The effect of social connections on capital structure in supplier-customer relationships[1]

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ABSTRACT

Suppliers socially connected to major customers with relation-specific investments have higher leverage ratios compared to unconnected suppliers. The presence of connections partially reduces supplier underleverage observed in supplier-customer relationships with relation-specific investments. Consistent with the role of connections in bonding trading parties' commitment, connections to major customers help to increase customer purchases, and supplier leverage increases are primarily observed in firms with high intensity of customer purchases. Additionally, connected suppliers are associated with higher leverage primarily when information asymmetry between parties is high. Overall, connections help strengthening implicit contracts through establishing trust between trading parties.

1. Introduction

Theoretical arguments introduced by Titman (1984) suggest that relationship to non-financial stakeholders such as customers is an important factor affecting firms' capital structure policies. Suppliers making capital structure decisions need to consider the consequences of such decisions for major customers. For example, in case of a supplier liquidation, its bankruptcy costs will spill over the customer causing potential disruptions in the supply chain process. Recent COVID-19 induced financial crisis has been associated with such risks of supplier financial distress. For example, in March 2020, financial analysts expressed concerns about the supply chains disruptions of retailers J. Crew and Jo-Ann that sourced 54% and 40% of its merchandize, respectively, from Chinese manufacturers badly affected by the impact of COVID-19.[2] The bankruptcy concerns have been particularly severe in case of high-tech partnerships. In May 2020, Boeing cited the need to help its 17,000 suppliers which employ 2.5 million workers as one of the reasons to borrow $25 billion,[3] while one of their key suppliers – Spirit AeroSystems – lost over 60% of its market value and was in danger of default on its

debt worth $3 billion by June 2020.[4] These examples of anecdotal evidence demonstrate the importance of supplier financial health for the customer, because suppliers distress can create spillover effects on customer business.

The customer may be concerned of the supplier's financial situation even outside supplier's bankruptcy, as a financially distressed supplier may have incentives to lower the quality of goods and services in order to boost profits. The losses due to supplier's distress may be particularly high when the customer has committed resources towards the relationship. Indeed, previous research shows that in the presence of relation-specific investments, suppliers tend to follow conservative capital structure policies and to maintain low debt levels (e.g. Kale and Shahrur (2007), Banerjee et al. (2008), Itzkowitz (2013)). Because of the supplier distress costs, customers with investments in relation-specific assets tend to be reluctant to deal with a supplier who may not have incentives to maintain reputation (Maksimovic and Titman (1991)).

In the real world, commitment to business partners goes beyond firm's boundaries, as corporate environments are saturated with a complex network of social ties, which affect the outcomes of financial decisions (e.g. Engelberg et al. (2013), Ishii and Xuan (2014)). Our paper uniquely documents how personal connections between respective managers of customer and supplier firms change capital structure decisions of suppliers in the context of the relation-specific investments. Using a broad sample of suppliers with social connections to customers, we are the first to show that social connections can mitigate suppliers' underleverage when dealing with R&D-intensive customers. We focus on studying capital structure decisions of dependent suppliers, because they are much smaller than customers, and the loss of the major customer may substantially damage the dependent supplier financial health.[5]

The effect of connections to major customers on the suppliers' capital structure is not obvious. On one hand, there are several reasons to expect the positive effect on leverage. First, connected suppliers are more likely to pursue higher leverage, as personal connections may lead to more stable supplier-customer relationships. We build on the vast literature in sociology and economics, which shows that connections can create trust between connected individuals (e.g. Coleman (1988), Nahapiet and Ghosal (1998), Woolcock (1998), Putnam (2000), Karlan et al. (2009)). Trust facilitated by connections can provide a "social collateral" similar to a physical collateral securing borrowing-lending transactions. The breach of social contracts can damage the reputation of both - firm and its executives (Labianca and Brass (2006), Karpoff and Lott Jr (1993)), so social connections should decrease the probability that each firm will behave opportunistically. In our setup, social connections should allow suppliers to increase leverage, as social connections both: (a) alleviate customer concerns about supplier reputation (as supplier will care more about the quality of goods and services) and (b) allow suppliers to be confident in the future stability of the relationship (and future repayment of the supplier debt). We label this channel as *bonding* channel.

Second, personal connections can mitigate information asymmetry between parties in supply-chain relationship (Chen et al. (2021)) by transmitting hard and soft information and lowering monitoring costs. Moreover, recent studies have provided evidence about the role of social connections in mitigating information asymmetries in financial decisions (e.g. Cohen, Frazzini and Malloy (2008, 2010), Duchin and Sosyura (2013)). Socially connected customer and supplier are likely to interact more frequently and more intensively than unconnected parties - even outside their formal business relationship. Frequent interactions facilitate information transfers between parties (e.g., through communication or factory site visits), thereby mitigating information asymmetry. Thus, connected suppliers and customers are likely to have better access to information about financial health of each other and can better evaluate the risk of counterparty's potential bankruptcy. This reduction in monitoring costs will be particularly relevant for (riskier) customers with significant investments in relation-specific assets and will enable their (typically smaller) suppliers to choose higher level of debt. We refer to this channel as *information asymmetry* channel.

On the other hand, there are reasons to believe that connections to major customers with relation-specific assets may lead to lower leverage. This happens, for example, if debt is used to protect profits from expropriation (e.g. Bronars and Deere (1991)). Higher debt held by suppliers may thus help to shield profits from being expropriated by customers. In our setting, social connections promoting trust between parties could lower the likelihood of the threat of aggressive renegotiation and thus allow the suppliers to choose lower (optimal) leverage. We label this channel as *bargaining* channel.[6]

We use BoardEx to calculate the connections between senior managers of customer and supplier firms. We consider two people as being connected if they participated in the same organization at the same time in the past. To account for potential reverse causality when business relationship leads to a formation of connections, we focus only on past connections formed at third-party organizations (e.g., universities, past employment). We take information from Compustat Segment files and use the combination of manual and automated procedures to identify the major customers (customers with >10% of supplier sales). Because relationship-specific investments are unobservable, we follow a common approach in the literature and use firm's research and development (R&D) expenditures as a proxy for relationship-specific investments (e.g. Titman and Wessels (1988), Allen and Phillips (2000), Banerjee et al. (2008)). R&D expenditures include expenses incurred in research and development of the product, reflecting firm's innovation effort. When a supplier (customer) firm makes relation-specific investments in a partner, it tends to produce unique and customized products that have no close substitutes (Titman and Wessels (1988), Banerjee et al. (2008)).

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[4] "A Key Boeing Supplier Drops on More Bad News about 737 MAX – Barrons.Com." *Dow Jones Institutional News,* June 23, 2020.

[5] Compared to the recent studies of Chen et al. (2021) and Dasgupta et al. (2021), we are focusing on capital structure decisions in supply chain. We are measuring social connections in a different way than in those studies, and our scaled measure better accounts for the respective sizes of supplier and customer firms (as larger firms typically associated with more executives and, hence, more potential connections). We are using a new identification method, which relies on tighter tests addressing the endogenous matching between suppliers and customers.

[6] Even though this channel assumes that suppliers should be overleveraged regardless of the relation-specific investment, we are not excluding this channel apriori as it is not clear how social connections will affect the leverage.

Using a matched supplier-customer sample of U.S. firms, we document that suppliers connected to key R&D-intensive customers operate with significantly higher market leverage. The effect of connections to key R&D-intensive customers on the leverage is economically meaningful. While previous research (e.g. Kale and Shahrur (2007)) has documented that suppliers dealing with R&D-intensive customers are significantly under-levered, we estimate that an increase in market leverage due to supplier-customer connections reverses approximately 35% of the original leverage decline. We further document that connections to R&D-intensive customers matter more for customers that account for larger percentage of supplier sales and for suppliers that have a higher likelihood of financial distress. We also find that connections do not significantly affect cost of supplier debt.

We address potential endogeneity concerns in our tests. All our models include supplier fixed effects to account for supplier-level unobservable factors. In addition, we examine the possibility that the allocation of certain types of suppliers across customer firms is not random, and suppliers' leverage choices could be a function of customer characteristics.[7] First, we use turnovers of top executives at the customer firms as exogenous shocks to supplier connections. These shocks are likely to be exogenous to the managers' connections at the supplier firms, as customer managerial turnovers are unlikely to be motivated by suppliers (on average, the purchases from a particular supplier constitute only <3% of customer's total purchases). The turnovers of key executives at the customer firms are likely to lead to a loss or break of social connections that suppliers have formed with the customer firms. Using difference-in-differences research design, we compare changes in leverage ratios of the connected suppliers that have lost connections vs. have not lost connections as a result of the turnover at the same customer firm. (Comparing suppliers for the same customer allows us to keep the quality of the customer - observed and unobserved - constant). We show that suppliers with R&D-intensive customers experience significant drops in leverage ratios following the loss of the connections due to customer firm executive turnovers.

We perform several additional robustness tests. First, we match connected and unconnected suppliers across observable characteristics and show that our main results continue to hold on a matched sample. Second, we address the potential reverse causality problem, as existing business relationships could facilitate the formation of social connections between trading partners at third party institutions following the establishment of supplier-customer relationship. We exclude (a relatively small proportion of) connections formed after the start of the business relationship between the two trading parties, and results are nearly identical with those based on the full sample of connections.

We next study the potential explanations for the positive effect of connections to R&D-intensive customers on leverage. We find support for the *bonding* channel and show that the effect of connections to R&D-intensive customers on leverage is significantly stronger when supplier has a stronger trading relationship with its key customers. (At the same time, social connections between suppliers and key customers are associated with higher sales to these customers.). We also provide some evidence consistent with the *information asymmetry* explanation. We find that the positive effect of social connections to R&D-intensive customers on market leverage is stronger (albeit not statistically significantly) in subsamples of high information asymmetry between supplier and key customers (proxied by either geographical distance between supplier and customer locations or supplier dispersion of analyst earnings forecasts).[8]

Our study contributes to the emerging research on the role of social connections in customer-supplier relationships. To our knowledge, we are the first to focus on the effect of social connections between customers and suppliers on supplier capital structure decisions. We extend the work of Chen et al. (2021), who study how social connections affect the selection of suppliers and contractual terms between suppliers and customers, and the work of Dasgupta et al. (2021), who study the effect of social connections between customers and suppliers on supplier innovation, and the study of Cai and Zhu (2020) who document lower cost of debt for suppliers in the presence of major supplier-customer relationship.

Our study also extends the stream of research on solutions to hold-up problems in customer-supplier relationships. For example, Johnson et al. (2015) find that IPO firms being heavily dependent on their business partners benefit from using takeover defenses to show commitment to their business relationships. When a firm goes public it becomes an easy target, especially when it is young and small. In case of a takeover the management is usually replaced, what can lead to renegotiation of previous informal agreements. The use of takeover defenses helps the firm to commit to its business strategy, and, moreover, to signal to the partner that it values the relationship. The work of Dass et al. (2014) suggests that trade credit can serve as a commitment device between vertically related firms, which invest in relationship-specific assets. In contrast to these studies, we document the positive role of social connections in bonding to partners' contracts.

2. Sample and data

2.1. Sample and variable construction

To construct the sample, we select all firms covered by the Compustat Customer Segment file during the period from 2000 through 2014. Customer Segment files gather statistics on supplier firms, which are required to report their principal customer (that accounts for >10% of their total sales) according to SFAS No. 131. We only keep firms with non-missing information on sales to major customers and exclude customers with names reported as "Customers", "Companies", "Distributors" or "Not reported". As customer names are

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[7] For example, Demirci (2016), Lian (2017) and Oliveira et al. (2017) show that customer financial health affects the leverage of the supplier.

[8] Higher distance is associated with higher costs of access to information and higher monitoring costs (Giroud (2013), Costello (2013)). Dispersion of analyst earnings forecasts is related to the informativeness of a firm's financial reporting, so that less dispersion among individual analysts' forecasts is associated with reduced information asymmetry (Lang and Lundholm (1996)).

often abbreviated in the Compustat Segment file, we follow Fee and Thomas (2004) and use a combination of automated and manual procedures to match the segment data info with Compustat/CRSP files. Specifically, we first match each customer name with several potential Compustat firms, based on customer name spelling. Then we manually check and confirm each match based on corporate names and industry classification. If the customer is a subsidiary of a publicly traded firm, then we assign to the customer the identifier of the parent corporation.[9] We tend to be conservative in our matching of customer names to firm identifiers to ensure that disclosed customers are matched to correct Compustat firms.[10] We then require that each customer-supplier pair be present in BoardEx database. BoardEx provides information on work and educational histories, board memberships and non-profit organization memberships, as well as information on bilateral social connections for senior executives. Because prior to 2000 the coverage of BoardEx is limited, we use 2000 as a starting year to mitigate survivorship bias (Engelberg et al. (2013)). We use CIK identifier to match BoardEx and Compustat databases. For cases, when CIK was not provided, we used a string-matching procedure to match company names from both databases. To ensure the quality of the matching procedure, we manually checked all matches and made necessary corrections. The matching procedures yielded a sample of 1764 suppliers, 966 customers and 14,733 observations.

We drop observations with missing or negative supplier sales to key customer and missing (negative) total supplier sales. Finally, we require that both suppliers and customers have non-missing financial information (across our lagged control variables), including non-missing and non-negative R&D expenditures. Firm-level financial variables are obtained from Compustat and CRSP databases. To eliminate outliers, we trim the sample by excluding observations with (a) market and book leverage >1, (b) firm cash flow (to total assets) and firm ROA >1 or <−1, (c) firm's Tobin's Q >10, (d) the ratio of firm selling, general and administrative expenses to total assets >1 and (e) ratio of supplier sales to key customer to total supplier sales >1. Then, we winsorize all variables at the 1st and 99th sample percentiles. The final sample consists of 1499 unique supplier firms, 724 customer firms, 10,838 supplier-customer-year observations and 7233 supplier firm-year observations.[11]

Our leverage measure is *Market Leverage,* equal to the sum of book values of long-term debt exceeding maturity of one year and short-term debt in current liabilities (with maturities due up to one year) divided by the sum of book values of long-term and short-term debt and market value of common equity (Baker and Wurgler (2002), Lemmon et al. (2008), Strebulaev and Yang (2013)).[12]

The data on social connections are obtained from BoardEx. Following the extensive literature in social networks area, we base our measure of social connections on employment, educational and social ties between senior managers of supplier and customer firms. We focus on connections formed between executives that potentially participate in supply chain decisions. Specifically, we restrict our attention to connections formed between senior managers (e.g. CEO, CFO, COO), excluding board members for the analysis. Besides CEO, CFO and COO, we consider the following titles frequently represented in our sample: "Senior Vice President", "Vice President", "Division VP/President", "General Manager", "Executive VP". We consider two people as being connected if they participated in the same organization at the same time in the past. For example, we would classify two executives as being connected if they both previously worked at the same public or private company. Because the business relationship between customer and supplier may lead to a formation of the connections between them, we require the employment connections be formed only at third-party companies. Similarly, two executives would share an educational connection if they both studied in the same university or were members of professional/social clubs during the same period of time in the past. The overwhelming majority of connections (about 93%) comes from employment or board memberships in public or private companies, about 4% are educational connections and the remaining connections (about 3%) - are connections formed through memberships in professional organizations and social clubs.[13]

We compute our measure of connections similar to Ishii and Xuan (2014). For each supplier-customer pair we count the number of connected pairs of individuals composed of one member of the supplier firm and one member of the customer firm. We then compute *Connections* by dividing the number of connected pairs (x 100) by the total number of pairs that exist between individuals of customer and supplier firms.

2.2. Descriptive statistics

Table 1 shows the summary statistics of variables we used in the empirical analysis. As shown in Panel A, the mean market leverage of the supplier is 18% and the average share of sales to a major customer is about 19%. Customers are much greater in size (as measured by book value of assets and market capitalization) than suppliers, and the comparison of the median values of book assets of

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[9] In few cases one customer included multiple divisions (variable cid), in these cases we aggregated all divisions by customer firm.

[10] We do not exclude financial firms (SIC codes between 6000 and 6999) and utilities (SIC codes between 4900 and 4999), which altogether account for only 5% of our sample. In unreported analysis, we find that our results remain nearly identical if exclude those firms.

[11] The sample size implies 4.8 observations on average per supplier firm. There are two key factors that limit our sample size. First, the need to match with BoardEx, where we require that both supplier and customer firms not only be present in the database, but the composition of executives be covered in the "Summary" files for both firms in a given year. Our sample size is reduced because the coverage of BoardEx is still limited for early 2000s, and we must drop supplier-customer pair in a given year if either firm is not represented in terms of composition of managers. Second, we aggregate the observations by supplier firm for all customers of a given supplier. As a result, our sample is not by pair-level, but by supplier firm-level. Later, in section 3.1 we describe our empirical model and the intuition behind supplier firm-level consideration.

[12] We are reporting our results using the Market Leverage definition of the debt ratio following Banerjee et al. (2008) and Kale and Shahrur (2007), however, all our main results hold using the Book Leverage definition of the debt ratio.

[13] We are excluding board members from analysis, but it is still possible that non-board executives (such as CEO, CFO, COO, etc.) could have served on boards of other companies and formed connections through board memberships at other companies. Hence, we do not exclude connections formed through serving on boards at other companies.

Table 1
Summary Statistics.

Panel A: Suppliers and Customers						
Variable	Mean	25th perc.	Median	75th perc.	St. dev.	N
Supplier-Level Characteristics:						
Supplier Market Leverage	0.183	0.003	0.116	0.294	0.206	7233
Supplier Market Value of Assets, $M	4641	200	768	2955	13,302	6836
Supplier Book Assets, $M	2593	128	497	2003	6495	7233
Supplier Sales, $M	2415	105	397	1570	6723	7233
Supplier Capital Expenditure/Assets	0.049	0.015	0.029	0.053	0.063	7227
Supplier Tobin's Q	1.884	1.164	1.529	2.167	1.153	7233
Supplier Return on Assets (ROA)	0.080	0.044	0.105	0.156	0.149	7229
Supplier Fixed Assets	0.234	0.066	0.151	0.308	0.232	7230
Supplier R&D Intensity	0.059	0.000	0.014	0.086	0.093	7233
Supplier Tax Credit	0.001	0.000	0.000	0.000	0.002	7233
Supplier Volatility	0.101	0.034	0.063	0.118	0.117	7233
Supplier Firm Age	2.831	2.303	2.833	3.367	0.705	7233
Supplier Industry Concentration	0.059	0.032	0.041	0.068	0.047	7233
Key Customers R&D	0.006	0.000	0.000	0.006	0.014	7233
Key Customers Industry Concentration	0.031	0.007	0.016	0.039	0.037	7233
Key Customers Change in Sales	0.003	0.000	0.002	0.008	0.015	7233
Supplier Sales to Key Customers	0.291	0.133	0.215	0.371	0.230	7233
Number of Customers per Supplier	1.498	1.000	1.000	2.000	0.864	7233
Average Distance to Key Customers	0.97	0.364	0.773	1.365	0.83	7233
Connections to Key R&D-int. Customers	0.002	0.000	0.000	0.000	0.008	7233
Connections to Key Customers	0.086	0.000	0.000	0.075	0.224	7233
Supplier-Customer-Level Characteristics:						
Customer Market Value of Assets, $M	131,015	16,600	44,390	174,069	229,934	8910
Customer Book Assets, $M	80,052	9546	28,589	105,676	133,528	10,838
Customer R&D intensity	0.020	0.000	0.000	0.025	0.037	10,838
Sales to Customer (as % of Supplier Sales)	0.195	0.106	0.155	0.237	0.146	10,838
Customer-Supplier Distance (1000 miles)	0.992	0.308	0.732	1.518	0.900	10,838
% of Suppliers with at least one connection	57.17%					
% of connected Suppliers with above median sales to Key Customers	39.83%					
Connections (per 100 pairs of executives)	0.322	0.000	0.000	0.311	1.307	10,838
Total number of connections between executives of supplier and customer firms if connection(s) exists between supplier and customer	2.982	1.000	2.000	3.000	6.856	3974

Panel B: Connected and Unconnected Suppliers							
Variable	Connected	N	Unconnected	N	Diff.	T-stat.	
Supplier Market Leverage	0.197	1827	0.179	5406	0.018	3.19	***
Key Customers R&D	0.010	1827	0.005	5406	0.005	12.99	***
Supplier Sales to Key Customers	0.424	1827	0.246	5406	0.178	30.35	***
Supplier Firm Size	6.743	1827	5.955	5406	0.788	15.82	***
Supplier Return on Assets	0.089	1827	0.086	5406	0.003	0.70	
Supplier Fixed Assets	0.232	1827	0.238	5406	−0.006	−1.02	
Supplier R&D Intensity	0.067	1827	0.054	5406	0.012	5.10	***
Supplier Tobin's Q	2.114	1827	1.899	5406	0.215	6.19	***
Supplier Volatility	0.106	1827	0.099	5406	0.007	2.15	**
Supplier Firm Age	2.662	1827	2.781	5406	−0.118	−5.75	***
Key Customers per Supplier	1.684	1827	1.436	5406	0.248	10.68	***

The table presents summary statistics for the sample of 1499 unique supplier firms and 724 customer firms between 2000 and 2014, which are covered both by Compustat Segments and BoardEx and have non-missing financial information. Panel A shows the financial characteristics of customers and suppliers, and panel B reports the results of univariate comparisons for the sample partitioned based on whether a supplier is connected to at least one of its major customers and has a proportion of sales to this particular customer above the sample median. All variables are defined in Appendix A. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

customers and suppliers indicates that the sample median customer is about 58 times bigger than the median supplier. The average value of Supplier R&D intensity shows that the average supplier invests 6% of the book assets in R&D, and key customers on average invest 2% of book assets. Overall, the descriptive statistics of independent variables show that firms in our sample differ significantly across characteristics of suppliers and their customers.

About 57% of suppliers are connected to at least one customer and about 40% of suppliers have at least one connection and proportion of sales to a major customer above the sample median. For the sample of connected pairs of suppliers and customers the average number of connections per 100 executives' pairs (*Connections)* is about 0.32, implying on average about three connections exist between a supplier and customer firms in our sample.[14] In panel B we report the numbers by subsamples based on existence of *Connections* between supplier and customer. An indicator variable *Connected* equals one if *Connections* is positive, meaning that a supplier has at least one connection with its key customer and has a proportion of sales to this particular customer above the sample median. Conditioning the existing connections on the proportion of sales allows to account for the fact that preexisting personal connections are not relevant if interaction and trading relationship between firms is weak. Using this definition, *Connected* suppliers have significantly higher level of leverage, higher book value of assets, invest more in R&D, have more volatile profits (as suggested by higher *Supplier Volatility*, defined as the standard deviation of ROA for the previous 10 years) than unconnected suppliers. *Connected* suppliers differ from unconnected suppliers along their customers' characteristics. For example, connected suppliers have higher number of major customers and have key customers with greater R&D-intensity. The summary statistics suggest that there are significant differences between connected and unconnected suppliers. Thus, in our empirical analysis we account for these differences - first, by explicitly controlling for these differences in our regression analysis; second, in robustness tests, by using propensity-score matching to create similar subsamples of connected and unconnected suppliers across these characteristics.

3. Empirical strategy and results

3.1. Empirical model

To test how connections to key customers that undertake relation-specific investments affect the firm leverage, we analyze the determinants of market leverage of suppliers. The intuition behind our key determinant of suppliers' debt choices is similar to that of the measure of weighted R&D intensities of all major customers introduced in Kale and Shahrur (2007) who showed that supplier market leverage is significantly negatively related to weighted R&D intensities - which implies that large relation-specific investments of key customers have a greater impact on supplier leverage. Similarly, as we predict that supplier-customer social connections will have a greater impact for R&D-intensive customers (due to bonding-, information asymmetry-, or bargaining-related factors), we define our key variable *Connections to Key R&D-intensive Customers* in order to reflect the greater expected relevance of supplier links to customers making large relation-specific investments:

$$Connections\ to\ Key\ R\&D\text{-}intensive\ Customers = \sum_{j=1}^{n} \left(Connections_j \times Key\ Customer\ R\&D_j \times Sales\ to\ Key\ Customer_j \right)$$

where n is the number of customer firms, *Connections$_j$* is the total number of connections between executives of supplier and customer firms scaled by the total number of possible executives' pairs (see the discussion of this measure in section 2.1), *Key Customer R&D$_j$* is equal to the R&D expense (scaled by total assets) of the jth customer, *Sales to Key Customer$_j$* is the percentage of firm's sales to the jth customer.[15]

We estimate the following regression model:

$$Supplier\ Debt_{it} = \beta_1\ Connections\ to\ Key\ R\&D\text{-}intensive\ Customers + \gamma X_{it-1} + \zeta_i + \delta_t + \epsilon_{it} \tag{1}$$

where *Supplier Debt$_{it}$* is market leverage of supplier i and *Connections to Key R&D-intensive Customers* is the above-defined measure. The regression also includes a set of control variables X_{it-1}, firm fixed effects ζ_i, and year fixed effects δ_t. We include firm fixed effects to account for cross-firm heterogeneity (such as strategy, managerial talent) that could potentially affect the amount of debt the firm takes. The year fixed effects help to account for macroeconomic factors that could affect the leverage decisions of sample firms. Because the unit of observation is supplier firm-year, we adjust standard errors for heteroscedasticity and cluster at firm (supplier) level.

As Kale and Shahrur (2007) show that suppliers' leverage depends on R&D intensities of all major customers, we control variables for *Key Customers R&D* defined as the sum of sales-weighted R&D intensities of all major customers for a supplier firm in a given year[16]:

$$Key\ Customers\ R\&D = \sum_{j=1}^{n} \left(Key\ Customer\ R\&D_j \times Sales\ to\ Key\ Customer_j \right)$$

Additionally, following the literature we include supplier and customer industry variables to control for supplier/customer industry

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[14] In unreported robustness analysis, we worked with alternative definitions of *Connections,* based on more restrictive definitions of supplier and customer executives. Our results were similar to those presented in this paper.

[15] As in Kale and Shahrur (2007), in our data the percentages of firm's sales to jth customer *Sales to Key Customer* are not summing to one as not all customers are reported. By construction, *Key Customer R & D$_j$* and *Connections to Key R&D-intensive Customers* are downward biased.

[16] Customer variables computed for jth customer and used in aggregated variables (*Key Customer R&D$_j$, Key Customer Industry Concentration$_j$, Key Customer Change in Sales$_j$*) are lagged by one year in order to capture the effect of customer characteristics on the subsequent supplier leverage choices.

concentration: *Supplier Industry Concentration* (Herfindahl–Hirschman Index (HHI) in the 2-digit SIC code), *Key Customers Industry Concentration* (sales-weighted HHI for all key customers). Kale and Shahrur (2007) shows that consistent with the bargaining role of debt, suppliers in highly customer-concentrated industries tend to have higher debt. Additionally, we control for growth in customer industries by including *Key Customers Change in Sales* (median one-year change in sales in the key customer 2-digit SIC industry sales-weighted for all key customers).

In all models we control for the risk of high concentration of sales to key customers measured as the total percent of sales to all key customers (*Supplier Sales to Key Customers*). Previous studies (e.g. Banerjee et al. (2008) and Itzkowitz (2013)) have shown that customer concentration has a negative effect on leverage for firms with high relation-specific investments. More recent evidence shows that customer concentration matters to supplier cost of debt (Campello and Gao (2017)) and cost of equity (Dhaliwal et al. (2016), and Cai and Zhu (2020)), which impacts on the decisions that affect levels of leverage.[17]

In addition, we include variables known to affect the firm leverage (e.g. Berger et al. (1997), MacKay and Phillips (2005), Kale and Shahrur (2007), Lemmon et al. (2008), Strebulaev and Yang (2013)). These variables include: *Supplier Size* (natural logarithm of total assets), *Supplier ROA* (operating income divided by total assets), *Supplier Fixed Assets* (net property, plant and equipment divided by total assets), *Supplier R&D* (research and development expenditures divided by total assets), *Supplier SGA* (selling, general and administrative expenses divided by total assets), *Supplier Tobin's Q* (book value of assets plus the market value of common equity minus the book value of common equity divided by book value of assets), *Supplier Volatility* (rolling standard deviation of ROA for the previous 10 years relative to a given year), *Supplier Non-Debt Tax Shields* (investment tax credit divided by total assets), *Supplier Firm Age* (natural logarithm of one plus number of years since the firm is reported in Compustat).

3.2. Connections to key R&D-intensive customers and dependent Suppliers' leverage: Baseline results

Table 2 reports the results of the analysis of determinants of suppliers' leverage, based on Eq. (1). In panel A, columns (1)–(3) contain the estimates for leverage determinants similar to those used by Kale and Shahrur (2007), while models with extra control *Supplier Sales to Key Customers* are analyzed in columns (4)–(6). First, similarly to Kale and Shahrur (2007), the results show the co-efficient on *Key Customers R&D* is negative and significant at 1%, suggesting that suppliers utilize lower leverage when they have R&D-intensive customers. Second, and more importantly, we document that *Connections to Key R&D-intensive Customers* are associated with higher leverage, as the coefficient on this variable is positive and significant in all 6 columns of Table 2. Columns (1) and (4) show the results without any fixed effects. Year and industry fixed effects (based on 2-digit SIC industry classification) are added in columns (2) and (5), to account for time-invariant industry differences in leverage and industry differences in R&D. Columns (3) and (6) report the results of regressions with year and firm fixed effects added. It's worth noting that firm fixed effects can also absorb slow-changing cross-firm differences in corporate governance (investor protection, antitakeover laws, etc.), since R&D expenses can be correlated with the quality of a supplier corporate governance (John et al. (2008), Sapra et al. (2014)). Columns (4)–(6) confirm that customer concentration affects negatively the leverage, and results are unchanged if *Supplier Sales to Key Customers* is included. Overall, the results in Panel A suggest that firms choose higher leverage when they have social connections to business partners who undertake relation-specific investments.[18]

3.3. Connections to key R&D-intensive customers and dependent Suppliers' leverage: economic significance

In order to isolate the effect of change in connections from change in R&D-intensity on leverage, we utilize two connections-related variables that do not include R&D-intensity. The first one is the indicator variable *Connected* introduced above. The second one is the *Connections to Key Customers*, which is the sum of sales-weighted connections that the particular supplier has with all its key customers in a given year:

$$Connections\ to\ Key\ Customers = \sum_{j=1}^{n} \left(Sales\ to\ Key\ Customer_j \times Connections_j \right)$$

where $Connections_j$ is the total number of connections between executives of supplier and customer firms scaled by the total number of possible executives' pairs (see the discussion of this measure in section 2.1). We split the sample in three subsamples – based on positive and zero R&D intensity of key customers, with positive R&D intensity subsample further divided into high (above the median)

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[17] Due to the fact that supplier sales is a component in other control variables to mitigate multicollinearity concerns we include *Supplier Sales to Key Customers* as residuals from a regression of this variable on other variables that include supplier sales (to individual customers): *Connections to Key R&D-int. Customers, Key Customers R&D, Key Customers Industry Concentration, Key Customers Change in Sales.* Our results are robust to the choice of the model we take residuals from. To avoid concerns that our results are driven only by including the residuals variable we report two version of our models – with and without *Supplier Sales to Key Customers* in all later tables.

[18] Notably, the estimates on other control variables in columns (1)–(6) have predicted signs. For example, higher supplier size and fixed assets are positively related to leverage, because larger firms or firms with higher collateral have lower costs in obtaining debt (e.g., Lemmon et al. (2008)). Firms with more growth opportunities (higher Tobin's Q), higher non-debt tax shields, and with more R&D investments have to maintain lower leverage (e.g. Banerjee et al. (2008), Kale and Shahrur (2007)). Consistent with the bargaining role of debt, suppliers with more concentrated customers (Key Customers Industry Concentration) increase leverage (Kale and Shahrur (2007)). Our results show that firm age is strongly nega-tively correlated with the market leverage consistent with findings in Strebulaev and Yang (2013) and Kieschnick and Moussawi (2018).

Table 2

The effect of connections to key r&d-intensive customers on the leverage of dependent suppliers.

Panel A: Baseline Results

	(1)	(2)	(3)	(4)	(5)	(6)
Connections to Key R&D-int. Customers	0.889**	0.789**	0.646***	0.923**	0.816**	0.654***
	(2.35)	(2.30)	(2.90)	(2.42)	(2.36)	(2.93)
Key Customers R&D$_{(t-1)}$	−0.683***	−0.615**	−0.519**	−0.659**	−0.587**	−0.473*
	(−2.65)	(−2.46)	(−2.17)	(−2.55)	(−2.35)	(−1.93)
Key Customers Industry Concentration$_{(t-1)}$	0.499***	0.443***	−0.110	0.496***	0.449***	−0.068
	(4.67)	(4.01)	(−0.77)	(4.61)	(4.04)	(−0.44)
Key Customers Change in Sales$_{(t-1)}$	0.123	−0.229*	−0.052	0.132	−0.206	−0.054
	(1.10)	(−1.80)	(−0.51)	(1.17)	(−1.59)	(−0.53)
Supplier Sales to Key Customers				−0.041*	−0.040*	−0.025
				(−1.84)	(−1.86)	(−1.14)
Supplier Industry Concentration$_{(t-1)}$	0.060	−0.105	−0.068	0.055	−0.130	−0.082
	(0.60)	(−0.52)	(−0.29)	(0.55)	(−0.64)	(−0.36)
Supplier Size$_{(t-1)}$	0.024***	0.022***	0.048***	0.024***	0.021***	0.047***
	(8.98)	(8.07)	(5.85)	(8.90)	(8.04)	(5.80)
Supplier ROA$_{(t-1)}$	−0.247***	−0.235***	−0.180***	−0.246***	−0.235***	−0.180***
	(−9.43)	(−9.30)	(−6.47)	(−9.43)	(−9.28)	(−6.48)
Supplier Fixed Assets$_{(t-1)}$	0.201***	0.257***	0.139**	0.203***	0.258***	0.139**
	(8.56)	(7.12)	(2.52)	(8.66)	(7.15)	(2.53)
Supplier R&D$_{(t-1)}$	−0.366***	−0.291***	−0.035	−0.362***	−0.289***	−0.035
	(−7.98)	(−6.32)	(−0.60)	(−7.90)	(−6.26)	(−0.61)
Supplier SGA$_{(t-1)}$	−0.035	−0.025	0.016	−0.040*	−0.028	0.015
	(−1.54)	(−1.08)	(0.48)	(−1.77)	(−1.20)	(0.45)
Supplier Tobin's Q$_{(t-1)}$	−0.035***	−0.036***	−0.009***	−0.034***	−0.035***	−0.009***
	(−15.71)	(−15.17)	(−4.15)	(−15.37)	(−14.98)	(−4.11)
Supplier Volatility$_{(t-1)}$	−0.092***	−0.045*	0.023	−0.084***	−0.039	0.024
	(−3.19)	(−1.66)	(0.70)	(−2.93)	(−1.45)	(0.72)
Supplier Nondebt Tax Shields$_{(t-1)}$	−3.369***	−3.608***	−0.193	−3.325***	−3.550***	−0.216
	(−3.50)	(−3.82)	(−0.29)	(−3.42)	(−3.74)	(−0.32)
Supplier Firm Age$_{(t-1)}$	−0.024***	−0.023***	0.010	−0.025***	−0.023***	0.010
	(−3.93)	(−3.68)	(0.52)	(−4.10)	(−3.81)	(0.52)
Year FE	No	Yes	Yes	No	Yes	Yes
Supplier Industry FE (2-digit SIC)	No	Yes	No	No	Yes	No
Supplier Firm FE	No	No	Yes	No	No	Yes
Observations	7233	7233	7233	7233	7233	7233
Adj. R-squared	0.29	0.35	0.76	0.30	0.35	0.76

Panel B: Subsamples of Customers' R&D-intensity

	Positive Key Customers R&D		Zero Key Customers R&D	Positive Key Customers R&D		Zero Key Customers R&D
	High	Low		High	Low	
	(1)	(2)	(3)	(4)	(5)	(6)
Connected	0.021**	0.001	0.001			
	(2.27)	(0.09)	(0.11)			
Connections to Key Customers				0.030**	−0.010	0.026
				(2.16)	(−0.29)	(1.15)
Key Customers Industry Concentration$_{(t-1)}$	−0.442	−0.181	−0.155	−0.457*	−0.159	−0.173
	(−1.50)	(−0.66)	(−0.79)	(−1.65)	(−0.57)	(−0.87)
Key Customers Change in Sales$_{(t-1)}$	0.009	−0.327	0.093	0.001	−0.322	0.094
	(0.05)	(−1.23)	(0.61)	(0.01)	(−1.21)	(0.62)
Supplier Industry Concentration$_{(t-1)}$	0.229	−0.520	0.055	0.194	−0.523	0.062
	(0.26)	(−1.31)	(0.20)	(0.22)	(−1.32)	(0.22)
Supplier Size$_{(t-1)}$	0.043**	0.073***	0.043***	0.042**	0.073***	0.043***
	(2.13)	(4.19)	(3.71)	(2.09)	(4.20)	(3.73)
Supplier ROA$_{(t-1)}$	−0.145***	−0.158**	−0.178***	−0.145***	−0.158**	−0.177***
	(−3.02)	(−2.32)	(−3.89)	(−2.97)	(−2.32)	(−3.89)
Supplier Fixed Assets$_{(t-1)}$	0.046	0.302***	0.110	0.049	0.304***	0.110
	(0.27)	(3.38)	(1.40)	(0.28)	(3.36)	(1.41)
Supplier R&D$_{(t-1)}$	0.035	0.032	−0.206	0.031	0.032	−0.201
	(0.39)	(0.33)	(−1.17)	(0.34)	(0.34)	(−1.13)
Supplier SGA$_{(t-1)}$	0.003	0.041	0.039	0.005	0.039	0.038
	(0.05)	(0.45)	(0.71)	(0.08)	(0.43)	(0.70)
Supplier Tobin's Q$_{(t-1)}$	−0.006*	−0.009*	−0.013***	−0.006*	−0.009	−0.013***
	(−1.80)	(−1.67)	(−3.44)	(−1.79)	(−1.64)	(−3.47)
Supplier Volatility$_{(t-1)}$	−0.029	−0.102	0.009	−0.030	−0.101	0.009

Table 2 (*continued*)

Panel B: Subsamples of Customers' R&D-intensity

	Positive Key Customers R&D		Zero Key Customers R&D	Positive Key Customers R&D		Zero Key Customers R&D
	High	Low		High	Low	
	(1)	(2)	(3)	(4)	(5)	(6)
	(−0.45)	(−0.70)	(0.18)	(−0.46)	(−0.70)	(0.17)
Supplier Nondebt Tax Shields$_{(t-1)}$	0.319	−0.567	−1.132	0.223	−0.620	−1.088
	(0.30)	(−0.27)	(−1.03)	(0.21)	(−0.30)	(−0.99)
Supplier Firm Age$_{(t-1)}$	0.018	0.062	−0.003	0.018	0.061	−0.002
	(0.38)	(1.29)	(−0.10)	(0.38)	(1.28)	(−0.08)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Supplier Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Chi^2 statistic (p-val)	3.55*(0.060)			2.82*(0.094)		
Observations	1822	1822	3589	1822	1822	3589
Adj. R-squared	0.75	0.79	0.77	0.75	0.79	0.77

Panel C: Economic Significance Estimations

	Predicted Market Leverage		
	Positive Key Customers R&D		Zero Key Customers R&D
	High	Low	
	(1)	(2)	(3)
Predicted Leverage			
Connected	0.1455	0.1914	0.2065
Unconnected	0.1248	0.1903	0.2054
Difference	0.0207***	0.0011	0.0010
F-test of equality of means (p-val)	8.82 (0.003)	0.01 (0.90)	0.03 (0.87)

The table presents the results of supplier-level regressions, in which each observation is supplier firm-year. The dependent variable is *Market Leverage* equal to the sum of book values of long-term debt and debt in current liabilities divided by the sum of book values of long-term debt and debt in current liabilities and market value of common equity. In Panel A the key explanatory variable, *Connections to Key R&D-intensive Customers,* is the sum of connections to each major customer weighted by R&D intensities and proportion of sales to each major customer, where connections to each major customer is the number of connected pairs multiplied by 100 and divided by the total number of pairs that exist between individuals of customer and supplier firms. *Key Customers R&D* is the sum of R&D intensities of all major customers weighted by the proportion of sales to each customer. In Panel B the key explanatory variable, *Connected*, is an indicator variable equal to 1 if a supplier is connected and has sales above sample median to at least one of its major customers. *Connections to Key Customers* is the sum of connections to each major customer weighted by proportion of sales to each major customer, where connections to each major customer is the number of connected pairs multiplied by 100 and divided by the total number of pairs that exist between individuals of customer and supplier firms. Panel C presents the estimated predicted mean market leverage using coefficients from Panel B and keeping all explanatory variables (except for *Connected*) at their mean values. All variables are winsorized at 1% and 99% levels. All variables are defined in Appendix A. t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the supplier firm level. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

vs. low (below the median) R&D-intensity. We estimate the effect of suppliers' connections on leverage for these subsamples. We keep the same set of control variables as in Panel A, but drop *Key Customers R&D* as it is the sorting variable.[19] In Panel B we report all specifications with supplier fixed effects added. We find that our two variables are statistically significant only when customers' R&D-intensity is high (above the median for the positive R&D intensity subsample), confirming our previous result that supplier-customer connections are relevant mainly for suppliers dealing with R&D-intensive customers.

In Panel C, we analyze the effects of presence vs. absence of connections (without considering the variation in connections tested in Panel A) on changes in predicted market leverage for the mean firm in each of the three subsamples examined in Panel B. In a sample of positive R&D customers, being connected to high R&D-intensive customers is associated with an increase in supplier leverage from 12.48% to 14.55% – or by 2.1 percentage points – compared to suppliers not having connections to those customers.[20] The difference of means is significant at 1%. On the other hand, being connected to low (or zero) R&D-intensive customers does not change leverage significantly. In a sample of positive but low R&D-intensive customers the leverage for a mean connected supplier equals 19.14% compared to the leverage of 19.03% for a mean unconnected supplier. The difference of mean values of leverage is not statistically significant at conventional levels. In a sample of zero R&D-intensive customers we observe a similar picture: the leverage for a mean connected supplier equals 20.65% compared to the leverage of 20.54% for a mean unconnected supplier. In terms of leverage levels, our results show that the mean leverage for suppliers connected to high R&D-intensive customers is lower than the leverage for

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[19] We drop *Supplier Sales to Key customers*, because 1) mechanically our *Connected* variable is conditioned on sales to customers; 2) Residuals are taken from other model and not consistent with these specifications.

[20] Note, the computed differences of means of leverage are equal to coefficients on Connected in Panel B.

suppliers connected to low (or zero) R&D-intensive customers, confirming the negative relation between supplier leverage and customers R&D-intensity documented previously by Kale and Shahrur (2007).

Panel C results also allow us to assess the economic significance of the relation between the supplier-customer connections and leverage directly. Using values of the average predicted leverage for high- (low-) Key Customers R&D from Columns (1) and (2), respectively, we estimate that the positive effect of being connected can compensate approximately 35% of the negative effect on leverage due to an increase in customer R&D investments.[21]

3.4. Addressing endogeneity concerns

While the results in Section 3.2 show that there is a positive relation between connections to key R&D-intensive customers and leverage, this relation is not necessarily causal. In our baseline regressions we control for unobserved factors at the supplier level using firm fixed effects. However, there are still some unobserved factors that could confound our results. The allocation of certain types of suppliers across customer firms is not random, and suppliers' leverage choices could be a function of customer characteristics. Specifically, Demirci (2016), Lian (2017), and Oliveira et al. (2017) show that customer financial health affects the leverage of the supplier. This leads to a potential endogeneity, which we address by employing a difference-in-differences framework and use managers' turnovers at customer firms as exogenous shocks to connectivity.

We focus on a subsample of turnovers of senior managers at the customer firms. Senior managers at the supplier firms who have social connections with the departing manager at the customer firm are likely to lose a connection with the customer firm. Hence, as a result of the turnover at the customer firm, the supplier firm may lose connection(s) with the customer firm. Importantly, the turnover of the senior manager at the customer firm is likely to be an exogenous shock to a supplier firm, and unrelated to supplier performance, as the average share of purchases from a particular supplier constitutes about 2.8% of customer's total purchases. Consequently, a causal support for the previously shown positive relation between supplier firm connectivity and leverage can be established if we find that supplier leverage decreases following a loss of connection due to plausibly exogenous shock to supplier firm connectivity due to customer firm managerial turnover.

We consider that a manager left the (customer) company when we cannot observe the record of this manager in the subsequent fiscal year in Boardex. Among all customer senior managers, we limit our attention to the departures of senior managers and executives who hold greater responsibility for the supply chain decisions, so that losing connections to them should affect the leverage of a supplier firm to a greater extent.[22] We identify 32 turnovers in which the connected supplier loses the connection to the customer.[23] To control for unobserved characteristics related to endogenous factors that affect the relationship of supplier and customer, we limit the sample to only connected suppliers and for each supplier that lost connection(s) due to turnovers in a customer firm we find a supplier (or suppliers) who has connections to the same customer firm but was not affected by the turnover at the customer firm. Following Fracassi and Tate (2012) we use difference-in-differences approach, which allows us to compare the leverage of a treatment group (suppliers who lost connection(s) to the customer firm) with the leverage of a control group (suppliers who did not lose any connections) while still being connected to the same customer firm. The advantage of this approach is that while comparing the leverage of the connected suppliers to the *same* customer firm, we rule out all confounding factors related to the quality of the customer.

As a result of our identification procedure, we create unique groups of suppliers with one supplier being affected (due to a turnover at a customer firm) and other supplier(s) being not affected by the turnover while both categories of supplies being connected to a common customer. We choose a five-year window centered on the event year (the fiscal year of the turnover) to minimize the possibility that other events could confound the tests. If as a result of the customer executive turnover, multiple supplier firms lose connection being connected to one particular customer executive, we treat each supplier firm event independently. If we observe that the same supplier falls into both categories (affected and unaffected), we treat this supplier as affected and exclude it from the group of unaffected suppliers. If one supplier loses more than one connection during a fiscal year (e.g. several executives leave the customer firm), we treat it as one event.

We analyze the following model:

$$
\begin{aligned}
Leverage_{it} = {} & \beta_1 \, After + \beta_2 \, Lost \; Connections \\
& + \beta_3 \, R\&D\text{-}intensive \; Customer \\
& + \beta_4 \, After \; x \; Lost \; Connections + \beta_5 \, After \; x \; R\&D\text{-}intensive \; Customer \\
& + \beta_6 \, Lost \; Connections \; x \; R\&D\text{-}intensive \; Customer \\
& + \beta_7 \, After \; x \; Lost \; Connections \; x \; R\&D\text{-}intensive \; Customer + \gamma X_{it} + \zeta_i + \delta_t + \varepsilon_{it}
\end{aligned}
\tag{2}
$$

Where *Leverage*$_{it}$ is a market leverage of supplier i in fiscal year t, *After* is a dummy variable that equals one for the fiscal years after the manager turnover at the customer firm (excluding the event year), *Lost Connections* is a dummy variable that equals one if the

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[21] We first compute the difference between the values of the average predicted leverage for Column (1) High Key Customers R&D and (2) Low Key Customers R&D (=0.0581). Since connection increases the predicted leverage in high Key Customer R&D sample by 0.0207, we then compute that having connections can compensate 35% (=0.0207/0.0581) of the negative effect on leverage due to an increase in key customers R&D.

[22] We consider list of manager titles of senior and executive managers potentially responsible for supply chain and finances such as CEO, CFO COO, Director of Operations/Finance, Senior VP of Operations/Finance, Treasurer, Controller, Executive VP of Supply Chain or Operations.

[23] We drop five turnovers in which we observed the supplier only one year within the defined window.

Table 3

Leverage of dependent suppliers and connections to key R&D-intensive customers: event studies.

Panel A: Means for Treated and Control Firms for Non-Matched and Matched Samples

Sample	Non-Matched Sample of Turnovers			Matched Sample of Turnovers (at Pre-Turnover Year)		
Variable	Treated	Control	Means test t-stat	Treated	Control	Means test t-stat
Connections	0.4128	0.2793	3.10***	0.4056	0.3045	1.87*
Key Customer R&D	0.0101	0.0051	1.91*	0.0105	0.0104	0.03
Sales to Key Customer	0.1992	0.2205	−1.22	0.2031	0.2012	0.11
Supplier Firm Size	8.2545	7.5975	2.40**	8.1508	7.6302	1.43
Supplier Return on Assets	0.1144	0.1249	−0.61	0.1128	0.1419	−1.42
Supplier R&D Intensity	0.0781	0.0553	1.66*	0.0766	0.0842	−0.45
Supplier Tobin's Q	2.6625	2.1483	2.26**	2.5947	2.5254	0.21
Supplier Volatility	0.0815	0.0745	0.46	0.0829	0.0854	−0.15
Supplier Firm Age	3.1708	3.1542	0.15	3.2362	3.0423	1.58

Panel B: Executives' Turnovers at Customer Firms: Supplier-Customer-Level Regressions

	Non-Matched Sample			Matched Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
After x Lost Connections x R&D-Intensive Customer	−0.156**	−0.189***	−0.152**	−0.148***	−0.184**	−0.119**
	(−2.20)	(−2.90)	(−2.39)	(−2.84)	(−2.39)	(−2.42)
After x R&D-Intensive Customer	0.028*	0.051***	0.042**	0.044*	0.029	0.037
	(1.99)	(3.22)	(1.99)	(1.95)	(0.91)	(1.08)
Lost Connections x R&D-Intensive Customer	0.112**	0.127***	omitted	0.242***	0.190***	omitted
	(2.35)	(3.07)		(5.32)	(3.89)	
After x Lost Connections	0.055	0.091	0.099*	0.052	0.090	0.055
	(0.89)	(1.60)	(1.74)	(1.20)	(1.37)	(1.36)
R&D-Intensive Customer	−0.003	omitted	omitted	−0.100***	omitted	omitted
	(−0.10)			(−3.10)		
Lost Connections	−0.099***	−0.106***	omitted	−0.200***	−0.134***	omitted
	(−3.09)	(−5.03)		(−5.85)	(−3.61)	
After	−0.021**	0.023	−0.009	−0.015	0.012	−0.017
	(−2.45)	(1.18)	(−1.12)	(−0.67)	(0.27)	(−0.65)
Sales to Key Customer	−0.109*	0.006	0.129	0.328	0.491	0.076
	(−1.83)	(0.12)	(1.15)	(1.67)	(1.60)	(0.38)
Control variables (Table 2)	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Supplier & Customer Industries FE	Yes	No	No	Yes	No	No
Common Customer FE	No	Yes	No	No	Yes	No
Pair FE	No	No	Yes	No	No	Yes
Observations	1176	1176	1176	226	226	226
Adj. R-squared	0.49	0.35	0.86	0.67	0.47	0.83

The table presents the analysis, in which each observation is a pair of supplier-customer. Panel A presents the results of comparison of means of key characteristics between treated and control firms for non-matched and matched subsamples. Panels B and C present the results of regression analysis. The dependent variable is *Market Leverage* equal to the sum of book values of long-term debt and debt in current liabilities divided by the sum of book values of long-term debt and debt in current liabilities and market value of common equity. *After* is a dummy variable that equals one for the fiscal years after the manager turnover at the customer firm, *Lost Connections* is a dummy variable that equals one if the connected supplier lost connection after the turnover, *R&D-Intensive Customer* is a dummy variable that equals one if the averaged (by years) R&D-intensity of the key customer is above the median of the sample distribution. The key variable *After x Lost Connections x R&D-intensive Customer* captures the effect of change in leverage after a turnover at a customer firm for a supplier who lost connection(s) and was connected to an R&D-intensive customer. We control for the same set of supplier-level control variables as in Table 2 and the corresponding set of customer variables computed for a key customer: *Key Customer Industry Concentration, Key Customer Industry Change in Sales*. We omit customer R&D intensity as it is included as a dummy variable. We use a five-year window centered on the event year (the fiscal year of the turnover) to minimize the possibility that other events will confound the tests. If as a result of the customer executive turnover, multiple supplier firms lose connection being connected to one particular customer executive, we treat each supplier firm event independently. If we observe that the same supplier falls into both categories (affected and unaffected), we treat this supplier as affected and exclude it from the group of unaffected suppliers. If one supplier loses more than one connection during a fiscal year (e.g. several executives leave the customer firm), we treat it as one event. Calendar year fixed effects are included in all regressions, industry fixed effects (based on 2-digit SIC industries) are included in columns (1) and (4). In columns (2) and (5) common customer fixed effects (that combine suppliers connected to a common customer) are added. In columns (3) and (6) supplier-customer pair fixed effects are added. All continuous variables are winsorized at 1% and 99% levels. All other variables are defined in Appendix A. t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the common customer-firm level. In columns (3) and (6) where pair fixed effects are added, t-statistics are clustered at pair level. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

connected supplier lost at least one connection after the turnover, *R&D-Intensive Customer* is a dummy variable that equals one if the averaged (by years) R&D-intensity of the key customer is above the sample median. The coefficient on *After* shows the change in leverage for the connected suppliers who did not lose connection after the turnover. The variable *After × Lost Connections* captures the difference in differences effect of change in leverage for a supplier who lost connection to a customer firm and *After x R&D-intensive Customer* (as defined as customer with above median R&D intensity) shows the changes in leverage for suppliers connected to R&D-intensive customers after the turnover.

Our key variable of interest is *After x Lost Connections x R&D-intensive Customer* as it captures the effect of change in leverage after a turnover at a customer firm for a supplier who lost connection(s) and was connected to an R&D-intensive customer. We use the same set of supplier-level control variables as in Table 2 and the corresponding set of customer variables computed for a key customer: *Key Customer Industry Concentration* and *Key Customer Industry Change in Sales*. *Key Customer Industry Concentration* is measured as the Herfindahl–Hirschman Index (HHI) in the 2-digit SIC code of the customer industry in a given year and *Key Customer Change in Sales* is the median change in sales in the key customer 2-digit SIC industry. We omit customer R&D intensity as it is included as a dummy variable and control for *Sales to Key Customer* in each model.

In Panel A of Table 3, we compare means for affected and unaffected suppliers across key characteristics. The results show that affected suppliers are more connected, larger in size, have more growth opportunities (as proxied by Tobin's Q), more R&D-intensive and have more R&D-intensive customers. Apparently, firms that have more connections to customers are more likely to lose a connection due to a turnover.

In Panel B of Table 3, we first report the results of analysis based on the full sample of events, and then address the differences between groups of supplies by matching them in pre-event year. The results of the full-sample tests are reported in the first three columns of Table 3. In all regressions we include calendar year fixed effects, and in column (1) supplier and customer industry fixed effects (based on 2-digit SIC industries) are included. To account for the possibility that unobserved customer effects happening in an event year could affect differently the treated and control suppliers, in column (2) we add common customer fixed effects (that combine suppliers connected to a common customer) and cluster standard errors at the common customer-firm level. Finally, in column (3) we include supplier-customer pair fixed effects to control for unobserved supplier-customer time-invariant factors (e.g. relative risk of each pair). The positive coefficient on *Lost Connections x R&D-intensive Customer* (significant at 5% level) reveals that before the turnover the affected suppliers with R&D-intensive customers have much higher level of leverage than unaffected suppliers. The coefficient on our main variable of interest *After × Lost Connections × R&D-intensive Customer* is negative and significant across all models.[24] Our results hold if we add common customer or pair fixed effects.

We next match the affected and unaffected suppliers to eliminate differences across observable characteristics discussed above. In each cluster of treated (affected) and non-treated (non-affected) supplier that are connected to a common customer, we find up to two nearest neighbor matches for each treated supplier. The treatment and control suppliers are matched using propensity score from a logit model run at the pre-turnover year based on *Supplier Size, Tobin's Q* and *Supplier Firm Age*. Last three columns of Panel A of Table 3 show that after matching most of the differences were eliminated, except for marginal difference in connections between treated and control group.[25] Columns (4)–(6) in Panel B show that the reported estimated results of regression model (2) based on the matched sample are very similar to those on the full events sample.[26]

Fig. 1 plots the yearly averages of market leverage for the 5-year window centered around the executive turnover at the customer firm. Each year on X-axis depicts the fiscal year prior or after the fiscal year-0 at which the turnover occurred. Panel A shows the suppliers subsample with high R&D-intensive customers (above sample median). The leverage of treated group moves synchronously with the control group before year 0, and then drops in the post-turnover period.

Overall, the results suggest that suppliers with R&D-intensive customers lower their levels of debt in the years following the loss of connection(s) with a top customer executive (e.g. CEO, CFO, COO) resulting from the managerial turnover at the customer firm.

3.5. Supplier-customer connections and supplier leverage: examination of channels

3.5.1. Bonding channel

So far, we have established that suppliers with connections to R&D-intensive customers maintain relatively higher leverage compared to suppliers with no customer connections. Based on the bonding channel described in Section 1, connected suppliers should be able to operate with more debt, as supplier-customer connections build mutual trust between the two contracting parties (e.g. Coleman (1988), Nahapiet and Ghosal (1998), Woolcock (1998), Putnam (2000), Karlan et al. (2009)). Customers - especially those associated with large relationship-specific investment - are likely to trust their higher-levered connected suppliers to commit to maintaining their reputation and not behaving opportunistically. Consequently, such customers should be willing to pursue more trading-intense relationships with the connected supplies. Similarly, suppliers should also have more trust in the customer's financial

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[24] In models (3) and (6), which include pair fixed effects three dummies: *Lost Connections, R&D-intensive Customer, Lost Connections x R&D-intensive Customer* have variation at supplier-customer level, and therefore were excluded due to multicollinearity.

[25] In unreported analysis, we additionally check for potential violation of parallel trends assumption by computing sample *t*-tests of differences in average growth rates of market leverage. We find no differences between groups in pre-turnover period (Roberts and Whited (2013)).

[26] The loss of connections is associated with economically significant change in leverage of suppliers dealing with R&D-intensive customers. For example, based on Column 3, the sum of *After x Lost Connections* (0.099) and *After x Lost Connections x R&D-Intensive Customer* (−0.152) equals −0.053. Relative to the sample mean of 0.183, this is a drop of market leverage by about 29%.

Panel A: Subsample of high R&D-intensive Customers
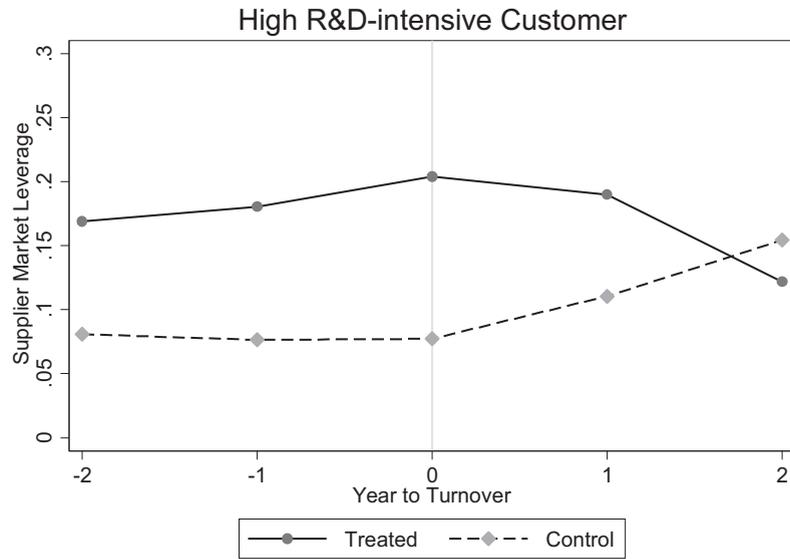
Panel B: Subsample of low R&D-intensive Customers
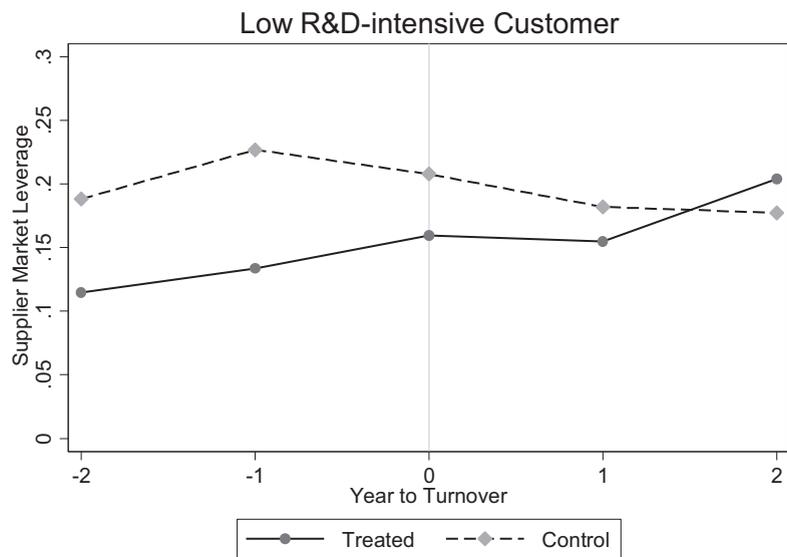
Fig. 1. Supplier Market Leverage around Executive Turnover at the Customer Firm.
The figures plot the mean values of market leverage of the supplier around executive turnover at the customer firm. *Market Leverage* is equal to the sum of book values of long-term debt and debt in current liabilities divided by the sum of book values of long-term debt and debt in current liabilities and market value of common equity. *Treated* refers to a connected supplier that lost connection after the turnover, and *Control* refers to a supplier that did not lose connection after the turnover while being connected to the same customer as the Treated supplier. *High (low) R&D-Intensive Customer* denotes customers which have averaged (by years) R&D-intensity above (below) the median of the sample distribution.

Table 4
Leverage of dependent suppliers and connections to key R&D-intensive customers: bonding channel.

Measure	Supplier Sales to Key Customers	
Degree	High	Low
	(1)	(2)
Connections to Key R&D-int. Customers	1.396***	−0.019
	(3.63)	(−0.04)
Key Customers R&D(t-1)	−1.003***	0.226
	(−3.00)	(0.29)
Key Customers Industry Concentration(t-1)	0.087	−0.393
	(0.48)	(−0.79)
Key Customers Change in Sales(t-1)	−0.094	−0.056
	(−0.78)	(−0.16)
Supplier Industry Concentration(t-1)	−0.373	0.227
	(−1.15)	(0.71)
Supplier Size(t-1)	0.062***	0.043***
	(5.29)	(3.21)
Supplier ROA(t-1)	−0.159***	−0.182***
	(−4.30)	(−3.57)
Supplier Fixed Assets(t-1)	0.120	0.146*
	(1.41)	(1.72)
Supplier R&D(t-1)	−0.090	0.007
	(−1.16)	(0.07)
Supplier SGA(t-1)	0.048	−0.030
	(1.08)	(−0.53)
Supplier Tobin's Q(t-1)	−0.005*	−0.013***
	(−1.78)	(−3.21)
Supplier Volatility(t-1)	0.026	−0.005
	(0.58)	(−0.08)
Supplier Nondebt Tax Shields(t-1)	0.062	−0.616
	(0.07)	(−0.41)
Supplier Firm Age(t-1)	0.014	0.013
	(0.46)	(0.39)
Year FE	Yes	Yes
Supplier Firm FE	Yes	Yes
Chi² statistic (p-val)	9.10*** (0.003)	
Observations	3616	3617
Adj. R-squared	0.76	0.79

The table presents the results of supplier-level regressions, in which each observation is supplier firm-year. The dependent variable is *Market Leverage* is equal to the sum of book values of long-term debt and debt in current liabilities divided by the sum of book values of long-term debt and debt in current liabilities and market value of common equity. *Connections to Key R&D-intensive Customers* is the sum of connections to each major customer weighted by R&D intensities and proportion of sales to each major customer, where connections to each major customer is the number of connected pairs multiplied by 100 and divided by the total number of pairs that exist between individuals of customer and supplier firms. *Key Customers R&D* is the sum of R&D intensities of all major customers weighted by the proportion of sales to each customer. *Supplier Sales to Key Customers* is equal to the total sales to key customers divided by the lagged total sales of the supplier. The sample is split according to whether the *Supplier Sales to Key Customers* is above (below) of the sample distribution. All continuous variables are winsorized at 1% and 99% levels. All other variables are defined in Appendix A. t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the supplier firm level. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

health and the stability of the relationship with the connected customer, which should allow suppliers to increase leverage thanks to higher confidence in being able to repay the debt obligations. In unreported analysis we first show that supplier-customer connections indeed increase the trade intensity of the relationship between the two contracting parties.[27] Next, we analyze whether social connections can be related to supplier leverage choice through bonding effects exemplified by greater trade intensity. We use trade intensity of the relationship to assign suppliers into two subsamples according to expected high (above median *Supplier Sales to Key Customers*) vs. low trading intensity. Table 4 repeats the analysis of Table 2 separately for the two supplier subsamples. The positive

[27] To measure the intensity of relationship, we use *Supplier Sales to Key Customers* (total supplier sales to key customers scaled by total lagged supplier sales), which characterizes the importance of relationship (e.g. Banerjee et al. (2008), Itzkowitz (2013)). Our chief explanatory variable, *Connections to Key Customers* is the sum of sales-weighted connections that the particular supplier has with all its key customers in a given year (see the discussion of this measure in section 3.3). We find that *Connections to Key Customers* are significantly positively related to *Supplier Sales to Key Customers*. Additionally, our results show that the magnitude of coefficients on *Connections to Key Customers* is significantly higher (at 5% level) in the subsample of suppliers with customers who invest in R&D suggesting that connections appear to be associated with greater trade intensity primarily when customers make significant relation-specific investments.

relation between connections to R&D-intensive customers and market leverage is significant only in the subsample of suppliers with high trading intensity (the coefficients for *Connections to Key R&D-intensive Customers* are highly statistically significantly different between the two subsamples). Overall, the results in Table 4 suggest that connected suppliers choose higher debt only if relationship is trade intensive, consistent with the presumed bonding channel effects.[28]

3.5.2. Information asymmetry channel

Extensive research on social connections supports the premise that social connections facilitate communication and decrease information acquisition costs (e.g. Cohen, Frazzini and Malloy (2008, 2010), Duchin and Sosyura (2013)). In the context of customer-supplier relationships, Chen et al. (2021) show that social connections between the two trading parties tend to reduce information asymmetry, facilitate transmission of hard and soft information, and ultimately substitute for formal contractual terms. Consistent with information asymmetry channel, customers and suppliers may be able to assess the financial health of each other more accurately, at a lower cost. This cheaper mutual monitoring should be particularly important for (riskier) customers with significant investment in relationship-specific assets and should enable their (typically smaller) suppliers to choose higher levels of debt. These connected suppliers should have less need to pre-commit to lower leverage in order to secure the ongoing relationship with R&D-intensive customers and/or to protect themselves from future customer financial distress (that would be costly to evaluate in cases of absent social connections).

If lower information asymmetry is indeed a relevant channel for the positive relation between connections and supplier leverage, then we presume this effect to be particularly strong in cases when supplier-customer interactions happen in the environment characterized by high information asymmetry. Based on previous financial research, we use two measures to assess the degree of information asymmetry between two trading parties. The first measure is the geographical distance between supplier and customer locations. Higher distance is associated with higher costs of access to information and, hence, with higher information asymmetry (e.g. Giroud (2013)). For example, Costello (2013) shows that higher geographical supplier-customer distance increases the probability of using restrictive financial covenants in supplier contracts (as financial covenants are needed to mitigate higher information asymmetry). We expect that social connections should be more significantly positively related to supplier leverage when customers and suppliers are located further away from each other.

We measure *Distance* as an average geographical distance between a supplier and its key customers, measured in miles. The average distance is computed by averaging the distances between the headquarters location of supplier and that of each of its customers. We compute the distance between two points on Earth's surface using latitude and longitude coordinates for the addresses of the supplier (customer) headquarters obtained from the U.S. Census Bureau's Gazetteer City-State File. As shown in Table 1, the mean (median) geographical distance between the supplier and customer pair is 992 (732) miles, and the mean (median) distance between supplier and its key customers is 970 (773) miles, which are similar values as the ones found in other supply chain-related papers (e.g. Chu et al. (2018), Dasgupta et al. (2021)).

In Panel A of Table 5, we present the analysis of the relation between supplier market leverage and the *Connections to Key R&D-intensive Customers* (performed in Table 2) separately for two supplier subsamples based on high (i.e. above sample median) vs. low average distance from their key customers. The results show that while the coefficient on *Connections to Key R&D-intensive Customers* is not significantly different between the two subsamples, the existence of connections is significantly positively related to supplier leverage only in the subsample of the suppliers located far away from their major customers – that is, suppliers which are likely to suffer from higher information asymmetry problems when dealing with customers.

The second measure of information asymmetry is the dispersion of analyst forecasts. This variable has been shown to reflect the quality of information flows between shareholders and managers (Lang and Lundholm (1996)). We compute the dispersion of analyst forecasts (*Analyst Forecast*) as the standard deviation of analyst estimates of EPS for the current fiscal year averaged over the sample fiscal years for a given supplier. We obtain the data from the I/B/E/S database. Panel B of Table 5 show that *Connections to Key R&D-intensive Customers* is an important determinant of supplier leverage only in subsample with high (above median) dispersion of analyst forecasts (though the coefficient difference between the two subsamples is not statistically significant). Overall, the results in Table 5 provide evidence that information asymmetry channel could be a relevant channel for the explanation of the positive relation between the existence of supplier-customer connection and supplier leverage.

3.6. Additional evidence and robustness checks

3.6.1. Propensity-score matching

Our alternative method for mitigating potential endogeneity concerns is a propensity score matching approach, leading to a creation of samples of connected and unconnected suppliers with similar observable characteristics. We match connected with unconnected suppliers based on the following variables: *Supplier Size, Supplier Firm R&D, Supplier ROA, Key Customers R&D, Supplier*

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[28] Our findings also complement the evidence in Kadapakkam and Oliveira (2021) who focus on the relationship age and interlocking directors between supplier and customer firms. The authors hypothesize that these factors build trust and stability of the relationship between firms and report the positive effect on leverage. While time-overlapping professional and business links can promote business relationship by increasing sales, we separate personal connections formed in the past and, importantly, outside of the business relationship (third-party firms) thereby addressing reverse causality problem. We document a direct link of how such pre-existing personal connections affect business relationship and further show that such connections are a relevant factor for the leverage.

Table 5
Leverage of dependent suppliers and connections to key R&D-intensive customers: information asymmetry channel.

Panel A: Subsamples based on the Distance to Key Customers

Degree	High	Low	High	Low
	(1)	(2)	(3)	(4)
Connections to Key R&D-int. Customers	0.752**	0.534	0.752**	0.664*
	(2.03)	(1.48)	(2.04)	(1.84)
Key Customers R&D$_{(t-1)}$	−0.522	−0.655*	−0.522	−0.401
	(−1.55)	(−1.73)	(−1.51)	(−1.08)
Key Customers Industry Concentration$_{(t-1)}$	0.050	−0.117	0.051	0.007
	(0.27)	(−0.48)	(0.25)	(0.03)
Key Customers Change in Sales$_{(t-1)}$	0.035	−0.130	0.035	−0.147
	(0.23)	(−0.83)	(0.23)	(−0.92)
Supplier Sales to Key Customers			−0.000	−0.084**
			(−0.01)	(−2.37)
Supplier Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Supplier Firm FE	Yes	Yes	Yes	Yes
Chi² statistic (p-val)	0.27(0.61)		0.04(0.84)	
Observations	3616	3617	3616	3617
Adj. R-squared	0.76	0.78	0.76	0.78

Panel B: Subsamples based on the Analyst Forecast

Degree	High	Low	High	Low
	(1)	(2)	(3)	(4)
Connections to Key R&D-int. Customers	0.656**	0.610	0.645**	0.609
	(2.05)	(1.51)	(2.00)	(1.45)
Key Customers R&D$_{(t-1)}$	−0.007	−0.975**	0.073	−0.976**
	(−0.02)	(−2.07)	(0.23)	(−2.01)
Key Customers Industry Concentration$_{(t-1)}$	−0.015	−0.009	0.065	−0.011
	(−0.07)	(−0.05)	(0.27)	(−0.05)
Key Customers Change in Sales$_{(t-1)}$	0.112	−0.221	0.112	−0.221
	(0.74)	(−1.54)	(0.75)	(−1.56)
Supplier Sales to Key Customers			−0.036	0.001
			(−1.07)	(0.02)
Supplier Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Supplier Firm FE	Yes	Yes	Yes	Yes
Chi² statistic (p-val)	0.01(0.92)		0.01(0.94)	
Observations	2554	2557	2554	2557
Adj. R-squared	0.77	0.71	0.77	0.71

The table presents the results of supplier-level regressions, in which each observation is supplier firm-year. The dependent variable is *Market Leverage* is equal to the sum of book values of long-term debt and debt in current liabilities divided by the sum of book values of long-term debt and debt in current liabilities and market value of common equity. *Connections to Key R&D-intensive Customers* is the sum of connections to each major customer weighted by R&D intensities and proportion of sales to each major customer, where connections to each major customer is the number of connected pairs multiplied by 100 and divided by the total number of pairs that exist between individuals of customer and supplier firms. *Key Customers R&D* is the sum of R&D intensities of all major customers weighted by the proportion of sales to each customer. *Distance* is the average distance between a supplier and its key customers, measured in miles. *Distance* is computed by averaging the distances between the headquarters location of supplier and that of each of its customers. *Analyst Forecast* is the standard deviation of analyst estimates of EPS for the current fiscal year averaged over the sample fiscal years for a given supplier. The sample is split according to value of *Distance* and *Analyst Forecast* is above (below) of the sample distribution. All continuous variables are winsorized at 1% and 99% levels. All other variables are defined in Appendix A. t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the supplier firm level. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Tobin's Q, Supplier Volatility and *Supplier Firm Age*. In the matching procedure we use a propensity score obtained from predicted values from the logit regression of the being connected (Variable *Connected* discussed in Section 2.2) in on the predictor (mentioned above) variables. For each observation from a connected supplier (in a given year) we search an observation from another unconnected supplier in the same 2-digit industry using nearest neighbor estimator without replacement. This procedure yields 3600 firm-years that cover 593 connected (treated) suppliers matched to 818 unconnected (control) suppliers.[29]

Table 6 Panel A reports the descriptive statistics for the matched and control supplier samples. The results show that the matched connected and unconnected supplier samples are very similar - no significant differences exist across all the key factors that have been

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[29] The reason for the uneven number of connected and unconnected suppliers is because we match firm-year observations.

Table 6

Leverage of dependent suppliers and connections to key R&D-intensive customers: propensity-score matching.

Panel A: PSM Matched Sample of Suppliers (3600 obs.)

Variable	Connected	Unconnected	Diff.	T-stat.
Key Customers R&D$_{(t-1)}$	0.0066	0.0044	0.00214	0.35
Supplier Firm Size$_{(t-1)}$	5.2541	5.8755	−0.62140	−0.85
Supplier Return on Assets$_{(t-1)}$	−0.0319	−0.0183	−0.01354	−0.16
Supplier R&D Intensity$_{(t-1)}$	0.0595	0.0661	−0.00668	−0.14
Supplier Tobin's Q$_{(t-1)}$	1.8178	1.2592	0.55860	1.04
Supplier Volatility$_{(t-1)}$	0.1313	0.0918	0.03953	1.19
Supplier Firm Age$_{(t-1)}$	2.8204	3.0265	−0.20610	−0.56

Panel B: Regression Analysis of Leverage (Matched Sample)

	(1)	(2)	(3)	(4)
Connections to Key R&D-int. Customers	0.781**	0.645***	0.806**	0.666***
	(2.23)	(2.59)	(2.27)	(2.64)
Key Customers R&D$_{(t-1)}$	−0.808***	−0.470**	−0.783***	−0.429*
	(−2.93)	(−2.03)	(−2.84)	(−1.87)
Key Customers Industry Concentration$_{(t-1)}$	0.445***	0.076	0.480***	0.172
	(3.45)	(0.36)	(3.70)	(0.67)
Key Customers Change in Sales$_{(t-1)}$	−0.165	−0.069	−0.143	−0.068
	(−1.04)	(−0.51)	(−0.89)	(−0.51)
Supplier Sales to Key Customers			−0.042*	−0.034
			(−1.84)	(−1.06)
Supplier Industry Concentration$_{(t-1)}$	0.142	0.231	0.097	0.196
	(0.51)	(0.83)	(0.35)	(0.69)
Supplier Size$_{(t-1)}$	0.021***	0.038***	0.021***	0.038***
	(6.02)	(3.25)	(5.99)	(3.21)
Supplier ROA$_{(t-1)}$	−0.249***	−0.157***	−0.247***	−0.157***
	(−7.77)	(−4.15)	(−7.71)	(−4.14)
Supplier Fixed Assets$_{(t-1)}$	0.214***	0.064	0.215***	0.064
	(5.10)	(0.81)	(5.14)	(0.81)
Supplier R&D$_{(t-1)}$	−0.251***	0.004	−0.249***	0.004
	(−4.56)	(0.06)	(−4.50)	(0.06)
Supplier SGA$_{(t-1)}$	−0.045	−0.007	−0.047*	−0.008
	(−1.60)	(−0.17)	(−1.68)	(−0.18)
Supplier Tobin's Q$_{(t-1)}$	−0.032***	−0.010***	−0.032***	−0.010***
	(−11.80)	(−3.17)	(−11.61)	(−3.15)
Supplier Volatility$_{(t-1)}$	−0.036	0.007	−0.029	0.007
	(−1.14)	(0.15)	(−0.90)	(0.16)
Supplier Nondebt Tax Shields$_{(t-1)}$	−2.416**	1.093	−2.404**	1.030
	(−2.23)	(1.14)	(−2.21)	(1.07)
Supplier Firm Age$_{(t-1)}$	−0.021***	0.031	−0.021***	0.031
	(−2.75)	(1.11)	(−2.82)	(1.15)
Year FE	Yes	Yes	Yes	Yes
Supplier Industry FE	Yes	No	Yes	No
Supplier Firm FE	No	Yes	No	Yes
Observations	3600	3600	3600	3600
Adj. R-squared	0.40	0.78	0.40	0.78

Panel A reports differences-in-means estimates by subsamples of propensity score matched *Connected* and *Unconnected* suppliers. *Connected* supplier is a supplier that has least one connection and sales above sample median to one of its major customers. Panel B presents the results of the regression analysis of market leverage on the propensity-score matched sample of suppliers. *Connections to Key R&D-intensive Customers* is the sum of connections to each major customer weighted by R&D intensities and proportion of sales to each major customer, where connections to each major customer is the number of connected pairs multiplied by 100 and divided by the total number of pairs that exist between individuals of customer and supplier firms. All continuous variables are winsorized at 1% and 99% levels. All other variables are defined in Appendix A. t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the supplier firm level.***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

shown to affect firm leverage (e.g. Berger et al. (1997), MacKay and Phillips (2005), Kale and Shahrur (2007), Lemmon et al. (2008)). Panel B reports the results of the regression analysis of the model based on Eq. (1), for samples containing connected and unconnected suppliers selected by the above-described propensity-score matching methodology. Similarly to the full-sample results in Table 2, the matched-sample findings in Panel B show a positive and significant relation between connections to key R&D-intensive customers and the market leverage of the dependent suppliers.

3.6.2. Reverse causality

Reverse causality is a concern in studies about personal connections. In the setting of our paper, the reverse causality could imply

Table 7

Leverage of dependent suppliers and connections to key R&D-intensive customers: additional tests.

Panel A: Reverse Causality

	(1)	(2)	(3)	(4)	(5)	(6)
Connections to Key R&D-int. Customers	1.094**	0.979**	0.755***	1.123**	1.004**	0.764***
	(2.53)	(2.45)	(2.63)	(2.58)	(2.49)	(2.66)
Key Customers R&D$_{(t-1)}$	−0.699***	−0.632**	−0.519**	−0.673***	−0.602**	−0.472*
	(−2.69)	(−2.49)	(−2.20)	(−2.58)	(−2.38)	(−1.95)
Key Customers Industry Concentration$_{(t-1)}$	0.499***	0.443***	−0.110	0.496***	0.450***	−0.068
	(4.67)	(4.02)	(−0.78)	(4.61)	(4.04)	(−0.45)
Key Customers Change in Sales$_{(t-1)}$	0.122	−0.229*	−0.052	0.132	−0.206	−0.054
	(1.09)	(−1.79)	(−0.50)	(1.17)	(−1.59)	(−0.52)
Supplier Sales to Key Customers				−0.040*	−0.040*	−0.025
				(−1.83)	(−1.85)	(−1.14)
Supplier Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	No	Yes	Yes
Supplier Industry FE (2-digit SIC)	No	Yes	No	No	Yes	No
Supplier Firm FE	No	No	Yes	No	No	Yes
Observations	7233	7233	7233	7233	7233	7233
Adj. R-squared	0.29	0.35	0.76	0.30	0.35	0.76

Panel B: Excluding Customers with Sales <10%

	(1)	(2)	(3)	(4)	(5)	(6)
Connections to Key R&D-int. Customers	0.979**	0.886**	0.726***	1.007**	0.907**	0.737***
	(2.41)	(2.42)	(2.86)	(2.47)	(2.47)	(2.92)
Key Customers R&D$_{(t-1)}$	−0.566**	−0.533**	−0.479*	−0.560**	−0.524**	−0.448*
	(−2.29)	(−2.23)	(−1.94)	(−2.27)	(−2.19)	(−1.76)
Key Customers Industry Concentration$_{(t-1)}$	0.561***	0.495***	−0.096	0.555***	0.496***	−0.063
	(5.05)	(4.40)	(−0.68)	(5.00)	(4.39)	(−0.41)
Key Customers Change in Sales$_{(t-1)}$	0.085	−0.201	−0.061	0.090	−0.189	−0.062
	(0.76)	(−1.57)	(−0.59)	(0.79)	(−1.46)	(−0.60)
Supplier Sales to Key Customers				−0.027	−0.025	−0.018
				(−1.21)	(−1.09)	(−0.83)
Supplier Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	No	Yes	Yes
Supplier Industry FE (2-digit SIC)	No	Yes	No	No	Yes	No
Supplier Firm FE	No	No	Yes	No	No	Yes
Observations	6210	6210	6210	6210	6210	6210
Adj. R-squared	0.29	0.35	0.76	0.29	0.35	0.76

Panel C: Subsamples based on Suppliers' R&D expenses

	Pos. Supplier R&D	Zero Supplier R&D	Pos. Supplier R&D	Zero Supplier R&D	Pos. Supplier R&D	Zero Supplier R&D
	(1)	(2)	(3)	(4)	(5)	(6)
Connections to Key R&D-int. Customers	0.946**	0.469	0.887**	1.634	0.708***	1.234
	(2.56)	(0.21)	(2.55)	(0.74)	(3.17)	(1.03)
Key Customers R&D$_{(t-1)}$	−0.621**	−1.849**	−0.593**	−1.566**	−0.565**	−0.970
	(−2.47)	(−2.28)	(−2.33)	(−2.01)	(−2.24)	(−0.75)
Key Customers Industry Concentration$_{(t-1)}$	0.638***	0.377**	0.565***	0.307	−0.075	−0.037
	(5.19)	(2.00)	(4.53)	(1.53)	(−0.43)	(−0.13)
Key Customers Change in Sales$_{(t-1)}$	0.129	0.153	−0.084	−0.426	−0.060	−0.066
	(1.12)	(0.70)	(−0.64)	(−1.64)	(−0.49)	(−0.35)
Supplier Sales to Key Customers	−0.034	−0.050	−0.017	−0.072*	0.007	−0.087**
	(−1.43)	(−1.20)	(−0.75)	(−1.72)	(0.29)	(−2.22)
Supplier Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Supplier Industry FE (2-digit SIC)	No	No	Yes	Yes	No	No
Supplier Firm FE	No	No	No	No	Yes	Yes
Observations	4618	2615	4618	2615	4618	2615
Adj. R-squared	0.28	0.26	0.34	0.33	0.74	0.75

Table 7 (*continued*)

Panel D: Baseline Results: Supplier-Customer Sample

	Full Sample			Excluded Customers with Sales <10%		
	(1)	(2)	(3)	(4)	(5)	(6)
Connections	0.002	0.002	0.006	0.004	0.005	0.010
	(0.31)	(0.60)	(1.39)	(0.77)	(0.96)	(1.40)
Key Customer R&D$_{(t-1)}$	0.113	0.152	0.100	0.168	0.203	0.114
	(0.95)	(1.39)	(1.31)	(1.20)	(1.50)	(0.94)
Sales to Key Customer	0.031	0.029	0.001	0.085***	0.066**	0.014
	(1.05)	(1.05)	(0.05)	(3.00)	(2.39)	(0.77)
Conn.*Key Cust. R&D$_{(t-1)}$	−0.116	−0.135**	−0.086*	−0.159**	−0.173**	−0.113*
	(−1.60)	(−2.36)	(−1.90)	(−1.98)	(−2.56)	(−1.76)
Key Cust. R&D$_{(t-1)}$*Sales to Key Cust.	−1.281***	−1.301***	−0.525*	−1.298***	−1.320***	−0.638*
	(−2.96)	(−3.12)	(−1.89)	(−2.75)	(−2.77)	(−1.84)
Conn.*Sales to Key Cust.	−0.002	−0.006	−0.007	−0.006	−0.008	−0.012
	(−0.29)	(−0.97)	(−1.38)	(−0.79)	(−1.11)	(−1.32)
Conn.*Key Cust. R&D$_{(t-1)}$*Sales to Key Cust.	0.792***	0.812***	0.404**	0.885***	0.873***	0.464*
	(2.63)	(3.50)	(2.10)	(2.89)	(3.63)	(1.81)
Key Customer Ind. Concentration$_{(t-1)}$	0.187***	0.186***	0.055**	0.209***	0.202***	0.072*
	(4.27)	(4.21)	(2.00)	(4.59)	(4.35)	(1.93)
Key Customer Change in Sales$_{(t-1)}$	0.062*	−0.046	−0.028	0.042	−0.062	−0.028
	(1.84)	(−1.11)	(−0.87)	(1.14)	(−1.38)	(−0.77)
Supplier Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	No	Yes	Yes
Supplier Industry FE (2-digit SIC)	No	Yes	No	No	Yes	No
Supplier Firm FE	No	No	Yes	No	No	Yes
Observations	10,838	10,838	10,838	8458	8458	8458
Adj. R-squared	0.30	0.36	0.78	0.30	0.36	0.77

Panels A, B and C present the results of supplier-level regressions from Table 2. In Panel A the connections variable is adjusted to address reverse causality by dropping connections formed after the formation of business relationship. Panel B presents the results of regressions where the customers with the proportion of sales <10% of supplier total sales are excluded. Panel C presents the results of regressions in subsamples of suppliers with average positive (zero) R&D-intensity. Panel D presents the results of regressions, where the unit of observation is supplier-customer-year. All regressions include the set of supplier-specific control variables from Table 2. All continuous variables are winsorized at 1% and 99% levels. All variables are defined in Appendix A. t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the supplier firm level. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

that an existing business relationship facilitates creation of social connections. For example, even though the connections in our sample are strictly established at third-party organizations (e.g. universities, past employment), it could still be possible that executives of trading partners are more likely to interact beyond the business relationship at the third-party organizations after establishing the supplier-customer relationship (sit on a joint board, establish personal contact at an MBA program, etc.). To address this concern, we eliminate social connections that were formed after the firms became business partners. We record the year the firms became business partners the first year we observe these firms in the database. Using this filter, we drop about 17.8% of connections, as the significant majority of connections was formed in distant past. Panel A of Table 7 repeats the analysis of the relation between supplier market leverage and the *Connections to Key R&D-intensive Customers* (performed in Table 2). The results are very similar to the baseline results in Table 2, implying that reverse causality is unlikely to drive our results.

3.6.3. Important customers

Compustat Customer Segment files may contain suppliers that report customers representing <10% of total sales. Supplier-customer relationships involving such suppliers are likely less important, and we expect that, on average, suppliers will not operate with higher leverage specifically because of these customers. In Panel B of Table 7, we analyze supplier leverage excluding observations with below 10% sales to customers. The results are very similar to those in full-sample analysis in presented in Table 2, suggesting that relationships with important customers (those with sales >10%) are the main drivers of the relation between supplier-customer links and supplier leverage.

3.6.4. R&D intensity

As widely accepted in previous studies, we consider R&D spending of the customer as a proxy for innovation input and relationship-specific investments between supplier and customer (Titman and Wessels (1988), Allen and Phillips (2000), Kale and Shahrur (2007), Banerjee et al. (2008)). Consistent with the above studies, our assumption is that customer's R&D expenses should capture the relation-specific investment with the supplier. To strengthen this argument, in this section we focus on R&D-intensity of the suppliers as well. Simultaneous investments in innovation inputs by both parties will most likely indicate the presence of the relation-specific investments across the supply chain (Dasgupta et al. (2021)). We rerun the regressions from Table 2 for subsamples of suppliers investing vs. not investing in R&D. Panel C of Table 7 presents the results. The coefficient on *Connections to Key R&D-intensive Customers* is not

significant in the subsample of suppliers that do not invest in R&D. On the other hand, our results hold on the subsample of the positive R&D suppliers, consistent with the assumption that both parties are engaged in relation-specific investments.

3.6.5. Analysis of non-aggregated supplier-customer pairs

The key variable, *Connection to Key R&D-intensive Customers*, by construction is the product of social connections, customers R&D intensity, and sales between the supplier and customer, aggregated across all major customers the supplier has. Even though we isolate the effect of change in connections from change in R&D-intensity on leverage in Panel B of Table 2, it might be not clear which component is driving the variation. To overcome this, we run the main test of the impact of connections on supplier leverage for non-aggregated sample of supplier-customer pairs. We assess the effect of connections to R&D-intensive customers on leverage using the triple interaction of three variables: *Connections*, *Key Customer R&D* and *Sales to Key Customer*. The results are reported in Panel D of Table 7. The first three columns show the results for the full sample and the remaining three columns refer to the subsample of supplier-customer pairs with customers that take >10% of supplier sales. First, all specifications show that the negative effect of customers' R&D on supplier leverage is persistent and increases with supplier sales to that customer (as shown by the negative coefficient on interaction term *Conn.*Key Cust. R&D$_{(t-1)}$*Sales to Key Cust.*). Second, and more importantly, the coefficient on triple interaction is significantly positive uniformly across all specifications confirming our main result that suppliers with connections to R&D-intensive customers maintain higher leverage. Results in columns (4)–(5) further show that our results hold with the same significance in the subsample of customers with proportion of sales >10%.

3.6.6. Cost of debt financing

The bonding channel discussed in the paper implicitly assumes that the cost of financing is non-decreasing. Nevertheless, if creditors value the stability of supply chain relationships, suppliers may be able to arrange lower costs of financing. Cheaper financing would allow suppliers to borrow more and adjust to higher levels of leverage.

To explore this potential effect, we use Thomson-Reuters' DealScan database to obtain data on historical bank loan pricing of the sample firms. We estimate pooled regressions, in which the dependent variable is the natural logarithm of the all-in spread over LIBOR. In addition to the control variables used in Table 2, we utilize standard loan controls, such as *Loan Size* (committed facility amount scaled by supplier total assets), *Maturity* (maturity of loan package in months) and *Revolver* (indicator variable if the loan is a revolving line of credit with maturity greater than one year). The regression models in Table 8 are estimated both with and without industry, supplier firm dummies, year dummies, above-mentioned loan controls, and controls from Table 2. We consistently find that suppliers

Table 8

Leverage of dependent suppliers and connections to key R&D-intensive customers: Cost of Debt Financing

	(1)	(2)	(3)	(4)	(5)	(6)
Connections to Key R&D-intensive Customers	4.010**	1.374	−0.395	3.956**	1.374	0.058
	(2.25)	(0.81)	(−0.07)	(2.30)	(0.81)	(0.01)
Market Leverage	0.787***	0.929***	0.624***	0.795***	0.931***	0.609***
	(8.82)	(9.94)	(4.19)	(8.86)	(9.91)	(4.07)
Loan Size	−0.627***	−0.799***	−0.730***	−0.631***	−0.798***	−0.736***
	(−5.26)	(−7.27)	(−4.64)	(−5.35)	(−7.26)	(−4.69)
Maturity	0.245***	0.194***	0.099***	0.242***	0.194***	0.098***
	(7.90)	(6.92)	(3.05)	(7.93)	(6.93)	(3.01)
Revolver	−0.232***	−0.251***	−0.202***	−0.232***	−0.251***	−0.201***
	(−8.76)	(−10.40)	(−7.52)	(−8.87)	(−10.41)	(−7.52)
Key Customers R&D$_{(t-1)}$	−1.491	−0.249	−1.119	−2.232	−0.426	−0.362
	(−0.96)	(−0.13)	(−0.16)	(−1.37)	(−0.23)	(−0.05)
Key Customers Ind. Concentration$_{(t-1)}$	−0.255	−0.357	−0.928	−0.185	−0.351	−0.684
	(−0.54)	(−0.79)	(−0.92)	(−0.40)	(−0.77)	(−0.61)
Key Customers Change in Sales$_{(t-1)}$	−2.865***	0.773	1.143	−3.033***	0.728	1.270
	(−2.84)	(0.79)	(0.94)	(−3.07)	(0.73)	(1.05)
Supplier Sales to Key Customers				0.325***	0.067	−0.210
				(2.77)	(0.63)	(−1.14)
Supplier Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	No	Yes	Yes
Supplier Industry FE (2-digit SIC)	No	Yes	No	No	Yes	No
Supplier Firm FE	No	No	Yes	No	No	Yes
Observations	3190	3190	3190	3190	3190	3190
Adj. R-squared	0.41	0.53	0.68	0.42	0.53	0.68

The table presents the results of regressions of connections to key R&D-intensive customers on loan spreads for originated loans by the supplier firm. The dependent variable is *Spread* equal to the natural logarithm of all-in-spread over LIBOR. *Market Leverage* is equal to the sum of book values of long-term debt and debt in current liabilities divided by the sum of book values of long-term debt and debt in current liabilities and market value of common equity. *Loan Size* is the committed facility amount scaled by supplier total assets. *Maturity* is the maturity of loan package in months. *Revolver* is an indicator variable if the loan is a revolving line of credit with maturity greater than one year. All regressions include the set of supplier-specific control variables from Table 2. All continuous variables are winsorized at 1% and 99% levels. All other variables are defined in Appendix A. t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the supplier firm level. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

with connections to key R&D-intensive customers are not rewarded with lower loan spreads. The coefficients on the connection variable are not significant if any fixed effects are considered, suggesting that cost of financing is unlikely to be a channel through which connections affect the leverage.

3.6.7. Distressed suppliers

Finally, we explore how supplier firms' financial health affects the relation between social connections and supplier capital structure. Titman (1984) and Maksimovic and Titman (1991) argue that high leverage reduces the incentive to make relationship-specific investments, as such investment would lose value if either of the contracting parties ends up in financial distress or bankruptcy. Consequently, a firm may choose low leverage to decrease the chance of default in order to facilitate relationship specific investment.

We investigate whether the existence of social connections between suppliers and customers facilitates lower supplier leverage particularly among firms closer to financial distress (which, in the absence of social connections would have likely had to commit to low leverage in order to attract relationship-specific investment). To capture several dimensions of financial distress, we define a distressed supplier if the year-averaged Altman's *Z*-score is <2, year-averaged supplier cash flow is below the sample median, or the supplier has a negative book value of common equity in any of the sample years (Altman (1968); Graham et al. (1998), Bhagat et al. (2005)). Table 9 presents the results of regressions from the Table 2 run on the sample of presumably distressed suppliers (Panel A) vs. non-distressed suppliers (Panel B). The effect of *Connections to Key R&D-int. Customers* is significant only for the distress-prone suppliers in Panel A (and Panel A *Connections to Key R&D-int. Customers* coefficients are significantly greater than those in Panel B for all six

Table 9

Leverage of dependent suppliers and connections to key R&D-intensive customers: Distressed Suppliers

Panel A: Distressed Suppliers

	(1)	(2)	(3)	(4)	(5)	(6)
Connections to Key R&D-int. Customers	1.182***	0.890***	0.814***	1.204***	0.906***	0.816***
	(3.05)	(2.87)	(3.02)	(3.11)	(2.93)	(3.00)
Key Customers R&D$_{(t-1)}$	−0.848***	−0.745***	−0.501*	−0.833***	−0.735***	−0.495*
	(−2.96)	(−2.65)	(−1.76)	(−2.92)	(−2.63)	(−1.72)
Key Customers Industry Concentration$_{(t-1)}$	0.651***	0.298*	−0.205	0.662***	0.315*	−0.196
	(3.69)	(1.69)	(−0.88)	(3.66)	(1.73)	(−0.77)
Key Customers Change in Sales$_{(t-1)}$	−0.162	−0.431**	−0.134	−0.147	−0.409**	−0.134
	(−0.88)	(−2.27)	(−0.71)	(−0.80)	(−2.13)	(−0.70)
Supplier Sales to Key Customers				−0.027	−0.023	−0.005
				(−0.89)	(−0.85)	(−0.15)
Supplier Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	No	Yes	Yes
Supplier Industry FE (2-digit SIC)	No	Yes	No	No	Yes	No
Supplier Firm FE	No	No	Yes	No	No	Yes
Observations	3330	3330	3330	3330	3330	3330
Adj. R-squared	0.38	0.49	0.77	0.38	0.49	0.77

Panel B: Non-Distressed Suppliers

	(1)	(2)	(3)	(4)	(5)	(6)
Connections to Key R&D-int. Customers	0.026	−0.050	−0.044	0.093	0.006	−0.019
	(0.05)	(−0.10)	(−0.09)	(0.19)	(0.01)	(−0.04)
Key Customers R&D$_{(t-1)}$	−0.557	−0.356	−0.155	−0.501	−0.242	−0.020
	(−1.52)	(−0.95)	(−0.39)	(−1.32)	(−0.63)	(−0.05)
Key Customers Industry Concentration$_{(t-1)}$	0.403***	0.421***	0.060	0.364***	0.402***	0.097
	(3.54)	(3.45)	(0.40)	(3.27)	(3.34)	(0.63)
Key Customers Change in Sales$_{(t-1)}$	0.330***	−0.057	0.056	0.336***	−0.038	0.049
	(2.64)	(−0.39)	(0.49)	(2.69)	(−0.26)	(0.43)
Supplier Sales to Key Customers				−0.065***	−0.070***	−0.033
				(−2.82)	(−2.78)	(−1.08)
Supplier Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	No	Yes	Yes
Supplier Industry FE (2-digit SIC)	No	Yes	No	No	Yes	No
Supplier Firm FE	No	No	Yes	No	No	Yes
Observations	3609	3609	3609	3609	3609	3609
Adj. R-squared	0.28	0.33	0.72	0.28	0.33	0.72

The table presents the results of supplier-level regressions from Table 2. Panel A reports the results for the subsample of the distressed suppliers, and Panel B – for non-distressed suppliers. Distressed supplier is a supplier if: year-averaged Altman's *Z*-score is <2, year-averaged cash flow is below the sample median, or the supplier has a negative book value of common equity in any of the sample years (Altman (1968); Graham et al. (1998), Bhagat et al. (2005)). All regressions include the set of supplier-specific control variables from Table 2. All continuous variables are winsorized at 1% and 99% levels. All other variables are defined in Appendix A. t-statistics, reported in parentheses, are based on standard errors that allow for clustering at the supplier firm level. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

columns at 5% significance level), suggesting that the effect of social connections between suppliers and customers is stronger for suppliers that have a higher likelihood of being in financial distress. These results are consistent with the hypothesis that social connections are important for the potentially distressed suppliers who in the absence of social ties would have to maintain lower leverage to keep business relationships with their customers.

4. Conclusion

In this paper we study the relation between suppliers' social connections to R&D-intensive customers and suppliers' capital structure decisions. We find that suppliers with social connections to high-R&D customers choose relatively higher levels of market leverage, resulting in partial reduction of underleverage typically pursued when dealing with high-R&D customers in the absence of social connections. Additionally, we mitigate endogeneity concerns by analyzing customer firm top management turnovers – we show that supplier leverage significantly declines in firms that lose social connections to customer managers following the customer management turnover. We further support our findings by additional robustness tests based on propensity score matching and by tests addressing reverse causality.

We find support that mutual bonding of suppliers and customers may explain the positive relation between supplier leverage and supplier-customer connections, as the effect of the connections to high-R&D customers on leverage is driven by suppliers with intensive trading relationship. In addition, we provide some evidence that reduced information asymmetry between suppliers and customers can also facilitate the link between supplier leverage and connections, as the positive relation between social connections to R&D-intensive customers on leverage is stronger (albeit not statistically significantly) in subsamples where information asymmetry between supplier and key customers (proxied by either geographical distance between supplier and customer locations or supplier dispersion of analyst earnings forecasts) is high. Overall, we show that social connections among managers of supplier and customer firms play an important role in supplier capital structure decisions.

Data availability

The authors do not have permission to share data.

Appendix A. Variables Definitions

Analyst Forecast - the standard deviation of analyst estimates of EPS for the current fiscal year averaged over the sample fiscal years for a given supplier. The data on analyst forecasts is obtained from I/B/E/S database.

Connected supplier is a supplier that has least one connection and a proportion of sales above the sample median to one of its major customers.

Connections - the total number of connections between executives of supplier and customer firms multiplied by 100 and divided by the total number of possible executives' pairs.

Connections to Key Customers - the sum of connections to each major customer weighted by proportion of sales to each major customer, where connections to each major customer is the number of connected pairs multiplied by 100 and divided by the total number of pairs that exist between individuals of customer and supplier firms.

Connections to Key R&D-intensive Customers - the sum of connections to each major customer weighted by R&D intensities and proportion of sales to each major customer, where connections to each major customer is the number of connected pairs multiplied by 100 and divided by the total number of pairs that exist between individuals of customer and supplier firms.

Distance - average geographical distance between a supplier and its key customers, measured in miles. The average distance is computed by averaging the distances between the headquarters location of supplier and that of each of its customers. We compute the distance using latitude and longitude coordinates for the addresses of the supplier (customer) headquarters obtained from the U.S. Census Bureau's Gazetteer City-State File. We then apply the formula to calculate the distance between two points on Earth's surface.

Key Customer Change in Sales is the median change in sales in the key customer 2-digit SIC industry. Change is sales is computed as percentage difference in sales (scaled by assets) between the current and the previous year.

Key Customer Industry Concentration is the key customer industry concentration measured as the HHI in the 2-digit SIC code of the customer industry in a given year.

Key Customer R&D is the R&D intensity of the key customer.

Key Customers Change in Sales - the sum of *Key Customer Change in Sales* of all major customers weighted by the proportion of sales to each major customer.

Key Customers Industry Concentration - the sum of *Key Customer Ind. Concentration* of all major customers weighted by the proportion of sales to each major customer.

Key Customers R&D - the sum of R&D intensities of all major customers weighted by the proportion of sales to each customer.

Loan Size is the committed facility amount scaled by supplier total assets.

Market Leverage - equal to the sum of book values of long-term debt and debt in current liabilities divided by the sum of book values of long-term debt and debt in current liabilities and market value of common equity.

Maturity is the maturity of loan package in months.

R&D intensity - research and development expenditures divided by total assets. Following the literature, we set missing values of research and development expenditures to equal zero.

R&D-Intensive Customer is a dummy variable that equals one (zero) if the averaged (by years) R&D-intensity of the key customer is above (below) median of the sample distribution.

Revolver is an indicator variable if the loan is a revolving line of credit with maturity greater than one year.

Sales to Key Customer - sales to key customer$_j$ divided by the lagged total sales of the supplier.

Spread - the natural logarithm of all-in-spread over LIBOR (on originated loans) measured in basis points.

Supplier Firm Age – natural logarithm of one plus number of years since the firm is first recorded in Compustat.

Supplier Fixed Assets - net property, plant and equipment divided by total assets.

Supplier Industry Concentration - supplier industry concentration measured as the Herfindahl–Hirschman Index (HHI) (sum of squared market shares in sales) in the 2-digit SIC code.

Supplier Non-Debt Tax Shields - investment tax credit divided by total assets.

Supplier ROA - operating income divided by total assets.

Supplier Sales to Key Customers - total sales to key customers divided by the total lagged sales of the supplier.

Supplier SGA - selling, general and administrative expenses divided by total assets.

Supplier Size - natural logarithm of total assets.

Supplier Tobin's Q - book value of assets minus book value of common equity plus the market value of common equity divided by book value of assets.

Supplier Volatility - rolling standard deviation of ROA for the previous 10 years relative to a given year.

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