reorganization plan leads to only one of two following scenarios: the supplier's financial claim is fully repaid or the wholesale price is reduced to the supplier's marginal cost. Compared to the case when the supplier is not a creditor, the additional financial linkage between the two parties further increases the likelihood of reorganization and supply chain efficiency. This result provides a possible explanation for why financing is commonly seen between supply chain partners.

To summarize, in bankruptcy, the supplier lowers the wholesale price of the bankrupt firm to improve the chance of reorganization, always lowering its own profit and possibly the profit of the nondistressed competitor. This recourse creates intricate behavior in the prebankruptcy period, which we discuss in the

next section. For tractability, we confine the following sections to the base model where the supplier is not a creditor, which does not change our results qualitatively.

6. Balancing Three Supply Chain Effects

Moving to the prebankruptcy period, in the endogenous differentiated pricing case, the supplier chooses w_1^d and w_1^n to maximize its long-run profit $\Pi^s = w_1^d q_1^d + w_1^n q_1^n + \pi_2^s$, in which q_1^d and q_1^n follow the downstream firms' response functions in §4. Intuitively, the supplier chooses wholesale prices by balancing three forces: its first-period profit from the distressed firm ($w_1^d q_1^d$), that from the nondistressed firm ($w_1^n q_1^n$), and its second-period profit (π_2^s). Similar to the definition of δ^n in §4, we define the (marginal) *supplier impact* $\delta^s = -\partial \pi_2^s / \partial \pi_1^d$. Since $\delta^s = f(\alpha_b)(\pi_b^s - \pi_c^s) < 0$, the supplier has the incentive to grant concessions to the distressed firm in the first period to lower the probability of bankruptcy, similar to bailing out the bankrupt firm in the second period. Therefore, one may contemplate that the supplier should behave similarly to the situation of bankruptcy with the bail-out effect.

These intuitive conjectures turn out not to be the case. In contrast, as shown in Proposition 5, the supplier's choice of optimal first-period wholesale prices is influenced by intricate dynamics between the three firms beyond the predation and bail-out effects. For notational convenience, we further define $\epsilon^n = -\pi_1^d(\partial \delta^n / \partial \pi_1^d)$ as the *second-order competitor impact*, and $\delta^M = \delta^s + \epsilon^n / 1 + \delta^n / 2 - \epsilon^n$ as the (scaled) *total supplier impact*, consisting of direct supplier impact (δ^s), and ϵ^n, that, as shown later, can be interpreted as an indirect supplier impact.

PROPOSITION 5. *In the prebankruptcy period, the supplier offers wholesale prices:*

$$w_1^d = \left(1 + \frac{2\delta^M}{6 - \delta^n + 4\delta^M}\right)\left(\frac{\mu_1}{2}\right) \quad and$$

$$w_1^n = \left(1 + \frac{\delta^n}{6 - \delta^n + 4\delta^M}\right)\left(\frac{\mu_1}{2}\right), \qquad (4)$$

where δ^n and δ^M are functions of π_1^d satisfying

$$\pi_1^d = \left(\frac{\mu_1^2}{6 - \delta^n + 4\delta^M}\right)^2. \qquad (5)$$

Correspondingly, the two downstream firms' quantities are $q_1^d = \mu_1/(6 - \delta^n + 4\delta^M)$ and $q_1^n = (1 + \delta^M)q_1^d$. That is, the distressed firm's market share $(1/2 + \delta^M)$ decreases in δ^M. The nondistressed firm's profit $\pi_1^n = (1 - \delta^n + \delta^M)(1 + \delta^M)\pi_1^d$. The supplier's first-period profit is $\pi_1^s = [6 - \delta^n + 2\delta^M(4 + \delta^M)]\pi_1^d$.

To better understand the previous results, we construct three hypothetical auxiliary scenarios to isolate different drivers behind the supplier's decisions. The first hypothetical scenario assumes that the competitor is myopic, that is, its objective in the first period is to maximize π_1^n. Obviously, this scenario leads to $\delta^n = 0$ and $\epsilon^n = 0$, allowing us to single out the bailout effect ($\delta^s < 0$). This scenario confirms that the implication of the bail-out effect before bankruptcy is consistent with that in bankruptcy. Specifically, the supplier lowers the distressed firm's wholesale price w_1^d to lower the probability of bankruptcy and minimize the total bail-out cost. The nondistressed firm's wholesale price remains the same as the no-distress benchmark because the supplier has no incentive to deviate w_1^n from the no-distress benchmark when the nondistressed firm is myopic. However, facing a rival with lower cost, the nondistressed firm's first-period profit, $\pi_1^n = (1 + \delta^s)^2\mu_1^2/(6 + 4\delta^s)^2$, decreases as the bailout effect is stronger. In summary, the bail-out effect benefits the distressed firm but hurts its competitor.

Similarly, assuming that the supplier is myopic, hence, only maximizing π_1^s, allows us to mute the bail-out effect ($\delta^s = 0$). We further consider two subscenarios. First, when $|\delta^n| \gg |\epsilon^n| \approx 0$, the predation effect is singled out. Since $\epsilon^n = \pi_1^d f'(\alpha_b)(\pi_b^n - \pi_c^n)$, the previous condition technically corresponds to $f(\alpha_b) \gg \pi_1^d f'(\alpha_b)$. Recall that §4 concludes that the predation effect ($\delta^n > 0$) lends the nondistressed firm a competitive advantage before bankruptcy as its more aggressive best-response quantity leads to a larger market share. However, Proposition 5 shows that, with pricing power, the supplier can take advantage of this aggressive quantity response to adjust wholesale prices to *balance* the order quantities from the two downstream firms, leading to $q_1^n = q_1^d$. For example, when $\delta^n > 0$, the supplier raises w_1^n, leading to $w_1^n >$

$\mu_1/2 = w_1^d$, and consequently, $\pi_1^d = \mu_1^2/(6 - \delta^n)^2 > (1 - \delta^n)\mu_1^2/(6 - \delta^n)^2 = \pi_1^n$. That is, in the first period, the predation effect actually benefits the distressed firm and hurts the nondistressed firm. In this sense, with endogenous pricing, the predation effect smoothes out the two downstream firms' profits over the two periods so that a second-period gain is always associated with first-period loss and vice versa. This is completely opposite to the passive pricing case where the nondistressed firm benefits in both periods. Finally, note that the supplier's first-period profit $\pi_1^s = \mu_1^2/6 - \delta^n$, greater than the no-distress benchmark. That is, one customer's financial distress may be a positive externality to the supplier when downstream competition is present.

Last, consider the case in which ϵ^n is significantly greater than δ^n. By definition, ϵ^n captures the changes in the predation effect. With $\epsilon^n > 0$, the predation effect becomes stronger as the bankruptcy risk increases (π_1^d decreases). Because the supplier benefits from a stronger predation effect, this effect provides an incentive to *abet* the nondistressed firm's predatory behavior by pushing the distressed firm into bankruptcy. In this sense, ϵ^n reflects the impact of the distressed firm's bankruptcy on the supplier through an indirect channel, the nondistressed competitor, creating an indirect supplier impact as interpreted from the definition of δ^M. This impact generates the third supply chain effect: the *abetment* effect. Indeed, for $\epsilon^n > 0$, the wholesale prices are $w_1^d > w_1^n = \mu_1/2$. That is, the supplier creates a cost disadvantage to the distressed firm. This leads to $\pi_1^d = (1 - \epsilon^n)^2\mu_1^2/(6 - 2\epsilon^n)^2 < \mu_1^2/(6 - 2\epsilon^n)^2 = \pi_1^n$, revealing that the abetment effect benefits the nondistressed firm but hurts the distressed firm. Finally, note that $\pi_1^s = \mu_1^2/6 + 2(\epsilon^n)^2/(3 + 2\epsilon^n)$ is less than the no-distress benchmark. Therefore, the abetment effect alone actually hurts the supplier. However, it benefits the supplier indirectly by strengthening the predation effect. This mechanism reveals a fundamental difference between the abetment effect and the bail-out and predation effects, both of which reflect the direct consequence of the distressed firm's bankruptcy.

Although the three supply chain effects are singled out separately in the three hypothetical scenarios, they coexist in practice and their magnitudes are interdependent. To illustrate the aggregate force of the three effects, we conduct a numerical study with results presented in Figures 4 and 5. The parameters are as follows. $\mu_1 = \mu_2$; $\tilde{\alpha}$ follows a normal distribution with $\mathbb{E}[\tilde{\alpha}] = 0$ and $\sigma = \pi_a^d/2$. The distressed firm's starting net asset $A = -\frac{1}{2}(\pi_a^d + \pi_c^d)$. The axes represent the normalized mean of the cost of reorganization following an exponential distribution as described in Figure 3.

Figure 4   (Color online) First-Period Wholesale Prices and Probability of Bankruptcy Under Endogenous Differentiated Pricing
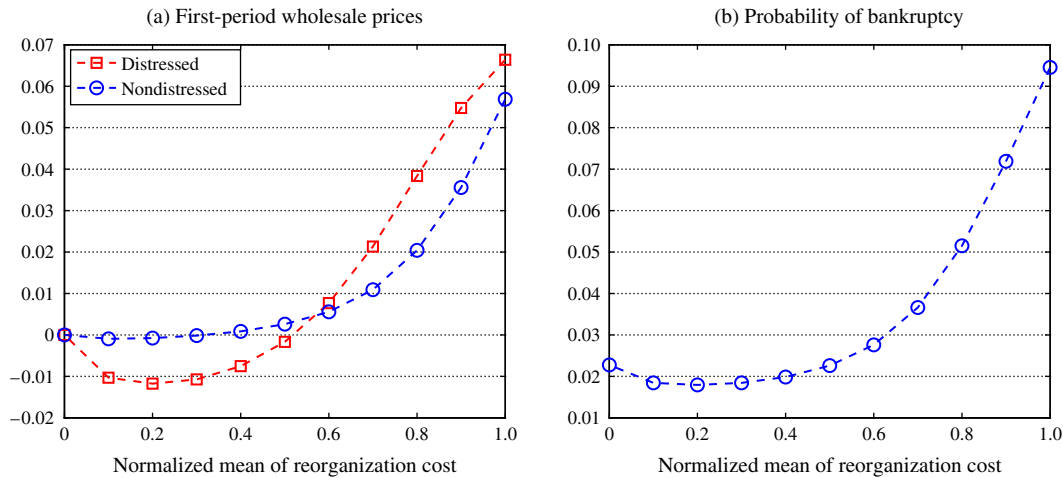
Note. The y axis in panel (a) is presented as the relative differences between the plotted quantity and the corresponding no-distress benchmark.

Figure 4(a) confirms that δ^n plays a pivotal role in w_1^n. Specifically, w_1^n is higher than the no-distress benchmark when the cost of reorganization is large and the nondistressed firm benefits in bankruptcy ($\delta^n > 0$) and lower when bankruptcy is a negative externality ($\delta^n < 0$). On the other hand, w_1^d is determined by balancing the bail-out effect and the abetment effect: when the cost of reorganization is low, the bail-out effect dominates; hence, the supplier has incentive to lower w_1^d. As reorganization becomes more costly, the abetment effect becomes more prominent; thus, the supplier starts to squeeze the distressed firm to induce a larger quantity from the nondistressed competitor. This result provides an explanation for why suppliers may not want to lower the price to a distressed buyer before bankruptcy, even though bankruptcy hurts the supplier directly.

Figure 4(b) shows that the firm's probability of bankruptcy is sensitive to the cost of reorganization, ranging from 2% under costless reorganization to 10% when the cost of reorganization is prohibitively high. Further, the probability is not necessarily monotone in the cost. The trend is consistent with the cost difference between the two competitors ($w_1^n - w_1^d$) in Figure 4(a). When the cost of reorganization is small, the probability of bankruptcy decreases with the cost of reorganization, as the bail-out effect dominates; however, the trend is reversed as reorganization becomes more costly and the abetment effect becomes more important.

As a result of the wholesale prices, the three firm's profits and consumer surplus are also influenced by the cost of reorganization, as shown in Figure 5. First, note that as the cost of reorganization increases, the supplier benefits from the predation effect, whereas the competitor benefits from the abetment effect. The fact that the supplier's total profit could be higher

than the no-distress benchmark again confirms that, in the presence of downstream competition, facing a distressed customer actually benefits the supplier. On the other hand, the distressed firm and consumers benefit when the cost of reorganization is relatively low (but not zero). This is because in this region the supplier grants more concessions to the distressed firm, and the lowered wholesale price and larger quantity are passed to consumers. The fact that a less costly reorganization could actually dominate costless reorganization is because the overall benefit of lower wholesale prices dominates the cost in bankruptcy, which includes the possibility of liquidation for consumers and the distressed firm and the cost of reorganization.

7. Uniform Pricing: The Power of Commitment

The last two sections show how the risk of bankruptcy and the cost of reorganization influence different parties' profitability when the supplier can charge different wholesale prices to the two firms. However, under certain circumstances, the supplier may prefer or be restricted to offer identical prices to both firms for various reasons. Competitors may also demand equal treatment when the distressed firm is in bankruptcy. For example, according to Milliot and Rosen (2011), during negotiations between Borders and major publishers when the bookstore chain was close to bankruptcy, its major competitor Barnes and Nobles raised questions about the fairness and demanded that publishers "offer the same terms to all booksellers." In this section, we examine how the supply chain dynamics change when such a uniform pricing constraint is imposed.

Figure 5   (Color online) Long-Run Performance Under Endogenous Differentiated Pricing
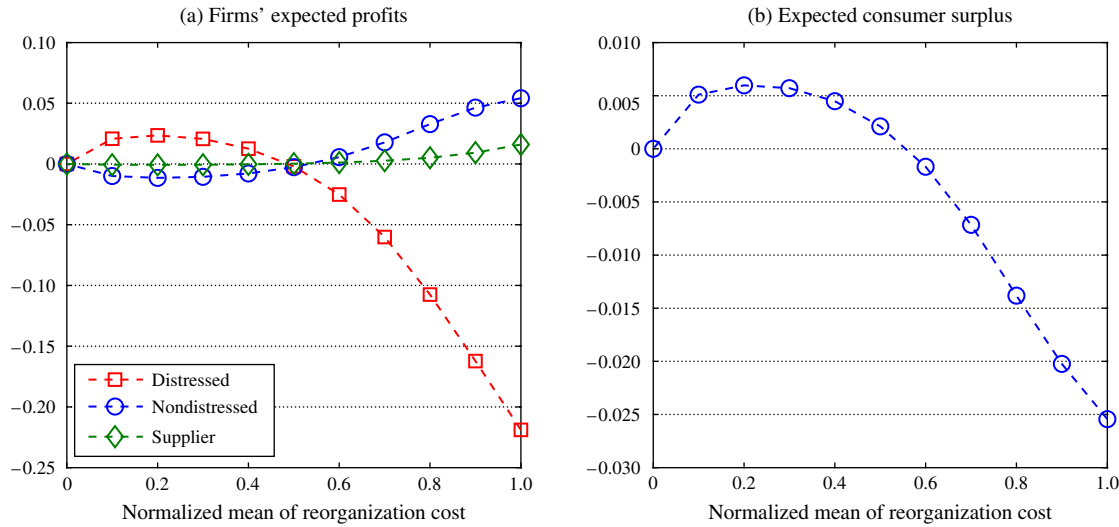
Note. The *y* axes are presented as the relative differences between the plotted quantity and the corresponding no-distress benchmark.

We again conduct the analysis backward in time. Similar to the actions in §5, in bankruptcy, the supplier chooses w_r to maximize its surplus in reorganization over liquidation, $G(\pi_r^d)(\pi_r^s - \pi_l^s)$, subject to $\pi_r^s = w_r(q_r^d + q_r^n)$, $q_r^d = q_r^n = \frac{1}{3}(\mu_2 - w_r)$, and $\pi_l^s = \mu_2^2/16$.

Proposition 6. *In bankruptcy, the supplier offers wholesale price* $w_r = \mu_2 - 3\sqrt{x^*}$, *where* $x^* = \arg\max_{x \in [\mu_2^2/36,\, \mu_2^2/16]} G(x)(\mu_2\sqrt{x} - 3x - \mu_2^2/16)$. *When $G(x)$ is concave for $x \geq \mu_2^2/36$,*

$$x^* = \frac{\mu_2^2}{36}\left[1 + \frac{(x^* - \mu_2^2/48)g(x^*)}{G(x^*) + (x^* + \mu_2^2/48)g(x^*)}\right]^2. \quad (6)$$

Compared with Proposition 2, the previous result shows that the bankrupt firm receives less of a concession (smaller π_r^d) under uniform pricing than under differentiated pricing, leading to a higher probability of liquidation. This is because the supplier faces larger costs to bail out the bankrupt firm as it loses the power of differentiating the two downstream firms in bankruptcy. Consequently, the competitor is always better off when the distressed firm files for bankruptcy. Moreover, compared with the no-distress benchmark, the nondistressed competitor actually benefits from the distressed firm's successful reorganization by free-riding the lower price faced by the bankrupt firm.

Corollary 2. *As the random reorganization cost $\tilde{C}_r$ increases (according to the monotone likelihood ratio property), π_r^d and π_r^n increase; w_r^d, π_r^s, and π_b^s decrease.*

Corollary 2 suggests that more costly reorganization inevitably generates a stronger predation effect. The supplier, on the other hand, facing higher costs in bankruptcy, also has a stronger incentive to bail out the firm in the first period.

Moving to the first-period decisions, as in the previous notation, we define δ_U^s and ϵ_U^n as the (marginal) supplier impact and second-order competitor impact, and $\delta_U^M = (\epsilon_U^n + \delta_U^s)/(1 + \delta_U^n/2 - \epsilon_U^n)$, except that all terms now correspond to those under uniform pricing. Simple algebra shows that facing w_1, the downstream firms' first-period production quantities are $q_1^d = 1/(3 + \delta_U^n)(\mu_1 - w_1)$ and $q_1^n = (1 + \delta_U^n/3 + \delta_U^n)(\mu_1 - w_1)$. This suggests that the market share is determined solely by the competitor impact (δ_U^n) instead of the (total) supplier impact (δ^M) as in §6. This is because the uniform pricing constraint strips the supplier's power to balance its sales through the two channels by adjusting their prices separately and, hence, converts the market share back to the passive pricing case. Facing best-response demand functions q_1^d and q_1^n, the supplier chooses the optimal wholesale price according to the following proposition.

Proposition 7. *The optimal wholesale price under uniform pricing is*

$$w_1 = \left(1 + \frac{\delta_U^M}{6 + 2\delta_U^n + \delta_U^M}\right)\left(\frac{\mu_1}{2}\right), \quad (7)$$

*where π_1^d, δ_U^n, and δ_U^M satisfy*

$$\pi_1^d = \left(\frac{\mu_1}{6 + 2\delta_U^n + \delta_U^M}\right)^2. \quad (8)$$

Accordingly, $\pi_1^n = (1 + \delta_U^n)\pi_1^d$ and $\pi_1^s = (2 + \delta_U^n)(3 + \delta_U^n + \delta_U^M)\pi_1^d$.

Comparing Proposition 7 with Proposition 5, the first observation is that the optimal uniform price w_1 shares some similarity with w_1^d under the differentiated pricing case in that the bail-out effect and

Figure 6 (Color online) The First-Period Wholesale Price and Probability of Bankruptcy Under Endogenous Uniform Pricing
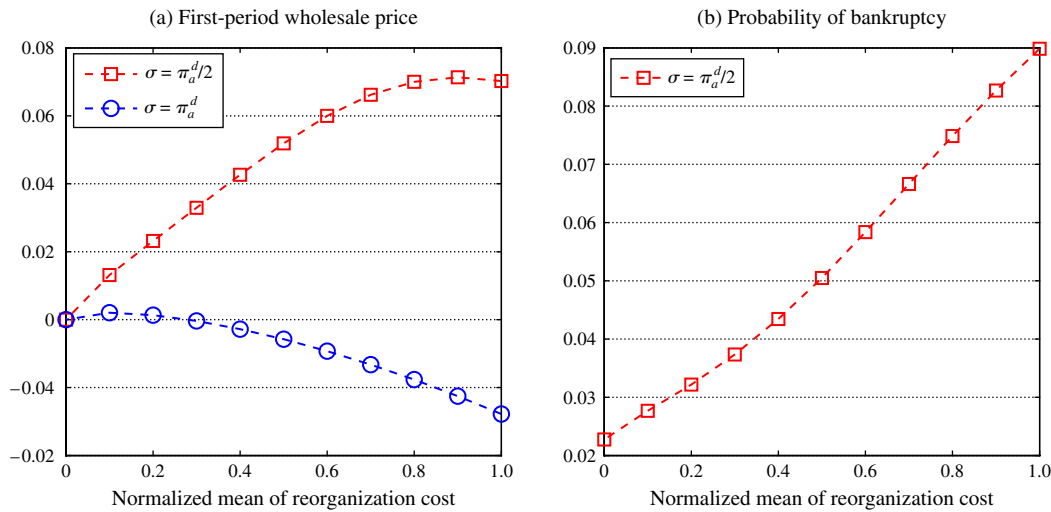
Notes. Parameters: $\mu_1 = \mu_2$; $\tilde{\alpha}$ follows a normal distribution with $\mathbb{E}[\tilde{\alpha}] = 0$ and $A = -\frac{1}{2}(\pi_a^d + \pi_c^d)$. The y axis in panel (a) is presented as the relative differences from the no-distress benchmark.

the abetment effect play the major roles in determining the optimal price: when the bail-out effect dominates the abetment effect, that is, $\epsilon_U^s > |\delta_U^s|$, w_1 is higher than the no-distress benchmark as the supplier increases w_1 to profit more from the nondistressed firm. This is confirmed in the case of $\sigma = \pi_a^d/2$ of Figure 6(a), in which the abetment effect is more significant relative to the bail-out effect as the cost of reorganization increases. Correspondingly, the probability of bankruptcy also increases in the cost of reorganization, as shown in Figure 6(b). On the other hand, when the bail-out effect dominates ($\epsilon_U^s < |\delta_U^s|$), it is more crucial for the supplier to increase the distressed firm's likelihood of survival; hence, the supplier lowers w_1 as the cost of reorganization increases as shown in the case of $\sigma = \pi_a^d$.

Under the optimal wholesale price contract, the three firms' profits are shown in Figure 7(a). Comparing these results with Figure 5(a), three phenomenon stand out. First, the distressed firm's profit is lower than that in the differentiated pricing case especially as the cost of reorganization becomes large. This result is intuitive as uniform pricing increases the supplier's cost to bail out the distressed firm. Furthermore, recall that in the differentiated pricing case, the predation effect leads to a cost advantage for the nondistressed firm. However, this advantage disappears because of the uniform pricing constraint. Instead, employing the hypothetical scenario that isolates the predation effect, ($\delta_U^n > 0$, $\delta_U^s = \epsilon_U^n = 0$), one can show that $\pi_1^d = \mu_2^2/(6 + 2\delta_U^n)^2$, decreasing in δ_U^n. That is, the predation effect has a negative impact on the distressed firm's profit, reverting back to the passive supply scenario.

Considering the nondistressed firm's profit, despite the fair treatment it receives, the nondistressed com-

petitor could face a lower profit than in the differentiated pricing case. This result is mainly driven by the higher wholesale price faced by the nondistressed firm.

Finally, even though the supplier loses its power to differentiate the two downstream buyers through pricing, it could earn more profit in the long run. Because the uniform pricing constraint always hurts the supplier in bankruptcy, the benefit comes in the prebankruptcy period. This is because this constraint serves as a commitment to the nondistressed firm to be treated fairly in bankruptcy. This commitment in turn strengthens the predation effect. Employing the hypothetical scenario that isolates the predation effect ($\delta_U^n > 0$ and $\delta_U^s = \epsilon_U^n = 0$), one can find that $\pi_1^s = (2 + \delta_U^n)\mu_1^2/4(3 + \delta_U^n)$, increasing in δ_U^n. That is, a stronger predation effect benefits the supplier. As the numerical study shows, the benefit from this commitment dominates the in-bankruptcy harm, leading to an overall benefit to the supplier.

This benefit, however, comes with a cost to consumers. As shown in Figure 7(b), consumers in general are hurt in the presence of bankruptcy risk, which follows for two reasons: first, in the prebankruptcy period, to benefit from the nondistressed firm's inflated demand, the supplier increases the first-period price, hurting consumers; second, in bankruptcy, it is more costly for the supplier to rescue the bankrupt firm, leading to a higher probability of liquidation that also hurts consumers. In this sense, our model provides an additional explanation for the argument that price discrimination does not necessarily hurt consumers. Indeed, when the two downstream buyers are in different financial situations, treating the two firms differently can in fact benefit consumers.

Figure 7 (Color online) Long-Run Performance Under Endogenous Uniform Pricing
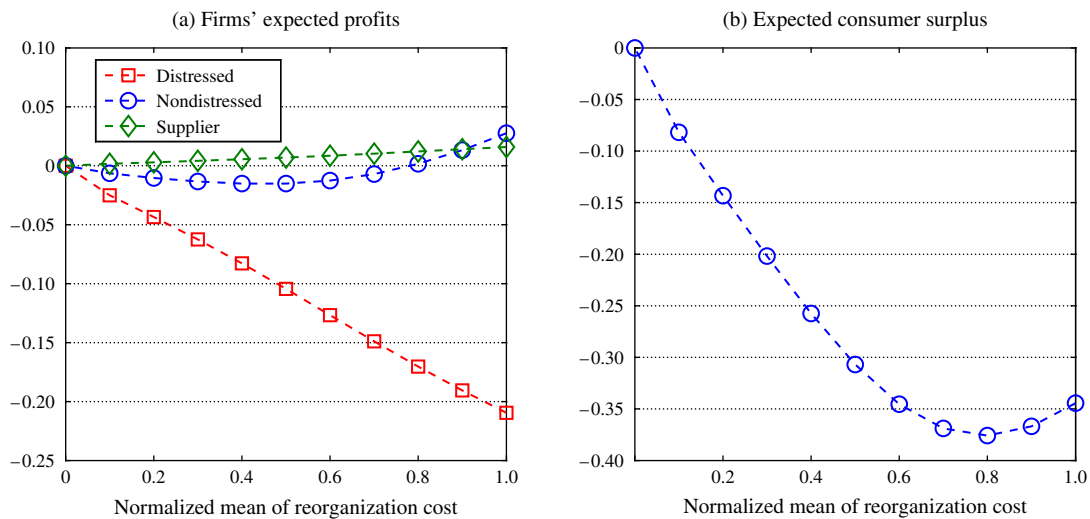
Notes. Parameters used are the same as in Figure 5. The *y* axes are presented as the relative differences from the no-distress benchmark.

8. Conclusion

Bankruptcy is an important business decision. With the possibility of reorganization, the bankrupt firm can be rehabilitated and re-emerge as a stronger competitor. The possibility of bankruptcy and the following reorganization has a significant impact on not only the firm that faces bankruptcy risk but also other operationally linked firms. In this paper, we focus on the mutual influence of bankruptcy risk and supply chain dynamics. We identify three supply chain effects of bankruptcy and find that they capture an intricate interplay among the different parties in the supply chain.[13]

First, under the predation effect, the nondistressed firm competes aggressively before bankruptcy, forming an important source of indirect cost of financial distress to the distressed firm. When supply price is less responsive to the firm's financial situation, this effect benefits the nondistressed firm before bankruptcy as the market share it gains overcompensates the margin loss. However, a supplier with strong pricing power could take advantage of the competitor's inflated demand and extract this benefit. The supplier could further strengthen the predation effect and enjoy higher profit if it can credibly commit to uniform pricing in bankruptcy.

Second, the bail-out effect dictates that the supplier has the incentive to lower the distressed firm's whole-

sale price both before and after bankruptcy. This effect becomes stronger when the supplier is also a creditor of the distressed firm, justifying the exclusivity rule in Chapter 11. Depending on whether the supplier can treat the two firms differently, the bail-out effect could hurt or benefit the nondistressed competitor. In this sense, one firm's bankruptcy could actually become a negative externality to its competitor.

Finally, the abetment effect arises from the supplier's incentive to profit more from the nondistressed firm. Consequently, the supplier creates a cost disadvantage to the distressed firm, helping the nondistressed firm to push the distressed firm into bankruptcy. This effect may explain why the supplier does not grant concessions to the buyer before bankruptcy but does so afterwards.

Depending on the relative strength of these effects, the possibility of bankruptcy could also benefit consumers by redistributing the power between supply chain partners and intensifying competition. These effects, combined with their impact on firms' profitability, convey important policy implications. Although previous research evaluates the efficiency of a bankruptcy mechanism within a firm, this paper shows that, when assessing this efficiency, it is important to take into consideration the responses and performance of other players in the supply chain. For example, when the interaction between the supplier and the competitor is strong, less costly reorganization is generally more efficient at the chain and consumer level; when the interaction is weak, more costly reorganization could benefit consumers and be more efficient at the societal level. Finally, as §7 shows, stripping the power of price differentiation from the supplier may actually hurt consumers, which

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[13] Some, but not all, effects may also arise under retail competition scenarios when firm exit is a possibility. For example, if one of the downstream firm may credibly commit to offer lower prices for several periods, which drives the competitor's expected discounted long-term profit to be negative, the competitor may withdraw from the market. This example induces the predation effect, or bail-out effect, but not both simultaneously. However, because bankruptcy is never ex post optimal, all these effects may not be replicated by intrafirm decision making.

provides an additional justification of the current trend of a restrictive interpretation of the Robinson–Patman Act.

As a first attempt to study the impact of bankruptcy in the supply chain context, our paper is not without limitations. First, although we consider both the role played by the competitor and supplier, we do not model consumers' reactions to bankruptcy. Intuitively, sophisticated consumers could expect that a bankrupt firm produces goods of lower quality. Therefore, besides the predation effect, the demand faced by the distressed firm may also be influenced by consumers.[14] Second, to focus on the operational strategies of different supply chain players, we treat reorganization as an instantaneous process. However, in practice, reorganization can be lengthy; hence, operational decisions within the process could be a promising research direction. Finally, we treat the firms' financial obligations as given and assume only one downstream firm is in distress. However, one may argue that all parties in the supply chain may choose an optimal financial structure according to the cost of reorganization and supply chain structure, and these endogenous leverage decisions remain as a question to be answered.

Supplemental Material

Supplemental material to this paper is available at http://dx.doi.org/10.1287/mnsc.2014.2079.

Acknowledgments

Appendix A. List of Notation

Table A.1 summarizes a list of notation. In the paper, superscript i represents the firm. Specifically, $i = d$ for the *distressed* firm, $i = n$ for the *nondistressed* firm, $i = s$ for the *supplier*. Subscript j is used to represent the scenario the firm is in: $j = 1$ for the *first period*, $j = a$ for the *no-distress benchmark in the first period*, $j = 2$ for the *second period* in expectation, $j = c$ for the second period without bankruptcy (*continuation*), $j = l$ for *liquidation*, $j = r$ for *reorganization*, $j = b$ for *bankruptcy* in expectation, and $j = r, b$ for *reorganization with Nash bargaining* (in §5.1).

[14] Birge et al. (2014) study a retailer's operational decisions by explicitly modeling the customer's strategic behavior in anticipation of liquidation sales and the impact on the retailer's demand.

Table A.1   Notation

A	The net asset (asset minus liability) of the distressed firm at the beginning of the first period
π_j^i	The profit of firm i in period/scenario j
Π^i	The long-run profit of firm i
Π_e^d	The shareholder value of the distressed firm in the beginning of the first period
μ_j	The jth period demand intercept, $j = 1, 2$
p_j	The market clearing price in scenario $j = 1, c, r, l$
q_j^i	The production/order quantity of firm i in scenario j
$\tilde{\alpha}$	The random shock to the distressed firm in the first period, following CDF $F(\cdot)$ and PDF $f(\cdot)$. $\mathbb{E}[\tilde{\alpha}] = 0$. α represents the realization of $\tilde{\alpha}$
$\tilde{C}_r$	The random cost of reorganization in bankruptcy, with support $[0, +\infty)$, following CDF $G(\cdot)$ and PDF $g(\cdot)$; C_r represents the realization of $\tilde{C}_r$
α_b	The bankruptcy threshold; the distressed firm files for bankruptcy when $\alpha < \alpha_b$
Ψ	The probability of bankruptcy, $\Psi = F(\alpha_b)$
Φ	The probability of reorganization conditional on bankruptcy, $\Phi = G(\pi_1^d)$
δ^n	The marginal competitor impact, $\delta^s = -\partial \pi_2^n / \partial \pi_1^d$
δ^s	The marginal supplier impact, $\delta^s = -\partial \pi_2^s / \partial \pi_1^d$
ϵ^n	The second-order competitor impact, $\epsilon^n = -(\pi_1^d) \partial \delta^n / \partial \pi_1^d$
δ_U^n, δ_U^s, and ϵ_U^n	The corresponding impacts under *uniform* pricing
L^s	The amount the bankrupt firm owes the supplier upon bankruptcy
y_r^s	The amount chosen by the bankrupt firm repaid to the supplier without Nash bargaining
$y_{r,b}^s$	The amount chosen by the bankrupt firm repaid to the supplier with Nash bargaining

Appendix B. Proofs

Lemma B.1. *To maximize its long-run profit or equity value, the distressed firm's first-period objective is to maximize π_1^d.*

Proof of Lemma B.1. We first consider the case where the distress firm's objective is to maximize its long-run profit $\Pi^d = \pi_1^d + \pi_c^d - \Psi(\pi_c^d - \pi_b^d)$. Since $\Psi = F(-(A + \pi_1^d + \pi_c^d))$, and π_c^d is independent of π_1^d, Ψ decreases in π_1^d. Therefore, Π^d decreases in π_1^d.

Similarly, when the distressed firm's objective is to maximize its equity value $\Pi_e^d = \int_{\alpha_b}^{+\infty} (\pi_1^d + \pi_c^d + \alpha + A) \, dF(\alpha)$, where $\alpha_b = -(A + \pi_1^d + \pi_c^d)$, we have $d\Pi_e^d/d\pi_1^d = F(\alpha_b) > 0$. Therefore, to maximize Π_e^d, the distressed firm should focus on maximizing π_1^d in the first period. $\square$

Proof of Proposition 1. First, the distressed firm's first-period production decision is the same as the no-distress benchmark. Second, as the distressed firm will always be reorganized without any cost, we have $\pi_r^d = \pi_c^d$ and the probability of reorganization $\Phi = 1$. That is, the first-period decisions of supplier(s) and competitor(s) do not influence their second-period payoffs. Therefore, all first-period decisions are independent of whether the distressed firm files for bankruptcy or not; hence, they are the same as those under the no-distress benchmark. $\square$

Proposition B.1. *When $xf'(-x - A - \pi_c^d) < 3/2(\pi_b^n - \pi_c^n)$ for $x \in (0, \pi_a^d)$, the unique quantity equilibrium (q_1^d, q_1^n) is*

$$q_1^d = q_a^d - \left(\frac{\delta^n}{3 + \delta^n}\right)q_a^d \quad and \quad q_1^n = q_a^n + \left(\frac{2\delta^n}{3 + \delta^n}\right)q_a^d, \quad \text{(B1)}$$

where δ^n and π_1^d are jointly determined by $(1 + \delta^n/3)^2 \pi_1^d = \pi_a^d$.

PROOF OF PROPOSITION B.1. Equation (B1) can be obtained by combining the two best-response functions. Note that $q_1^d = \sqrt{\pi_1^d}$. Replacing q_1^d and q_1^n by π_1^d leads to $(1 + \delta^n/3)^2 \pi_1^d = \pi_a^d$.

To show the equilibrium exists, define function $H(\pi_1^d) = \pi_1^d (1 + \delta^n/3)^2 - \pi_a^d$. Obviously, $\pi_1^d \in (0, \pi_a^d)$ is an equilibrium if and only if $H(\pi_1^d) = 0$. Note that $H(\pi_a^d) > 0$ and $H(0) < 0$. Therefore, there *exists* at least one $\pi_1^d \in (0, \pi_a^d)$ such that $H(\pi_1^d) = 0$. To show the equilibrium is unique, note that when $xf'(-x - A - \pi_c^d) < 3/2(\pi_b^n - \pi_c^n)$ for $x \in (0, \pi_a^d)$, we have that for all $\pi_1^d \in (0, \pi_a^d)$ such that $H(\pi_1^d) = 0$, $H'(\pi_1^d) > 0$. Therefore, the solution, as well as the corresponding equilibrium, is unique. □

COROLLARY B.1. *When π_b^n increases (or equivalently, π_b^d decreases), π_1^d and q_1^d decrease, and the probability of bankruptcy, q_1^n, and the total quantity $q_1^d + q_1^n$ increase.*

PROOF OF COROLLARY B.1. Define $H(\pi_1^d, \pi_b^n) = \pi_1^d [3 + (\pi_b^n - \pi_c^n) f(-A - \pi_c^d - \pi_1^d)]^2 - 9\pi_a^d$. Obviously, $H(\pi_1^d, \pi_b^n) = 0$ defines π_1^d as an implicit function of π_b^n. Proposition B.1 shows that $\partial H/\partial x > 0$ for $H(x, \pi_b^n) = 0$. On the other hand, $\partial H/\partial \pi_b^n = 2\pi_1^d f(-A - \pi_c^d - \pi_1^d)(3 + \delta^n) > 0$. Therefore, π_1^d decreases in π_b^n. Since Ψ is decreasing in π_1^d, it increases in π_b^n. Since $f(\cdot)$ is nondecreasing, Ψ also increases in π_b^n, so is δ^n. Therefore, when π_b^n increases, q_1^d decreases and q_1^n increases. Finally, the total first-period quantity $q_1^d + q_1^n = q_a^d + q_a^n + (\delta^n/3 + \delta^n)q_a^d$, which increases in δ^n and hence increases in π_b^n. □

COROLLARY B.2. *The nondistressed competitor's first-period profit is greater than the no-distress benchmark when $\delta^n > 3$, and it increases in δ^n for $\delta^n \leq 1$.*

PROOF OF COROLLARY B.2. For π_1^n, note that

$$\pi_1^n = \pi_a^n + \left(\frac{\delta^n}{3 + \delta^n}\right)\sqrt{\pi_a^d \pi_a^n} - 2\left(\frac{\delta^n}{3 + \delta^n}\right)^2 \pi_a^d. \quad (B2)$$

Therefore, π_1^n is greater than π_a^n for moderate δ^n ($\delta^n < 3$), and it increases in δ^n for $\delta^n \leq 1$. □

PROOF OF PROPOSITION 2. Because the bankrupt firm holds private information about its realized cost of reorganization, the supplier faces the same problem as in Samuelson (1984). Therefore, the supplier's optimal strategy is to offer profit π_r^d to the distressed firm so as to maximize its expected profit $(1 - \Phi)\pi_l^s + \Phi\pi_r^s$, or equivalently, its expected surplus under reorganization, $\Phi(\pi_r^s - \pi_l^s)$, where $\pi_l^s = \mu_2^2/8$. To maximize $G(\pi_r^d)(\pi_r^s - \pi_l^s)$, we rewrite the supplier's optimization problem as a function of π_r^d, or equivalently, q_r^d, noting that under Equation (1), $\pi_r^d = (q_r^d)^2$. To do so, we rearrange Equation (1) to write w_r^d and w_r^n as functions of q_r^d and q_r^n: $w_r^d = \mu_2 - 2q_r^d - q_r^n$ and $w_r^n = \mu_2 - 2q_r^n - q_r^d$. Substituting them into the supplier's profit function under reorganization $\pi_r^s = w_r^d q_r^d + w_r^n q_r^n$ leads to $\pi_r^s = \mu_2(q_r^d + q_r^n) - 2(q_r^d)^2 - 2(q_r^n)^2 - 2q_r^d q_r^n$. Setting $\partial \pi_r^s/\partial q_r^n = 0$, we have $q_r^n = \mu - 2q_r^d/4$. Substituting this condition to $w_r^n = \mu_2 - 2q_r^n - q_r^d$ leads to $w_r^n = \mu_2/2$. Substituting q_r^n and w_r^n into π_r^s, we have: $\pi_r^s = \mu_2^2/8 + \mu_2/2\sqrt{\pi_r^d} - \frac{3}{2}\pi_r^d$. Therefore, the supplier's objective is to maximize $G(\pi_r^d)[\mu_2/2\sqrt{\pi_r^d} - \frac{3}{2}\pi_r^d]$ subject to $\pi_r^d \in [\mu_2^2/36, \mu_2^2/9]$, where $\pi_r^d = \mu_2^2/9$ leads to $\pi_r^s = \mu_2^2/8 = \pi_l^s$.

Note that $(\mu_2/2\sqrt{\pi_r^d} - \frac{3}{2}\pi_r^d)$ is concave and decreasing in π_r^d, and $G(\pi_r^d)$ is increasing in π_r^d. Therefore, when $G(\pi_r^d)$ is also concave in π_r^d, the supplier's objective function, $G(\pi_r^d)(\mu_2/2\sqrt{\pi_r^d} - \frac{3}{2}\pi_r^d)$, is concave in π_r^d, and hence the first order condition guarantees global optimality. Equation (3) follows immediately. □

PROOF OF COROLLARY 1. We can show that the objective function is log-supermodular, hence the monotonic comparative statics follow for π_r^d. The monotonicity of π_r^s follows directly from the Envelope Theorem and the fact that $G(\pi_r^d)$ decreases as reorganization becomes more costly under fixed π_r^d. □

PROOF OF PROPOSITION 3. This result is independent of the sequence of the decisions, that is, whether the supplier or the bankrupt firm moves first, or two parties move simultaneously. Without loss of generality, we prove the proposition by assuming that the supplier moves first by offering w_r^d. Clearly, after receiving this contract (w_r^d), the bankrupt firm has no incentive to offer y_r^s higher than 0. Anticipating this, the supplier chooses the same wholesale prices as if there is no financial linkage between the two parties. □

PROOF OF PROPOSITION 4. According to the setting, the two parties' disagreement points under Nash bargaining are $\pi_b^d = \int_0^{\pi_b^r}(\pi_b^r - x)\, dG(x)$ for the distressed (bankrupt) firm, and $\pi_b^s = \mu_2^2/8 + G(\pi_r^d)(\mu_2/2\sqrt{\pi_r^d} - \frac{3}{2}\pi_r^d)$ for the supplier. The two parties negotiate to maximize the following Nash product:

$$\left[\int_0^{\pi_{r,b}^d - y_{r,b}^s}(\pi_{r,b}^d - y_{r,b}^s - x)\, dG(x) - \pi_b^d\right]$$

$$\cdot \left[\frac{\mu_2^2}{8} + G(\pi_{r,b}^d - y_{r,b}^s)\left(\frac{\mu_2}{2}\sqrt{\pi_{r,b}^d} - \frac{3}{2}\pi_{r,b}^d + y_{r,b}^s\right) - \pi_b^s\right] \quad (B3)$$

subject to $y_{r,b}^s \in [0, L^s]$. The stated results can be proven by construction, that is, showing that any solution with $y_{r,b}^s < L^s$ and $w_{r,b}^d > 0$ is dominated by a boundary solution. □

PROOF OF PROPOSITION 5. We rewrite w_1^d and w_1^n as functions of q_1^d and q_1^n: $w_1^d = \mu_1 - 2q_1^d - q_1^n$, and $w_1^n = \mu_1 - 2q_1^n - (1 - \delta^n)q_1^d$. The distressed firm's first-period profit $\pi_1^d = (q_1^d)^2$. The bankruptcy threshold $\alpha_b = -A - (q_1^d)^2 - \pi_c^d$. Using the aforementioned equations, the supplier's long-run profit can be rewritten as

$$\Pi^s = w_1^d q_1^d + w_1^n q_1^n + \pi_2^s = \mu_1(q_1^d + q_1^n) - 2(q_1^d)^2 - 2(q_1^n)^2$$
$$- (2 - \delta^n)q_1^d q_1^n + \pi_2^s. \quad (B4)$$

Note that α_b is not related to q_1^n; therefore, setting $\partial \Pi^s/\partial q_1^n = 0$, $q_1^n = \frac{1}{4}[\mu_1 - (2 - \delta^n)q_1^d]$. Substituting this back into Π^s, and using $q_1^d = \sqrt{\pi_1^d}$,

$$\Pi^s = \left(\frac{\mu_1^2}{8} + \frac{\mu_1\sqrt{\pi_1^d}}{2} - \frac{3\pi_1^d}{2}\right)$$
$$+ \left(\frac{\delta^n}{8}\right)\left[2\mu_1\sqrt{\pi_1^d} - (4 - \delta^n)\pi_1^d\right] + \pi_2^s, \quad (B5)$$

which represents Π^s as a function of only π_1^d. As shown, Π^s includes three parts: the first part is exactly the same as

the no-distressed benchmark; the second part comes from the aggressive competition behavior from the nondistressed firm (loss from the distressed firm because of lower price, gain from the nondistressed firm because of higher price, and gain from the nondistressed firm because of higher quantity); the third part captures the supplier's consideration of the second-period profit, which is a function of π_1^d through the probability of bankruptcy. The necessary condition for π_1^d to be optimal is $d\Pi_s/d\pi_1^d = 0$:

$$\left(\frac{\mu_1}{\sqrt{\pi_1^d}} - 6\right) + \left(\frac{\delta^n}{2}\right)\left[\frac{\mu_1}{\sqrt{\pi_1^d}} - (4 - \delta^n)\right]$$
$$- \epsilon^n\left[\frac{\mu_1}{\sqrt{\pi_1^d}} - (2 - \delta^n)\right] - 4\delta^s = 0. \quad (B6)$$

Rearranging the previous equation:

$$\left[1 + \left(\frac{\delta^n}{2}\right) - \epsilon^n\right]\frac{\mu_1}{\sqrt{\pi_1^d}} - \left[6 + \delta^n\left(2 - \frac{\delta^n}{2}\right)\right.$$
$$\left. + (2 - \delta^n)\epsilon^n + 4\delta^s\right] = 0. \quad (B7)$$

Defining δ^M as in the paper, the results for π_1^d and wholesale prices follow immediately. □

Proof of Proposition 6. Similar to §6, it is more convenient to express every quantity as a function of π_r^d, the bankrupt firm's operating profit under reorganization as follows: $w_r = \mu_2 - 3\sqrt{\pi_r^d}$, $q_r^d = q^n = \sqrt{\pi_r^d}$. $\pi_r^n = \pi_r^d$, $\pi_r^s = 2\mu_2\sqrt{\pi_r^d} - 6\pi_r^d$. Obviously, for the supplier to prefer reorganization to liquidation, $\pi_r^d \leq \mu_2^2/16$. Therefore, the supplier's profit surplus in reorganization $G(\pi_r^d)(2\mu_2\sqrt{\pi_r^d} - 6\pi_r^d - \mu_2^2/8)$. Equation (6) follows from the first order condition, under the concavity condition as in Proposition 2. □

Proof of Corollary 2. The proof is similar to Corollary 1 and the detail is omitted here. □

Proof of Proposition 7. For convenience, we write all first-order quantities as functions of π_1^d: $w_1 = \mu_1 - (3 + \delta_U^n)\sqrt{\pi_1^d}$, $q_1^d = \sqrt{\pi_1^d}$, and $q_1^n = (1 + \delta_U^n)\sqrt{\pi_1^d}$. Going back to the supplier's problem, $\Pi_s = \pi_1^s + \pi_2^s$, where $\pi_1^s = w_1(q_1^d + q_1^n) = 2(\mu_1\sqrt{\pi_1^d} - 3\pi_1^d) + (\delta_U^n)[\mu_1\sqrt{\pi_1^d} - (5 + \delta_U^n)\pi_1^d]$. The previous equation suggests if the supplier only maximizes its first-period profit, it should result in a π_1^d less than the no-distress benchmark. In fact, the greater δ_U^n is, the greater π_1^d deviates from the no-distress benchmark. However, δ_U^s dictates that a larger π_1^d is favorable. To see the long-term effect, setting $d\Pi^s/d\pi_1^d = 0$,

$$\left(\frac{\mu_1}{\sqrt{\pi_1^d}} - 6\right) + \frac{\delta_U^n}{2}\left[\frac{\mu_1}{\sqrt{\pi_1^d}} - 2(5 + \delta_U^n)\right]$$
$$- \epsilon_U^n\left[\frac{\mu_1}{\sqrt{\pi_1^d}} - (5 + 2\delta_U^n)\right] - \delta_U^s = 0. \quad (B8)$$

Rearranging the first-order condition using δ_U^M leads to the expressions of π_1^d and w_1. □

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