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The Financial Implications of Supply Chain Changes

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We examine how a firm's bankruptcy affects the bank financing costs of its key suppliers. We do so by using an extensive, hand-collected data set that captures the supply chain relationships of bankrupt firms over the time period 1990–2009. Looking at a sample of more than 2,000 loan contracts, we compare the average borrowing cost of suppliers in the two years prior to the bankruptcy of a key customer to the average cost in the two years following the announced bankruptcy. We find the average loan spreads increase by roughly 20% following the customer's announced bankruptcy. These effects are even stronger if the bankrupt firm is operating within a distressed industry or when there is a strong supplier–customer relationship. We also find that the structure of lending agreements significantly changes in the aftermath of a client bankruptcy. More specifically, we find that the number of covenants increases and the lead banker(s) take an increasingly important role in the period following the client's bankruptcy. Taken together, the results of this study provide new insights into the financial implications of supply chain changes.

Keywords: supply chain; credit events; loan spreads; loan contracting
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1. Introduction

Firms rarely operate in a vacuum. Their fortunes are often tied to the welfare of their key competitors, investors, customers, and suppliers, and the nature and extent of these interconnections are likely to vary across time and across firms in a number of interesting ways. In the context of supply chain relationships, suppliers and customers are important stakeholders in each other's operations. The theoretical literature (e.g., Titman 1984) offers a number of interesting insights into the value implications of this relationship-specific investment and emphasizes how the resulting switching costs influence the structure of these arrangements. Building upon these ideas, the recent empirical literature explores how the supply chain relationship affects the firms' overall capital structure (e.g., Banerjee et al. 2008) and equity ownership in the trading partner (e.g., Fee et al. 2006). To gauge the economic importance of the customer–supplier tie more directly, recent studies also explore the supplier's market reactions to bankruptcies in the client's industry (e.g., Hertzel et al. 2008).[1]

Whereas these studies strongly demonstrate the equity value implications of the supply chain relationship, perhaps less is known about the specifics of whether and how creditors value this relationship. Within this context, this study explores how supply chain relationships affect corporate debt financing costs and arrangement by examining the impact of client bankruptcies. Specifically, looking at a sample of bankrupt firms, we examine whether their demise had a significant impact on the borrowing costs of their key suppliers. Exploring this issue enables us to measure the spillover risks of bankruptcy, and it helps provide us with a better understanding of how these risks are propagated throughout the supply chain. Moreover, the multidimension nature of loan contracts provides broader insights into the financial implications of supply chain disruptions. By looking at loan data, not only can we explore how loan

[1] Specifically, Hertzel et al. (2008) find that the portfolio of suppliers experiences a −1.9% average abnormal return over the five-day window surrounding the date of the clients' bankruptcy filings. Some other recent papers have also uncovered a number of interesting results. For example, Itzkowitz (2011) shows that firms increase their precautionary cash holdings to hedge against key disruptions in the supply chain, and Shenoy and Williams (2011) demonstrate the link between the supply chain relationship and corporate liquidity management.

prices respond to client bankruptcies, but we can also see whether the customer firm's bankruptcy affects other terms of lending to the suppliers including the imposed covenants and the structure of the lending syndicate.[2]

The existing literature suggests a number of direct and indirect channels through which suppliers (and their creditors) are affected by their customers' defaults.[3] First, and perhaps foremost, the demise of a key customer represents lost business to the supplier, thereby producing a decline in the supplier's future cash flows, which may lead bankers to view the supplier as a riskier borrower. Moreover, a supplier faces significant switching costs following its client's bankruptcy, and it may have a difficult time recovering or salvaging the valuable relationship-specific investments that it created through its supply chain relationship (Titman 1984). In line with this argument, Kolay et al. (2012) find that suppliers experience higher selling, general and administrative expenses and lower profit margins in the year following their clients' distress. Furthermore, bankers may be concerned that a client's bankruptcy is part of a larger wave that may spread to other related firms, including firms in the same industry and their suppliers (Lang and Stulz 1992). It is also possible that bankers view a client bankruptcy as a broader signal that the supplier has done an insufficient job of managing/monitoring its key business risks. All these potential effects may increase the suppliers' perceived credit risk. With these issues in mind, it is interesting to explore whether banks take supply chain risks into account when pricing and structuring loans.

To explore this issue, we took a series of steps to gather information regarding the key suppliers of U.S. public firms that went bankrupt over the time period 1990–2009. From this set of key suppliers, we focus on the set of firms that had bank loans reported both in the period prior to and subsequent to its client's bankruptcy. This approach enables us to determine whether the client's bankruptcy had a significant impact on both the supplier's borrowing costs and the structure of the lending agreements.

Our set of bankrupt firms comes from two key data sources: Moody's Default and Recovery Database (MDRD) and data reported on BankruptcyData.com (BD). From the filings of these bankrupt firms, we manually searched among the reported claims of the largest stakeholders for the names of the firms' key suppliers. From there we searched the DealScan database to ascertain whether the supplier had a reported loan in a two-year period prior to the client bankruptcy and in the two-year period subsequent to the bankruptcy. This approach enables us to directly test whether a client bankruptcy had a significant effect on the price and nonprice terms of the supplier's lending agreements.

In our analysis, we find that, on average, the overall cost of bank lending increases by roughly 20%–25% in the aftermath of a key customer declaring bankruptcy. This increase is statistically significant at the 1% level. To drill further down, we also investigate the mechanisms through which the credit risks and the associated switching costs and recovery of relationship-specific investments caused by the bankruptcy of the customers might be accentuated or attenuated. Intuitively, we expect that the impact of client bankruptcies would vary depending on the bankruptcy effect on the expected future cash flows of the suppliers. Specifically, the effect of client bankruptcy on the cost of bank financing to the supplier should be more profound in situations where the lost relationship is important and where the supplier faces more substantial switching costs.

Indeed, we find the effect of a client's bankruptcy on the supplier's borrowing costs becomes even larger if the bankrupt client's industry is in economic distress. Holding other things constant, we find that the supplier's costs of borrowing increase by an additional 11.8% after the client's credit event, when there is a one standard deviation drop in the industry median distance to default (DTD) of the client industry. These results demonstrate that suppliers are less likely to recover the lost business from a client bankruptcy if other firms in that industry are also struggling. Arguably, these effects occur because suppliers are less likely or able to switch to different customers when the entire industry is under economic distress.[4] These effects suggest that in these circumstances, firms find it hard to salvage the relationship-specific investments that were damaged following the bankruptcy of a key customer.

Ideally, one would also like to control for the strength of the supply chain relationship prior to the client's bankruptcy. Although there are no readily available data regarding the dollar size of the supplier relationship, we classify a client as being "large"

[2] The tighter covenants might impose additional indirect costs of debt. For instance, firms might be forced to pass up positive net present value investment opportunities to comply with the covenant restrictions (Campello et al. 2011)

[3] It is important to note that in our setup, bankruptcy is primarily viewed as a significant event that enables us to measure financial distress using an explicit/objective criterion. In this context, we are abstracting from the potentially important issue regarding the timing and the structure of the bankruptcy process. See Jiang et al. (2012) for an excellent discussion related to these broader issues.

[4] These results shed light on the findings in Hertzel et al. (2008), which document more pronounced supplier value losses for the subsample of client bankruptcy filings in which horizontal rivals have negative filing period abnormal returns.

if the supply relationship is reported in the Compustat Segment database.[5] We also find that the average supplier's borrowing costs increase by an additional 25%–30% if the bankrupt client was a major customer. In further tests, we also find that the effects of a client's bankruptcy on a supplier's borrowing costs are more profound the larger the amount of trade credit between the supplier and the client.

At the same time, we find that client bankruptcies also tend to affect the structure of lending agreements. Depending on estimation methods, we find that the average number of covenants in the lending agreement increases by about 20% to 47% of the sample mean following a client bankruptcy. Because many of these restrictive covenants impose extra costs by reducing financing flexibility and restricting firms' investment activities (Graham et al. 2008, Campello et al. 2011), the economic effect of client bankruptcy on the effective cost of bank financing is likely even higher than that implied by the loan pricing increase alone. The finding is consistent with the existing literature, which documents a negative relation between credit risks and covenant intensity and tightness (e.g., Demiroglu and James 2010, Graham et al. 2008).

In addition to changes in contractual terms of loans, we also find that syndicate structures adjust in meaningful ways in the aftermath of a client bankruptcy. Specifically, we find that the amount of the loan held by the lead lender(s) increases by about 20% in the aftermath of a supply chain disruption. As discussed in the literature, the participant banks would demand a greater fraction of the loan be held by the lead arranger to increase the monitoring incentives and improves monitoring effectiveness in an environment of increased risks and uncertainty (e.g., Holmstrom and Tirole 1997, Lin et al. 2012). To the extent that borrowers require more intense monitoring and oversight from their lenders after the supply chain disruption, our results are consistent with the arguments and findings about the link between monitoring needs and syndicate structure. Taken together, our findings dovetail the findings of a number of past papers that have shown that shifts in risk affect monitoring incentives and the structure of nonprice terms such as covenants and collateral (e.g., Rajan and Winton 1995) and the structure of loan syndicates (e.g., Lin et al. 2012).

Our results confirm that supply chain disruptions have strong spillover effects regarding the structure and pricing of bank loans. Building upon these results, we also explore a specific channel in which a client bankruptcy might directly affect the terms of the supplier's bank financing. More specifically, we explore how the client's bankruptcy influences the supplier's total sales. Here we find strong evidence that supplier sales growth decreases significantly after the client bankruptcy, suggesting that the loss of an important client often has a significant real impact on a firm's operating performance and growth.

On balance, our results have important implications for three separate literatures. To the best of our knowledge, our paper is the first to explore the effects that client bankruptcies have on the borrowing costs of their key suppliers. Our paper also adds to the growing literature that has focused on the important role that the supply chain plays in shaping corporate policies and outcomes (e.g., Joskow 1987, 1988; Fee and Thomas 2004; Fee et al. 2006; Cohen and Frazzini 2008; Hertzel et al. 2008; Itzkowitz 2011; Harford et al. 2012; Kolay et al. 2012).[6] In particular, our paper complements Hertzel et al. (2008) by documenting the credit market response to supply chain shocks. Finally our paper makes a contribution to the loan contracting literature (e.g., Graham et al. 2008, Jiang et al. 2010, Campello et al. 2011, Lin et al. 2011, Hertzel and Officer 2012, Saunders and Steffen 2011) by showing that bankers take these types of supply chain risks into account when structuring and pricing their lending agreements.

The rest of this paper proceeds as follows. Section 2 outlines the data and the methodology used to construct our sample. Section 3 provides a detailed description of the key variables and the corresponding summary statistics. Section 4 presents the results illustrating the effects that bankruptcies have on the borrowing costs and other terms of lending to the distressed firms' suppliers. Section 5 concludes.

2. Sample Construction

To understand how bankruptcy risk transforms through the supply chain, we collected data on bankrupt companies and their suppliers. The bankruptcy data come from two sources: BankruptcyData.com and the Moody's Default and Recovery Database. Starting first with BD, we identified 1964 companies that filed for bankruptcy between 1990 and 2000, with assets exceeding $50 million in the bankruptcy year. Searching through the BD database, we found reported information regarding the claims of the key stakeholders for 793 of the 1964 bankrupt firms.

We manually searched the 793 files and applied some additional filters. First, we deleted all stakeholders operating in regulated industries such as banks, nonbank financial institutions, or utility companies.

[5] The Financial Accounting Standards Board requires firms to disclose the names of their principle customers who generate sales revenue more than 10% of total revenue of the firms.

[6] See Itzkowitz (2011) for a recent review of the literature.

Next, we set out to isolate the stakeholders whose reported claim type suggested a customer–supplier relationship. We eliminated claim types identified as "deferred compensation," "property taxes," "judgment debt," "legal service," "rejected lease," or "utility." Alternatively, we classified a stakeholder as a supplier if the claim type was related to trade debt, vendor, service, trade payable, or purchase. From there, we eliminated suppliers with listed claims of less than \$50,000, and we also required that the supplier be listed as a borrower in the DealScan database during both the prebankruptcy period (up to two years before the bankruptcy announcement date) and the postbankruptcy period (up to two years after the announcement date).

From DealScan, we extracted key loan characteristics such as loan spreads, size, maturity, lender(s), and covenants. Utilizing the suppliers' GVKEYs, we also mapped the suppliers to the Center for Research in Security Prices (CRSP) and Compustat databases, where we collected stock return data from CRSP and firm characteristics from Compustat. Based on the information, we calculated the firm's operating profitability, market-to-book (M/B) ratio, cash flow volatility, distance to default, cumulative abnormal return, and other firm-level variables.

Next, we worked with MDRD, where the defaulted firms are classified as having one of the following three types of credit events: (1) a missed or delayed interest and/or principal payment, (2) a distress exchange, or (3) a formal bankruptcy. We focused exclusively on the set of bankrupt companies, which includes the set of firms that declared either Chapter 7 or Chapter 11, or engaged in a prepackaged Chapter 11. From this source, using the same screens that we applied to the BD database, we were able to identify an additional 645 U.S. firms that went bankrupt during the time period 1990–2009.[7]

From there, we manually searched for the names of these 645 bankrupt firms in the Compustat Segment Customer (CSC) file. Two hundred seventy-eight of these firms were listed as customers in the CSC file. Next, we applied the same set of conditions as for BD to find the suppliers' information in DealScan, Compustat, and CRSP.

As a final step, we merged the two samples from BD and MDRD to generate a database of suppliers of bankrupt firms that includes information from DealScan, Compustat, and CRSP. The database includes 2,254 loan observations from 213 unique suppliers linked to 217 unique bankrupt customers. The final breakdown includes 198 suppliers associated with 2,147 loan facilities, where the data were initially generated from BD. The remaining 15 suppliers (and their associated 107 loan facilities) originated from the CSC file.

[7] We placed this filter to map the suppliers of the bankrupt companies to the DealScan database, which begins in 1988.

3. Data and Summary Statistics

As indicated above, our complete data set includes details regarding the characteristics of the borrowing firms that are suppliers to the bankrupt firms in our sample. We also collected details about each loan contract, as well as the syndicate structure of each facility. Table 1 provides a list and definition of each of these variables. Details regarding some of these key variables are described below.

3.1. Firm Characteristics

The cost of borrowing for a supplier company both before and after the bankruptcy of its key client is likely to be influenced by a number of measureable firm characteristics that capture credit risk. These measures include firm size, operating profitability, the tangibility of assets, the market-to-book ratio, cash flow volatility, and leverage. All of these variables are standard control variables that have been used in recent loan pricing studies (e.g., Graham et al. 2008, Campello et al. 2011). Following the literature, firm size is measured by log assets. Profitability is defined as earnings before interest divided by total assets. Asset tangibility is calculated using the approach outlined by Almeida and Campello (2007).[8] The market-to-book ratio is equal to the sum of the market value of equity and the book value of debt divided by total assets. Leverage is equal to the sum of the long-term debt and current debt divided by total assets. Cash flow volatility is the standard deviation of the cash flow over four fiscal years before the year of the facility start date. The firm characteristics are winsorized at the 1% level. The summary statistics of the variables are listed in Table 2.

We also use two other measures to help capture the probability of default. The first measure is a series of dummy variables that correspond to the S&P credit rating. This index has values extending from 1 (which corresponds to a AAA rating) to 7 (which corresponds to a rating below B). The second measure is the calculated distance to default. This measure uses market-based data to gauge the likelihood that the value of a firm's assets will fall below its level of debt. Building on Merton (1974), this measure was first proposed by Crosbie and Bohn (2003) and has been applied recently as a key market-based measure of credit risk.[9]

[8] Based on their analysis, Almeida and Campello (2007, p. 1441) use the following calculation to measure the tangibility of assets: $Tangibility = 0.715 * Receivables + 0.547 * Inventory + 0.535 * Capital$, where receivables, inventory, and capital correspond to Compustat items 2.3 and 8, respectively.

[9] A specific definition of the variable can be found in Table 1. See Campello et al. (2011) for a detailed estimation method.

Table 1 Definitions of the Key Variables Used in the Empirical Analysis

Variable names	Variable definitions
Firm characteristics	
Log *assets*	Natural log of total assets = log(AT, from Compustat)
Profitability	Earnings before interest, tax, depreciation, and amortization/total assets = EBITDA/AT
Tangibility	Tangibility is following Almeida and Campello (2007); Tangibility = (0.715 ∗ RECT + 0.547 ∗ INVT + 0.535 ∗ PPENT)/AT
M/B	(Market value of equity + the book value of debt)/total assets = (CSHO ∗ PRCC_F + AT-CEQ)/AT
Leverage	(Long-term debt + debt in current liabilities)/total assets = (DLTT + DLC)/AT
Distance to default	$(V_a - D)/(V_a * s_a)$; V_a is market value of assets, which is unobservable; D is current liabilities + 0.5 ∗ long-term debt; s_a is one-year asset volatility, which is unobservable. The two unknown variables are estimated following Bharath and Shumway (2008).
Cash flow volatility	Cash flow is measured by quarterly net cash flow/(debt in current liabilities + total long-term debt) = OANCFY/(DLCQ + DLTTQ). Cash flow volatility is the standard deviation of the cash flow over four fiscal years before the loan initiation year.
Client industry median DTD	Client industry median DTD is the median distance to default of CRSP listed firms in the three-digit Standard Industrial Classification (SIC) code of the bankruptcy client in the loan initiation year.
Client industry median stock return	Client industry median stock return is the median stock return of CRSP listed firms in the three-digit SIC code of the bankruptcy client. It is the annual return of year $T - 1$.
Client industry ROA growth	The industry ROA growth is calculated as industry ROA in year $T - 1$ minus that number in year $T - 2$. Industry ROA is total industry net income divided by the total industry assets.
Client industry sales growth	Sum the total industry sales in year $T - 1$, divided by the total industry sales in year $T - 2$, then take the log.
Loan characteristics	
Log(*loan spread*)	Natural log of loan spread, all-in drawn spread reported in DealScan
Log *loan size*	Natural log of loan amount, for each facility, reported in DealScan
Log *maturity* (in months)	Natural log of loan maturity in months, for each facility, reported in DealScan
Performance pricing	Dummy variable that equals 1 if the loan facility uses performance pricing
Term loan	Dummy variable that equals 1 if the loan type is term loan for the following types, "Term Loan," "Term Loan A," "Term Loan B," "Term Loan C," "Term Loan D," or "Term Loan E"
Loan purpose	Six dummy variables if the loan purpose belongs to "working capital," "acquisition line or takeover," "commercial paper backup," "corporate purposes," "debt repay," or "other"
# financial covenants	Number of financial covenants reported in DealScan
# general covenants	Number of general covenants reported in DealScan
# all covenants	Number of all covenants reported in DealScan
Syndicate structure	
Log(*# lead lenders*)	Natural log of number of lead lenders for each facility reported in DealScan
Total lead lender shares	Summary of lender share of all lead lenders
Log(*total lead lender amount*)	Natural log of the summary of the lender amount for all lead lenders

Intuitively, it estimates the number of standard deviations a firm is away from default. Therefore, a high value indicates better financial status and lower credit risk. Since our empirical results are robust to either risk measure, we use DTD in most of the model specifications.[10] We thus expect to see a negative relationship between DTD and loan spreads.

We also consider three separate measures to control for the financial condition of the bankrupt firm's industry. These measures (all calculated on an annual basis) are the sales growth, return on assets (ROA) growth, and stock returns of all the Compustat companies operating in the same industry as the bankrupt firm.

3.2. Loan Characteristics

Our main dependent variable is the natural log of the supplier's loan spread reported in the DealScan database. Specifically, we use the all-in-drawn spread, which is measured in terms of basis point spread above the LIBOR (London Interbank Offered Rate) index plus associated origination and recurring annual fees. Following the recent literature (e.g., Graham et al. 2008), we use the natural log of the loan spread to mitigate skewness-related effects.[11]

Following the recent literature (e.g., Lin et al. 2011), we also control for other loan characteristics that might affect loan spreads. Specifically, we control for loan size, loan maturity, and a dummy variable that indicates the presence of a performance pricing clause. Also, loans underwritten for different purposes may have different risks and may be priced differently. We therefore include a set of dummy variables to capture the effects of different loan purposes (i.e., working capital, general corporate purpose, refinancing, acquisition, commercial paper backup, and others). We also include a set of dummy variables to control for the effects of different loan types.

[10] For brevity, the empirical results based on Z-score as a risk control are not presented, but are available from the authors upon request.

[11] The variable is winsorized at the 1% level. Our results are robust to using the nonlog all-in-drawn spread as the dependent variable.

Table 2 Summary Statistics

	Obs.	Mean	Std. dev.	Min	Max
Firm characteristics					
S&P firm ratings	2,254	4.219	1.923	1	7
Log(*asset*, mn$)	2,254	9.668	1.656	5.078	12.537
Profitability	2,254	0.131	0.069	−0.023	0.298
Tangibility	2,240	0.317	0.106	0.074	0.533
M/B	2,254	1.727	0.850	0.842	4.545
Leverage	2,254	0.295	0.153	0.012	0.768
Distance to default	2,153	2.638	1.367	0.040	6.995
Cash flow volatility	2,190	0.641	3.089	0.009	23.079
Client industry median DTD	2,188	1.529	0.830	0.134	4.748
Loan characteristics					
Log(*loan spread*)	1,888	4.072	1.041	2.603	6.215
Log(*loan size*, $)	2,247	20.327	1.415	13.816	23.942
Loan size (bn$)	2,247	1.715	3.394	0.001	25
Log *maturity* (in months)	2,187	3.248	0.828	0.693	5.529
Performance pricing	2,254	0.349	0.477	0	1
Term loan	2,254	0.126	0.331	0	1
# financial covenants	2,254	0.750	1.090	0	7
# all covenants	2,254	1.621	2.514	0	13
Syndicate structure					
Total lead lender shares	660	0.252	0.238	0.011	1
Log(*total lead lender amount*)	660	19.010	1.515	13.816	22.600
Total lead lender amount (bn$)	660	0.575	1.148	0.001	6.533
Log(*# lead lenders*)	660	0.438	0.428	0	2.197

Notes. This table reports the number of observations, mean, standard deviation, minimum value, and maximum value for each of the key variables used in the empirical analysis. The detailed variable definitions can be found in Table 1.

In addition to loan spreads, lenders also use covenants as another mechanism to manage the borrowers' risk, and one might expect the intensity of covenants to affect bankers' incentives to monitor borrowers (Rajan and Winton 1995). The existing literature suggests that covenants are used more frequently when there is a greater need for monitoring, which may arise because firms are in financial distress and/or because there are significant information asymmetries between the borrower and lender (Graham et al. 2008). Given these arguments, one might expect that when a company's customer files for bankruptcy, the company's bankers may perceive a greater need for monitoring, which may lead to a corresponding increase in the number of covenants imposed on new loans. Consequently, we also collect information regarding the total number of covenants, the number of general covenants, and the number of financial covenants corresponding to each loan agreement.[12]

[12] DealScan categorizes financial covenants into 20 different types. The 20 financial covenants are maximum CapEx, maximum debt to EBITDA, maximum debt to equity, maximum debt to tangible net worth, maximum leverage ratio, maximum loan to value, maximum net debt to assets, maximum senior debt to EBITDA, maximum senior leverage, maximum total debt (including contingent liabilities) to tangible net worth, minimum cash interest coverage, minimum current ratio, minimum debt service coverage, minimum EBITDA, minimum equity to asset ratio, minimum fixed charge coverage, minimum interest coverage, minimum net worth to total asset, minimum quick ratio, and other ratio.

3.3. Syndicate Structure

As pointed out in the literature (e.g., Holmstrom and Tirole 1997), monitoring is costly, but not directly observable. As the principal monitor, the lead arranger bears all of the monitoring costs, but only owns part of the loan. Therefore, the lead lender is more likely to shirk its monitoring duties if the loan requires more intensive monitoring (Hertzel and Officer 2012, Lin et al. 2012). Recognizing this incentive, the participant banks are likely to require the lead banks to hold a greater fraction of the loan to signal their monitoring commitment. Thus, in our setting, it may be reasonably assumed that the lead lender(s) will hold a larger share in the aftermath of a customer bankruptcy that increases the supplier's credit risk. To test these effects, we construct two measures of syndicate structure: the share of the loan held by the lead lender(s) and the log of the dollar amount held by the lead arranger(s).

3.4. Summary Statistics Before and After the Announced Bankruptcy

To understand the impact of the customer's bankruptcy on the supplier's loan spreads, we choose suppliers that have loan facilities both before and

Table 3 Summary Statistics: Before and After the Announced Bankruptcy

	Before bankruptcy					After bankruptcy					
	Obs.	Mean	Std. dev.	Min	Max	Obs.	Mean	Std. dev.	Min	Max	*t*-value
Firm characteristics											
S&P firm ratings	1,133	4.089	1.935	1	7	1,121	4.351	1.902	1	7	3.235***
Log(*asset*, mn$)	1,133	9.625	1.708	5.078	12.537	1,121	9.711	1.602	5.078	12.537	1.232
Profitability	1,133	0.134	0.068	−0.023	0.298	1,121	0.129	0.070	−0.023	0.298	−1.919*
Tangibility	1,129	0.320	0.103	0.074	0.533	1,111	0.313	0.108	0.074	0.533	−1.438
M/B	1,133	1.813	0.899	0.842	4.545	1,121	1.641	0.788	0.842	4.545	−4.839***
Leverage	1,133	0.296	0.154	0.012	0.768	1,121	0.294	0.153	0.012	0.768	−0.326
Distance to default	1,076	2.552	1.269	0.040	6.995	1,077	2.724	1.454	0.040	6.995	2.931***
Cash flow volatility	1,085	0.652	3.021	0.009	23.079	1,105	0.630	3.156	0.009	23.079	−0.164
Client industry median DTD	1,119	1.410	0.769	0.134	4.748	1,069.0	1.654	0.873	0.134	4.748	6.955***
Loan characteristics											
Log(*loan spread*)	956	3.921	0.988	2.603	6.215	932	4.227	1.073	2.603	6.215	6.448***
Log(*loan size*, $)	1,132	20.328	1.463	13.816	23.942	1,115	20.327	1.366	13.816	23.942	−0.017
Loan size (bn$)	1,132	1.907	3.872	0.001	25.000	1,115	1.521	2.815	0.001	25.000	−2.699***
Log *maturity* (in months)	1,082	3.208	0.844	0.693	4.796	1,105	3.288	0.811	0.693	5.529	2.245**
Performance pricing	1,133	0.342	0.474	0	1	1,121	0.356	0.479	0	1	0.715
Term loan	1,133	0.116	0.320	0	1	1,121	0.136	0.343	0	1	1.431
# financial covenants	1,133	0.671	1.071	0	7	1,121	0.830	1.103	0	5	3.469***
# all covenants	1,133	1.472	2.476	0	13	1,121	1.772	2.545	0	10	2.831***
Syndicate structure											
Total lead lender shares	326	0.224	0.210	0.024	1	334	0.280	0.259	0.011	1	2.994***
Log(*total lead lender amount*)	326	19.028	1.544	15.294	22.550	334	18.993	1.488	13.816	22.600	−0.295
Total lead lender amount (bn$)	326	0.613	1.197	0.004	6.212	334	0.538	1.100	0.001	6.533	−0.839
Log(*# lead lenders*)	326	0.380	0.419	0	2.079	334	0.493	0.430	0	2.197	3.418***

Notes. This table provides summary statistics for each of the key variables, both before and after the firm's announced bankruptcy. The reported *t*-values correspond to the estimates from a paired *t*-test for differences in the mean values after and before the announced bankruptcy.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

after the default event. To distinguish the loan spreads a supplier paid before and after the bankruptcy event of its customer, we create our main dummy variable, *after bankruptcy*, which equals 1 if the facility starting date is after the bankruptcy announcement date and 0 otherwise. Table 3 provides summary statistics regarding the key firm characteristics, loan characteristics, and syndicate structure, calculated before and after the announced bankruptcy date. The final column also reports the *t*-statistics from a paired *t*-test of the differences in means calculated after and before the announced bankruptcy.

Looking at the summary statistics, we see that there are significant shifts in many of the key variables after the announced bankruptcy date. Borrowers experienced a significant decline in their credit ratings and market-to-book ratios. On the other hand, however, they also experienced an increase in DTD, suggesting a need to control for both credit rating and DTD in the regression analyses. At the same time, there is a significant reduction in the default risk of the median firm in the defaulting client's industry (as measured by DTD), suggesting that the increase in loan spreads is not likely to be driven by the overall condition of the bankrupt firm's industry. Perhaps most notably, in the *after bankruptcy* period, borrowers realized a significant increase in loan spread and an increase in the average number of covenants attached to the loan. We also find a significant increase in loan maturity and a significant reduction in loan size. Finally, in the *after bankruptcy* period, there is a significant shift in syndicate structure, in that there is an increase in both the average number of lead lenders and the total share held by the lead lenders.

4. Empirical Results

4.1. The Effects of Client Bankruptcy on Loan Spreads: Baseline Results

In our initial baseline results, we examine whether suppliers pay higher loan costs in the aftermath of a client's bankruptcy. In our empirical design, we gather information on all of the reported loans to the supplier in the period beginning two years prior to the announced bankruptcy and ending two years after the bankruptcy.[13] Our baseline

[13] The results are robust to a window period beginning one year prior to the announced bankruptcy and ending one year after the bankruptcy. For brevity, the empirical results are not presented, but are available from the authors.

Table 4 The Effect of Client Bankruptcy on Loan Spread

	Log(*loan spread*)				
	(1)	(2)	(3)	(4)	(5)
After bankruptcy	0.265***	0.258***	0.220***	0.221***	0.203***
	[0.043]	[0.047]	[0.052]	[0.052]	[0.052]
Log *asset*	−0.228***	−0.171***	−0.137***	−0.137***	−0.190***
	[0.026]	[0.030]	[0.026]	[0.026]	[0.023]
Profitability	−1.956**	−1.907**	−2.190**	−2.201**	−2.348**
	[0.818]	[0.865]	[0.886]	[0.880]	[0.880]
M/B	−0.093*	−0.101**	−0.070*	−0.069*	−0.072
	[0.046]	[0.045]	[0.040]	[0.040]	[0.043]
Tangibility	0.248	0.175	0.369	0.360	0.269
	[0.526]	[0.528]	[0.414]	[0.414]	[0.393]
Leverage	1.446***	1.479***	1.206***	1.197***	1.060***
	[0.349]	[0.324]	[0.250]	[0.253]	[0.264]
Cash flow volatility	0.008	0.012*	0.008	0.008	0.001
	[0.006]	[0.006]	[0.007]	[0.007]	[0.005]
Distance to default	−0.155***	−0.158***	−0.153***	−0.152***	−0.153***
	[0.021]	[0.020]	[0.020]	[0.020]	[0.021]
Log *maturity* (in months)		0.069**	−0.001	−0.000	−0.006
		[0.026]	[0.021]	[0.020]	[0.006]
Log *loan size*		−1.755***	−1.536***	−1.518***	0.007
		[0.395]	[0.478]	[0.472]	[0.018]
Client industry median stock return				−0.013	−0.007
				[0.023]	[0.024]
Client industry ROA growth				−0.244	−0.355*
				[0.221]	[0.206]
Client industry sales growth				−0.058	−0.103
				[0.104]	[0.110]
S&P firm ratings	Yes	Yes	Yes	Yes	Yes
Performance pricing	No	Yes	Yes	Yes	Yes
Term loan	No	No	Yes	Yes	Yes
Loan purpose	No	No	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes
Observations	1,715	1,690	1,690	1,690	1,765
Adjusted R^2	0.741	0.750	0.790	0.791	0.785

Notes. The dependent variable is the log of *loan spread*. *Leverage* is the ratio of total debt to total assets. S&P ratings are converted to an index from 1 to 7, and we include dummy variables for each rating category. *M/B* is the market-to-book ratio. *Profitability* is EBITDA divided by total assets. *Leverage* is debt divided by total assets. *Tangibility* follows Almeida and Campello (2007). In column (5), we add back those suppliers who got loans during $(t-2, t)$ but did not get loans during $(t, t+2)$ with their loans during $(t+2, t+4)$. Heteroskedasticity-consistent standard errors clustered at the supplier industry level are reported in brackets.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

model can be expressed in the following condensed form:

$$\text{Log}(\textit{loan spread}) = f(\textit{after bankruptcy}, \textit{firm characteristics}, \textit{loan characteristics}, \textit{industry and time effects}). \quad (1)$$

The dependent variable is the natural log of the reported all in drawn loan spread. The main independent variable (*after bankruptcy*) is a dummy variable that equals 0 in the prebankruptcy period and 1 in the postbankruptcy period. The other right-hand side variables consist of a variety of firm-level and loan-level controls. Following the recent literature (e.g., Graham et al. 2008), the firm controls include firm size, profitability, leverage, cash flow volatility, calculated distance to default, market-to-book ratio, the Almeida and Campello (2007) measure of asset tangibility, and the S&P credit rating dummies. The loan controls are loan size, maturity, types, and purposes. We also include a dummy variable that equals 1 if the loan facility uses performance pricing. After merging all the relevant variables, our sample consists of 1,715 loans. Of the 1,715 loans, 25 do not include full details regarding the loan characteristics.

In Table 4 we present the results. Column (1) reports the results for the full sample of 1,715 loans, but it does not include the set of loan-related controls.

Columns (2) and (3) report the results for the subsample of 1,690 loans where we have the full details regarding the loan characteristics. The distinction is that column (2) does not include controls for loan type and loan purpose, whereas column (3) does.

The results indicate that the supplier's average loan spread significantly increases following a client's bankruptcy. This increase is statistically significant at the 1% level. The corresponding coefficients on the *after bankruptcy* dummy range from 0.220 in column (3) to 0.265 in column (1). Given the semilog specification, these findings suggest that the average loan spread increases anywhere from 22%–26% in the aftermath of a client's bankruptcy. This translates into an average loan spread increase of roughly 23 to 27 basis points, which is economically significant. Overall, the results provide evidence that there are significant spillover effects along the supply chain that are demonstrated through higher loan spreads.

The firm-level controls work as expected. Larger firms, more profitable firms, and firms with a greater distance to default have significantly lower loan spreads. These results are consistent with the findings in the existing literature (e.g., Campello et al. 2011). Consistent with previous studies (e.g., Graham et al. 2008), we also find that firms with higher market-to-book ratios tend to have lower spreads. This result might be due to the fact that market-to-book ratio reflects the additional value over book assets that creditors can access in the default scenario (Graham et al. 2008). In addition, we find that firms with greater leverage pay higher loan spreads. The loan-level controls also generally conform to our priors. It is worth pointing out that our regressions also include a range of indicator variables to control for the various effects of firm credit ratings, the presence of performance pricing clauses, loan types, loan purposes, industry effect, and year effect. For brevity, these coefficients are not presented in the table.

Although the baseline results strongly suggest that suppliers see a significant shift in the structure and cost of bank borrowing when a key client goes bankrupt, it is important to also consider some alternative explanations and implications for the observed findings. One interesting question is whether the actual event of bankruptcy has a specific influence on the supplier's borrowing costs, or whether a general decline in the client firm's industry is enough to drive the observed effects. To get at this issue, we also include a set of results (reported in column (4) of Table 4) that also include three measures related to the client firm's industry size and performance (median stock return and growth in the industry's sales and ROA) as additional controls. The detailed definitions of these additional controls can be found in Table 1. Interestingly, we find that the underlying results remain largely unchanged, and none of the industry-level controls have a significant influence on the supplier's borrowing costs. These results suggest that the client firm's bankruptcy is a distinct event that has a specific spillover effect on its suppliers.

Another concern is that our methodology requires the supplier to receive loans both prior to and after the client's bankruptcy, which may inadvertently create some important selection and/or look-ahead biases. Indeed, our approach may inadvertently eliminate suppliers from the tail ends of the sample distribution. The poorest performing suppliers may themselves go bankrupt, which would reduce the possibility that they would receive loans in the post-bankruptcy period. Omitting these cases, however, works against our findings and results in an underestimation of the spillover effect on the change of loan spreads. At the other extreme, the best performing suppliers that have generated sufficient internal cash may also be less likely to obtain loans in the post-bankruptcy period. Omitting these cases might result in overstated spillover effect. Taking a closer look at our sample, we find that there are 30 suppliers who borrowed before, but not after the client bankruptcy. Five of these suppliers either went bankrupt or were acquired. Of the remaining 25 suppliers, 21 did receive a loan, but at a later date (between two and four years after the client bankruptcy). As an additional robustness test, we also included these 21 additional suppliers along with the original sample in a separate set of tests. These results are reported in column (5) of Table 4. Once again, the underlying results are unchanged.

A third concern is that the shifts in supplier borrowing costs may be driven by secular shifts in the quality of the suppliers that are independent of the observed client bankruptcy. To address this issue, we construct a set of "placebo" tests where we replicate the results in Table 4, but we now run the tests using the time period $T-5$ to $T-1$, where $T-3$ is assumed to be the hypothetical event year (once again, $T=0$ is the year of the actual bankruptcy). As expected, the coefficients related to the *after bankruptcy* dummy are no longer statistically significant. The empirical results are presented in Table 5.

4.2. Factors Influencing the Link Between Client Bankruptcy and the Supplier's Cost of Borrowing

In this section, we examine the factors that affect the relationship between client bankruptcy and the suppliers' cost of borrowing. Our goal is to investigate the channels through which the credit risks and the associated switching costs and recovery of relationship-specific investments caused by the bankruptcy of the customers might be exacerbated or attenuated. Intuitively, we expect the effect of client bankruptcy on

Table 5 The Effect of Client Bankruptcy on Loan Spread: Placebo Test

	Log(*loan spread*)	
	(1)	(2)
After bankruptcy	0.050	0.041
	[0.055]	[0.052]
Log *asset*	−0.137***	−0.133***
	[0.032]	[0.033]
Profitability	−3.320***	−3.259***
	[0.792]	[0.777]
M/B	−0.082	−0.085
	[0.062]	[0.061]
Tangibility	−0.003	0.006
	[0.154]	[0.150]
Leverage	0.866***	0.857***
	[0.218]	[0.211]
Cash flow volatility	0.018*	0.018
	[0.011]	[0.011]
Distance to default	−0.037	−0.035
	[0.026]	[0.026]
Log *maturity* (in months)	0.003**	0.003**
	[0.001]	[0.001]
Log *loan size*	−0.118***	−0.117***
	[0.039]	[0.039]
Client industry median stock return		−0.007
		[0.067]
Client industry ROA growth		−0.437
		[0.276]
Client industry sales growth		−0.205**
		[0.091]
S&P firm ratings	Yes	Yes
Performance pricing	Yes	Yes
Term loan	Yes	Yes
Loan purpose	Yes	Yes
Industry effect	Yes	Yes
Year effect	Yes	Yes
Observations	1,644	1,644
Adjusted R^2	0.712	0.713

Notes. The dependent variable is log of *loan spread*. *Leverage* is the ratio of total debt to total assets. S&P ratings are converted to an index from 1 to 7, and we include dummy variables for each rating category. *Profitability* is EBITDA divided by total assets. *Tangibility* follows Almeida and Campello (2007) Heteroskedasticity-consistent standard errors clustered at the supplier industry level are reported in brackets.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

the cost of borrowing to the supplier to be stronger in situations where the supplier faces higher default risks, more substantial switching costs, and/or low recovery of relationship-specific investments.

So far, the empirical results indicate that bankers respond to bankruptcies by charging higher loan spreads to the suppliers of the bankrupt firms. As we indicated in the introduction, these effects may arise for at least three reasons: (1) the lost business directly threatens the health of the supplier; (2) bankers worry that the client's bankruptcy is part of a broader wave that may spread to other related firms; (3) bankers may view the bankruptcy as evidence that the supplier has done a poor job of managing its key business risks.

4.2.1. Financial Condition of the Client's Industry. Among these three effects, the third one is not directly testable. For the first effect, we conduct relevant empirical tests in §4.2.3. In an attempt to get at the second of the three effects, we explore whether these effects are stronger in those instances when other firms in the client's industry are also experiencing financial distress. To gauge these effects, we include the median DTD among the firms in the bankrupt client's industry as an additional control, and we also interact it with the *after bankruptcy* variable. These results are reported in Table 6. Once again, we find that the *after bankruptcy* variable remains positive and statistically significant at the 1% level. The other coefficients regarding the firm-level and loan-level controls are also similar to the findings reported in Table 4. More importantly, we find that the measure interacting the *after bankruptcy* dummy variable and *Client industry median DTD* is negative and statistically significant, suggesting that a client bankruptcy has a particularly large effect on the supplier's cost of borrowing when the client's industry is in economic distress (as evidenced by a lower DTD). Specifically, we find that the suppliers' costs of borrowing increase by an additional 11.8% after the client's credit event, when there is a one standard deviation drop in the industry median distance to default of the client industry.

4.2.2. The Strength of the Supply Chain Relationship. The results in Tables 4 and 6 consistently demonstrate that a supplier encounters a significant increase in its borrowing costs when one of its customers declares bankruptcy. One might expect that these results will be even stronger if the bankrupt client is a large customer to the supplier. Although there are not readily available data regarding the exact dollar amount of each supply chain relationship, we classify a customer as a large client if the relationship is reported in the Compustat Segment database. In previous work, (Banerjee et al. 2008, p. 2514) pointed out that "the Financial Accounting Standards Board (FASB) requires firms to disclose the name of and the sales to their principle customers, if the revenue generated from the sales to a particular customer exceeds 10% of total revenue of the firm, or if the firm considers the sales important to its business." Given this guideline, we argue that a client is important to a supplier if the supply chain relationship is reported in the Compustat Segment database.

The results reported in Table 7 illustrate that the suppliers face a larger increase in their borrowing

Table 6 The Effect of Client Bankruptcy on Loan Spread When the Bankrupt Client's Industry Has High Default Risks

	Log(*loan spread*)			
	(1)	(2)	(3)	(4)
After bankruptcy	0.415***	0.415***	0.414***	0.420***
	[0.052]	[0.052]	[0.055]	[0.056]
Client industry median DTD	0.063	0.064	0.080**	−0.130***
	[0.041]	[0.040]	[0.037]	[0.038]
After bankruptcy × *Client industry median DTD*	−0.099**	−0.102***	−0.127***	0.083**
	[0.038]	[0.037]	[0.037]	[0.040]
Log *asset*	−0.225***	−0.171***	−0.131***	−0.131***
	[0.028]	[0.030]	[0.024]	[0.024]
Profitability	−1.915**	−1.895**	−2.184**	−2.190**
	[0.753]	[0.816]	[0.834]	[0.825]
M/B	−0.092*	−0.100**	−0.068	−0.068
	[0.046]	[0.046]	[0.042]	[0.041]
Tangibility	0.306	0.249	0.490	0.481
	[0.536]	[0.537]	[0.414]	[0.413]
Leverage	1.434***	1.475***	1.195***	1.187***
	[0.353]	[0.326]	[0.249]	[0.251]
Cash flow volatility	0.008	0.012*	0.008	0.008
	[0.006]	[0.006]	[0.007]	[0.007]
Distance to default	−0.156***	−0.159***	−0.154***	−0.153***
	[0.021]	[0.020]	[0.021]	[0.022]
Log *maturity* (in months)		0.071***	0.002	0.002
		[0.026]	[0.020]	[0.020]
Log *loan size*		−1.568***	−1.430***	−1.407***
		[0.381]	[0.430]	[0.422]
Client industry median stock return				−0.021
				[0.024]
Client industry ROA growth				−0.199
				[0.223]
Client industry sales growth				−0.048
				[0.119]
S&P firm ratings	Yes	Yes	Yes	Yes
Performance pricing	No	Yes	Yes	Yes
Term loan	No	No	Yes	Yes
Loan purpose	No	No	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
Observations	1,663	1,638	1,638	1,638
Adjusted R^2	0.747	0.754	0.796	0.797

Notes. The dependent variable is log of *loan spread*. *Industry distress* is measured by median DTD in the client industry at three-digit Standard Industrial Classification code level. *Leverage* is the ratio of total debt to total assets. S&P ratings are converted to an index from 1 to 7, and we include dummy variables for each rating category. *Profitability* is EBITDA divided by total assets. *Tangibility* follows Almeida and Campello (2007). Heteroskedasticity-consistent standard errors clustered at the supplier industry level are reported in brackets.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

costs if the bankrupt customer is a large client (where *large client* is a dummy variable that equals 1 if the supply chain relationship is reported in the Compustat Segment database). For example, looking at the results in column (4), which includes the full set of control variables, we find that the average supplier's borrowing cost increases 21% in cases where the bankrupt client is not large. Quite notably, the average borrowing cost increases by a significantly higher 47%—which is found by summing the coefficients on the *after bankruptcy* variable and the variable that interacts *after bankruptcy* with *large client*. The strength of these findings further supports the argument that the increased borrowing costs can be largely attributed to contagion effects resulting from the lost supply chain relationship.

As an alternative measure of the strength of the supply chain relationship, we also consider the amount of trade credit that the client has with the supplier. These results are reported in Table 8. Once again, we find that the supplier's lending costs increase significantly after the bankruptcy of a client,

Table 7 The Effect of Client Bankruptcy on Loan Spread When the Client Is a Large Client

	Log(*loan spread*)			
	(1)	(2)	(3)	(4)
After bankruptcy	0.254***	0.248***	0.212***	0.214***
	[0.044]	[0.049]	[0.053]	[0.053]
Large client	0.103	0.121	0.055	0.257**
	[0.194]	[0.198]	[0.213]	[0.118]
After bankruptcy × *Large client*	0.292**	0.263*	0.266**	0.060
	[0.139]	[0.139]	[0.118]	[0.210]
Log *asset*	−0.229***	−0.171***	−0.139***	−0.139***
	[0.027]	[0.030]	[0.026]	[0.026]
Profitability	−1.849**	−1.797**	−2.126**	−2.133**
	[0.822]	[0.867]	[0.904]	[0.899]
M/B	−0.098**	−0.106**	−0.074*	−0.073*
	[0.045]	[0.043]	[0.040]	[0.040]
Tangibility	0.226	0.154	0.346	0.337
	[0.529]	[0.530]	[0.417]	[0.417]
Leverage	1.448***	1.481***	1.208***	1.200***
	[0.344]	[0.319]	[0.249]	[0.251]
Cash flow volatility	0.009	0.013*	0.009	0.009
	[0.007]	[0.007]	[0.007]	[0.007]
Distance to default	−0.152***	−0.154***	−0.150***	−0.149***
	[0.020]	[0.020]	[0.020]	[0.020]
Log *maturity* (in months)		0.068**	−0.001	−0.001
		[0.026]	[0.021]	[0.021]
Log *loan size*		−1.765***	−1.550***	−1.531***
		[0.404]	[0.484]	[0.479]
Client industry median stock return				−0.015
				[0.023]
Client industry ROA growth				−0.226
				[0.219]
Client industry sales growth				−0.058
				[0.103]
S&P firm ratings	Yes	Yes	Yes	Yes
Performance pricing	No	Yes	Yes	Yes
Term loan	No	No	Yes	Yes
Loan purpose	No	No	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
Observations	1,715	1,690	1,690	1,690
Adjusted R^2	0.743	0.751	0.791	0.791

Notes. The dependent variable is log of *loan spread*. *Large client* is a dummy variable that equals 1 if the supply chain relationship can be found in Compustat Segment data set and 0 otherwise. The FASB requires firms to disclose the identity of each customer that accounts for at least 10% of total revenue. *Leverage* is the ratio of total debt to total assets. S&P ratings are converted to an index from 1 to 7, and we include dummy variables for each rating category. *Profitability* is EBITDA divided by total assets. *Tangibility* follows Almeida and Campello (2007). Heteroskedasticity-consistent standard errors clustered at the supplier industry level are reported in brackets.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

and the effects of the other control variables are similar to those reported in Table 7. Looking at the interactive term, we do see that the effects are somewhat more pronounced the larger the trade credit relationship between the supplier and the bankrupt client.

4.2.3. Additional Robustness Tests. The above results demonstrate that suppliers face higher loan costs following the bankruptcy of a key client, and that the magnitude of these effects is stronger when the failed client is large, when the failed client's industry is in a weaker position (as indicated by a lower distance to default), and when the supplier has a stronger trade credit relationship with the failed client. One possible concern is that these linkages are all interconnected, which makes it harder to sort out the relative importance of the various effects influencing loan spreads. We address this concern by conducting a "horse race" test, where we simultaneously control for each of these effects. The results of these tests are presented in Table 9.

Table 8 The Effect of Client Bankruptcy on Loan Spread When the Supplier Has High Trade Credit to the Bankruptcy Client

	Log(*loan spread*)			
	(1)	(2)	(3)	(4)
After bankruptcy	0.243***	0.242***	0.199***	0.201***
	[0.043]	[0.046]	[0.053]	[0.053]
Supply amount	0.001	0.001	0.000	0.003*
	[0.002]	[0.002]	[0.002]	[0.002]
After bankruptcy × *Supply amount*	0.004***	0.002	0.003*	0.000
	[0.001]	[0.002]	[0.002]	[0.002]
Log *asset*	−0.223***	−0.155***	−0.122***	−0.122***
	[0.029]	[0.030]	[0.024]	[0.024]
Profitability	−1.936**	−1.875**	−2.106**	−2.103**
	[0.858]	[0.909]	[0.947]	[0.945]
M/B	−0.078	−0.089*	−0.057	−0.058
	[0.049]	[0.048]	[0.043]	[0.043]
Tangibility	0.223	0.161	0.377	0.364
	[0.526]	[0.531]	[0.425]	[0.423]
Leverage	1.479***	1.526***	1.233***	1.225***
	[0.361]	[0.332]	[0.249]	[0.251]
Cash flow volatility	0.001	0.006	0.001	0.001
	[0.004]	[0.006]	[0.004]	[0.004]
Distance to default	−0.158***	−0.161***	−0.158***	−0.157***
	[0.022]	[0.021]	[0.020]	[0.021]
Log *maturity* (in months)		0.070**	0.002	0.002
		[0.026]	[0.021]	[0.021]
Log *loan size*		−2.014***	−1.758***	−1.731***
		[0.330]	[0.356]	[0.352]
Client industry median stock return				−0.017
				[0.017]
Client industry ROA growth				−0.115
				[0.151]
Client industry sales growth				−0.082
				[0.109]
S&P firm ratings	Yes	Yes	Yes	Yes
Performance pricing	No	Yes	Yes	Yes
Term loan	No	No	Yes	Yes
Loan purpose	No	No	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
Observations	1,655	1,630	1,630	1,630
Adjusted R^2	0.746	0.756	0.797	0.797

Notes. The dependent variable is log of *loan spread* for a single bank loan. *Supply amount* is a measure of the trade credit that the bankruptcy client owes the supplier in million of dollars. Leverage is the ratio of total debt to total assets. S&P ratings are converted to an index from 1 to 7, and we include dummy variables for each rating category. *Profitability* is EBITDA divided by total assets. *Tangibility* follows Almeida and Campello (2007). Heteroskedasticity-consistent standard errors clustered at the supplier industry level are reported in brackets.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Looking at Table 9, we see once again that the *after bankruptcy* dummy continues to have a positive and statistically significant influence on loan spreads and that the coefficients on the main control variables are similar to those reported in the baseline model. Moreover, the interactive terms related to client size and the industry median DTD have the same signs and levels of statistical significance as reported in Tables 6 and 7, respectively. Likewise, consistent with the results reported in Table 8, the effects related to the trade credit relationship are positive, but the statistical significance varies depending on the model specification. Overall, the main results are upheld using a horse race test, and the test confirms that the client size and median DTD of the firms in the defaulting client industry have the strongest influence on the link between client bankruptcy and loan pricing.

Although our main results control specifically for the default risk of the bankrupt client's industry, one might expect that the health of the supplier may also be relevant. Indeed, in a series of unreported results,

Table 9 The Effect of Client Bankruptcy on Loan Spread: Horse Race

	Log(*loan spread*)			
	(1)	(2)	(3)	(4)
After bankruptcy	0.364***	0.368***	0.361***	0.368***
	[0.063]	[0.062]	[0.062]	[0.063]
Supply amount	0.001	0.001	0.000	0.000
	[0.002]	[0.002]	[0.002]	[0.002]
Large client	−0.042	−0.031	−0.066	−0.058
	[0.308]	[0.302]	[0.290]	[0.285]
Client industry median DTD	0.056	0.057	0.073**	0.075*
	[0.040]	[0.039]	[0.035]	[0.037]
After bankruptcy × *Supply amount*	0.003**	0.002	0.003*	0.003*
	[0.002]	[0.002]	[0.002]	[0.002]
After bankruptcy × *Large client*	0.509**	0.487**	0.438***	0.426***
	[0.238]	[0.217]	[0.155]	[0.150]
After bankruptcy × *Client industry median DTD*	−0.087**	−0.090**	−0.113***	−0.117***
	[0.040]	[0.039]	[0.037]	[0.038]
Log *asset*	−0.221***	−0.155***	−0.114***	−0.114***
	[0.032]	[0.032]	[0.027]	[0.027]
Profitability	−1.838**	−1.800**	−2.061**	−2.054**
	[0.804]	[0.861]	[0.906]	[0.899]
M/B	−0.078	−0.089*	−0.056	−0.057
	[0.047]	[0.047]	[0.044]	[0.044]
Tangibility	0.266	0.221	0.472	0.458
	[0.542]	[0.546]	[0.439]	[0.435]
Leverage	1.471***	1.528***	1.235***	1.227***
	[0.369]	[0.338]	[0.252]	[0.254]
Cash flow volatility	0.001	0.005	0.001	0.001
	[0.004]	[0.005]	[0.004]	[0.004]
Distance to default	−0.157***	−0.160***	−0.157***	−0.157***
	[0.022]	[0.021]	[0.022]	[0.022]
Log *maturity* (in months)		0.072***	0.005	0.005
		[0.025]	[0.020]	[0.020]
Log *loan size*		−1.861***	−1.705***	−1.674***
		[0.318]	[0.337]	[0.331]
Client industry median stock return				−0.024
				[0.019]
Client industry ROA growth				−0.040
				[0.143]
Client industry sales growth				−0.081
				[0.125]
S&P firm ratings	Yes	Yes	Yes	Yes
Performance pricing	No	Yes	Yes	Yes
Term loan	No	No	Yes	Yes
Loan purpose	No	No	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
Observations	1,603	1,578	1,578	1,578
Adjusted R^2	0.754	0.763	0.805	0.805

Notes. The dependent variable is log of *loan spread*. For each supplier in the baseline regression in Table 4, supply amount is a measure of the trade credit that the bankruptcy client owes the supplier in million of dollars. *Large client* is a dummy variable that equals 1 if the supply chain relationship can be found in the Compustat Segment data set, and 0 otherwise. *Client industry median DTD* is the median DTD in the client industry at the three-digit Standard Industrial Classification code level. *Leverage* is the ratio of total debt to total assets. S&P ratings are converted to an index from 1 to 7, and we include dummy variables for each rating category. *Profitability* is EBITDA divided by total assets. *Tangibility* follows Almeida and Campello (2007). Heteroskedasticity-consistent standard errors clustered at the supplier industry level are reported in brackets.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 10 The Effect of Client Bankruptcy on Loan Spread: Difference-in-Differences Estimation

	Log(*loan spread*)		
	(1)	(2)	(3)
After bankruptcy	0.103***	0.098***	0.061*
	[0.035]	[0.035]	[0.034]
Affected	0.143	0.113	0.127
	[0.120]	[0.105]	[0.077]
After bankruptcy × *Affected*	0.144**	0.157**	0.155***
	[0.071]	[0.061]	[0.055]
Log *asset*	−0.245***	−0.167***	−0.152***
	[0.018]	[0.024]	[0.023]
Profitability	−2.002***	−1.664**	−1.990***
	[0.713]	[0.655]	[0.602]
M/B	−0.182**	−0.147***	−0.110**
	[0.085]	[0.053]	[0.047]
Tangibility	−0.041	0.005	−0.004
	[0.555]	[0.470]	[0.455]
Leverage	1.191***	1.218***	0.939***
	[0.189]	[0.142]	[0.142]
Cash flow volatility	0.008	0.004	0.001
	[0.014]	[0.012]	[0.012]
Distance to default	−0.129***	−0.133***	−0.107***
	[0.025]	[0.023]	[0.026]
Log *maturity* (in months)		0.002	−0.001
		[0.001]	[0.001]
Log *loan size*		−0.162***	−0.141***
		[0.021]	[0.019]
S&P firm ratings	Yes	Yes	Yes
Performance pricing	No	Yes	Yes
Term loan	No	No	Yes
Loan purpose	No	No	Yes
Industry effect	Yes	Yes	Yes
Year effect	Yes	Yes	Yes
Observations	2,897	2,766	2,766
Adjusted R^2	0.605	0.689	0.729

Notes. The dependent variable is log of *loan spread*. For each supplier in the baseline regression in Table 4, we try to find a matched firm (i.e., control group). The matching process is as follows. We first focus on the firms in the same industry as the supplier. We then include in our sample only the firms that have access to loans both before and after the client bankruptcy during the time period $(t-2, t+2)$. We then choose the firm that is closest to the supplier in firm size. After the initial matching, there are 1,935 facilities in the control group. And corresponding unique control firms can be found for 174 of 213 unique suppliers. The sample size ranges from 2,766 to 2,897. *Affected* is a dummy variable that equals 1 if the firm is a supplier with bankrupt client and 0 if the firm is the control firm. For both the supplier and control firm, *After bankruptcy* equals 1 if the facility starting date is after the client bankruptcy announcement date and 0 otherwise. *Leverage* is the ratio of total debt to total assets. S&P ratings are converted to an index from 1 to 7, and we include dummy variables for each rating category. *Profitability* is EBITDA divided by total assets. *Tangibility* follows Almeida and Campello (2007). Heteroskedasticity-consistent standard errors clustered at the supplier industry level are reported in brackets.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

we also find that there is a more profound client bankruptcy effect on the supplier's cost of borrowing when the supplier has higher default risk. Taking these arguments a step further, one could argue that the economic conditions of both the supplier's and bankrupt client's industries have independent influences on how lenders respond to the damaged supply chain relationship. One might expect, however, that these effects are not entirely independent, and that there could be common shocks that simultaneously affect the supplier's and bankrupt client's industries. If this effect is occurring, all firms in the supplier's industry might experience an increase in borrowing costs regardless of whether the firm has lost a key client to bankruptcy.

To address this concern, we employ a difference-in-differences (DID) analysis where we construct a set of matched firms that are from the same industry as the supplier, with similar size. Specifically, we first focus on the firms that are in the same

industry as the supplier. We then consider as possible matches only those firms that have loans reported in DealScan both before and after the supplier's client bankruptcy, but did not have any of their customers report bankruptcy. Among this set, we choose the firm closest to the supplier in terms of firm size. Focusing on the sample of suppliers for which we are able to successfully find a matched firm, we include these suppliers and their corresponding control firms in our DID regression estimation. In this analysis, we create a dummy variable, *affected*, which equals 1 if the firm is the supplier in our baseline regression and 0 if the firm is the corresponding firm in the control group. These results are reported in Table 10. The details of the matching process of control firms are reported in the appendix Table A.1. As can be seen from Table 10, the empirical results are highly consistent with our main findings, as indicated by the positive and statistically significant interactive term between *after bankruptcy* and *affected*. Specifically, compared to the control firms, the borrowing costs of the suppliers increased by about 15.5% after client bankruptcy.

In separate tests, reported in the appendix, we also reestimate our baseline regressions using only the control firms. Here we find that the *after bankruptcy* coefficient is also positive for this control group. These results suggest that all firms in the supplier's industry experience an increase in borrowing costs regardless of whether the firm has lost a key client to bankruptcy. Indeed, this evidence highlights the importance of conducting difference-in-differences analysis. Although somewhat concerning, the DID results in Table 10 strongly indicate that these effects are significantly more pronounced if the supplier has lost a client to bankruptcy, and overwhelmingly suggest that only the suppliers with bankrupt clients realize higher borrowing costs. In this regard, these results further emphasize that lenders specifically evaluate the strength of a borrower's supply chain relationships.

Finally, we consider a more restrictive test that employs a single observation for each supplier (rather than treating each facility as a separate observation). Here, we begin by calculating the average change in loan spread (before and after the observed bankruptcy) across each facility held by each supplier. The right-hand side variables are then calculated as changes in the main control variables used in earlier models (again where the changes are the differences in these variables before and after the observed bankruptcy). These results are reported in Table 11.

As expected, the number of observations falls dramatically, but the overall qualitative results remain the same. Loan spreads increased significantly more after a bankruptcy if the defaulting firm was a large client, and if the client was operating in a weaker industry (as measured by a lower DTD). The estimated coefficient related to the trade credit relationship remains positive, but the link is not statistically significant—which is perhaps not surprising, given that in the earlier tests the statistical significance of these results varied according to the estimated specification.

Table 11 The Effect of Client Bankruptcy on Loan Spread: First Difference Regression

	D. Log(*loan spread*)	
	(1)	(2)
D. Log *asset*	−0.254	−0.047
	[0.197]	[0.165]
D. *Profitability*	0.718**	0.468
	[0.295]	[0.290]
D. *M/B*	−0.111	−0.044
	[0.085]	[0.082]
D. *Tangibility*	0.222	1.438
	[1.723]	[1.336]
D. *Leverage*	0.874***	0.813**
	[0.218]	[0.310]
D. *Cash flow volatility*	−0.002	−0.040
	[0.036]	[0.032]
D. *Distance to default*	−0.066***	−0.098**
	[0.020]	[0.047]
D. *Client industry median stock return*	0.016	0.007
	[0.036]	[0.054]
D. *Client industry ROA growth*	−0.253	0.239
	[0.514]	[0.503]
D. *Client industry sales growth*	−0.018	−0.341**
	[0.268]	[0.139]
Supply amount		0.001
		[0.003]
Large client		0.668***
		[0.203]
D. *Client industry median DTD*		−0.178***
		[0.062]
S&P firm ratings	Yes	Yes
Industry effect	Yes	Yes
Year effect	Yes	Yes
Observations	324	289
Adjusted R^2	0.340	0.417

Notes. The dependent variable is log of *loan spread* after the client bankruptcy. *Leverage* is the ratio of total debt to total assets. S&P ratings are converted to an index from 1 to 7, and we include dummy variables for each rating category. *Profitability* is EBITDA divided by total assets. *Tangibility* follows Almeida and Campello (2007) Heteroskedasticity-consistent standard errors clustered at the supplier industry level are reported in brackets. The "D." terms represent the first differences in these variables calculated before and after the observed bankruptcy.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

4.3. Does Client Bankruptcy Affect Nonspread Contractual Terms and Loan Structure?

The aforementioned analysis has focused mostly on loan pricing changes resulting from the client

bankruptcy. However, the unique features of bank loan contracts provide multidimensional information about debt financing, which enables us to also explore whether the client bankruptcy results in spillover effects beyond increasing the price of bank loans (Graham et al. 2008). And many of these nonprice terms (e.g., loan covenants) impose extra costs of debt by reducing financing flexibility and restricting firms' investment activities (Campello et al. 2011). With these issues in mind, we examine in this section the effects that client bankruptcy has on the nonprice aspects of debt, such as covenant intensity and syndicate structure.

From the creditors' perspective, covenants enhance banks' monitoring incentives (Rajan and Winton 1995). Moreover, covenants play a protective role by constraining the borrowers from engaging in moral hazard activities and by allowing lenders to take control and intervene before severe losses are realized. As a consequence, banks are more likely to impose intensive covenants on firms that require stricter monitoring, which likely includes firms that are closer to financial distress (Graham et al. 2008). Therefore, we expect that firms tend to have more intensive financial covenants in their loan agreements following a client bankruptcy filing. Following the literature (e.g., Graham et al. 2008), we construct three measures of covenant intensity: one that tracks the number of financial covenants, one that tracks the number of general activity covenants, and a third measure that tracks the overall number of covenants included in the loan agreements. Detailed definitions of the three variables can be found in §3. We then estimate the following regression:

$$\begin{aligned}&\textit{Covenant intensity}\\&\quad = f(\textit{after bankruptcy}, \textit{firm characteristics}, \textit{loan}\\&\qquad \textit{characteristics}, \textit{industry and time effects}).\end{aligned} \tag{2}$$

The key independent variable and the control variables are as defined previously. Once again, to control for secular shifts in covenant intensity, we employ a DID analysis where we consider the same set of matched firms that are used to generate the loan pricing results in Table 11. The empirical results are presented in Table 12. Columns (1) and (2) report the results using the financial covenant intensity as a dependent variable. Columns (3) and (4) report the results using the general covenant intensity as a dependent variable, and columns (5) and (6) report the results using the overall covenant intensity as a dependent variable. Columns (1), (3), and (5) are based on Poisson regression estimations, and columns (2), (4), and (6) are based on Tobit regression models.

Consistent with our expectations, we find that lenders impose more restrictions on loans to suppliers in the aftermath of a key client's bankruptcy—indeed the coefficients related to the variable that interacts the *after bankruptcy* dummy with the *affected* dummy are statistically significant across five of six model specifications. As can be seen from columns (5) and (6), compared to the control firms, we find that the covenant intensity in the lending agreement increases by about 20% (based on the Poisson model) to 47% (based on the Tobit model) of the sample mean following a client bankruptcy. Overall, the results bolster our previous findings and suggest that there are also resulting effects related to the nonprice contract terms.

Using a similar approach, we explore the effect of client bankruptcy on syndicate structure. As pointed out in the literature (e.g., Holmstrom and Tirole 1997), monitoring is costly, but not directly observable. Therefore, for loans that require more intensive monitoring, the lead lender has particularly strong incentives to shirk because it bears all the monitoring costs but only owns parts of the loan (Lin et al. 2011). However, recognizing this incentive, the participant banks require the lead banks to hold a greater fraction of the loan to signal their commitment to monitor the loan. In short, the literature suggests a positive relation between the monitoring requirement and shares held by lead arrangers. To the extent that client bankruptcy increases the risk of lending to the supplier, we therefore expect a positive link between client bankruptcy and shares held by lead arrangers. We test this hypothesis with the following regression:

$$\begin{aligned}&\textit{Shares held by lead arrangers}\\&\quad = f(\textit{after bankruptcy}, \textit{firm characteristics}, \textit{loan}\\&\qquad \textit{characteristics}, \textit{industry and time effects}).\end{aligned} \tag{3}$$

We construct three dependent variables: the share of the loan held by the lead lender(s), the log of the dollar amount held by the lead arranger(s), and the number of lead arrangers. The key independent variable and the control variables are as defined previously. The empirical results are presented in Table 13. Columns (1) and (2) report the results using the aggregate shares held by lead arrangers as the dependent variable, whereas columns (3) and (4) report the results using the aggregate loan amount held by lead arrangers (in natural logarithm) as the dependent variable, and columns (5) and (6) use the natural logarithm of the number of lead lenders as the dependent variable.

Here we again we employ a DID estimation, with the same set of control firms used in Tables 11 and 12. The key coefficient of interest in Table 13 is related to the interacted variable *after bankruptcy* × *affected*. This coefficient is consistently positive, suggesting that for

Table 12 The Effect of Client Bankruptcy on Covenant Restrictions: Difference-in-Differences Estimation

	# financial covenants		*# general covenants*		*# all covenants*	
	(1)	(2)	(3)	(4)	(5)	(6)
After bankruptcy	0.055	0.106***	0.039	−0.143***	0.086	0.071**
	[0.057]	[0.021]	[0.107]	[0.022]	[0.142]	[0.029]
Affected	0.044	0.187***	0.173	0.269***	0.224	0.588***
	[0.091]	[0.019]	[0.139]	[0.019]	[0.183]	[0.027]
After bankruptcy × *Affected*	0.174**	0.374***	0.139	0.658***	0.318*	0.768***
	[0.087]	[0.030]	[0.114]	[0.034]	[0.169]	[0.042]
Log *asset*	−0.261***	−0.560***	−0.316***	−0.843***	−0.571***	−1.167***
	[0.030]	[0.001]	[0.051]	[0.001]	[0.077]	[0.001]
Profitability	−1.337**	−3.083***	−1.751**	−6.207***	−3.095**	−6.724***
	[0.672]	[0.062]	[0.791]	[0.082]	[1.252]	[0.092]
M/B	−0.133	−0.196***	−0.295***	−0.454***	−0.414***	−0.412***
	[0.084]	[0.004]	[0.063]	[0.005]	[0.137]	[0.007]
Tangibility	0.519	1.390***	−0.787	−1.435***	−0.229	0.969***
	[0.443]	[0.022]	[0.610]	[0.043]	[0.796]	[0.032]
Leverage	0.738**	1.513***	1.190***	3.072***	1.955***	4.222***
	[0.312]	[0.021]	[0.410]	[0.039]	[0.686]	[0.029]
Cash flow volatility	0.007	0.014***	0.003	−0.004	0.007	0.030***
	[0.010]	[0.003]	[0.020]	[0.003]	[0.023]	[0.004]
Distance to default	−0.007	0.005	−0.048	−0.084***	−0.055	−0.052***
	[0.031]	[0.004]	[0.042]	[0.005]	[0.071]	[0.007]
Log *maturity* (in months)	0.000	−0.003***	−0.001	−0.006***	−0.001	−0.007***
	[0.001]	[0.000]	[0.001]	[0.000]	[0.003]	[0.000]
Log *loan size*	0.002	0.049***	0.134**	0.356***	0.139	0.342***
	[0.041]	[0.000]	[0.062]	[0.000]	[0.101]	[0.001]
S&P firm ratings	Yes	Yes	Yes	Yes	Yes	Yes
Performance pricing	Yes	Yes	Yes	Yes	Yes	Yes
Term loan	Yes	Yes	Yes	Yes	Yes	Yes
Loan purpose	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,096	3,096	3,096	3,096	3,096	3,096

Notes. The dependent variables are *number of financial covenants*, *number of general covenants*, and *number of all covenants*. Columns (1), (3), and (5) are based on Poisson regressions, and columns (2), (4), and (6) are based on Tobit regressions. For Tobit estimations, the marginal effects are presented. *Affected* is a dummy variable that equals 1 if the firm is a supplier with bankrupt client and 0 if the firm is the control firm. For both the supplier and control firm, *after bankruptcy* equals 1 if the facility starting date is after the client bankruptcy announcement date, and 0 otherwise. *Leverage* is the ratio of total debt to total assets. S&P ratings are converted to an index from 1 to 7, and we include dummy variables for each rating category. *Profitability* is EBITDA divided by total assets. *Tangibility* follows Almeida and Campello (2007). Heteroskedasticity-consistent standard errors clustered at the supplier industry level are reported in brackets.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

the affected firms, lead lenders take on an increasingly important role after the announced bankruptcy of a key client. However, the statistical significance of these effects varies according to the dependent variable and the model specification. The strongest links appear to relate to the number of lead lenders (the results shown in columns (5) and (6)), where the results are significant at the 1% level in the expected direction. Specifically, we find that the amount of the loan held by the lead lender(s) increases by about 20% and the number of lead lenders increases by 16% in the aftermath of a supply chain disruption. These results provide further evidence that lenders adjust the nonprice terms (i.e., syndicate structure) of their loan contracts to suppliers following a client's bankruptcy. The results also provide further evidence that lenders expand their monitoring of suppliers following the bankruptcy of their key customers. Overall, they are consistent with the arguments summarized in Lin et al. (2011) suggesting that lead arrangers tend to form syndicates with a structure that facilitates enhanced monitoring efforts as the borrower's risk increases.

We also check the impact of client bankruptcy on other loan characteristics such as the collateral requirement. We find that for suppliers, the percentage of secured loans increases by about 5.8% after a client bankruptcy, Whereas, in contrast, the percentage of

Table 13 The Effect of Client Bankruptcy on Syndicate Structure: Difference-in-Differences Estimation

	Total lead lender shares		Log(*total lead lender amount*)		Log(*#lead lenders*)	
	(1)	(2)	(3)	(4)	(5)	(6)
After bankruptcy	−0.022	−0.012	−0.065	−0.004	−0.028	−0.022
	[0.029]	[0.023]	[0.108]	[0.078]	[0.037]	[0.050]
Affected	0.013	0.021	−0.068	−0.031	−0.137**	−0.131**
	[0.022]	[0.023]	[0.067]	[0.073]	[0.056]	[0.059]
After bankruptcy × *Affected*	0.072*	0.049	0.310**	0.203*	0.180***	0.162***
	[0.041]	[0.033]	[0.144]	[0.111]	[0.046]	[0.042]
Log *asset*	−0.013	−0.010	−0.108	−0.081	−0.000	0.001
	[0.012]	[0.015]	[0.069]	[0.087]	[0.046]	[0.054]
Profitability	0.499*	0.361	1.691**	1.229*	0.631*	0.524
	[0.281]	[0.295]	[0.702]	[0.680]	[0.335]	[0.349]
M/B	−0.023	0.002	−0.000	0.102	0.049	0.073
	[0.027]	[0.026]	[0.096]	[0.116]	[0.044]	[0.058]
Tangibility	−0.207	−0.312**	−0.503	−0.852*	−0.310	−0.415
	[0.144]	[0.129]	[0.603]	[0.432]	[0.587]	[0.440]
Leverage	0.018	−0.075	−0.413	−0.830	−0.405	−0.488
	[0.137]	[0.126]	[0.552]	[0.598]	[0.446]	[0.475]
Cash flow volatility	0.013	0.014*	0.045	0.064	−0.006	−0.007
	[0.008]	[0.008]	[0.031]	[0.039]	[0.027]	[0.025]
Distance to default	−0.014	−0.009	−0.035	−0.008	0.030	0.032
	[0.012]	[0.009]	[0.050]	[0.034]	[0.033]	[0.033]
Log *maturity* (in months)	0.001	0.000	0.001	−0.001	0.001	0.000
	[0.001]	[0.001]	[0.002]	[0.002]	[0.001]	[0.001]
Log *loan size*	−0.080***	−0.081***	0.763***	0.737***	0.034***	0.036***
	[0.011]	[0.013]	[0.039]	[0.056]	[0.010]	[0.008]
S&P firm ratings	Yes	Yes	Yes	Yes	Yes	Yes
Performance pricing	Yes	Yes	Yes	Yes	Yes	Yes
Term loan	No	Yes	No	Yes	No	Yes
Loan purpose	No	Yes	No	Yes	No	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	750	750	750	750	750	750
Adjusted R^2	0.475	0.543	0.845	0.872	0.407	0.423

Notes. The dependent variables are the logs of *total lead lender shares*, *total lead lender amount*, and *total of lead lenders*, respectively. Leverage is the ratio of total debt to total assets. S&P ratings are converted to an index from 1 to 7, and we include dummy variables for each rating category. *Profitability* is EBITDA divided by total assets. *Tangibility* follows Almeida and Campello (2007). Heteroskedasticity-consistent standard errors clustered at the supplier industry level are reported in brackets.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

secured loans increases only by 0.82% for the controlled sample. The difference in differences is statistically significant. The empirical results are reported in appendix Table A.2.

4.4. Does a Client Bankruptcy Affect Supplier Sales?

Table 14 reports the results from a final set of tests where we consider the effects that a client bankruptcy has on the total sales of its key suppliers. In many respects, these tests provide additional insights into the channels in which shocks to the supply chain spill over to the lending market.

Panel A summarizes the mean change in sales over different time periods for the set of supplier firms. We specifically contrast sales changes in the periods before the announced bankruptcy to those following the bankruptcy. For each of the estimated windows, the estimated sales change falls after the bankruptcy, suggesting that the supplier sales growth falls significantly after the observed bankruptcy. In panel B, we use a DID approach where we use as the control firms the same sample of matched firms described in §4.2.3 that did not experience a client bankruptcy. These results indicate that the affected firms realized a significant decline in sales growth following the observed bankruptcy relative to the unaffected control firms. On balance, these findings indicate that client bankruptcies have significant real effects on their suppliers, and that these effects are ultimately priced by the lenders. In this regard, these results provide an interesting confirmation of the financial impacts of supply chain credit events.

Table 14 The Effect of Client Bankruptcy on Sales Change

Panel A: Comparison of sales changes

Version	Period 1	*SALE_chg* Obs.	*SALE_chg* Mean	*SALE_chg* Std. dev.	Period 2	*SALE_chg* Obs.	*SALE_chg* Mean	*SALE_chg* Std. dev.	Mean comparison *t*-value
1	Change from year −2 to year −1	331	0.086	0.192	Change from year −1 to year 0	331	0.061	0.204	−1.54
2	Change from year −1 to year 0	331	0.060	0.201	Change from year 0 to year +1	324	0.046	0.181	−1.05
3	Change from year −2 to year −1	331	0.085	0.188	Change from year +1 to year +2	316	0.056	0.174	−2.09**
4	Change from year −2 to year 0	331	0.158	0.360	Change from year 0 to year +2	316	0.113	0.307	−1.78*
5	Change from year −3 to year 0	330	0.292	0.550	Change from year 0 to year +3	306	0.208	0.452	−2.21**
6	Change from year −3 to year −2	330	0.098	0.192	Change from year +2 to year +3	306	0.065	0.166	−2.35**
7	Change from year −3 to year −1	330	0.204	0.367	Change from year +1 to year +3	306	0.139	0.334	−2.25**
Ave	Average change from year −3 to year 0	331	0.082	0.139	Average change from year 0 to year +3	324	0.054	0.128	−2.64***

Panel B: Difference-in-differences regression results

	Sales change, industry median adjusted (1) (−1, 0) vs. (0, +1)	(2) (−2, −1) vs. (+1, +2)	(3) (−2, 0) vs. (0, +2)
After bankruptcy	−0.009	0.004	−0.013
	[0.011]	[0.014]	[0.024]
After bankruptcy × *Affected*	−0.026**	−0.033**	−0.055**
	[0.011]	[0.016]	[0.025]
Affected	0.002	0.013	0.006
	[0.029]	[0.022]	[0.051]
Log *asset*	−0.000	−0.002	−0.002
	[0.005]	[0.007]	[0.010]
M/B	0.020**	0.003	0.026**
	[0.008]	[0.005]	[0.013]
Tangibility	−0.052	0.020	−0.019
	[0.113]	[0.066]	[0.145]
Leverage	0.044	0.002	0.071
	[0.049]	[0.045]	[0.078]
S&P firm ratings	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes
Year effect	Yes	Yes	Yes
Observations	1,266	1,263	1,252
Adjusted R^2	0.105	0.060	0.101

Notes. The dependent variables are sales change (*SALE_chg*), which is sales at year T minus year $T-n$ and then divided by sales at year $T-n$. Year T is the client default year, or year 0. A negative (positive) year number is the number of years before (after) client bankruptcy. We select a control by first focusing on the five companies in the same industry with the closest size (measured by average total assets during $t-3$ to $t-1$). We then choose the one with the closest average sales to total asset ratio during the same period. To run DID estimation, we conduct an industry median adjustment for both treatment and control companies. *Leverage* is the ratio of total debt to total assets. S&P ratings are converted to an index from 1 to 7, and we include dummy variables for each rating category. *Profitability* is EBITDA divided by total assets. *Tangibility* follows Almeida and Campello (2007). Heteroskedasticity-consistent standard errors clustered at the supplier industry level are reported in brackets.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

5. Conclusions

In this paper, we explore the effects that a firm's bankruptcy has on the borrowing costs of its key suppliers. We find that the borrowing costs of these key suppliers significantly increased in the aftermath of their client firm's bankruptcy. Our empirical design uses an approach that compares the cost of bank funding in the two-year periods before and after the client's bankruptcy. On average, borrowing costs increase by more than 20% following a client bankruptcy, and these effects are more pronounced in cases where the bankrupt firm's industry or the supplier's industry is undergoing economic distress, where there are horizontal intraindustry effects, and where there are stronger trade credit links between the supplier and bankrupt client. Taken together, these findings shed direct light on an important channel through which the supply chain relationship affects corporate value. One key advantage of using loan data to test the spillover effects of bankruptcy is that we can explore not only how the client bankruptcy affects the cost of bank borrowing, but also how it affects the nonprice terms and overall structure of the lending agreement. Here we find that after client bankruptcies, lenders

tend to increase the number of covenants in the lending agreement, and they take steps to modify the structure of the lending syndicate. In particular, we find that lead banks take a larger role in the syndicate in the period following the client bankruptcy. We believe that these results make a contribution to the loan contracting literature, and, in particular, they demonstrate how lenders respond to a perceived shift in the borrower's risk.

Taking a closer look at the impact of disrupted supply chains, we also find that suppliers with bankrupt clients realize significantly lower sales growth (relative to control firms that do not experience a disruption). The resulting decline in sales growth is arguably the channel that leads lenders to charge higher rates. More specifically, our study focuses on how lenders respond to a disruption in a firm's supply chain. In this regard, our paper adds to a growing literature that has focused on the important role that trade credit has on the structure of firms' contracts. More broadly, our paper provides a further demonstration of how firms are interconnected and illustrates how the decline of one firm can have spillover implications to its connected firms.

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Appendix

Table A.1 The Effect of Client Bankruptcy on Loan Spread: Control Firms Only

	Log(*loan spread*)		
	(1)	(2)	(3)
After bankruptcy	0.114**	0.115**	0.114***
	[0.043]	[0.044]	[0.037]
Log *asset*	−0.268***	−0.239***	−0.240***
	[0.031]	[0.044]	[0.038]
Profitability	−2.540***	−2.342***	−2.247***
	[0.797]	[0.724]	[0.564]
M/B	−0.066	−0.069	−0.087
	[0.073]	[0.066]	[0.054]
Tangibility	−0.618	−0.594	−0.413
	[0.590]	[0.562]	[0.609]
Leverage	1.220***	1.241***	0.904***
	[0.251]	[0.236]	[0.215]
Cash flow volatility	0.015	0.005	0.007
	[0.019]	[0.018]	[0.021]
Distance to default	−0.120***	−0.119***	−0.103***
	[0.034]	[0.034]	[0.032]
Log *maturity* (in months)		−0.000	−0.001
		[0.001]	[0.001]
Log *loan size*		−0.069*	−0.077**
		[0.036]	[0.029]
S&P firm ratings	Yes	Yes	Yes
Performance pricing	No	Yes	Yes
Term loan	No	No	Yes
Loan purpose	No	No	Yes
Industry effect	Yes	Yes	Yes
Year effect	Yes	Yes	Yes

Table A.1 (Continued)

	Log(*loan spread*)		
	(1)	(2)	(3)
Observations	1,193	1,153	1,153
Adjusted R^2	0.698	0.724	0.752

Notes. The dependent variable is log of *loan spread*. For each supplier in the baseline regression in Table 4, we try to find a matched firm (i.e., control group). The matching process is as follows. We first focus on the firms in the same industry as the supplier. We then include in our sample only the firms that have access to loans both before and after the client bankruptcy during the time period $(t-2, t+2)$. We then choose the firm that is closest to the supplier in firm size. After the initial matching, there are 1,935 facilities in the control group. And corresponding unique control firms can be found for 174 of 213 unique suppliers. We then focus on the sample of control firms in Table 11 only. The sample size ranges from 1,153 to 1,193. *After bankruptcy* equals 1 if the facility starting date is after the client bankruptcy announcement date and 0 otherwise. Leverage is the ratio of total debt to total assets. S&P ratings are converted to an index from 1 to 7, and we include dummy variables for each rating category. *Profitability* is EBITDA divided by total assets. *Tangibility* is net property, plant, and equipment/total assets. Heteroskedasticity-consistent standard errors clustered at the supplier industry level are reported in brackets.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Table A.2 The Effect of Client Bankruptcy on the Proportion of Secured Loans: Difference-in-Differences Tests

	Treatment	*N*	Mean	*t*-value	*p*
Sec_chg	1	313	0.0580	2.801***	0.005
Sec_chg	0	313	0.0082	0.468	0.640
Sec_chg	Diff (1 − 0)		0.0499	1.840*	0.066

Notes. The key variable is the change of proportion of secured loans (*Sec_chg*). The matching sample is the same as that in Table 11. The secured loan is identified by the variable "Secured" in DealScan. The proportion of secured loans is calculated by the number of loans with "Secured = Yes" over the total number of loans facilities borrowed by the supplier during two years before/after the client bankruptcy event. The change of secured loan proportion is the difference between before and after (after minus before) for the treatment and control.

*, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

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