Customer Concentration and Firm Risk:

The Role of Outside Directors from Customers

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Abstract

This paper examines the effect of outside directors from major customers on suppliers' risk arising from customer concentration. Using a sample of US suppliers over the 2001–2016 period, we find that a positive relationship between customer concentration and suppliers' risk is weakened when customers' representatives sit on the suppliers' board as outside directors. We further show that the presence of customer-affiliated outside directors at suppliers is positively related to these firms' aggressive financial policies of taking higher leverage, lower working capital, and lower cash reserves. Our results suggest that customers' board membership at suppliers helps alleviate the customer concentration risk by strengthening the supplier–customer relationship and reducing their information asymmetry.

JEL classifications: G30; G32; G34; M40; M41

Keywords: Customer concentration; Firm risk; Interlocked board; Outside directors; Relationship-specific investments; Information asymmetry

1. Introduction

More than 30% of US manufacturers' sales are generated from a few large customers (Campello and Gao, 2017), and approximately 45% of public firms attribute a significant proportion of revenues to major customers (Ellis, Fee, and Thomas, 2012). Along with the increasing importance of customer concentration in corporate business practices, its related issues have attracted much attention from academic research.[4] Existing studies in finance focus on the effect of customer concentration on corporate policies and decisions.[5] In particular, many of these studies associate customer concentration with an increase in suppliers' business risk. For example, Kale and Shahrur (2007) and Banerjee, Dasgupta, and Kim (2008) find that suppliers with major customers tend to decrease their leverage level. Meanwhile, Itzkowitz (2013) provides evidence that suppliers hold more cash reserves when their operations rely on a highly concentrated customer base. Recent studies by Dhaliwal, Judd, Serfling, and Shaikh (2016) and Campello and Gao (2017) further confirm that a greater level of customer concentration results in higher financing costs to suppliers.

While previous literature suggests negative implications of customer concentration on firm risk, little is known about how firms mitigate their business risks arising from customer concentration. In this paper, we explore the relationship between board composition and firm risk in the customer concentration context because the board of directors plays a critical role in setting corporate control and decisions. Specifically, we examine whether appointing major customers' representatives on the suppliers' board can alleviate customer concentration risk.

A concentrated supplier–customer relationship generates both benefits and costs to a supplier. Having fewer and larger customers can benefit firms by enhancing operational efficiencies and further achieving economies of scales because it helps the firms reduce overhead costs (Patatoukas, 2012). Moreover, having major customers signals positive information on a firm's quality to the market participants (Cen *et al.*, 2015). On a related issue, suppliers with more concentrated customers experience higher valuation in initial public offerings (IPOs) and greater long-run performance than those with less concentrated customer base (Johnson, Karpoff, and Yi, 2015).

However, a concentrated customer base is more likely to increase suppliers' risk. Suppliers who depend on a few major customers can lose their substantial future sales when those customers switch the suppliers or decide to manufacture products directly (Campello and Gao, 2017). Several prior studies (e.g., Kolay, Lemmon, and Tashjian, 2016; Intintoli, Serfling, and Shaikh, 2017) show that suppliers' stock price significantly drops when the bad news threatening relationships with major customers is released, reverberating throughout their supply chains. Furthermore, suppliers are exposed to the risk of losing expected cash flows from failing to collect account receivables if major customers declare bankruptcy (Dhaliwal *et al.*, 2016). Consistent with this view, Jorion and

[4] The concept of "customer concentration" is prevalent in the supplier–customer relationship literature. Higher customer concentration of a supplier means that the supplier depends on a small number of major customers for a considerable portion of sales.

[5] For instance, see Wang (2012) for payout policy, Habib, Hasan, and Bhuiyan (2015) for corporate social responsibility (CSR) activities, Cen, Dasgupta, Elkamhi, and Pungaliya (2015) for corporate governance choice, and Crawford, Huang, Li, and Yang (2020) for information disclosure issues.

Zhang (2009) find that suppliers who have more trade credit with major customers experience greater negative market reactions to the announcement of a customer's bankruptcy filing.

Concerning the greater business risks associated with a higher level of concentrated customer base, managing these risks is vital for suppliers. Then, a natural question arises: how can suppliers alleviate the risk arising from a concentrated customer base?

When the suppliers' operation relies heavily on a few large customers, their relationship with these customers becomes important because this relationship influences their day-to-day business activities such as cash flows and liquidity management (Campello and Gao, 2017). Moreover, the built relationship with key customers tends to persist for a long time (Emshwiller, 1991), motivating suppliers to keep this relationship. Thus, concentrated supplier–customer ties frequently involve suppliers engaging in relationship-specific investments (Titman and Wessels, 1988; Banerjee *et al.*, 2008).

Under this type of investments, firms with greater bargaining power have an incentive to typically behave opportunistically to expropriate the quasi-rents of their supply chain counterparties because relationship-specific investments have limited value outside the supplier–customer relationship (e.g., Shleifer and Summers, 1988; Coates IV, 2001; Stout, 2002; Gillan, Hartzell, and Parrino, 2009).[6] As a result, relationship-specific investments face the risk of underinvestment problems arising from incomplete contracts (e.g., Grossman and Hart, 1986; Hart and Moore, 1990; Dasgupta and Tao, 2000; Fee, Hadlock, and Thomas, 2006). Furthermore, suppliers with only a few major customers can confront a greater hold-up risk by their concentrated customers because of their strong bargaining power over the suppliers. Hence, the suppliers are likely to be concerned with the termination of the relationships with customers and seek to resolve incentive conflicts with customers.

Board members at supplier firms can play a central role in easing incentive problems between suppliers and customers. In particular, the presence of interlocked boards, by obtaining seats on their trading partner's board, is effective in bonding the relationship between supply chain partners (Fee *et al.*, 2006; Minnick and Raman, 2017). For suppliers with highly concentrated customer base, the appointment of customers' representatives on their board enhances trust, coordination, and cooperation with their customers, opens up and expands networks of directors with customer board, and strengthens an informal (implicit) contract with customers that curbs their opportunistic action (Gulati, 1995; Mizruchi, 1996; Baker, Gibbons, and Murphy, 2002). Consequently, this type of board interactions enables suppliers to facilitate transactions with them and further keep the supplier–customer relationships along with greater relationship-based investments.

Suppliers with high customer concentration are also likely to obtain greater information on customers and reduce information asymmetry by appointing customers on their board (e.g., Haunschild, 1993; Mizruchi, 1996; Haunschild and Beckman, 1998; Dass, Kini, Nanda, Onal, and Wang, 2014; Minnick and Raman, 2017). Through a decline in information asymmetry, these suppliers can alleviate potential uncertainties, such as the financing and operational risks of customers and the possibilities that customers may change their partners or

[6] Quasi-rents arise when a counterparty commits into a relationship-specific investment that may hurt the value if the firm switches its corporate policy decisions (Johnson *et al.*, 2015).

decide to directly produce goods, which can arise from a concentrated customer base. Furthermore, by acquiring information on customer firms via customer-affiliated directors, suppliers can obtain greater bargaining power in the negotiation process (Minnick and Raman, 2017). This increase in bargaining power helps suppliers alleviate contractual inefficiencies arising from relationship-specific investments. Hence, directors from concentrated customers are likely to mitigate firm risk because they can benefit their firms by improving trust and cooperation with customers and reducing information asymmetry.

Suppliers, however, can face a potential threat from customer-affiliated board members due to conflicts of interest. Directors from customers may serve the interests of their affiliated firms (customers) rather than these suppliers, affecting the suppliers' managers to run their firms in ways that would benefit customers (Baiman and Rajan, 2002; Dass *et al.*, 2014).[7] Specifically, suppliers can be exposed to the risk of revealing valuable information to their customers by allowing representatives of the major customers on the board. The information revealed can increase customers' relative bargaining power, putting suppliers at risk of losing a competitive position (Baiman and Rajan, 2002; Li and Zhang, 2008). Therefore, suppliers' managers will seek ways to alleviate conflicts of interest by avoiding the leakage of their important information to customers (Li, 2002; Zhang, 2002; Drake and Haka, 2008; Dass *et al.*, 2014).

Existing studies show that outside directors face a higher cost to acquire information and tend to depend more on managers' information (e.g., Adams and Ferreira, 2007; Harris and Raviv, 2008; Kumar and Sivaramakrishnan, 2008; Fahlenbrach, Low, and Stulz, 2017). In this line of reasoning, outside directors are more limited in accessing suppliers' detailed information than inside (executive) directors. Thus, suppliers are likely to have stronger incentives to assign customers' representatives on the board as outside directors rather than inside directors to prevent sharing of their proprietary information with customers.

In summary, having directors from major customers on the board benefits suppliers by reducing their risk, whereas this way is costly to suppliers by possibly leaking their valuable information to customers. Meanwhile, outside directors from concentrated customers are likely to help suppliers decrease the costs arising from conflicts of interest because outside directors have more limited access to suppliers' important information compared with inside directors. Thus, appointing directors from major customers as outside directors can allow suppliers to enjoy considerable benefits that outweigh the costs. Based on this discussion, we propose our hypothesis that suppliers with customer-affiliated outside directors are likely to mitigate their firm risk arising from customer concentration.

Using a sample of 6,350 US supplier-years (1,491 distinct suppliers with customer concentration) over the 2001–2016 period, we examine the effect of outside directors from major customers on suppliers' risk associated with a concentrated customer base. We find that a positive relationship between a higher level of customer concentration and suppliers' risk is significantly weakened when customers' representatives sit on the suppliers' board as outside directors. Our results suggest that suppliers mitigate their customer concentration risk

[7] For example, customer-affiliated directors may attempt to make the terms of contract favorable to their affiliated firms or induce suppliers' management to initiate new business that is helpful to the customers.

by having outside directors from customers on the board.

While we argue the causality from the presence of customer-affiliated outside directors to suppliers' risk, our baseline results might be subject to endogeneity issues including omitted variable bias and reverse causality. Thus, we perform additional tests to alleviate endogeneity concerns. Our results are qualitatively similar when we estimate two-stage least square (2SLS) regressions and conduct event studies based on a difference-in-differences framework.

Subsequently, we focus our attention on the relationship between outside directors from major customers and suppliers' corporate financial policies. Extant literature shows that managers of suppliers with highly concentrated customer base run their firms more conservatively as a precaution against additional risks arising from the customer concentration. Our baseline results suggest that appointing customers' representatives as outside directors reduces suppliers' risk associated with customer concentration; thus, we expect that suppliers with outside directors from customers are likely to adopt relatively less conservative financial policies, compared with other customer-concentrated suppliers. Our results show that the presence of customer-affiliated outside directors is positively (*negatively*) related to book and market leverage (*working capital and cash*), supporting our prediction.

Finally, we investigate possible channels through which outside directors from customers mitigate suppliers' customer centration risk. We have argued that suppliers can strengthen the relationship with customers and reduce their information asymmetry by having customer-affiliated outside directors on the board. To test these arguments, we first analyze suppliers' transaction data and find that the presence of outside directors from customers is positively related to transaction volume and periods between suppliers and customers. These results suggest that the appointment of customers' representatives on the board enhances trust, coordination, cooperation, and further informal contracts between supply chain partners, which leads to a substantial rise in transaction volume and periods. Next, we examine whether customer-affiliated outside directors help suppliers predict and manage negative shocks from customers that might disrupt supplier–customer relationships. Using the replacement of a customer's CEO as a disruptive event (Intintoli *et al.*, 2017), we find that the losses of suppliers' sales following customers' CEO turnovers greatly decrease when suppliers have customer-affiliated outside directors on the board. This finding indicates that suppliers can acquire greater information such as negative shocks from customers by appointing customers' representatives as outside directors.

Our paper contributes to several strands of accounting and finance literature. First, we enrich discussion in accounting and finance studies of customer concentration. Existing studies in this area have largely focused on the relationship between customer concentration risk and corporate policies (e.g., Kale and Shahrur, 2007; Banerjee *et al.*, 2008; Itzkowitz, 2013; Dhaliwal *et al.*, 2016; Campello and Gao, 2017). However, we analyze the manners to alleviate the customer concentration risk. Specifically, we show that having customers' representatives on the board play a central role in mitigating the threats arising from customer concentration. Second, our paper is in line with the findings of Dass *et al.* (2014), which show that having directors from customers' industries on the board can benefit suppliers by preventing negative shocks in supply chain and improving operating efficiency. We add further discussion on the benefit of the customer-related board from the viewpoint of resource dependence.

While Dass *et al.* (2014) focus on reducing the information gap as a possible channel to mitigate the resource-dependent risk, our paper highlights the importance of strengthening the relationship with supply-chain partners as another channel. Third, our study adds to the existing literature on board composition and the role of directors' expertise. Prior studies have investigated the role of directors who are specialized in banking, law, and politics (e.g., Burak Güner, Malmendier, and Tate, 2008; Goldman, Rocholl, and So, 2009; Krishnan, Wen, and Zhao, 2011; Erkens, Subramanyam, and Zhang, 2014). We further complement the literature on directors' experience in a supply chain by focusing on customer-specific expertise of directors.

The rest of the paper is organized as follows. Section 2 presents data description and discusses the research design. Section 3 presents baseline results and possible channels. In addition, Section 3 addresses endogeneity issues and reports the findings from robustness tests. Section 4 concludes the paper.

2. Data description and research design

2.1 Sample construction

We construct our sample using several databases. First, the supplier–customer data are obtained from Compustat's segment customer files that provide necessary information on suppliers and customers.[8] We also obtain accounting and financial data from Compustat and Center for Research in Securities Prices (CRSP). From the BoardEx database, we further collect various information such as employment history of directors and characteristics of boards and executives. Moreover, we exclude suppliers of which major customers are not identified because this paper focuses on suppliers that face customer concentration risk. Finally, our sample contains 6,530 US supplier-year observations on 1,491 distinct suppliers with major customers over the 2001–2016 period.

2.2 Directors from major customers

To find the outside directors from major customers, we first identify suppliers and their major customers using Compustat's segment customer files. Since 1976, the Statement of Financial Accounting Standards No. 14 (SFAS 14) has required suppliers to report customers that represent 10% or more of their total sales. The segment customer files provide information on the SFAS 14 regulation, including identifiers of suppliers, names of suppliers and their major customers, and their sales to each major customer.[9] In the process of identifying major customers, we manually match their names with these of firms in Compustat database because identifiers (*GVKEY*) of major customers are not available in the segment customer files, unlike those of suppliers. Next, we obtain data on executives and directors and their employment history from BoardEx, which provides information on which

[8] Compustat's segment customer files define a major customer as a customer that accounts for 10% or more of its supplier's total sales. As in the customer concentration literature, we follow this definition to identify major customers.

[9] Some suppliers voluntarily report information on customers that account for less than 10% of total sales. To ensure the consistency of data, we exclude these customers when considering major customers (Dhaliwal *et al.*, 2016).

employees are in a firm, whether or not they are outside directors, and when and where they have worked. By intersecting Compustat's segment customer files and BoardEx, we identify suppliers' outside directors who have worked for major customers and construct our main explanatory variable, outside directors from major customers (*Outside Directors from Customers*). *Outside Directors from Customers* is defined as an indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for major customers as executives or outside directors, and 0 otherwise.

We follow the same procedure to identify whether at least one inside director of a supplier comes from major customers and define this supplier as *Inside Directors from Customers*. We also construct *All Directors from Customers* that is an indicator variable equal to 1 if one or more employees from major customers sit on a supplier's board regardless of which positions they have, and 0 otherwise. Lastly, we measure the number of a supplier's outside directors from major customers (*No. of Outside Directors from Customers*) as a continuous variable.

Panel A of Table 1 shows the summary statistics of directors from major customers.[10] The mean value of *Outside Directors from Customers* is 0.101, which means that 10.1% of suppliers with major customers have at least one outside director from these customers.[11] This mean value is about seven times higher than the mean value of *Inside Directors from Customers* (0.015). This finding implies that suppliers prefer outside directors to inside directors when they appoint customer representatives as directors. The number of customer-affiliated outside directors per supplier (*No. of Outside Directors from Customers*) is 0.140 on average. Given that approximately 10% of suppliers in our sample have at least one outside director from customers, the mean value of 0.140 indicates that typical suppliers have one or two customer-affiliated outside directors on the board.

[INSERT TABLE 1 HERE]

2.3 Firm risk

We employ realized stock return volatility (*RVOL*) and idiosyncratic stock return volatility (*IVOL*) as our main proxies for firm risk.[12] *RVOL* is the standard deviation of daily stock returns over the fiscal year multiplied by the square root of 252. To estimate *IVOL*, we calculate the standard deviation of daily excess stock returns over the fiscal year multiplied by the square root of 252. Following Dhaliwal *et al.* (2016), we define excess stock returns as the residuals from regressing daily stock returns on value-weighted market returns that are estimated over the fiscal year and provided by CRSP. Panel B of Table 1 shows the summary statistics of these firm risk variables. On average, *RVOL* and *IVOL* of suppliers in our sample are 46.303 and 41.341, respectively.

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[10] Compustat's segment customer files only identify major customers, not all customers. Thus, the 'customers' in this paper means major customers. For brevity, we frequently mention major customers as customers throughout the paper.

[11] According to Ellis *et al.* (2012), about 45% of US public firms have one or more major customers. Therefore, the ratio of suppliers with outside directors from major customers among US public firms is roughly calculated to be 4.5% (=0.45 × 0.101).

[12] The customer concentration literature (e.g., Dhaliwal *et al.*, 2016; Campello and Gao, 2017) shows that customer concentration affects firm risk in various ways such as greater cost of capital and increased risk in production management. Thus, we use market-based risk measures (i.e., *RVOL* and *IVOL*) to capture overall firm risk.

2.4 Control variables

We control for various firm-, board-, and CEO-level characteristics of suppliers that have been identified in previous literature as meaningful factors contributing to firm risk. Following Pan, Wang, and Weisbach (2015) and Dhaliwal *et al.* (2016), as firm-level controls, we include the natural logarithm of market value of equity (ln(*ME*)), market-to-book ratio (*M/B*), return on assets (*ROA*), market leverage (*Mkt. Lev.*), cash ratio (*Cash*), dividend dummy (*Dividend Dum.*), research and development ratio (*R&D*), and property, plant, and equipment ratio (*PPE*), as well as the natural logarithm of one plus firm age (ln(1+*Firm Age*)), market beta (*Mkt. Beta*), and momentum (*Momentum*). Panel C of Table 1 shows the summary statistics of these firm characteristics. Suppliers, on average, have market equity of $ 3,200.837 million, market-to-book ratio of 2.970, and return on asset of 0.067. The average market leverage, cash ratio, and research and development ratio are 0.127, 0.247, and 0.074, respectively. The mean property, plant, and equipment ratio and firm age stand at 0.239 and 20.542, respectively. In addition, suppliers have market beta of 1.036 and momentum of 0.141 on average. The mean value of dividend variable is 0.314, which indicates that 31.4% of suppliers in our sample pay dividends to shareholders.

Following Bernile, Bhagwat, and Yonker (2018), we also include the natural logarithm of board size (ln(*Board Size*)), CEO duality (*Duality*), and the natural logarithm of one plus CEO tenure (ln(1+*CEO Tenure*)) as board- and CEO-level controls. In Panel D of Table 1, the average number of directors on the board is 7.931, 47.5% of CEOs serve as chairperson of the board, and the average tenure of CEOs is 5.296 years. With detailed descriptions, all variable definitions are provided in the Appendix.

2.5 Empirical methodology

Prior literature argues that suppliers face customer concentration risk when they depend on a small set of customers for a large portion of sales (Bae and Wang, 2015; Itzkowitz, 2015; Dhaliwal *et al.*, 2016; Campello and Gao, 2017). Meanwhile, we expect that suppliers' outside directors from customers can play a central role in mitigating customer concentration risk. To confirm our prediction, we first check the presence of customer concentration risk and then examine the effect of customer-affiliated outside directors on this risk.

In our sample, all suppliers have at least one major customer because we exclude suppliers whose major customers are not identified in the database. Thus, we match our sample to benchmark firms without major customers to compare the firm risk between suppliers with and those without major customers. Specifically, we link each supplier to the firms that satisfy the following conditions: (1) firms with no major customer, (2) firms that fall within ±30% of total assets of paired supplier, and (3) firms in the same industry and year.[13] We then construct the customer concentration variable (*Customer Concentration*), which is defined as an indicator variable equal to 1 if a firm has at least one major customer, and 0 otherwise. That is, our customer concentration variable has a value of 1 (*0*) if a firm belongs to our main sample (*a benchmark firm*). We regress firm risk variables on

[13] Our main findings remain unchanged even when we include all firms that appear in the Compustat database or change the matching condition related to total assets.

this customer concentration measure to identify the presence of customer concentration risk. In the regressions, we also include an interaction term between customer concentration and outside directors from major customers (i.e., *Customer Concentration* × *Outside Directors from Customers*) to examine the effect of customer-affiliated outside directors on customer-dependent suppliers' risk. The regression specification is as follows:

$$Firm\ \ Risk_{i,t} = \alpha + \beta_1 Customer\ \ Concentration_{i,t-1} + \beta_2 Customer\ \ Concentration_{i,t-1} \times Outside\ \ Directors\ \ from\ \ Customers_{i,t-1} + Controls_{i,t-1} + \varepsilon_{i,t}, \quad (1)$$

where *i* and *t* indicate a supplier and a given year, respectively.[14] *RVOL* or *IVOL* is used to measure firm risk. As controls, firm-, board-, and CEO-level variables are included in the regression.

Our preceding discussion suggests that suppliers with concentrated customer base face higher risks than those that do not depend on a few large customers, but these suppliers can reduce firm risk arising from customer concentration by having outside directors from major customers on their board. Thus, the coefficient on customer concentration (β_1) is expected to be positive, whereas the coefficient on the interaction term between customer concentration and outside directors from major customers (β_2) is predicted to be negative.

Next, we directly examine a difference in firm risks between customer-dependent suppliers with and without outside directors from major customers by using our main sample (i.e., the sample that only consists of suppliers with at least one major customer). To test this, we regress firm risk variables on *Outside Directors from Customers* as follows:

$$Firm\ \ Risk_{i,t} = \alpha + \beta_3 Outside\ \ Directors\ \ from\ \ Customer_{i,t-1} + Controls_{i,t-1} + \varepsilon_{i,t}, \quad (2)$$

where *i* and *t* indicate supplier and the given year, respectively. *RVOL* or *IVOL* is used to measure firm risk. As controls, firm-, board-, and CEO-level variables are included in the regression. Based on our conjecture, we expect the coefficient on *Outside Directors from Customers* (β_3) to be negative in the regression.

The presence of outside directors from major customers and a degree of firm risk can vary across years and industries. We thus include year and industry fixed effects in all regressions. Moreover, estimated standard errors are adjusted for heteroscedasticity and clustered at the firm level to correct for serial correlations within observations for a firm. Furthermore, all outside variables are lagged by one year relative to a dependent variable.

3. Empirical findings

3.1 Univariate tests

We perform univariate tests to obtain preliminary insights into the relationship between the appointment of outside directors from customers to a supplier board and customer concentration risk. To set these tests, we split our sample into two groups according to whether or not a supplier has at least one customer-affiliated outside

[14] *Outside Directors from Customers* is from suppliers with outside directors who have worked in major customers, not in all customers. Therefore, these suppliers have at least one major customer and *Customer Concentration* × *Outside Directors from Customers* is identical to *Outside Directors from Customers*. Hence, we do not control for *Outside Directors from Customers* in the regression.

director on the board. Then, we conduct difference-in-mean and median tests between those two groups. In Table 2, the results show that suppliers with outside directors from customers face lower firm risks than those without. The mean realized stock return volatility (*RVOL*) is 43.897 for suppliers with customer-affiliated outside directors, whereas it is 46.575 for those without. This difference is statistically significant at the 1% confidence level. This result also holds when we use idiosyncratic stock return volatility (*IVOL*) as a measure of firm risk. Furthermore, we find that suppliers with outside directors from customers have greater market value of equity, higher market leverage ratio, higher market beta, and larger board size, as well as smaller cash ratio, lower presence of CEO duality, and shorter CEO tenure, compared with suppliers that do not have customer-affiliated outside directors on the board.

[INSERT TABLE 2 HERE]

3.2 Baseline results

3.2.1 Outside directors from major customers and firm risk

In this section, we run multivariate regressions to examine the effect of outside directors from customers on customer concentration risk after controlling for various firm-, board-, and CEO-level characteristics. Table 3 reports the results of multivariate regressions.

[INSERT TABLE 3 HERE]

We conjecture that customer-affiliated outside directors play a central role in reducing the firm risk arising from customer concentration. Thus, we first examine whether suppliers with concentrated customer base experience greater risks and then whether these suppliers' risk decreases by having customers' representatives on the board as outside directors. To test those predictions, we estimate equation (1) using the matched pairs of sample firms described in Section 2.5 and report the results in columns (1) and (2) of Table 3. First, we find that the presence of customer concentration is positively related to suppliers' risk. In column (1), the coefficient on *Customer Concentration* is 1.275, which suggests that a supplier with at least one major customer experiences higher *RVOL* as much as 1.275 points. In column (2), the coefficient on *Customer Concentration* also implies that concentrated customer base increases *IVOL* of suppliers by 1.503 points. However, our results show that this positive association between customer concentration and firm risk is weakened when suppliers have customer-affiliated outside directors on the board. In columns (1) and (2), the coefficients on *Customer Concentration* × *Outside Directors from Customers* are significantly negative, indicating that the presence of customer-affiliated outside directors is negatively related to the risk of suppliers with major customers. Interestingly, the sum of the coefficients on *Customer Concentration* and *Customer Concentration* × *Outside Directors from Customers* is quite small (0.134 and 0.242) in columns (1) and (2). These findings imply that suppliers who depend on concentrated customer base can substantially remove the risks inducing from customer concentration by having customers' representatives on the board as outside directors.

Furthermore, we estimate equation (2) to compare firm risks directly between customer-dependent suppliers with and without customer-affiliated outside directors. Columns (3) and (4) of Table 3 present the results

from regressions of firm risk on outside directors from customers. In both columns, the coefficients on *Outside Directors from Customers* are significantly negative, which means that customer-dependent suppliers with customer-affiliated outside directors have lower firm risk than those without. In the perspective of economic significance, the coefficient on *Outside Directors from Customers* in column (3) indicates that suppliers with at least one outside director from customers have lower *RVOL* by 1.213 points, compared with those without. Given that the mean *RVOL* is 46.303 (in Table 1), the 1.213-point decrease corresponds to a 2.6% (=1.213/46.303) decrease in *RVOL* relative to the sample mean. Moreover, the coefficient on *Outside Directors from Customers* in column (4) suggests that suppliers with outside directors from major customers have lower *IVOL* as much as 1.373 points, amounting to a 3.3% (=1.373/41.341) decrease relative to the mean *IVOL* of 41.341.[15] Overall, the results of Table 3 suggest that the appointment of customers' representative as outside directors enables suppliers to reduce their firm risk arising from customer concentration.

3.2.2 Outside directors from major customers and a supplier's financial policies

In this section, we investigate how the presence of outside directors from customers affects suppliers' financial policies. Existing studies argue that suppliers with concentrated customers adopt conservative financial policies as precautions against the additional firm risk arising from customer concentration (e.g., Banerjee *et al.*, 2008; Itzkowitz, 2013; Bae and Wang, 2015). However, if customer-affiliated outside directors help mitigate customer concentration risk, managers of suppliers with these directors will run their firms less conservatively, compared with those customer-concentrated suppliers without customer-affiliated outside directors. Therefore, we expect that the presence of outside directors from customers is related to less conservative financial policies. Following the corporate finance literature, we employ leverage ratio, net working capital (the measure of asset liquidity), and cash reserves as the proxy of conservatism in corporate financial decisions. We then examine whether the presence of outside directors from customers is positively (*negatively*) associated with suppliers'

[15] To separately analyze outside directors who are currently working for major customers and those who previously worked for major customers, we construct *Outside Directors from Customers_Current* (*Outside Directors from Customers_Previous*) that is equal to 1 if a supplier has at least one outside director who is currently working (*previously worked*) for major customers as executives or outside directors, and 0 otherwise. Then, we re-estimate equation (2) including *Outside Directors from Customers_Current* and *Outside Directors from Customers_Previous*, instead of *Outside Directors from Customers*. In untabulated results, the coefficients on *Outside Directors from Customers_Current* and *Outside Directors from Customers_Previous* are significantly negative with respect to *RVOL*, and interestingly, the magnitudes of those coefficients, -1.44 and -1.40, are similar. The benefits of having outside directors from customers on the board, which strengthens the relationship with customers and reduces information asymmetry, may decrease when those directors leave customers. Based on this reasoning, the coefficient on *Outside Directors from Customers_Current* is likely to be larger than that on *Outside Directors from Customers_Previous*. However, suppliers can face greater risk of revealing valuable information to their customers by employing outside directors who are currently working for major customers than those who previously worked for major customers. Overall, suppliers benefit more from having customer-affiliated outside directors who currently work for customers, but those can experience a greater detrimental impact arising from possible conflicts of interest, indicating that the benefits are offset by substantial costs. Thus, this discussion on the benefits and costs suggests that the value of coefficient on *Outside Directors from Customers_Current* is likely to be similar to that on *Outside Directors from Customers_Previous*, making our observed coefficients (i.e., -1.44 and -1.40) reasonable.

leverage ratio (*net working capital and cash reserves*).

Table 4 reports the regression results on the relationship between the presence of outside directors from customers and suppliers' financial policies. In the regressions, we include the same set of control variables used in Table 3 except for market leverage and cash ratio because these two variables are used as dependent variables in the regressions. In columns (1)-(4), we use book leverage (*Book Lev.*), market leverage (*Mkt. Lev.*), net working capital (*Net Working Capital*), and cash ratio (*Cash*) as dependent variables, respectively. Definitions for these variables are provided in the Appendix. The coefficients on *Outside Directors from Customers* in columns (1) and (2) are significantly positive, whereas those on columns (3) and (4) are significantly negative, indicating that suppliers with outside directors from customers have higher leverage ratio and less net working capital and cash reserves than those without. Overall, the findings imply that suppliers with customer-affiliated outside directors tend to adopt less conservative financial policies because the presence of these outside directors enables suppliers to reduce customer concentration risk.

[INSERT TABLE 4 HERE]

3.3 Possible channels

As possible channels through which outside directors from customers mitigate suppliers' customer concentration risk, we have argued that customer-affiliated outside directors can strengthen the supplier–customer relationship and reduce their information asymmetry. In this subsection, we test these mechanisms.

We first analyze suppliers' transaction data to compare a difference in supplier–customer relationship between suppliers with and without outside directors from customers. The appointment of customers' representatives on the board can enhance trust, coordination, cooperation, and further informal contracts between supply chain partners, resulting in a substantial rise in their transaction volume and periods. Thus, we predict that suppliers with outside directors from customers have larger transaction volume and longer transaction periods with their customers.

To test this prediction, we transform our supplier-level data to supplier–customer paired data because we now focus on the effect of customer-affiliated outside directors on the supplier–customer relationship. We construct three variables for transaction volume: *Sales_Rel.*, *Sales_Rel./Sales_Sup.*, and *Sales_Rel./Cogs_Cus*. *Sales_Rel.* is defined as a supplier's sales to each major customer. *Sales_Rel./Sales_Sup.* (*Sales_Rel./Cogs_Cus.*) is measured as a supplier's sales to each major customer divided by the supplier's total sales (*the customer's total purchases*). We then regress these variables on outside directors from customers to examine the effect of customer-affiliated outside directors on transaction volume. Next, we focus on how the presence of customer-affiliated outside directors influences transaction period between suppliers and customers. We construct *Transaction Termination* that is an indicator variable equal to 1 if the transaction between suppliers and their major customers is terminated, and 0 otherwise. Then, we regress *Transaction Termination* on outside directors from customers. In the regressions, we control for the characteristics of suppliers and customers, which are denoted as *Controls_Sup.* and *Controls_Cus.*, respectively.

Table 5 presents the results of the association between the presence of customer-affiliated outside directors and a supplier–customer relationship. In columns (1)–(3), *Sales_Rel.*, *Sales_Rel./Sales_Sup*, and *Sales_Rel./Cogs_Cus.* are used as dependent variables. All coefficients on *Outside Directors from Customers* are significantly positive concerning all measures of transaction volume. The positive coefficients suggest that transaction volume between suppliers and their customers increases when suppliers sit customer-affiliated outside directors on the board. Columns (4) and (5) report the results of logit and Cox regressions to investigate how the presence of customer-affiliated outside directors relates to transaction period between suppliers and customers. In both columns, the coefficients on *Outside Directors from Customers* are significantly negative, indicating that the transaction is less likely to be terminated when at least one customer-affiliated outside director sits on the board of suppliers. Collectively, the results show that outside directors from customers play important roles in strengthening supplier–customer relationships, thereby confirming a possible mechanism behind our argument.

[INSERT TABLE 5 HERE]

So far, we have argued that by having customer-affiliated outside directors on the board, suppliers can obtain greater information on customers and alleviate potential uncertainties, such as the possibilities that customers may change their partners or decide to produce goods directly. We test this claim by investigating whether suppliers with customer-affiliated outside directors can better anticipate and manage shocks from customers that might disrupt supplier–customer relationships than other suppliers do. According to Intintoli *et al.* (2017), the replacement of a customer's CEO largely influences its relationships with dependent suppliers because this replacement often prompts strategic and operational changes within the customer. Therefore, we use customers' CEO turnovers as disruptive events that result in suppliers' significant losses, expecting that these losses are smaller when suppliers have customer-affiliated outside directors on the board.

To test this prediction, we perform a difference-in-differences analysis using supplier–customer paired sample as follows:

$$Suppliers'\ Sales\ to\ Each\ Customter_{i,t} = \alpha + \beta_6 After_{Turnover_{i,t}} + \beta_7 After_{Turnover_{i,t}} \times Treatment_{i,t} + Controls_{i,t-1} + \varepsilon_{i,t}, \quad (3)$$

where *i* and *t* indicate a supplier and a given year, respectively. *Sales_Rel.*, *Sales_Rel./Sales_Sup*,. or *Sales_Rel./Cogs_Cus.* is used to measure a supplier's sales to each customer. *After_Turnover* is an indicator variable equal to 1 if the given year is the year after the replacement of a major customer's CEO, and 0 otherwise. *Treatment* is an indicator variable that identifies whether the supplier has employed outside directors from customers. Control variables are identical to those in Table 5. All difference-in-differences specifications contain supplier and customer fixed effects.[16]

Panel A of Table 6 presents the results of the difference-in-differences estimation. Using a supplier's sales to each customer (*Sales_Rel.*) as a dependent variable, we estimate equation (3) for the 3-year event window [−1, 1] in column (1). The coefficient on *After_Turnover* is significantly negative, which indicates that suppliers

[16] We identify 1,392 events that a customer replaces its CEO in our sample. Among suppliers involved in these events, 85 (6.1%) suppliers have outside directors from customers on their boards.

experience significant losses in sales to customers when the customers replace their CEOs. However, the coefficient on *After_Turnover* × *Treatment* is positive, with statistical significance. Collectively, these results suggest that the losses of suppliers' sales following customers' CEO turnovers substantially reduce when they have customer-affiliated outside directors on the board. The findings are qualitatively similar when we use *Sales_Rel./Sales_Sup.* and *Sales_Rel./Cogs_Cus.* as the measure of a suppliers' sales to each customer in columns (2) and (3). Subsequently, columns (4)–(6) show the results that re-estimate equation (3) for the 5-year event window [−2, 2]. All results in columns (4)–(6) are consistent with the findings in columns (1)–(3), as expected.

[INSERT TABLE 6 HERE]

Furthermore, we examine the differential sales response of suppliers to negative shocks from customers by focusing on the suppliers whose transactions with customers are terminated after the shocks. Suppliers with customer-affiliated outside directors obtain greater information on customers that includes negative shocks from customers; hence, these suppliers can be better prepared for the possibility of losing business with customers and rapidly find alternative ones after the existing supplier–customer relationship ends. Thus, we predict that suppliers with customer-affiliated outside directors are less likely to experience sales losses even though their transactions with customers are terminated after customers' CEO turnovers.

Panel B of Table 6 presents the results of re-estimating equation (3) with the sample where the supplier–customer relationship ends after a customer replaces its CEO. In this setting, we use a supplier's total sales (*Sales_Sup*) as a dependent variable because a supplier's sales to each customer are zero. In all event windows, the coefficients on *After_Turnover* are significantly negative, whereas those on *After_Turnover*×*Treatment* are significantly positive. These results suggest that the losses of suppliers' sales arising from the termination of transactions following customers' CEO turnovers greatly decrease when suppliers have customer-affiliated outside directors on the board. Overall, the results of Table 6 support our argument that suppliers with customer-affiliated outside directors can better anticipate and handle negative shocks from customers than do suppliers without these directors.

3.4 Endogeneity issue

Our main findings have shown a negative relationship between the presence of outside directors from major customers and customer concentration risk. However, our results might be subject to some types of endogeneity problems such as omitted variable bias and reverse causality. Although we control for various firm-, board-, and CEO-level characteristics identified in the extant literature, omitted variables may still affect both the presence of outside directors from customers and customer concentration risk. Further, while we argue the causality from the presence of customer-affiliated outside directors to suppliers' risk, our findings could be attributable to the possibility that suppliers with low risks prefer to appoint customers' representatives as outside directors. From these possibilities, our ordinary least squares (OLS) estimations could be biased and inconsistent. We thus perform additional tests to mitigate endogeneity concern.

3.4.1 Event study

To address the endogeneity issue, we conduct an event study using exogenous shocks to board composition. Existing studies (e.g., Fracass and Tate, 2012; Lee, Lee, and Nagarajan, 2014) document that directors' retirements are regarded as the exogenous changes in board composition which do not arise from the conditions inside the firm. In particular, given that a firm's mandatory retirement age is generally predetermined regardless of current firm risk, the event study using the retirements of outside directors are less subject to endogeneity issues. Then, we examine how suppliers' customer concentration risk varies around this event.

We first define director departures as retirements if directors are over 65 years old.[17] On the basis of this criterion, we identify 616 retirements of outside directors in our sample. Then, we set the retirements of outside directors from customers and those of the other outside directors as "treatment" events and "control" events, respectively. In our retirement sample, 43 (*573*) retirements are classified as treatment (*control*) events. Using difference-in-differences estimation, we compute the differences in the changes in firm risk around these two types of events (i.e., treatment and control events). We expect that the firm risk of suppliers will significantly increase after the retirements of customer-affiliated outside directors compared with that of the other directors because these customer-affiliated outside directors play central roles in alleviating firm risks arising from customer concentration over their tenure.

Figure 1 shows the mean firm risk of suppliers for the 7-year window around the retirements of their outside directors, where year 0 is the fiscal year when the retirements of outside directors occur. We include two lines together in Figure 1 to compare the impacts of retirements of customer-affiliated outside directors (blue line) and the other outside directors (red line). As the measure of customer concentration risk, *RVOL* and *IVOL* are used in Panels A and B, respectively.

[INSERT FIGURE 1 HERE]

In Panels A and B, the graphs (blue lines) for outside directors from customers show that the suppliers' firm risk significantly increases after the event. The average changes in *RVOL* and *IVOL* from year −1 to year +3 are 12.089 and 10.533, respectively, which are significant at the 1% level.[18] In the graphs for outside director from customers, we also observe a slight decrease in firm risk before the event (year −3 to year −1). This finding indicates that overall increases in firm risk over the periods between year −3 and +3 result from treatment events, not a long-term trend.

By comparing the graphs between customer-affiliated and other outside directors, we find that suppliers with customer-affiliated outside directors experience consistently lower firm risk over years before the event, compared with those that do not have customers' representatives on the board. All differences in the mean firm risk between suppliers with outside directors from customers and the other suppliers are significant at the 1% level in every year before the event. However, these differences in customer concentration risk consistently

[17] Our results from event study remain unchanged even when our definition of retirement age is changed to 60 or 70 years.

[18] The test results for statistical significance are omitted for brevity.

decrease after the event. The largest reduction in these differences occurs in year 0, and the statistical significance for the differences in risks between two groups disappears in year 3. Moreover, the differences in customer concentration risk between two groups are constant over the periods before the event (year −3 to year −1), showing that the setting of our event study meets the parallel trend assumption of difference-in-differences estimation.

Next, we analyze the patterns found in Figure 1 by using the difference-in-differences framework. Following prior literature (e.g., Fracass and Tate, 2012; Huang and Kisgen, 2013), we set the difference-in-differences estimation model as follows:

$$Firm\ \ Risk_{i,t} = \alpha + \beta_4 After\_Retirement_{i,t} + \beta_5 After\_Retirement_{i,t} \times Treatment_{i,t} + Controls_{i,t-1} + \varepsilon_{i,t}, \quad (4)$$

where *i* and *t* indicate a supplier and a given year, respectively. *After_Retirement* is an indicator variable that identifies whether the given year is the year after the retirement of the outside directors. *Treatment* is an indicator variable that identifies whether the supplier has employed outside directors from customers. Dependent and control variables are identical to those in equations. (1) and (2). All difference-in-differences specifications contain firm fixed effects.

Table 7 presents the results of the difference-in-differences estimation. Using realized stock return volatility as the risk measure, we estimate equation (4) for the 3-year event window ([−1, 1]) in column (1). The coefficient on *After_Retirement* is negative but insignificant. By contrast, the coefficient on *After_Retirement*×*Treatment* is significantly positive. These results suggest that suppliers' firm risk increases when their outside directors from customers retire, whereas the retirements of the other outside directors are not related to the risk. Specifically, the difference in differences is 5.810, indicating that *RVOL* increases by 5.810 points on average in suppliers that experience the retirements of customer-affiliated outside directors. Using idiosyncratic stock return volatility as the risk measure, we re-run the difference-in-differences estimation in column (2). The result is consistent with the finding in column (1). Furthermore, we re-estimate equation (4) for the 5-year event window ([−2, 2]) and present the results in columns (3) and (4). The results of columns (3) and (4) are qualitatively similar to the findings based on event windows [−1, 1] in columns (1) and (2). Finally, our results in columns (1)–(4) remain unchanged even when the definition of retirement age is changed to 70 years old in columns (5)–(8). In short, the results of the difference-in-differences regressions confirm our main findings, implying that the endogeneity is not likely to make our findings biased.

[INSERT TABLE 7 HERE]

3.4.2 Two-stage least squares regressions

We run 2SLS regressions with instrumental variables to further address endogeneity concerns. In the 2SLS analyses, instrumental variables should satisfy two conditions: (1) instruments are related to the presence of customer-affiliated outside directors (a relevance condition) and (2) instruments are associated with customer concentration risk only through their relationship with the presence of customer-affiliated outside directors (an exclusion condition).

Prior literature on board composition and the role of directors' expertise (e.g., Knyazeva, Knyazeva, and Masulis, 2013; Wang, Xie, and Zhu, 2015; Kang, Kim, and Lu, 2018) points out that the potential supply and demand of labor determine the employment of the director. In line with the literature, Knyazeva *et al.* (2013) use the number of potential candidates with industry-specific expertise as an exogenous variable to examine the effect of directors from related industries. In a similar vein, as the instrument, we select the number of customers' directors (*No. of Customers' Directors*), which is defined as the number of customers' executives and outside directors who currently work or formerly worked for major customers, scaled by the supplier's board size. A greater number of customers' directors indicates the high supply of customer-affiliated director candidates, thereby increasing the possibility that the supplier employs customer-related candidates as its outside directors. In addition, the standardization of the number of customers' directors by the supplier's board size implicitly controls for firm size because a greater supplier tends to have a larger board. Consequently, the number of customers' directors scaled by the supplier's board size is likely to meet a relevance condition. Meanwhile, the number of customers' directors is not directly related to a supplier's firm risk. Thus, the number of customers' directors appears to plausibly capture an exogenous variation in the presence of outside directors from customers.

The results of 2SLS regressions are presented in Table 8. Column (1) of Table 8 presents the first-stage result obtained from the regression of customer-affiliated outside directors on our instrument and controls. As we expected, the coefficient on *No. of Customers' Directors* is positive, with statistical significance at the 1% level. The second-stage regression results in columns (2) and (3) show that the presence of outside directors from customers is negatively related to firm risk. These findings suggest that suppliers with outside directors from customers face a lower customer centration risk compared with those without. We perform two tests to confirm the validity of our 2SLS estimations, as common in previous literature. First, the *F*-statistic for the weak instrument test is sizable, exceeding the generally accepted value of 10. Second, the Wu-Hausman tests reject the null hypothesis that customer-affiliated outside directors are exogenous to customer concentration risk. Taken together, the results from 2SLS regressions are consistent with those from OLS regressions, suggesting that our findings are not likely to be driven by endogeneity issues.

[INSERT TABLE 8 HERE]

3.5 Additional robustness tests

3.5.1 Outside directors from major customers and firm risk under different business circumstances

In this section, we turn our attention to potential circumstances where the presence of outside directors from customers is more important in mitigating suppliers' customer concentration risk. According to Schumacher (1991), Inderst and Wey (2007), and Dhaliwal *et al.* (2016), suppliers that have low market shares or operate in competitive industries face higher customer concentration risk because they have more competitors and are easily replaced. Therefore, the role of customer-affiliated outside directors in reducing suppliers' customer concentration risk appears to be more important in suppliers with low market shares or in competitive industries.

For the analyses related to market shares, we split the sample into two subsamples according to whether or not a supplier' market shares are lower than the median of the full sample. Market shares are defined as a supplier's sales divided by total sales of industry (based on two-digit SIC codes) that the supplier operates. Then, we re-estimate equation (2) in each subsample (suppliers with low vs. high market shares) and compare the results between two subsamples. Columns (1)–(4) of Table 9 report the regression results of the subsample analysis based on market shares. The coefficients on *Outside Directors from Customers* are significantly negative for suppliers with low market shares whereas not significant for those with high market shares.

[INSERT TABLE 9 HERE]

Furthermore, we conduct subsample analyses based on the extent of market competition. *Market Competition* is first measured as the Herfindahl index, calculated as the sum of the squared market shares of each firm in total industry sales based on two-digit SIC codes. Then, we define competitive industries as the industries in which the Herfindahl index is lower than the median Herfindahl index of the total sample. In columns (5)–(8) of Table 9, the coefficients on *Outside Directors from Customers* are significant only for suppliers that operate in competitive industries. Taken together, the findings of Table 9 suggest that the presence of customer-affiliated outside directors is much more important in suppliers that belong to markets with greater customer concentration risk.

3.5.2 Various types of customer-affiliated directors

In this subsection, we examine how the effects of customer-affiliated directors on suppliers' customer concentration risk vary depending on which types of directors are appointed in suppliers and what roles the directors play in customers. According to Dass *et al.* (2014) and Minnick and Raman (2017), customer-affiliated directors can influence a supplier's management to act in a way that benefits a customer rather than the supplier's shareholders. Our preceding discussions suggest that inside directors are more accessible to suppliers' information with lower information acquisition costs than outside directors, resulting in a higher possibility of suppliers' proprietary information disclosure to customers. Thus, if customers' representatives sit on the suppliers' board as inside directors, the suppliers are more likely to face a potential risk arising from conflicts of interest. Accordingly, we conjecture that the relation between the presence of inside directors from customers and firm risk is insignificant or weak because these inside directors can induce more conflicts of interest, although they help suppliers strengthen the relationship with customers.

To test our prediction, we re-run the regressions of equation (2) with *Inside Directors from Customers* instead of *Outside Directors from Customers*. The regression results are reported in columns (1) and (2) of Panel A in Table 10. The coefficients on *Inside Directors from Customers* are insignificant as expected. Subsequently, we also examine the effect of all customer-affiliated directors (including both outside and inside directors) on customer concentration risk by regressing suppliers' firm risk on *All Directors from Customers*. In columns (3) and (4), the coefficients on *All Directors from Customers* are not statistically significant. These results indicate that suppliers' customer concentration risk does not vary with the presence of inside directors from customers. By

contrast, the coefficients on *Outside Directors from Customers* are negatively significant in columns (5) and (6) (these coefficients are identical to the coefficients in columns (3) and (4) of Table 3). Overall, the findings of Panel A suggest that suppliers' risk arising from their highly concentrated customer base is alleviated only when they appoint customers' representatives as outside directors.

[INSERT TABLE 10 HERE]

Suppliers that appoint customers' representatives as outside directors can reduce customer concentration risks by gaining access to information on customers' future strategies and prospects. Moreover, this benefit will be larger when customer-affiliated directors have more information on customers. Because insiders are less limited in acquiring firms' detailed information than outsiders (e.g., Adams and Ferreira, 2007; Harris and Raviv, 2008; Kumar and Sivaramakrishnan, 2008; Fahlenbrach *et al.*, 2017), we expect that suppliers' outside directors who are current or former executives in customers would reduce customer concentration risks more, compared to those who are outside directors in customers.

To test our expectation, we re-estimate the regressions of equation (2) using *Outside Directors Being Executives in Customers* and *Outside Directors Being Outside Directors in Customers* instead of *Outside Directors from Customers*. *Outside Directors Being Executives in Customers* (*Outside Directors Being Outside Directors in Customers*) is defined as an indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for major customers as executives (outside directors), and 0 otherwise.[19] In Panel B in Table 10, the coefficients on *Outside Directors Being Executives in Customers* are significantly negative, while those on *Outside Directors Being Outside Directors in Customers* are not significant, regardless of whether *RVOL* or *IVOL* are used in regressions. These results indicate that the effect of customer-affiliated directors on suppliers' risk is larger when the directors are current or former executives compared to outside directors.

3.5.3 Outside directors from major customers versus those from customer industries

Dass *et al.* (2014) argue that directors who currently work in upstream or downstream industries positively influence the value of their firms because they provide specific information on upstream or downstream industries. In a line of this argument, outside directors from customer industries may affect firm risk that suppliers face. Thus, our observed relation between the presence of customer-affiliated outside directors and suppliers' firm risk might be driven by inclusion of outside directors from customer industries. To test this possibility, we identify outside directors who have worked for firms in the same two-digit standard industrial classification (SIC) industries as customers and compare the risk-mitigation impact of outside directors from customer industries to that of customer-affiliated outside directors.

Columns (1) and (2) of Table 11 present the regression results to examine the pure effect of customer-affiliated outside directors on suppliers' customer concentration risk. For this analysis, we exclude suppliers that

[19] Among 662 outside directors from customers, 526 directors are currently working or previously worked for customers as executives and 136 directors are current or former outside directors in customers.

have at least one outside director from customer industries and then regress firm risk on *Outside Directors from Customers*. The coefficients on *Outside Directors from Customers* are significantly negative across risk measures, showing that the observed negative relation between customer-affiliated outside directors and firm risk holds even when we rule out the possible impact of outside directors from customer industries. Next, columns (3) and (4) report the regression results that investigate the association between outside directors from customer industries and firm risk. For this analysis, we first define *Outside Directors from Customer Industries* as an indicator variable that is equal to 1 if suppliers have at least one outside director from customer industries, and 0 otherwise. Then we regress firm risk on *Outside Directors from Customer Industries* using the sample that excludes suppliers with customer-affiliated outside directors. In columns (3) and (4), the coefficients on *Outside Directors from Customer Industries* are not significant. These results show that the presence of outside directors from customer industries is not related to firm risk of customer-concentrated suppliers. In columns (5) and (6), we further present the results from the regressions of firm risk on *Outside Directors from Customers* and *Outside Directors from Customer Industries*. The coefficients on *Outside Directors from Customers* in columns (5) and (6) are significantly negative, suggesting that having customer-affiliated outside directors on the board is negatively associated with the customer concentration risk of suppliers even after controlling for the outside directors including those from customer industries on the board. Overall, our main findings remain unchanged even when we separate the outside directors from customer industries from our sample.

[INSERT TABLE 11 HERE]

3.5.4 Alternative measures of firm risk and outside directors from major customers

Using alternative measures of our main variables, we re-examine the association between outside directors from major customers and suppliers' customer concentration risk to obtain robustness on our results. Following Kini and Williams (2012), Pan *et al.* (2015), and Bernile *et al.* (2018), we construct the following three additional measures for firm risk: (1) *CF Vol.* is the cash flow volatility that is calculated as the standard deviation of quarterly cash flows over total assets for the 5-year window (year t to year $t + 4$). In this measure, cash flows are defined as earnings before interest, taxes, depreciation, and amortization. (2) *RVOL_Month* is the standard deviation of monthly stock returns over the fiscal year multiplied by the square root of 21. (3) *IVOL_3Factor* is the square root of 252 multiplied by the standard deviation of the residuals from the Fama-French three-factor model using daily stock return. This variable is estimated over the fiscal year. Columns (1)–(3) of Table 12 present the results from the regressions of these firm risk measures on *Outside Directors from Customers*. All coefficients on *Outside Directors from Customers* are significantly negative, confirming our main findings.

[INSERT TABLE 12 HERE]

Furthermore, as additional variables for customer-affiliated outside directors, we employ three other variables: (1) *Ratio of Outside Directors from Customers* is the ratio of the number of a supplier's outside directors from major customers to the number of the supplier's total outside directors. (2) *Outside Directors from Customers_15%* is an indicator variable equal to 1 if a supplier has at least one outside director who is currently

working or previously worked for customers that account for 15% or more of the supplier's total sales, and 0 otherwise. (3) *Outside Directors from Customers_20%* is an indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for customers that account for 20% or more of the supplier's total sales, and 0 otherwise. Columns (4) to (6) show the regression results based on these alternative variables. The coefficients on *Ratio of Outside Directors from Customers* are significantly negative, indicating that suppliers' firm risk tends to decrease as the number of customer-affiliated outside directors sitting on the board increases. Moreover, the coefficients on *Outside Directors from Customers_15%* and *Outside Directors from Customers_20%* are significantly negative, which suggests that our main findings still hold when we use alternate definitions for major customers. Collectively, the findings of Table 12 are consistent with our main findings.

4. Conclusion

In response to a gradually growing customer concentration in business, the accounting and finance literature devotes significant attention to analyzing customer concentration's influence on corporate financial policies and decisions. Especially, the literature highlights the negative implications of customer concentration on supplier risk. However, little is known about how suppliers who depend on a few large customers alleviate the risk arising from their highly concentrated customer base. This paper focuses on the role of board composition at customer-concentrated suppliers in reducing risk. Specifically, we explore whether appointing major customers' representatives as outside directors of suppliers mitigates the customer concentration risk.

Our results show that a positive association between customer concentration and suppliers' risk is significantly reduced when suppliers have customer-affiliated outside directors on the board. This finding remains unchanged even after addressing endogeneity concerns. Furthermore, we focus on the relationship between customer-affiliated outside directors and suppliers' financial policies, and find that the presence of customer-affiliated outside directors is related to less conservative financial policies that are measured by leverage, working capital, and cash reserves. We also show that the existence of these outside directors is positively associated with transaction volume and periods between suppliers and customers, implying that suppliers are likely to strengthen the relationship with customers by appointing customers' representatives as outside directors. Finally, we find that suppliers with customer-affiliated outside directors can better predict and treat negative shocks from customers because these directors help suppliers obtain greater information on customers and thus reduce their information asymmetry.

Our paper contributes to several strands of accounting and finance literature. First, we directly investigate the ways to alleviate the customer concentration risk. We contribute to the literature on customer concentration by suggesting that customer-related boards of suppliers play a central role in reducing the customer concentration risk. Second, our findings enrich the literature on possible channels to mitigate the resource-dependent risk because we highlight the importance of strengthening the relationship with supply-chain partners. Finally, our study complements the existing literature on board composition and the role of directors' expertise by

shedding light on customer-specific expertise of directors.

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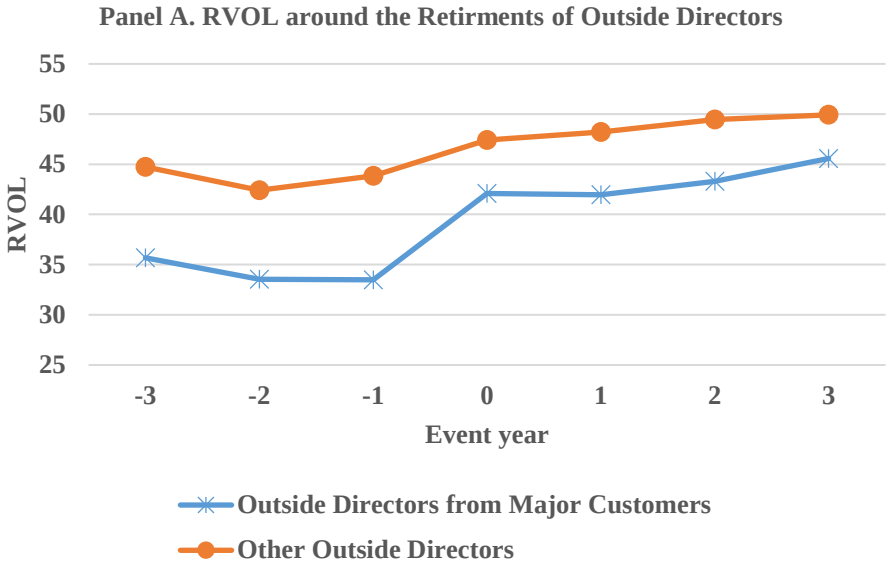
Appendix. Variable Definitions

Variable	Definition
Variables for customer-affiliated directors:	
Outside Directors from Customers	An indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for major customers as executives or outside directors, and 0 otherwise.
Inside Directors from Customers	An indicator variable equal to 1 if a supplier has at least one inside director who is currently working or previously worked for major customers as executives or outside directors, and 0 otherwise.
All Directors from Customers	An indicator variable equal to 1 if a supplier has at least one director who is currently working or previously worked for major customers as executives or outside directors, and 0 otherwise.
Outside Directors Being Executives in Customers	An indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for major customers as executives, and 0 otherwise.
Outside Directors Being Outside Directors in Customers	An indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for major customers as outside directors, and 0 otherwise.
No. of Outside Directors from Customers	The number of a supplier's outside directors who is currently working or previously worked for major customers as executives or outside directors.
Ratio of Outside Directors from Customers	The ratio of the number of a supplier's outside directors from major customers to the number of the supplier's total outside directors.
Outside Directors from Customers_15%	An indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for customers that account for 15% or more of the supplier's total sales, and 0 otherwise.
Outside Directors from Customers_20%	An indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for customers that account for 20% or more of the supplier's total sales, and 0 otherwise.
Firm risk variables:	
RVOL	Realized stock return volatility, calculated as the standard deviation of daily stock returns over the fiscal year multiplied by the square root of 252.
IVOL	Idiosyncratic stock return volatility, calculated as the standard deviation of daily excess stock returns over the fiscal year multiplied by the square root of 252. Excess stock returns are defined as the residuals from regressing daily stock returns on the value-weighted market returns that is estimated over the fiscal year. The value-weighted market returns are provided by CSRP.
CF Vol.	Cash flow volatility, calculated as the standard deviation of quarterly cash flows over total assets for the five-year window (year *t* to year *t+4*). Cash flows are defined as earnings before interest, taxes, depreciation, and amortization.
RVOL_Month	Realized monthly stock return volatility, calculated as the standard deviation of monthly stock returns over the fiscal year multiplied by the square root of 21.
IVOL_3Factor	Idiosyncratic stock return volatility from the Fama-French three-factor model, calculated as the square root of 252 multiplied by the standard deviation of the residuals from the

	Fama-French three-factor model using daily stock return (estimated over the fiscal year).
Firm-level characteristics:	
ME	The market value of equity.
M/B	Market-to-book ratio, calculated as the market value of equity divided by the book value of equity.
ROA	Return on assets, calculated as operating income before depreciation divided by total assets.
Mkt. Lev.	Market leverage, calculated as the sum of long-term debt and current liabilities divided by the market value of assets.
Book Lev.	Book leverage, calculated as the sum of long-term debt and current liabilities divided by total assets.
Cash	Cash ratio, which is calculated as the sum of cash and short-term equivalents divided by total assets.
Dividend Dum.	An indicator variable equal to 1 if a supplier pays dividend, and 0 otherwise.
R&D	Research and development (R&D) ratio, calculated as R&D expenses (set to 0 if missing) divided by total assets.
PPE	Property, plant, and equipment ratio, calculated as net property, plant, and equipment divided by total assets.
Net Working Capital	Working capital, calculated as current assets minus current liabilities minus cash reserves divided by total assets minus cash reserves.
Firm Age	Ages of a supplier based on the years that appear in Compustat.
Mkt. Beta	Market beta, calculated as the coefficient on market return from regressing daily stock returns on the value-weighted market returns that are estimated over the fiscal year and are provided by CRSP.
Momentum	Annual holding period return from daily stock returns.
Board- and CEO-level characteristics:	
Board Size	The number of directors on the board.
Duality	An indicator variable equal to 1 if a CEO is a board chairman, and 0 otherwise.
CEO Tenure	CEO tenure in a given year.
Customer concentration variable:	
Customer Concentration	An indicator variable that is equal to 1 if a supplier reports at least one corporate customer that accounts for more than 10% of its sales, and 0 otherwise.
Instrumental variables:	
No. of Customers' Directors	The number of customers' executives and outside directors who are currently working or previously worked for major customers, scaled by a supplier's board size.
Variables for event studies:	
After_Retirement	An indicator variable equal to 1 if the given year is the year after the retirement of the outside directors, and 0 otherwise.
After_Turnover	An indicator variable equal to 1 if the given year is the year after the replacement of a major customer's CEO, and 0 otherwise.
Treatment	An indicator variable equal to 1 if a supplier has hired an outside director from major customers, and 0 otherwise.
Variables for the supplier–customer relationship:	
Sales_Rel.	A supplier's sales to each major customer.

Sales_Sup.	A supplier's total sales.
Cogs_Cus.	A major customer's cost of goods sold.
Transaction Termination	An indicator variable equal to 1 if the transaction between a supplier and its major customers is terminated, and 0 otherwise.
Variables for outside directors from customer industries:	
Outside Directors from Customer Industries	An indicator variable equal to 1 if a supplier has at least one outside director from firms in the same two-digit SIC industry as major customers, and 0 otherwise.
Variables for business circumstances:	
Market Share	A supplier's sales divided by total sales of industry (based on the two-digit SIC level) that the supplier operates.
Market Competition	The Herfindahl index, calculated as the sum of the squared market shares of each firm in total industry sales based on two-digit SIC level.



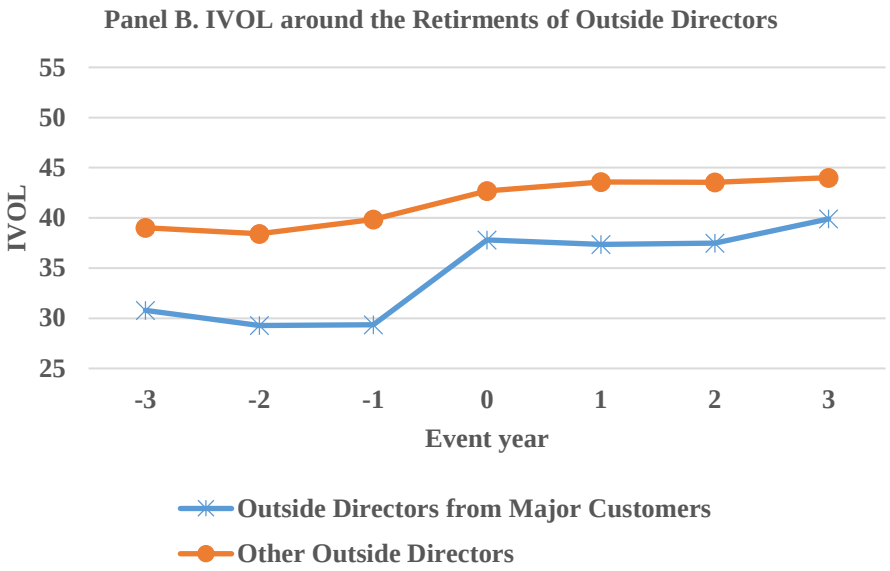


Figure 1. Firm Risk around the Retirements of Outside Directors

RVOL (IVOL) are measured as the standard deviations of daily stock returns (daily excess stock returns) over the fiscal year multiplied by the square root of 252. Outside directors from major customers are a supplier's outside directors who are currently working or previously worked for major customers as executives or outside directors. Year 0 is the fiscal year when the retirements of the outside directors in a supplier occur. The other outside directors are a supplier's outside directors that are not affiliated with customers (that is, outside directors except for outside directors from major customers.)

Table 1. Summary Statistics

This table presents summary statistics of variables used in our analysis. Panel A reports the number of observations, 25th percentile, mean, median, 75th percentile, and standard deviations for the measures of directors from major customers. Panels B, C, and D provide descriptive statistics of firm (supplier) risk measures and various firm-board-, and CEO-level characteristics of a supplier. The sample includes 6,530 supplier-year observations from 2001 to 2016. All continuous variables are winsorized at the 1% level. Detailed definitions of the variables are provided in the Appendix.

	Obs.	25%	Mean	Median	75%	Std.
Panel A : Directors from major customers						
Outside Directors from Customers	6,530	0.000	0.101	0.000	0.000	0.302
Inside Directors from Customers	6,530	0.000	0.015	0.000	0.000	0.184
All Directors from Customers	6,530	0.000	0.116	0.000	0.000	0.320
No. of Outside Directors from Customers	6,530	0.000	0.140	0.000	0.000	0.469
Panel B : Firm risk						
RVOL	6,530	32.242	46.303	43.381	57.769	18.565
IVOL	6,530	28.119	41.341	38.302	52.053	17.598
Panel C : Firm characteristics						
ME (in $ millions)	6,530	144.506	3,200.837	500.577	1,725.175	9,592.216
ln(*ME*)	6,530	4.973	6.254	6.216	7.453	1.911
M/B	6,530	1.308	2.970	2.122	3.653	4.094
ROA	6,530	0.032	0.067	0.107	0.163	0.188
Mkt. Lev.	6,530	0.000	0.127	0.078	0.210	0.145
Cash	6,530	0.045	0.247	0.168	0.398	0.240
Dividend Dum.	6,530	0.000	0.314	0.000	1.000	0.464
R&D	6,530	0.000	0.074	0.019	0.104	0.118
PPE	6,530	0.065	0.239	0.155	0.321	0.237
Firm Age (years)	6,530	9.000	20.524	16.000	27.000	14.959
ln(1+*Firm Age*)	6,530	2.303	2.837	2.833	3.332	0.691
Mkt. Beta	6,530	0.608	1.036	1.022	1.408	0.574
Momentum	6,530	-0.230	0.141	0.048	0.361	0.597
Panel D : Board and CEO characteristics						
Board Size	6,530	7.000	7.931	8.000	9.000	2.087
ln(*Board Size*)	6,530	1.946	2.036	2.079	2.197	0.263
Duality	6,530	0.000	0.475	0.000	1.000	0.499
CEO Tenure (years)	6,530	1.500	5.296	3.600	7.300	5.392
ln(1+*CEO Tenure*)	6,530	2.500	6.296	4.600	8.300	5.392

Table 2. Univariate Tests

This table reports the mean and median comparison tests of firm (supplier) risk measures and firm-, board-, and CEO-level characteristics of suppliers between two subsamples. The sample is split into two subsamples according to whether a supplier has at least one outside director from customers. t-tests and Willcoxon-Mann-Whitney tests are conducted for the comparison tests in the means and medians, respectively. Significance at the 10%, 5% and 1% is indicated by *, **, and ***, respectively.

	Suppliers with outside directors from customers (Obs. = 662)		Suppliers with no outside directors from customers (Obs. = 5,868)		Tests for difference	
	Mean	Median	Mean	Median	Mean	Median
RVOL	43.897	39.988	46.575	43.784	-2.677***	-3.796***
IVOL	38.402	35.054	41.672	38.777	-3.270***	-3.723***
ln(*ME*)	6.546	6.722	6.221	6.171	0.326***	0.551***
M/B	2.726	1.995	2.997	2.138	-0.271	-0.143**
ROA	0.066	0.106	0.067	0.107	-0.001	-0.001
Mkt. Lev.	0.145	0.105	0.125	0.076	0.020***	0.029***
Cash	0.225	0.124	0.250	0.173	-0.024**	-0.049***
Dividend Dum.	0.314	0.000	0.314	0.000	0.001	0.000
R&D	0.072	0.017	0.074	0.020	-0.002	-0.003
PPE	0.226	0.167	0.241	0.152	-0.015	0.015
ln(1+*Firm Age*)	2.863	2.833	2.834	2.833	0.029	0.000
Mkt. Beta	1.075	1.084	1.032	1.013	0.044*	0.071**
Momentum	0.140	0.059	0.141	0.047	-0.001	0.012
ln(*Board Size*)	2.103	2.079	2.029	2.079	0.074***	0.000***
Duality	0.411	0.000	0.483	0.000	-0.072***	0.000***
ln(1+*CEO Tenure*)	5.311	3.900	6.407	4.700	-1.096***	-0.800***

Table 3. Outside Directors from Major Customers and Firm Risk: OLS regressions

This table presents the results of OLS regressions to investigate the effects of outside directors from customers on firm risk. As dependent variables, two firm risk measures are used: (1) *RVOL* is the standard deviation of daily stock returns over the fiscal year multiplied by the square root of 252. (2) *IVOL* is the standard deviation of daily excess stock returns over the fiscal year multiplied by the square root of 252. *Customer Concentration* is an indicator variable equal to 1 if a supplier reports at least one corporate customer that accounts for more than 10% of its sales, and 0 otherwise. *Outside Directors from Customers* is an indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for major customers as executives or outside directors, and 0 otherwise. All other variable definitions are provided in the Appendix. All outside variables are lagged by 1 year. All regressions include year and industry fixed effects. Continuous variables are winsorized at the 1% level. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5% and 1% is indicated by *, ** and ***, respectively.

	(1)	(2)	(3)	(4)
	RVOL	*IVOL*	*RVOL*	*IVOL*
Customer Concentration	1.275***	1.503***		
	(4.74)	(5.52)		
Customer Concentration × *Outside Directors from Customers*	-1.132**	-1.261**		
	(-1.98)	(-2.26)		
Outside Directors from Customers			-1.213**	-1.373**
			(-2.11)	(-2.46)
ln(*ME*)	-4.411***	-4.973***	-4.265***	-4.820***
	(-41.31)	(-45.20)	(-26.33)	(-28.91)
M/B	0.165***	0.164***	0.177***	0.179***
	(6.48)	(6.44)	(4.05)	(4.12)
ROA	-18.802***	-18.519***	-20.077***	-19.721***
	(-20.75)	(-20.77)	(-14.06)	(-14.01)
Mkt. Lev.	5.388***	5.044***	6.647***	6.293***
	(5.00)	(4.70)	(4.23)	(3.97)
Cash	1.162	1.319*	-1.358	-1.668
	(1.50)	(1.72)	(-1.19)	(-1.48)
Dividend Dum.	-4.609***	-4.765***	-4.359***	-4.244***
	(-14.81)	(-15.16)	(-8.61)	(-8.20)
R&D	-0.021	1.407	4.569*	5.664**
	(-0.01)	(0.89)	(1.91)	(2.41)
PPE	3.489***	3.020***	3.844**	3.114*
	(3.52)	(2.94)	(2.23)	(1.77)
ln(1+*Firm Age*)	-1.842***	-2.073***	-2.203***	-2.383***
	(-8.72)	(-9.61)	(-6.75)	(-7.29)
Mkt. Beta	6.803***	3.315***	6.163***	2.693***
	(28.60)	(14.40)	(17.04)	(7.65)
Momentum	1.179***	0.810***	1.043***	0.618**
	(6.41)	(4.67)	(3.56)	(2.29)
ln(*Board Size*)	-0.656	-0.601	0.156	0.261
	(-1.09)	(-1.00)	(0.17)	(0.28)
Duality	0.092	0.026	-0.432	-0.532
	(0.38)	(0.11)	(-1.13)	(-1.40)
ln(1+*CEO Tenure*)	-0.071***	-0.066***	-0.051	-0.059
	(-3.26)	(-3.07)	(-1.41)	(-1.63)
Observations	17,578	17,578	6,525	6,525
Adjusted *R*-squared	0.668	0.678	0.662	0.667
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes

Table 4. Outside Directors from Major Customers and a Supplier's Financial Policies

This table presents the results of 2SLS regressions to examine the impacts of outside directors from customers on a supplier's financial policies. Book *Lev.* (*Mkt. Lev.*) is defined as long-term debt plus current liabilities divided by total assets (*the market value of assets*). *Net Working Capital* is current assets minus current liabilities minus cash reserves divided by total assets minus cash reserves. *Cash* is the sum of cash and short-term equivalents divided by total assets. *Outside Directors from Customers* is an indicator variable that equals to 1 if a supplier has at least one outside director who is currently working or previously worked for major customers as executives or outside directors, and 0 otherwise. All other variable definitions are provided in the Appendix. All outside variables are lagged by 1 year. All regressions include year and industry fixed effects. Continuous variables are winsorized at the 1% level. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5% and 1% is indicated by *, ** and ***, respectively.

	(1)	(2)	(3)	(4)
	Book Lev.	*Mkt. Lev.*	*Net Working Capital*	*Cash*
Outside Directors from Customers	0.016**	0.012**	-0.025**	-0.022**
	(2.03)	(2.30)	(-2.14)	(-2.04)
ln(ME)	0.014***	-0.003***	-0.025***	0.007**
	(8.07)	(-2.62)	(-9.07)	(2.26)
M/B	-0.001**	-0.002***	-0.000	0.003***
	(-2.40)	(-5.76)	(-0.27)	(3.61)
ROA	-0.181***	-0.092***	0.543***	-0.071**
	(-10.53)	(-7.65)	(21.22)	(-2.21)
Dividend Dum.	-0.007	-0.030***	-0.027***	-0.016*
	(-1.22)	(-6.97)	(-2.88)	(-1.76)
R&D	-0.228***	-0.270***	-0.949***	0.833***
	(-8.46)	(-13.72)	(-22.38)	(15.08)
PPE	0.249***	0.208***	-0.033	-0.286***
	(23.96)	(18.06)	(-1.25)	(-18.83)
ln(1+*Firm Age*)	-0.020***	-0.013***	0.042***	-0.030***
	(-5.40)	(-4.68)	(7.02)	(-4.52)
Mkt. Beta	-0.015***	0.004	0.021***	0.037***
	(-3.32)	(1.33)	(3.07)	(5.64)
Momentum	-0.008*	-0.016***	0.008	0.006
	(-1.69)	(-5.11)	(1.19)	(1.45)
ln(*Board Size*)	0.096***	0.082***	-0.023	-0.105***
	(8.74)	(10.52)	(-1.36)	(-5.02)
Duality	0.004	0.006*	0.019***	-0.022***
	(0.88)	(1.72)	(2.60)	(-2.94)
ln(1+*CEO Tenure*)	0.001*	0.000	0.002**	0.001
	(1.67)	(1.59)	(2.38)	(0.85)
Observations	6,525	6,525	6,525	6,525
Adjusted *R*-squared	0.265	0.310	0.442	0.480
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes

Table 5. Outside Directors from Major Customers and the Supplier-customer Relationship

This table presents the results of regressions to investigate the effects of outside directors from customers on the supplier-customer relationship. *Sales_Rel.* are a supplier's sales to each major customer. *Sales_Sup.* (*Cogs_Cus.*) is a supplier's total sales (*a major customer's cost of goods sold*). *Transaction Termination* is an indicator variable equal to 1 if the transaction between a supplier and its major customers is terminated, and 0 otherwise. *X_Sup.* (*X_Cus.*) are a set of firm-level characteristics of suppliers (*customers*) including *ME*, *M/B*, *ROA*, *Mkt. Lev*, *Cash*, *Dividend Dum*, *R&D*, *PPE*, and *Firm Age*. All other variable definitions are provided in the Appendix. All outside variables are lagged by 1 year. All regressions include year and industry fixed effects. Continuous variables are winsorized at the 1% level. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5% and 1% is indicated by *, ** and ***, respectively.

	OLS			Logit	Cox
	(1)	(2)	(3)	(4)	(5)
	ln(1+*Sales_Rel.)*	*Sales_Rel. / Sales_Sup.*	*Sales_Rel. / Cogs_Cus.*	*Transaction Termination*	*Transaction Termination*
Outside Directors from Customers	0.111*	0.029**	0.020***	-0.380***	-0.410***
	(1.71)	(2.37)	(3.00)	(-2.95)	(-2.91)
ln(*ME*)_*Sup.*	0.634***	-0.019***	0.009***	-0.081***	-0.061***
	(55.20)	(-9.64)	(9.16)	(-5.10)	(-3.87)
M/B_Sup.	-0.021***	0.001**	-0.000	0.010*	0.005
	(-7.29)	(2.45)	(-1.49)	(1.84)	(0.97)
ROA_Sup.	0.587***	-0.063***	0.000	-0.872***	-0.347***
	(6.75)	(-3.16)	(0.01)	(-5.75)	(-2.67)
Mkt. Lev._Sup.	1.997***	-0.039**	0.018**	0.117	-0.149
	(16.24)	(-2.16)	(2.07)	(0.61)	(-0.82)
Cash_Sup.	-1.385***	0.129***	-0.015**	0.359**	0.044
	(-15.74)	(7.30)	(-2.14)	(2.36)	(0.31)
Dividend Dum._Sup.	0.219***	0.005	0.003	-0.134*	-0.093
	(4.61)	(0.70)	(0.93)	(-1.66)	(-1.17)
R&D_Sup.	-0.385**	0.084**	-0.006	0.021	0.412*
	(-2.33)	(2.22)	(-0.49)	(0.08)	(1.76)
PPE_Sup.	-0.465***	0.036	-0.012	-0.018	0.005
	(-3.30)	(1.42)	(-1.09)	(-0.10)	(0.03)
ln(1+*Firm Age*)_*Sup.*	0.113***	-0.014***	0.003	-0.054	-0.101**
	(3.68)	(-2.93)	(1.44)	(-1.25)	(-2.43)
ln(*ME*)_*Cus.*	0.063***	0.006***	-0.023***	-0.066***	-0.057***
	(6.17)	(2.73)	(-11.78)	(-3.80)	(-3.42)
M/B_Cus.	-0.008**	0.001	0.002***	-0.001	-0.007
	(-1.97)	(1.30)	(4.32)	(-0.06)	(-0.86)
ROA_Cus.	0.516***	0.168***	-0.065**	-0.891**	0.171
	(2.64)	(3.50)	(-1.98)	(-2.34)	(0.46)
Mkt. Lev._Cus.	0.503***	0.042*	-0.032**	0.104	0.372*
	(3.54)	(1.82)	(-2.50)	(0.50)	(1.71)
Cash_Cus.	0.559***	0.020	0.125***	-0.213	-0.138
	(4.16)	(0.65)	(6.47)	(-0.82)	(-0.55)
Dividend Dum._Cus.	-0.072*	-0.011	0.007	0.087	-0.000
	(-1.92)	(-1.34)	(1.44)	(1.21)	(-0.00)
R&D_Cus.	-1.388***	0.231**	0.113**	2.700***	2.097***
	(-3.06)	(2.55)	(2.00)	(3.56)	(2.79)
PPE_Cus.	-0.002	0.007	0.042***	0.169	-0.228
	(-0.02)	(0.38)	(4.67)	(0.99)	(-1.45)
ln(1+*Firm Age*)_*Cus.*	-0.012	-0.012**	-0.005**	-0.010	0.042
	(-0.53)	(-2.44)	(-2.02)	(-0.25)	(1.03)
Observations	10,243	10,243	10,085	9,784	4,194
Adjusted *R*-squared	0.807	0.194	0.315	N/A	N/A
Pseudo *R*-squared	N/A	N/A	N/A	0.067	N/A
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes

Table 6. Outside Directors from Major Customers and CEO Turnovers of Customers

This table presents the results of difference-in-differences regressions to investigate the changes in suppliers' transactions with their major customers (Panel A) and those in their *total* sales (Panel B) around customers' CEO turnovers. *Sales_Rel.* are a supplier's sales to each major customer. *Sales_Sup.* (*Cogs_Cus.*) is a supplier's total sales (*a major customer's cost of goods sold*). *After_Turnover* is defined as an indicator variable equal to 1 if the given year is the year after the replacement of a major customer's CEO, and 0 otherwise. *Treatment* is an indicator variable equal to 1 if a supplier has hired an outside director from major customers, and 0 otherwise. *X_Sup.* (*X_Cus.*) is a set of firm-level characteristics of suppliers (*customers*) including *ME, M/B, ROA, Mkt. Lev, Cash, Dividend Dum, R&D, PPE,* and *Firm Age*. All other variable definitions are provided in the Appendix. All control variables are lagged by 1 year. All continuous variables are winsorized at the 1% level. In Panel A (*Panel B*), the regressions include supplier and customer fixed effects (*supplier fixed effects*). Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5% and 1% is indicated by *, ** and ***, respectively.

Panel A : Full sample

	[-1, 1]			[-2, 2]		
	(1) ln(1+*Sales_ Rel.)*	(2) *Sales_Rel. / Sales_Sup.*	(3) *Sales_Rel. / Cogs_Cus.*	(4) ln(1+*Sales_ Rel.)*	(5) *Sales_Rel. / Sales_Sup.*	(6) *Sales_Rel. / Cogs_Cus.*
After_Turnover	-0.383***	-0.024***	-0.001*	-0.625***	-0.036***	-0.001*
	(-9.75)	(-5.62)	(-1.92)	(-13.94)	(-8.76)	(-1.75)
After_Turnover × *Treatment*	0.447***	0.033**	0.004*	0.286*	0.027*	0.002*
	(3.82)	(2.22)	(1.77)	(1.93)	(1.89)	(1.73)
ln(*ME*)_*Sup.*	0.084*	-0.006	-0.000	0.118***	-0.005	0.001
	(1.77)	(-1.12)	(-0.03)	(2.59)	(-1.05)	(1.53)
M/B_Sup.	0.010*	0.001**	0.000	0.013***	0.001***	0.000
	(1.73)	(2.14)	(0.42)	(2.80)	(2.79)	(0.58)
ROA_Sup.	0.182	0.009	-0.000	0.168	0.012	-0.000
	(0.82)	(0.30)	(-0.07)	(1.03)	(0.53)	(-0.13)
Mkt. Lev._Sup.	-0.179	-0.048	-0.008*	0.197	-0.044	-0.005*
	(-0.48)	(-1.21)	(-1.87)	(0.58)	(-1.43)	(-1.70)
Cash_Sup.	-0.165	0.052	-0.001	-0.624**	0.003	-0.001
	(-0.51)	(1.49)	(-0.29)	(-2.55)	(0.12)	(-0.26)
Dividend Dum._Sup.	0.135	0.017	0.002	0.188	0.010	0.001
	(1.03)	(1.21)	(0.80)	(1.41)	(0.83)	(0.87)
R&D_Sup.	0.077	-0.034	-0.010	-0.023	-0.031	-0.006
	(0.13)	(-0.37)	(-1.15)	(-0.06)	(-0.49)	(-1.20)
PPE_Sup.	-0.742	0.047	-0.005	-0.689	0.047	-0.001
	(-1.37)	(0.60)	(-0.79)	(-1.48)	(0.77)	(-0.14)
ln(1+*Firm Age*)_*Sup.*	-0.150	-0.063**	0.003	-0.251	-0.071***	0.003
	(-0.67)	(-2.15)	(0.68)	(-1.23)	(-2.74)	(0.67)
ln(*ME*)_*Cus.*	0.478***	0.023***	-0.000	0.468***	0.024***	0.000
	(6.76)	(4.38)	(-0.40)	(7.45)	(5.25)	(0.52)
M/B_Cus.	-0.041**	-0.003**	0.000	-0.044***	-0.004***	-0.000
	(-2.47)	(-2.29)	(0.69)	(-3.19)	(-3.04)	(-0.04)
ROA_Cus.	2.554***	0.178**	0.026	1.481**	0.093	0.015
	(3.51)	(2.37)	(1.62)	(2.49)	(1.63)	(1.61)
Mkt. Lev._Cus.	2.125***	0.086*	0.006	1.918***	0.117***	0.008*
	(4.47)	(1.84)	(1.08)	(4.75)	(3.02)	(1.89)
Cash_Cus.	0.989	0.015	0.010	-0.658	-0.057	0.005
	(1.42)	(0.23)	(1.14)	(-1.14)	(-0.99)	(0.64)
Dividend Dum._Cus.	0.555***	0.031*	0.000	0.262**	0.018	-0.002
	(2.72)	(1.87)	(0.03)	(1.98)	(1.52)	(-0.66)
R&D_Cus.	0.385	0.145	-0.046	4.007*	0.206	-0.007
	(0.13)	(0.57)	(-1.15)	(1.76)	(1.04)	(-0.30)
PPE_Cus.	1.150	0.080	-0.008	-0.769	0.019	-0.014**
	(1.48)	(1.29)	(-1.29)	(-1.16)	(0.39)	(-2.10)
ln(1+*Firm Age*) _*Cus.*	-0.669	-0.055	-0.030***	-0.129	-0.045	-0.028***

	(-1.05)	(-0.78)	(-2.68)	(-0.21)	(-0.73)	(-2.69)
Observations	3,465	3,465	3,430	5,430	5,430	5,380
Adjusted *R*-squared	0.696	0.571	0.795	0.632	0.562	0.792
Supplier fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Customer fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Panel B : Sample where the supplier-customer relationship ends after customers' CEO turnover

	[-1, 1]	[-2, 2]
	(1)	(2)
	ln(*Sales_Sup.*)	ln(*Sales_Sup.*)
After_Turnover	-0.894***	-0.936***
	(-9.93)	(-10.59)
After_Turnover × *Treatment*	1.121**	0.824**
	(2.46)	(2.11)
Observations	1,466	2,237
Adjusted *R*-squared	0.324	0.514
Supplier control variables	Yes	Yes
Customer control variables	Yes	Yes
Supplier fixed effects	Yes	Yes
Customer fixed effects	Yes	Yes

Table 7. Outside Directors from Major Customers and Firm Risk: Event Studies

This table presents the results of difference-in-differences regressions to investigate the effects of outside directors from customers on firm risk. As dependent variables, two firm risk measures are used: (1) *RVOL* is the standard deviation of daily stock returns over the fiscal year multiplied by the square root of 252. (2) *IVOL* is the standard deviation of daily excess stock returns over the fiscal year multiplied by the square root of 252. *After_Retirement* is defined as an indicator variable equal to 1 if the given year is the year after the retirement of the outside directors, and 0 otherwise. *Treatment* is an indicator variable equal to 1 if a supplier has hired an outside director from major customers, and 0 otherwise. All other variable definitions are provided in the Appendix. All control variables are lagged by 1 year. All regressions include firm fixed effects. Continuous variables are winsorized at the 1% level. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5% and 1% is indicated by *, ** and ***, respectively.

	Retirement age = 65 years old				Retirement age = 70 years old			
	[-1, 1]		[-2, 2]		[-1, 1]		[-2, 2]	
	(1) *RVOL*	(2) *IVOL*	(3) *RVOL*	(4) *IVOL*	(5) *RVOL*	(6) *IVOL*	(7) *RVOL*	(8) *IVOL*
After_Retirement	-0.546	-0.286	-0.598	-0.299	-0.966	-0.445	-0.740	-0.293
	(-0.76)	(-0.44)	(-0.82)	(-0.46)	(-1.28)	(-0.68)	(-0.98)	(-0.44)
After_Retirement × *Treatment*	5.810***	5.474***	4.494**	4.554***	6.060***	5.671***	4.751**	4.625***
	(2.89)	(3.01)	(2.21)	(2.62)	(2.82)	(2.91)	(2.39)	(2.70)
ln(*ME*)	-3.281***	-4.277***	-3.991***	-5.054***	-2.495*	-3.713***	-3.668***	-4.908***
	(-3.24)	(-4.85)	(-4.67)	(-6.66)	(-1.83)	(-3.16)	(-3.23)	(-4.92)
M/B	0.074	0.008	0.080	0.018	-0.053	-0.107	-0.062	-0.103
	(0.85)	(0.10)	(0.97)	(0.23)	(-0.50)	(-1.08)	(-0.60)	(-1.10)
ROA	-10.597**	-11.178**	-9.845**	-9.818**	-12.051**	-11.463**	-9.832**	-8.649*
	(-2.18)	(-2.52)	(-2.35)	(-2.58)	(-2.06)	(-2.14)	(-1.98)	(-1.94)
Mkt. Lev.	14.543**	14.265**	12.088**	10.719**	15.306*	15.263**	10.653*	9.844*
	(2.10)	(2.33)	(2.28)	(2.22)	(1.78)	(1.97)	(1.78)	(1.80)
Cash	-1.759	-1.650	-2.640	-3.556	-3.033	-2.738	-2.085	-3.624
	(-0.50)	(-0.52)	(-0.81)	(-1.20)	(-0.69)	(-0.71)	(-0.50)	(-1.03)
Dividend Dum.	-1.255	-0.876	0.022	0.489	-1.754	-1.347	-0.045	-0.054
	(-0.70)	(-0.55)	(0.01)	(0.38)	(-0.83)	(-0.77)	(-0.03)	(-0.04)
R&D	-10.452	-11.472	-7.460	-7.595	-11.984	-10.996	0.130	1.363
	(-1.24)	(-1.46)	(-0.89)	(-0.95)	(-1.20)	(-1.17)	(0.02)	(0.17)
PPE	4.108	2.053	3.467	1.525	7.508	4.716	6.120	3.892
	(0.45)	(0.25)	(0.43)	(0.20)	(0.75)	(0.51)	(0.70)	(0.47)
ln(1+*Firm Age*)	-6.992	-6.342	-6.133*	-6.300*	-12.755*	-11.274*	-8.116*	-8.542**
	(-1.56)	(-1.59)	(-1.71)	(-1.96)	(-1.83)	(-1.94)	(-1.71)	(-2.00)
Mkt. Beta	4.355***	3.733***	5.139***	4.154***	3.885***	3.125***	4.722***	3.738***
	(4.42)	(4.69)	(5.93)	(5.69)	(3.81)	(3.69)	(4.96)	(4.68)
Momentum	2.632***	2.476***	2.504***	2.256***	2.631***	2.571***	2.585***	2.429***

	(3.49)	(3.70)	(4.45)	(4.45)	(2.76)	(2.99)	(3.67)	(3.83)
ln(*Board Size*)	1.095	1.934	-0.752	0.695	3.014	2.806	-0.959	0.685
	(0.42)	(0.85)	(-0.34)	(0.35)	(0.93)	(0.97)	(-0.38)	(0.30)
Duality	-0.545	0.268	0.077	0.622	-0.411	-0.167	-0.051	0.132
	(-0.39)	(0.22)	(0.07)	(0.66)	(-0.26)	(-0.12)	(-0.04)	(0.12)
ln(1+*CEO Tenure*)	0.152	0.156	0.122	0.136*	0.160	0.160	0.139	0.134
	(1.22)	(1.36)	(1.40)	(1.78)	(1.35)	(1.41)	(1.59)	(1.65)
Observations	1,455	1,455	1,994	1,994	1,167	1,167	1,617	1,617
Adjusted *R*-squared	0.777	0.809	0.747	0.784	0.776	0.809	0.756	0.792
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 8. Outside Directors from Major Customers and Firm Risk: 2SLS Regressions

This table presents the results of 2SLS regressions to examine the effects of outside directors from customers on firm risk. *No. of Customers' Directors* is an instrumental variable, which is defined as the number of customers' executives and outside directors who are currently working or previously worked for major customers scaled by a supplier's board size. *Outside Directors from Customers* is an indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for major customers as executives or outside directors, and 0 otherwise. *RVOL* (*IVOL*) is the standard deviation of daily stock returns (*daily excess stock returns*) over the fiscal year multiplied by the square root of 252. All other variable definitions are provided in the Appendix. All outside variables are lagged by 1 year. All regressions include year and industry fixed effects. Continuous variables are winsorized at the 1% level. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5% and 1% is indicated by *, ** and ***, respectively.

	1st stage	2nd stage	
	(1)	(2)	(3)
	Outside Directors from Customers	*RVOL*	*IVOL*
Outside Directors from Customers		-5.535**	-5.951***
		(-2.52)	(-2.77)
No. of Customers' Directors	0.002***		
	(6.21)		
ln(*ME*)	0.007	-4.288***	-4.839***
	(1.19)	(-25.76)	(-28.31)
M/B	-0.002	0.140***	0.140***
	(-1.64)	(3.11)	(3.16)
ROA	-0.071	-18.912***	-18.644***
	(-1.51)	(-11.73)	(-11.82)
Mkt. Lev.	0.024	6.889***	6.929***
	(0.36)	(3.95)	(3.92)
Cash	-0.014	-0.853	-1.176
	(-0.35)	(-0.70)	(-0.97)
Dividend Dum.	-0.038*	-4.827***	-4.746***
	(-1.81)	(-9.08)	(-8.77)
R&D	0.002	6.106**	7.199***
	(0.02)	(2.37)	(2.84)
PPE	0.082	5.049***	4.043**
	(1.40)	(2.66)	(2.09)
ln(1+*Firm Age*)	0.002	-1.877***	-2.037***
	(0.12)	(-5.43)	(-5.90)
Mkt. Beta	-0.004	6.102***	2.590***
	(-0.27)	(15.73)	(6.86)
Momentum	0.010	0.973***	0.541*
	(1.32)	(3.00)	(1.83)
ln(*Board Size*)	0.126***	0.608	0.797
	(3.57)	(0.60)	(0.79)
Duality	-0.024	-0.878**	-1.011**
	(-1.53)	(-2.13)	(-2.47)
ln(1+*CEO Tenure*)	-0.003**	-0.053	-0.065*
	(-2.34)	(-1.34)	(-1.68)
First stage *F*-statistic	16.187***	N/A	N/A
Wu-Hausman *F*-statistic	N/A	7.085***	8.883***
Observations	5,391	5,391	5,391
Adjusted *R*-squared	0.117	0.671	0.677
Year fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes

Table 9. Outside Directors from Major Customers and Firm Risk under Different Business Circumstances

This table presents the results of OLS regressions to investigate the effects of outside directors from customers on firm risk according to subsample analysis for suppliers in different business circumstances based on *Market Share* and *Market Competition*. *Market share* is a supplier's sales divided by total sales of industry (based on the two-digit SIC level) that the supplier operates. *Market* Competition is defined as the Herfindahl index, calculated as the sum of the squared market shares of each firm in total industry sales based on two-digit SIC level. As dependent variables, two firm risk measures are used: (1) *RVOL* is the standard deviation of daily stock returns over the fiscal year multiplied by the square root of 252. (2) *IVOL* is the standard deviation of daily excess stock returns over the fiscal year multiplied by the square root of 252. *Outside Directors from Customers* is an indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for major customers as executives or outside directors, and 0 otherwise. All other variable definitions are provided in the Appendix. Control variables are identical to controls in Table 3, whose estimates are omitted for brevity. All outside variables are lagged by 1 year. All regressions include year and industry fixed effects. Continuous variables are winsorized at the 1% level. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5% and 1% is indicated by *, ** and ***, respectively.

	Market Share				*Market Competition*			
	Low group		High group		Competitive industries		Non-competitive industries	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	RVOL	*IVOL*	*RVOL*	*IVOL*	*RVOL*	*IVOL*	*RVOL*	*IVOL*
Outside Directors from Customers	-1.578*	-1.725*	-0.631	-0.732	-2.203**	-2.466***	-0.326	-0.351
	(-1.75)	(-1.96)	(-0.88)	(-1.04)	(-2.53)	(-2.89)	(-0.45)	(-0.51)
Observations	3,263	3,263	3,260	3,260	3,265	3,265	3,260	3,260
Adjusted *R*-squared	0.613	0.628	0.652	0.613	0.671	0.672	0.663	0.670
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 10. Various Types of Customer-affiliated Directors

This table presents the results of OLS regressions to investigate how the effects of directors from customers on suppliers' firm risk vary according to which types of directors are appointed, that is, outside versus inside directors. As dependent variables, two firm risk measures are used: (1) *RVOL* is the standard deviation of daily stock returns over the fiscal year multiplied by the square root of 252. (2) *IVOL* is the standard deviation of daily excess stock returns over the fiscal year multiplied by the square root of 252. *Inside Directors from Customers* (Outside *Directors from Customers*) is an indicator variable equal to 1 if a supplier has at least one inside (outside) director who is currently working or previously worked for major customers as executives or outside directors, and 0 otherwise. *All Directors from Customers* is an indicator variable equal to 1 if a supplier has at least one director who is currently working or previously worked for major customers as executives or outside directors, and 0 otherwise. *Outside Directors Being Executives in Customers* (*Outside Directors Being Outside Directors in Customers*) is an indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for major customers as executives (outside directors), and 0 otherwise. All other variable definitions are provided in the Appendix. Control variables are identical to controls in Table 3, whose estimates are omitted for brevity. All outside variables are lagged by 1 year. All regressions include year and industry fixed effects. Continuous variables are winsorized at the 1% level. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5% and 1% is indicated by *, ** and ***, respectively.

Panel A : Inside vs. outside directors from major customers

	(1) *RVOL*	(2) *IVOL*	(3) *RVOL*	(4) *IVOL*	(5) *RVOL*	(6) *IVOL*
Inside Directors from Customers	1.349	1.153				
	(1.22)	(1.08)				
All Directors from Customers			-0.532	-0.722		
			(-0.95)	(-1.31)		
Outside Directors from Customers					-1.213**	-1.373**
					(-2.11)	(-2.46)
Observations	6,525	6,525	6,525	6,525	6,525	6,525
Adjusted *R*-squared	0.661	0.667	0.661	0.667	0.662	0.667
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Panel B : Outside directors being executives vs. outside directors in customers

	(1) *RVOL*	(2) *IVOL*	(3) *RVOL*	(4) *IVOL*
Outside Directors Being Executives in Customers	-1.184*	-1.431**		
	(-1.91)	(-2.36)		
Outside Directors Being Outside Directors in Customers			-1.582	-1.492
			(-1.28)	(-1.37)
Observations	6,525	6,525	6,525	6,525
Adjusted *R*-squared	0.662	0.667	0.661	0.667
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes

Table 11. Outside Directors from Major Customers vs. Outside Directors from Customer Industries

This table presents the results of OLS regressions to compare the effects of outside directors from customers and of outside directors from customer-related industries on firm risk. As dependent variables, two firm risk measures are used: (1) *RVOL* is the standard deviation of daily stock returns over the fiscal year multiplied by the square root of 252. (2) *IVOL* is the standard deviation of daily excess stock returns over the fiscal year multiplied by the square root of 252. *Outside Directors from Customers* is an indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for major customers as executives or outside directors, and 0 otherwise. *Outside Directors from Customer Industries* is an indicator variable equal to 1 if a supplier has at least one outside director from firms in the same two-digit SIC industries as major customers, and 0 otherwise. All other variable definitions are provided in the Appendix. Control variables are identical to controls in Table 3, whose estimates are omitted for brevity. All outside variables are lagged by 1 year. All regressions include year and industry fixed effects. Continuous variables are winsorized at the 1% level. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5% and 1% is indicated by *, ** and ***, respectively.

	(1) *RVOL*	(2) *IVOL*	(3) *RVOL*	(4) *IVOL*	(5) *RVOL*	(6) *IVOL*
Outside Directors from Customers	-1.408**	-1.623***			-1.079*	-1.168**
	(-2.37)	(-2.79)			(-1.83)	(-2.06)
Outside Directors from Customer Industries			-0.414	-0.716	-0.502	-0.766*
			(-0.89)	(-1.58)	(-1.16)	(-1.82)
Observations	5,026	5,026	5,865	5,865	6,525	6,525
Adjusted *R*-squared	0.663	0.671	0.660	0.667	0.662	0.668
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Table 12. Outside Directors from Major Customers and Firm Risk: Using Alternative Measures of Variables

This table presents the results of OLS regressions to examine the impacts of outside directors from customers on firm risk using alternative measures of our main explanatory and dependent variables. As dependent variables, four firm risk measures are used: (1) *CF Vol.* is the standard deviation of quarterly cash flows over book assets for the five-year window (year *t* to year *t+4*). (2) *RVOL_Month* is the standard deviation of monthly stock returns over the fiscal year multiplied by the square root of 21. (3) *IVOL_3Factor* is the square root of 252 multiplied by the standard deviation of the residuals from the Fama-French three-factor model using daily stock return (estimated over the fiscal year). (4) *RVOL* is the standard deviation of daily stock returns over the fiscal year multiplied by the square root of 252. Four measures of outside directors from customers are used: (1) *Outside Directors from Customers* is an indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for major customers as executives or outside directors, and 0 otherwise. (2) *Ratio of Outside Directors from Customers* is the ratio of the number of a supplier's outside directors from major customers to the number of the supplier's total outside directors. (3) *Outside Directors from Customers_15%* is an indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for customers that account for 15% or more of the supplier's total sales, and 0 otherwise. (4) *Outside Directors from Customers_20%* is an indicator variable equal to 1 if a supplier has at least one outside director who is currently working or previously worked for customers that account for 20% or more of the supplier's total sales, and 0 otherwise. All other variable definitions are provided in the Appendix. All outside variables are lagged by 1 year. All regressions include year and industry fixed effects. Continuous variables are winsorized at the 1% level. Standard errors are corrected for clustering at the firm level. *t*-statistics are in parentheses. Significance at the 10%, 5% and 1% is indicated by *, ** and ***, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	CF Vol.	*RVOL_Month*	*IVOL_3Factor*	*RVOL*	*RVOL*	*RVOL*
Outside Directors from Customers	-0.005**	-1.375*	-1.213**			
	(-2.06)	(-1.65)	(-2.18)			
Ratio of Outside Directors from Customers				-0.701*		
				(-1.86)		
Outside Directors from Customers_15%					-2.221***	
					(-3.55)	
Outside Directors from Customers_20%						-2.274***
						(-2.89)
ln(*ME*)	-0.003***	-4.022***	-4.777***	-4.333***	-4.269***	-4.279***
	(-4.38)	(-21.15)	(-28.43)	(-26.10)	(-26.42)	(-26.40)
M/B	-0.000	0.126**	0.176***	0.183***	0.177***	0.178***
	(-0.45)	(2.14)	(4.08)	(4.07)	(4.07)	(4.09)
ROA	-0.078***	-18.304***	-19.497***	-20.368***	-20.069***	-20.034***
	(-6.18)	(-9.58)	(-13.57)	(-13.84)	(-14.07)	(-14.02)
Mkt. Lev.	0.010	15.573***	6.577***	6.626***	6.564***	6.588***
	(1.14)	(7.39)	(4.15)	(4.12)	(4.19)	(4.21)
Cash	-0.006	0.082	-2.251**	-1.644	-1.397	-1.332
	(-1.06)	(0.05)	(-1.97)	(-1.41)	(-1.23)	(-1.17)
Dividend Dum.	-0.004**	-4.997***	-4.196***	-4.333***	-4.371***	-4.357***
	(-2.27)	(-7.96)	(-8.02)	(-8.45)	(-8.63)	(-8.59)
R&D	0.082***	12.214***	5.820**	4.674*	4.643*	4.669*

	(4.19)	(3.79)	(2.43)	(1.90)	(1.95)	(1.96)
PPE	-0.013*	1.435	2.854	3.729**	3.836**	3.840**
	(-1.82)	(0.70)	(1.61)	(2.13)	(2.23)	(2.23)
ln(1+*Firm Age*)	-0.004**	-2.818***	-2.381***	-2.278***	-2.198***	-2.206***
	(-1.96)	(-6.84)	(-7.20)	(-6.89)	(-6.76)	(-6.78)
Mkt. Beta	0.002	7.156***	1.896***	6.174***	6.168***	6.156***
	(1.34)	(14.33)	(5.40)	(16.69)	(17.07)	(17.01)
Momentum	-0.001	1.856***	0.467*	0.992***	1.037***	1.039***
	(-1.05)	(4.65)	(1.77)	(3.34)	(3.54)	(3.55)
ln(*Board Size*)	-0.008	0.279	0.422	0.204	0.173	0.164
	(-1.60)	(0.25)	(0.45)	(0.22)	(0.19)	(0.18)
Duality	0.000	-0.637	-0.445	-0.460	-0.472	-0.459
	(0.04)	(-1.34)	(-1.16)	(-1.18)	(-1.24)	(-1.20)
ln(1+*CEO Tenure*)	-0.000	-0.103**	-0.061*	-0.050	-0.050	-0.048
	(-1.34)	(-2.35)	(-1.68)	(-1.35)	(-1.37)	(-1.33)
Observations	6,028	6,522	6,461	6,525	6,525	6,525
Adjusted *R*-squared	0.279	0.476	0.666	0.659	0.662	0.662
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes