

# **Customer concentration and the supplier firm's cash flow risk: Evidence from China**

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## **Abstract**

We investigate how customer concentration impacts the supplier firm's cash flow risk. Employing a merged database containing 1,503 Chinese firms for the period 2007-2020, we provide evidence that higher customer concentration enhances the supplier firm's cash flow risk. This evidence still holds when we employ a battery of different techniques and robustness tests to mitigate endogeneity concerns. We further find that customer concentration increases the supplier firm's cash flow risk by boosting the supplier firm's trade credits and relation-specific investments, reducing its profit margin and receivables turnover, bringing about the potential risk of losing substantial future sales at once and being negatively affected by major customers' poor financial conditions.

**Keywords:** The customer-supplier relationship; Customer concentration; Cash flow risk; Earnings volatility.

## 1. Introduction

The recent debt defaults by Evergrande, one of the largest Chinese property developers, have shocked the capital market. Evergrande's total liabilities were estimated to be about 300 billion US dollars and constitute about 2% of China's GDP in 2020 (Hoskins, 2021; Stephenson and Li, 2021). Although Evergrande occupies a huge amount of illiquid real estate, it has insufficient cash to pay its debts. Consequently, a large number of Evergrande's suppliers have been heavily affected and stricken by the defaults, leading to increased cash flow risk in repaying their forthcoming debts. This event demonstrates the important role of the customer-supplier relationship, particularly the relationship between large customers and the supplier firm, in influencing the supplier firm's operating and financial activities in both China and other countries worldwide.

Scholars have approached and explained the economic effect of a firm concentrating its relationship on its major customers from two theoretical standpoints. On the one hand, researchers such as Galbraith and Stiles (1983) and Kelly and Gosman (2000) contend that driven by the self-interest of economic actors, the customer-supplier relationship is characterised by power and competition whereby large buyers extract economic rent at the expense of the supplier firm. On the other hand, Irvine, Park, and Yildizhan (2016) and Patatoukas (2012) consider concentrating on major customers as a cooperative behaviour that facilitates collaboration with the potential benefits accruing to both the supplier firm and its major customers.

Against the backdrop above, previous academic studies have documented that customer concentration has a significant impact on the supplier firm's business operations and economic outcomes (Itzkowitz, 2013), although the results have been mixed. For instance, Irvine, Park, and Yildizhan (2016) find that customer-base concentration reduces the supplier firm's profitability during the early years of the relationship, while the effect becomes positive as the relationship matures. Cohen and Li (2019) find that the concentration of major government customers enhances firm profitability, while the concentration of major corporate customers negatively affects

profitability. Krolkowski and Yuan (2017) find that customer concentration encourages the supplier firm to invest more in R&D and become more innovative, while Kim and Zhu (2018) document that customer concentration is negatively linked to the allocation of innovation resources by the supplier firm.

Further, Dhaliwal, Judd, Serfling, and Shaikh (2016) and Campello and Gao (2017) find that a concentrated customer base increases cost of equity and interest rate spreads of bank loans, while Cai and Zhu (2020) find that a concentrated customer base reduces cost of debt. Crawford, Huang, Li, and Yang (2020) find that customer concentration reduces the frequency of the supplier firms' earnings management and sales forecasts, while Cen, Dasgupta, Elkamhi, and Pungaliya (2015) and Huang, Lobo, Wang, and Xie (2016) document that a supplier firm with a concentrated corporate customer base is motivated to manage earnings upwards and avoid paying more taxes. Importantly, these studies have focused on US firms with developed financial markets and a sound legal environment. However, this topic remains largely unexplored in China, as the largest emerging economy with its unique features in terms of institutions and business environments, although the case above suggests it is crucial to explore the topic in this setting.

To fill in this research gap, this study attempts to examine the specific effect of concentrated customer base, namely relying on a few major customers for a large percentage of total sales, on the supplier firm's cash flow risk using Chinese firms. We believe that the relationship along the supply chain in China warrants an independent and systematic investigation for the following reasons. Firstly, based on World Bank statistics, China is the largest exporter (2,497,156 million dollars) in the world, compared to the US (1,428,798 million dollars) in 2020 (World Bank, 2020). As the world's largest producer and exporter of industrial goods, China is one of the most important participants in the global supply chain (Tang, 2020; Chor, Manova, and Yu, 2021). Thus, it is quite possible that risks or issues associated with China's supply chain have palpable implications for the global market.

Secondly, compared with Western countries, China has its unique political,

economic, and cultural backgrounds. These characteristics might create a customer-supplier relation with a different structure and produce a different effect of customer concentration on the operating and economic outcomes of Chinese firms. For instance, according to our statistics in respect of sample firms from the CSMAR database, only a small number of customers are large and listed firms in China, while this figure is four times as high in the US. This difference suggests a possibly less concentrated customer base in China, but a higher need to deal with the customer-supplier relationship carefully if the supplier firm concentrates on unlisted customers, a relationship that brings more uncertainty. Additionally, when doing businesses, firms in Western countries tend to follow contracts, while Chinese tend to value oral promises or implicit commitments based on strong relationships or ‘Guanxi’ (Hofstede, 2001; Samaha, Beck, and Palmatier, 2014). This trait suggests that a strong relationship or ‘Guanxi’ possibly developed from the customer-supplier relationship could generate the different impact on the supplier firm’s operating, investing and financial policies.

We put forward two competing hypotheses regarding the relation between customer concentration and the supplier firm’s cash flow risk below. On the one hand, we propose that customer concentration reduces the supplier firm’s cash flow risk. Firstly, the long-lasting and strong relationship between the supplier firm and its major customers reflects implicit contracts or implicit future commitments. Thus, it motivates the information sharing and the strategic collaboration along the supply chain (Kalwani and Narayandas, 1995; Kumar, 1996; Aviv, 2001). This benefit could increase the operating efficiency from several aspects, stabilise operating income and lower cash flow risk for the supplier firm. Secondly, the potential of joint investments between the supplier firm and its major customers or relationship-specific investments between them stimulates major customers to monitor and certify the supplier firm (Chevalier and Goolsbee, 2009; Itzkowitz, 2015). These two effects increase the supplier firm’s operation efficiency and reduce information asymmetry. So, the supplier firm is more likely to have better access to external funds with a lower cost

(Johnson, Kang, and Yi, 2010) and thus to increase financial flexibility and lower cash flow risk.

On the other hand, we propose that customer concentration increases the supplier firm's cash flow risk. Firstly, attaining strong bargaining power, major customers put pressure on purchase prices and the timing of payments, and require the supplier firm to invest in relationship-specific assets (Kale and Shahrur, 2007; Banerjee, Dasgupta, and Kim, 2008; Hui, Liang, and Yeung, 2019; Dong, Li, and Li, 2021). These disadvantages squeeze the supplier firm's profits and bring about extra hold-up costs and deployment expenses linked to these relationship-specific investments, leading to a higher uncertainty of operating income and future cash flows. Secondly, the supplier firm faces the potential risk of losing substantial future sales at once when one or a few major customers decide to switch supplier (Banerjee, Dasgupta, and Kim, 2008; Disney and Lambrecht 2008; Banker, Byzalov, and Plehn-Dujowich, 2014). Also, when a major customer becomes financially distressed or declares insolvency, it may default on its outstanding accounts payable or decrease the future demand for products from the supplier firm (Jarrow and Yu, 2001; Giesecke and Weber, 2004). These two potential risks could reduce the supplier firm's future earnings and make its cash flows more volatile.

To examine this research question, we use a merged database including 1,503 Chinese firms for the period 2007-2020. Following the logic of previous studies by Itzkowitz (2013), Huang, Lobo, Wang, and Xie (2016), Dong, Li, and Li (2021) and Chen, Su, Tian, and Xu (2022), we define the top five customers who account for the highest proportions of the supplier's total sales as major customers in China. This is because we can only obtain information on the top five customers of the supplier firm in China. Then, we use two measures to capture the degree to which a firm's customer base is concentrated. For the first measure, we define *Customer Sales* as the fraction of a supplier's annual total sales to the top five major customers. The second measure, *Customer HHI*, is a Herfindahl-Hirschman Index of sales to the top five major customers.

Following prior literature, we employ three main measures to capture firm cash flow risk (Daniel, Denis, and Naveen, 2008; Jayaraman, 2008; Chay and Suh, 2009). The first one is operating profit volatility (*ROAVol*), calculated as the standard deviation of operating rate of return (i.e., operating income/total assets) over the past five years including the current fiscal year. The second one is cash flow volatility (*CFVol*), calculated as the standard deviation of the ratios of operating cash flow to total assets for the previous five years. The third one is cash flow shortfall (*CashShort*), calculated as expected investment plus expected dividend minus available cash flow. Expected dividend is equal to dividend paid in the previous year and expected investment is the median value of industry investment scaled by total assets, where industry investment includes capital expenditures for fixed assets, intangible assets, and other long-term assets.

Empirically, we start by examining how customer concentration is related to the supplier firm's cash flow risk. We find that both *Customer Sales* and *Customer HHI* have a positive and significant impact on the three measures of cash flow risk. The effect has economic magnitude. For instance, a one-standard deviation increase in the firm's total sales to its top five major customers results in an increase in operating profit volatility, cash flow volatility and cash shortfall by 8.93%, 6.12% and 10.70% respectively. This evidence supports our hypothesis two (H2) that higher customer concentration enhances the potential cash flow risk of the supplier firm. Specifically, having strong bargaining power, major customers could generate extra operating and financial uncertainty for the supplier firm, resulting in higher cash flow risk.

Potential endogeneity issues might confront our baseline evidence. One endogeneity concern is that the supplier firm's customer concentration degree may be related to other unobserved or unmeasurable firm characteristics that are also mechanically correlated with cash flow risk, like corporate culture. Another endogeneity concern comes from reverse causality. Namely, customer concentration could be a function of the supplier firm's past cash flow risk. We firstly employ the propensity score matching (PSM) approach to exclude the confounding explanation

that our baseline results reveal the impact of other firm characteristics rather than customer concentration base on cash flow risk. We secondly adopt the 2SLS instrumental variable approach to further address our endogeneity concerns and validate the causal relation. We thirdly conduct a series of robustness tests, including the use of alternative measures of customer concentration, the exclusion of the 2007-2009 financial crisis period and the exclusion of the smallest 10% suppliers in terms of sales.

Additionally, we conduct a battery of cross-sectional tests that make use of the variation in several characteristics of the supplier firm and the customer-supplier relationship to support our baseline results and clarify the underlying mechanisms. We find that customer concentration increases the supplier's trade credits and R&D intensity, while it decreases its receivables turnover and profit margin. This supports our assertion that, in obtaining strong bargaining power, major customers enhance operating income volatility and cash flow risk for the supplier firm by asking for discounts, squeezing its profit margin, and requiring relation-specific investments.

We also find that the positive relation between customer concentration and the supplier firm's cash flow risk is augmented when the supplier firm's probability of being switched and its major customers' probability of suffering financial distress or bankruptcy are high. This evidence supports our interpretation that customer concentration leads to the supplier firm's potential risk of losing large customers or being negatively influenced by its large customers' poor financial conditions, which then enhances the firm's cash flow risk. We lastly find that, as relatively stable and reliable major customers, major government and local customers mitigate the positive impact of customer concentration on the supplier firm's cash flow risk. And the situation is reversed for major foreign customers, who are considered to be unstable major customers.

Our research offers two main contributions to existing literature. Firstly, our study adds to the strand of literature on the drivers of cash flow risk or earnings volatility. From both macro- and micro-perspectives, previous studies find that the

COVID-19 pandemic, financial development, product market threats, product mix, firm-specific investment sentiment, financial hedging, payout policy, performance, earnings disclosures, employee education and customer satisfaction are important determinants of cash flow risk or earnings volatility (Bradbury, 1992; DeYoung and Roland, 2001; Gruca and Rego, 2005; Khurana, Martin, and Pereira, 2006; Chay and Suh, 2009; Hoberg, Phillips, and Prabhala, 2014; Robinson, and Sensoy, 2016; Delaney and Devereux, 2019; Sun, Yin, and Zeng, 2022; Wulandhari, Budhwar, Misha, Akbar, Do, and Milligan, 2022; Guo, Yin, and Zeng, 2023). Our study expands this line of literature by identifying a new and important determinant: the customer-supplier relationship, since we find that customer concentration increases the supplier firm's cash flow risk and earnings volatility.

Secondly, our study extends the rapidly expanding body of literature on how major customers as one type of the most important stakeholders affect the supplier firm's financial and investment policies, and economic outcomes. Mostly focusing on US firms, prior operation and finance studies investigate the impact of customer concentration on cash holdings, cost of equity, cost of bank loans, inventory efficiency, tax avoidance, public disclosure, innovation, M&A performance, stock volatility and profitability (Itzkowitz, 2013; Dhaliwal, Judd, Serfling, and Shaikh, 2016; Huang, Lobo, Wang, and Xie, 2016; Campello and Gao, 2017; Hui, Liang, and Yeung, 2019; Crawford, Huang, Li, and Yang, 2020; Dong, Li, and Li, 2021), but do not obtain consistent results.

Recently, finance researchers have begun to shift their attention to the customer-supplier relationship in the context of China. They provide evidence that a supplier firm with higher customer concentration is more likely to engage in tax avoidance and exhibit higher bond spreads and more bond covenants (Liu, Xiao, and Xie, 2020; Wang and Mao, 2021), in line with that based on US firms, while reducing firm risk-taking (Cao, Dong, Ma, and Sun, 2021), different from US evidence (Mihov and Naranjo, 2017; Ma, Wang, Wu, and Zhang, 2020). Our findings enrich this growing stream of research by showing that customer concentration increases the supplier



firm's cash flow risk in China. Our study can provide guidelines to practitioners and policy makers in China and other emerging economics.

The rest of the paper is organised as follows. Section 2 develops our hypotheses. Section 3 describes the sample and empirical methodology. Section 4 discusses the main results and Section 5 addresses potential endogeneity issues. Section 6 examines the cross-sectional heterogeneity in the relation between customer concentration and cash flow risk for the supplier firm. Section 7 concludes.

## **2. Hypotheses Development**

A firm that has several major customers or higher customer concentration tends to depend on a few buyers for a large portion of its sales (Itzkowitz, 2013). Usually, implicit contracts or implicit future commitments between the firm and its major customers exist and last for several years. On the other hand, there are no explicit guarantees that major customers will purchase goods from the supplier firm in the future, and it is even possible that the supplier firm may lose these customers. Thus, for the firm, establishing a relationship with several major customers can be a double-edged sword, imposing different and inconclusive effects on its corporate policies and business outcomes (Ak and Patatoukas, 2016; Campello and Gao, 2017; Cao, Dong, Ma, and Sun, 2021). Due to this complexity, we put forward two competing hypotheses regarding the relation between customer concentration and the supplier firm's cash flow risk below.

### **2.1. Customer concentration reduces firm cash flow risk**

Specifically, based on implicit contracts or implicit future commitments, the long-lasting and strong relationship between the firm and its major customers encourages the sharing of information and the strategic collaboration along the supply chain (Kalwani and Narayandas, 1995; Kumar, 1996; Aviv 2001). Thus, this benefit could lead to better inventory management, higher asset utilisation, and a reduction in

transaction costs and discretionary expenses, like marketing, selling and administrative fees, for the supplier firm (Kinney and Wempe, 2002; Patatoukas, 2012; Wang, 2012; Irvine, Park, and Yildizhan, 2016). Particularly, Patatoukas (2012) documents that a supplier with a few large customers tends to experience significantly shorter receivables conversion periods, longer payables conversion periods and shorter inventory conversion periods. Similarly, Ak and Patatoukas (2016) find that a supplier with a more concentrated customer base holds few inventories for a short time and is less likely to hold excess inventories, indicating higher inventory management efficiency. As a result, the more efficient operation due to this supplier-customer relationship could contribute to more stable operating income (Cohen and Frazzini, 2008; Krolkowski and Yuan, 2017) and then lower cash flow risk for the supplier firm.

Moreover, the potential of joint investments between the firm and its major customers or relationship-specific investments between them motivates major customers to monitor and certify the supplier firm (Chevalier and Goolsbee, 2009; Itzkowitz, 2015). The monitoring effect could effectively discipline the firm and prevent opportunistic behaviours, like earnings management, contributing to higher firm accounting transparency and infrequency of sales forecasts (Crawford, Huang, Li, and Yang, 2020; Kim and Luo, 2021). Further, the certification effect could supplement financial statements and reduce information asymmetry by sending a positive signal to the capital market regarding the quality of the supplier firm (Itzkowitz, 2013; Cao, Dong, Ma, and Sun, 2021). Due to these two advantages, it is more likely that a firm with larger customers will have better access to external funds with a lower cost and thus increase financial flexibility and lower financial constraints (Johnson, Kang, and Yi, 2010).

Specifically, Cen, Dasgupta, Elkamhi, and Pungaliya (2015) find that a firm holding on to its principal customers longer is perceived as a safer one by banks, so its bank loans have smaller interest rate spreads and looser loan covenants. Using 5,704 US corporate bonds issued from 1983 to 2013, Cai and Zhu (2020) find that there is a

reduction in the cost of debt with the presence of a major customer-supplier relationship. Consequently, the greater ease of acquiring external funds for a firm with larger customers, indicating stable and sufficient backup funds, could further contribute to lower cash flow risk for this supplier firm. Kouvelis and Xu (2021) also document that higher customer concentration enables the supplier firm to sell its accounts receivable at a higher premium in order to receive cash for its immediate working capital needs.

The above discussions suggest that higher customer concentration could probably reduce cash flow risk for the supplier firm by increasing operating efficiency and financial flexibility. Thus, we make our first hypothesis as follows:

**H1: Customer concentration reduces the supplier firm's cash flow risk.**

## **2.2. Customer concentration increases firm cash flow risk**

Nonetheless, relying on a few large customers has shortcomings for the supplier as well. Firstly, in attaining strong bargaining power, major customers can put pressure on purchase prices and the timing of payments for the supplier firm (Saboo, Kumar, and Anand, 2017). Specifically, prior studies find that major customers demand prices lower than the industry average and lower prepayment rates, purchase irregularly using more flexible trade terms and often delay payments by the extension of trade credits (Fee and Thomas, 2004; Bhattacharyya and Nain, 2011; Kelly, Lustig, and Van Nieuwerburgh, 2013; Murfin and Njoroge, 2015; Chod, Lyandres, and Yang, 2019). Consequently, these disadvantages brought by higher bargaining power could squeeze the supplier firm's profits, exacerbate volatility in operating income and adversely impact its performance (Hui, Liang, and Yeung, 2019; Dong, Li, and Li, 2021), leading to higher cash flow risk.

Further, strong bargaining power embedded in the major customer-supplier relationship commonly requires the supplier firm to undertake investments in relationship-specific assets (Titman and Wessels, 1988; Allen and Phillip, 2000; Kale and Shahrur, 2007; Banerjee, Dasgupta, and Kim, 2008). These relationship-specific

investments particularly serve the needs of major customers, but might contain expenditures with more R&D, unique assets, and customised manufacturing process and logistics for the supplier firm (Campello and Gao, 2017; Krolkowski and Yuan, 2017). Thus, although these investments make major customers more trustworthy and favourable to the supplier firm, they also bring the supplier firm greater uncertainty in terms of success and limited resale options of outputs to alternative customers (Balakrishnan, Linsmeier, and Venkatachalam, 1996). As a result, higher hold-up costs and deployment expenses associated with these relationship-specific investments could burden the supplier firm, leading to a higher uncertainty of operating income and future cash flows.

Secondly, although a supplier firm with higher customer concentration relies on a small number of major customers for a significant part of its sales, these major customers do not explicitly guarantee a continuance of purchase orders in the future. Thus, the supplier firm faces the potential risk of losing substantial future sales at once when one or a few major customers decide to change their products or vendor structures, or to develop their products internally (Banerjee, Dasgupta, and Kim, 2008; Disney and Lambrecht 2008; Banker, Byzalov, and Plehn-Dujowich, 2014). Consequently, since it is hard in the short term to find and develop new major customers to replace the ones that quit, the supplier firm may exhibit a significant reduction in operating income and profits (Cohen and Frazzini, 2008; Jorion and Zhang, 2009; Kolay, Lemmon, and Tashjian, 2016), making its future cash flows more volatile and unexpected.

Thirdly, financial distress and bankruptcy could spread over the supply chain due to the business connection, showing a contagion effect (Hertzel, Li, Officer, and Rodgers, 2008). Particularly, when a major customer becomes financially distressed or declares bankruptcy, it decreases the future demand for products from the supplier firm, reducing the supplier firm's future earnings and cash flows (Olsen and Dietrich, 1985; Itzkowitz, 2013). Further, a financially unhealthy major customer may default on its outstanding accounts payable to the supplier firm. Then, the supplier firm will

experience a huge loss of revenue and a significantly amplified cash flow risk and default risk due to this customer's failure to fulfil its obligations (Jarrow and Yu, 2001; Giesecke and Weber, 2004). Lian (2017) documents that a supplier firm's financial distress probability is positively linked to its major customer's financial distress, especially when the customer-supplier relationship is stronger. Similarly, other scholars find a negative abnormal stock return for the supplier firm when a major customer files for bankruptcy (Cohen and Frazzini, 2008; Hertz and Officer, 2012; Kolay, Lemmon, and Tashjian, 2016). There is also evidence that a firm with a more concentrated customer base tends to have both higher equity and debt financing costs, indicating capital providers take this risk factor into consideration (Dhaliwal, Judd, Serfling, and Shaikh, 2016; Campello and Gao, 2017).

The above discussions suggest that higher customer concentration could probably enhance cash flow risk for the supplier firm by increasing both operating and financial uncertainty linked to major customers. Thus, we construct our second hypothesis as follows:

**H2: Customer concentration enhances the supplier firm's cash flow risk.**

### **3. Data and Empirical Methodology**

#### **3.1. Data source and sample selection**

To investigate the relation between customer concentration and firm cash flow risk, we collect data from the China Stock Market and Accounting Research (CSMAR) database. Listed firms in China have been required to disclose their aggregate sales to their top five customers by the China Securities Regulatory Commission (CSRC) since 2007. Thus, our sample contains the universe of Chinese listed firms over the period of 2007-2020 in the CSMAR database that provides firm-level financial data and customer data. We drop observations related to firms labelled as special treatment (ST or ST\*) by the CSRC and observations with missing values for the variables employed in the regressions. We also exclude observations related to the financial industry according to the CSRC industry classification standard. All continuous

variables are winsorised at the 1<sup>st</sup> and 99<sup>th</sup> percentiles to mitigate the potential impact of outliers. The final sample consists of 11,832 firm-year observations for 1,503 unique firms.

### 3.2. Measures of customer concentration

Due to the availability of data, previous related studies using US firms as the sample define a customer as a major customer when the sales to this customer account for 10% or more of the supplier firm's total sales (Itzkowitz, 2013; Huang, Lobo, Wang, and Xie, 2016; Dhaliwal, Judd, Serfling, and Shaikh, 2016; Cen, Maydew, Zhang, and Zuo, 2017). However, due to the lack of data, and following the logic of prior literature, we define the top five customers who account for the highest proportions of the supplier's total sales as major customers in China (Dong, Li, and Li, 2021; Chen, Su, Tian, and Xu, 2021).

Then, we use two measures to capture the degree to which a firm's customer base is concentrated. For the first measure, we define *Customer Sales* as the fraction of a supplier's annual total sales to the top five major customers. The second measure, *Customer HHI*, is a Herfindahl-Hirschman Index of sales to the top five major customers. Specifically, we measure the supplier firm  $i$ 's customer concentration in year  $t$  across the supplier's top five major customers as:

$$Customer\ HHI_{i,t} = \sum_{j=1}^5 \left( \frac{Sales_{j,i,t}}{Sales_{i,t}} \right)^2 \quad (1)$$

Where,  $Sales_{j,i,t}$  represents the supplier firm  $i$ 's sales to the major customer  $j$  in year  $t$ , and  $Sales_{i,t}$  represents the supplier firm  $i$ 's total sales in year  $t$ . Both measures, *Customer Sales* and *Customer HHI*, are bonded by 1, where higher values indicate more concentrated customer bases.

### 3.3. Measures of cash flow risk

We employ three measures to capture firm cash flow risk. Firstly, following

Daniel, Denis, and Naveen (2008) and Chay and Suh (2009), we use operating profit volatility (*ROAVol*) as the first proxy because operating income tends to be more volatile when cash flows are more unpredictable. *ROAVol* is defined as the standard deviation of operating rate of return (i.e., operating income/total assets) over the past five years including the current fiscal year. Secondly, following Jayaraman (2008) and Chay and Suh (2009), we use cash flow volatility (*CFVol*), defined as the standard deviation of the ratios of operating cash flow to total assets for the previous five years, as the second proxy.

Thirdly, following Daniel, Denis, and Naveen (2008), we employ cash flow shortfall (*CashShort*) as the third proxy. Cash flow shortfall is calculated as expected investment plus expected dividend minus available cash flow. For expected dividend, we follow extant literature to use dividend paid in the previous year (DeAngelo and DeAngelo, 1990; DeAngelo, DeAngelo, and Skinner, 1994). For expected investment, we follow the study of Daniel, Denis, and Naveen (2008) to estimate the median value of industry investment scaled by total assets, where industry investment includes capital expenditures for fixed assets, intangible assets, and other long-term assets. Available cash flow is the net cash flow from operating activities. Higher values of these three measures indicate higher firm cash flow risk.

### **3.4. Control variables**

Following prior literature, our models also include a set of firm-level control variables related to both firm cash flow risk and customer-based structure. Following Daniel, Denis, and Naveen (2008), Chay and Suh (2009), Bates, Kahle, and Stulz (2009), Alnahedh, Bhagat, and Obreja (2019), Cao, Dong, Ma, and Sun (2021), Chen, Su, Tian, and Xu (2021) and Dong, Li, and Li (2021), we control for firm characteristics, including firm size, measured as the natural logarithm of total assets (*Size*); sales growth, measured as the difference of current sales and lagged sales divided by lagged sales (*Sales Growth*); capital expenditures, measured as the ratio of capital expenditures to total assets (*Capital Expenditures*); scaled debts, measured as

the ratio of long-term debts to total assets (*Scaled Debts*); tangible assets, measured as fixed assets scaled by total assets (*Tangibility*); research and development investment, measured as the ratio of R&D expenditures to total assets (*R&D Expenditures*); profitability, measured as the return on assets (*ROA*); and market risk, measured as stock price volatility, which is equal to the standard deviation of monthly stock returns (*Stock Return Volatility*).

### 3.5. Empirical specification

To examine the relation between customer concentration and cash flow risk at the firm level, we estimate the following specification:

$$\begin{aligned}
 \text{Cash Flow Risk}_{i,t} &= \beta_0 + \beta_1 \text{Customer Concentration}_{i,t} + \beta_2 \text{Controls}_{i,t} \\
 &+ \beta_3 \text{Industry FE} + \beta_4 \text{Year FE} + \varepsilon_{i,t} \quad (2)
 \end{aligned}$$

The measures of cash flow risk and customer concentration are discussed in detail in Sections 3.2 and 3.3. *Controls* represents a vector of firm characteristics that might affect cash flow risk shown in Section 3.4. We include industry and year fixed effects to mitigate any concerns regarding omitted variables that are correlated with a firm's customer-base structure and vary within industries and years. Definitions of all variables are also shown in Appendix A.

**[Insert Appendix A here]**

### 3.6. Summary statistics

Panel A of Table 1 shows the distribution of industries with the highest and lowest proportions of sales contributed by the top five major customers in China. Specifically, we present five industries with the highest and lowest customer-based concentrations. As shown in the table, the manufacturing industries, such as metal mining, oil & gas extraction, and transportation equipment manufacturing, have the most concentrated customer structures where the top five major customers account for



more than 50% of the supplier firm's total sales. However, the service and agricultural industries, such as restaurant and food service, retailing and livestock, have the most diversified customer structures where the top five major customers account for less than 20% of the supplier firm's total sales.

Panel B reports descriptive statistics for the key variables used in our regressions based on the full sample, the subsample with major customers accounting for 50% or above of sales and the subsample with major customers accounting for less than 50% of sales. Overall, for the dependent variables, *ROAVol*, *CFVol* and *CashShort* have the mean values of 18.39%, 5.99% and 2.39% respectively, which are comparable to the reported numbers in previous studies (Chay and Suh, 2009). For the explanatory variables, the mean sales to the top five major customers account for 31.75% of the supplier firm's total sales and the mean of *Customer HHI* is 6.34%, which are also consistent with related studies by Dhaliwal, Judd, Serfling, and Shaikh (2016) and Cao, Dong, Ma, and Sun (2021).

The last column of Panel B reports the mean differences between the two subsamples. The means of profitability volatility, cash flow volatility and cash shortfall for supplier firms with major customers accounting for 50% or above of sales are obviously higher than those for supplier firms without this feature. These findings suggest that a supplier firm with a higher customer concentration has a higher cash flow risk. Further, the presence of a more concentrated customer base is associated with smaller firm size, more tangible assets, higher R&D expenditures, lower profitability, and higher stock return volatility. To further investigate the casual effect of customer-based concentration on cash flow risk of the supplier firm, we must look at the results from our regressions.

**[Insert Table 1 here]**

## **4. Empirical Results**

### **4.1. Baseline results**

We start our analysis by examining whether a concentrated customer base affects the supplier's cash flow risk. Panel A of Table 2 reports the baseline results using *Customer Sales* as the explanatory variable, while Panel B reports those using *Customer HHI* as the explanatory variable. To alleviate possible concern regarding the 'endogenous control' problem (Gormley and Matsa, 2016), we first present the empirical results with no control variables in the first three columns and then present those with all control variables in the last three columns.

As we can see, the coefficient estimates of *Customer Sales* and *Customer HHI* are positive and significant at the 1% level both with and without controls. These estimates show a positive link between customer concentration and supplier cash flow risk. The economic impact is also not trivial. For instance, the coefficient of *Customer Sales* on *ROAVol* (0.0713) in Column (4) suggests that a one-standard deviation increase in total sales of the firm to the top five major customers results in an increase in profitability volatility, on average, by 8.93%. Further, the coefficient of *Customer Sales* on *CFVol* (0.0159) in Column (5) and that on *CashShort* (0.011) in Column (6) suggest that a one-standard deviation increase in total sales of the firm to the top five major customers results in an increase in cash flow volatility by 6.12% and an increase in cash shortfall by 10.70% respectively. Overall, the evidence supports our hypothesis two (H2), indicating higher customer concentration enhances potential cash flow risk of the supplier firm. The plausible reason may be that, equipped with strong bargaining power, major customers could bring about extra operating and financial uncertainty to the supplier firm, leading to its higher cash flow risk.

Among the control variables, we find that firm size is negatively associated with all cash flow risk measures, probably because larger firms are usually more liquid and have stable cash flows. Sales growth, capital expenditures, R&D expenditures and debt ratio are positively linked to cash flow risk, consistent with the prediction that the uncertainty of cash flow increases as investment expenditures grow. Further, the firm's fixed assets size (*Tangibility*) and profitability are negatively associated with cash flow risk. Lastly, stock return volatility is positively related to cash flow risk.

This suggests that the firm's stock prices tend to fluctuate more when its cash flows are unpredictable. These results are in line with previous studies by Chay and Suh (2009), Dhaliwal, Judd, Serfling, and Shaikh (2016) and Cao, Dong, Ma, and Sun (2021).

**[Insert Table 2 here]**

## **5. Addressing Potential Endogeneity**

Although our results suggest that a more concentrated customer base increases the supplier firm's cash flow risk, the observed relation could tell us little about causality due to potential endogeneity issues. One endogeneity concern is that the supplier firm's customer concentration degree may be correlated with other unobserved or unmeasurable firm characteristics that are also mechanically linked to cash flow risk, like corporate culture. Another endogeneity concern comes from reverse causality. For example, it might not be easy for a supplier firm with a higher cash flow risk to find a large number of potential customers, hence it may only rely on several customers for a large portion of its sales, leading to a concentrated customer base. To alleviate these endogeneity concerns and increase the robustness of our baseline results, we adopt a set of approaches in this section.

### **5.1. Propensity score matching estimates**

Following Dhaliwal, Judd, Serfling, and Shaikh (2016) and Cao, Dong, Ma, and Sun (2021), we firstly employ the propensity score matching (PSM) approach to control for the differences in firm characteristics between firms with a concentrated customer base and those without. In this way, we could exclude the confounding explanation that our baseline results reveal the impact of other firm characteristics rather than customer concentration base on cash flow risk.

According to our definition that the top five customers of the supplier firm's sales are major customers, firms with major customers contributing to 50% or above

of their sales are regarded as those with a concentrated customer base and are assigned to the treatment group and the rest are placed into the control group. Using a one-to-one matching method without replacement, for each customer-concentrated firm, we select one non-customer-concentrated firm that is closest to this customer-concentrated firm based on observable firm characteristics. Specifically, the matching firm selected is the firm with the closest propensity score, estimated from a logit regression of *Customer Sales* or *Customer HHI* on a firm's size, sales growth, capital expenditures, scaled debts, tangibility, R&D expenditures, profitability, and stock return volatility. This procedure results in a matched sample of 6,368 observations, where the treatment and control groups are overall statistically indifferent based on firm characteristics (please see Panel A of Table 3).

Panel B of Table 3 reports regression results of cash flow risk using a matched sample of customer-concentrated firms and non-customer-concentrated firms. We find that an increase in customer concentration leads to a significant increase in cash flow risk of the supplier firm. This finding is shown by positive and significant coefficients on all three measures of cash flow risk with magnitudes comparable to those observed in baseline results, although *p*-values are slightly higher. Therefore, this evidence is consistent with that in baseline regressions, suggesting that customer concentration increases cash flow risk for the supplier firm.

**[Insert Table 3 here]**

## **5.2. Instrumental variable regressions**

To further address our endogeneity concerns and validate the causal relation between customer concentration and cash flow risk, we adopt the 2SLS instrumental variable approach. Following the logic of prior literature, we use the lag of the industry-year median customer concentration measures, *Industry\_Customer Sales* and *Industry\_Customer HHI*, as the instrumental variables (Dhaliwal, Judd, Serfling, and Shaikh, 2016; Cao, Dong, Ma, and Sun, 2021). These two IVs tend to be valid instruments to satisfy the relevance and exclusion restriction. Since the industry

median represents the overall structure of the customer concentration base in the supplier firm's industry, these two IVs are highly correlated with the supplier firm's customer concentration base but are less likely to be affected by the supplier firm's characteristics, as long as the industry is sufficiently sizable.

In Table 4, we report the regression results of the 2SLS instrumental variable estimator. Columns (1) and (2) present the first-stage regression results, while the remaining columns present the second-stage regression results. In the first stage, we regress *Industry\_Customer Sales* (or *Industry\_Customer HHI*) on *Customer Sales* (or *Customer HHI*). The coefficients on *Customer Sales* in Column (1) and *Customer HHI* in Column (2) are positive and significant at the 1% level, indicating a supplier firm's customer concentration is positively associated with that of the industry median, as expected. The evidence that the value of *F*-statistics is more than 10 at the bottom of the table supports the validity of our instruments to some extent. In the second stage, we regress cash flow risk measures on fitted values of customer concentration measures from the first-stage regressions. Columns (3) – (8) show a positive impact of customer concentration on the supplier firm's cash flow risk. Thus, our findings still hold when using the 2SLS IV estimate.

**[Insert Table 4 here]**

### **5.3. Robustness tests**

In this section, we conduct a series of robustness tests to further strengthen our baseline findings. Based on the general US definition of a major customer, we firstly follow studies by Itzkowitz (2013), Dhaliwal, Judd, Serfling, and Shaikh (2016), Campello and Gao (2017) and Chen, Su, Tian, and Xu (2021) to create three alternative measures of customer concentration. The first measure is *Major Customer*, a dummy variable that is equal to 1 if a supplier firm discloses at least one customer that accounts for 10% or more of its total sales, and 0 otherwise. The second measure is *Major Customer Max*, which is defined as the highest percentage sales to the top one major customer. The third measure is *Major Customer Count*, which is the total

number of a supplier firm's customers that account for 10% or more of its total sales. We rerun our baseline regressions employing these three alternative measures of customer concentration as explanatory variables respectively.

Secondly, following prior studies, we delete the 2007-2009 financial crisis period from our sample and rerun our baseline regressions. This allows us to exclude the cash flow disturbance caused by the crisis. Additionally, most Chinese firms only started to disclose their detailed customer information in 2009, although they were required to do so by the China Securities Regulatory Commission from 2007. Lastly, we follow the logic of Chen, Su, Tian, and Xu (2021) to replicate our baseline regressions by excluding the smallest 10% suppliers in terms of sales. This method could help us to mitigate the simultaneous endogeneity issue mainly caused by small supplier firms. Usually, a smaller supplier firm is more likely to attract fewer large customers and have unstable cash flows at the same time.

The regression results for tests using alternative measures are reported in Table 5, while those for exclusion tests of the smallest suppliers and the 2007-2009 financial crisis period are reported in Panel A and Panel B of Table 6 respectively. In Table 5, the coefficients of *Major Customer*, *Major Customer Max* and *Major Customer Count* are all positive and significant at the 5% level or above, indicating that customer concentration still increases cash flow risk of the supplier firm using new alternative measures. Additionally, in Table 6, the coefficients of *Customer Sales* and *Customer HHI* remain positive and significant at the 5% level or above across all columns, confirming that our main results are not biased by smaller suppliers and the 2007-2009 financial crisis. Overall, our baseline findings are robust to a body of robustness tests.

**[Insert Table 5 here]**

**[Insert Table 6 here]**

## **6. Cross-sectional Analyses**

We previously found that customer concentration has a positive impact on the supplier firm's cash flow risk. Nevertheless, the specific impact of customer concentration on the supplier firm's cash flow risk may vary in different situations. In this section, we conduct a set of cross-sectional tests that take into account the variation in several characteristics of the supplier firm and the customer-supplier relationship to corroborate our baseline results and illuminate the underlying mechanisms.

### **6.1. Customer concentration, bargaining power, and the supplier firm's trade credits and relationship-specific investments**

We firstly examine whether customer concentration increases the supplier firm's cash flow risk by enhancing major customers' bargaining power. If customer concentration embeds major customers with strong bargaining power, which allows them to successfully request lower purchase prices, lower prepayment rates and late payments of trade credits (Saboo, Kumar, and Anand, 2017; Chod, Lyandres, and Yang, 2019), it could result in volatile operating income (Hui, Liang, and Yeung, 2019; Dong, Li, and Li, 2021) and higher cash flow risk for the supplier firm. In this situation, we should observe that customer concentration leads to large trade credits, lower profit margins and lower receivables turnover for the supplier firm. Similarly, if customer concentration provides major customers with strong bargaining power, which enables them to successfully require the supplier firm to undertake relationship-specific investments, this could lead to higher hold-up costs and deployment expenses (Titman and Wessels, 1988; Balakrishnan, Linsmeier, and Venkatachalam, 1996; Kale and Shahrur, 2007; Banerjee, Dasgupta, and Kim, 2008), and then higher cash flow risk for the supplier firm. In this circumstance, we should observe that customer concentration results in higher relationship-specific investments for the supplier firm.

Following prior studies by Fee and Thomas (2004), Bhattacharyya and Nain (2011), Kelly, Lustig, and Van Nieuwerburgh (2013) and Murfin and Njoroge (2015),

we define *Trade Credits* as the ratio of accounts receivable to total assets of the supplier firm. *Profit Margin* is defined as the ratio of operating income to total sales. *Receivables Turnover* is defined as the ratio of total sales to receivables. To measure relationship-specific investments, we use *R&D Intensity* as the proxy of relationship-specific investments, calculated as R&D expenditures scaled by total assets (Kale and Shahrur, 2007; Raman and Shahrur 2008; Dass, Kale, and Nanda, 2015; Gonçalves, Schiozer, and Sheng, 2018; Cao, Dong, Ma, and Sun, 2021; Chen, Su, Tian, and Xu, 2021). Higher value of this proxy indicates possible higher extra relationship-specific investments (Levy, 1985; Holmstrom and Roberts, 1998; Allen and Phillips, 2000). To test these predictions, we repeat our baseline regressions after replacing the dependent variables with *Trade Credits*, *Profit Margin*, *Receivables Turnover* and *R&D Expenditures* respectively.

The empirical results considering the variation in the supplier firm's trade credits, profit margin, receivables turnover and that in the supplier firm's R&D expenditures are presented in Panel A and Panel B of Table 7 respectively. As we can see, the coefficients of both *Customer Sales* and *Customer HHI* on *Trade Credits* and *R&D Expenditures* are positive and significant at the 1% level or above, and those on *Receivables Turnover* and *Profit Margin* are negative and significant at the 1% level or above across the table. In line with our expectations, these findings indicate that, to sustain major customers with strong bargaining power, the supplier firm has to lower its profit margin and receivables turnover, and also increase its trade credits and relation-specific investments, which contribute to volatile operating income and higher cash flow risk.

**[Insert Table 7 here]**

## **6.2. The supplier firm's probability of being switched**

We proceed to explore whether the positive effect of customer concentration on the supplier firm's cash flow risk varies by the supplier firm's probability of being switched by its major customers, to further strengthen our baseline evidence and



interpretation. If major customers can easily replace the supplier firm with a new one, then the supplier firm faces a higher potential risk of losing substantial future sales at once, significantly lowering its operating income (Banerjee, Dasgupta, and Kim, 2008; Jorion and Zhang, 2009; Kolay, Lemmon, and Tashjian, 2016) and making its future cash flows more volatile and unexpected. Thus, we should observe that the positive impact of customer concentration on the supplier firm's cash flow risk is more obvious when the supplier firm's probability of being switched is high.

In line with prior literature, we employ the supplier firm's market share to proxy for its probability of being switched, which is defined as the ratio of the supplier firm's total sales to its industry's total sales using CSRC classification (Dhaliwal, Judd, Serfling, and Shaikh, 2016; Cao, Dong, Ma, and Sun, 2021; Chen, Su, Tian, and Xu, 2021). A supplier firm with a low market share indicates more alternative supplier firms that its major customers can switch to and a higher probability of being switched. Further, to test our expectation, we insert the interaction term *Customer Sales* (or *Customer HHI*)\**Market Share* in our baseline model and rerun the regressions.

The empirical results revealing the variation in the supplier firm's probability of being switched are shown in Table 8. The coefficients of the interaction term *Customer Sales* (or *Customer HHI*)\**Market Share* are negative and significant at the 5% level or above across the table. The findings indicate that the positive relation between customer concentration and the supplier firm's cash flow risk becomes weaker with the increase in the supplier firm's market share. Namely, the positive relation between these two factors is augmented with the increase in the supplier firm's probability of being switched. This evidence supports our evidence and interpretation that customer concentration brings about the potential risk of losing a large amount of sales at once and then enhances the supplier firm's cash flow risk.

**[Insert Table 8 here]**

### **6.3. Major customers' probability of experiencing financial distress or**

## **bankruptcy**

We thirdly explore whether the positive impact of customer concentration on the supplier firm's cash flow risk changes by major customers' probability of experiencing financial distress or bankruptcy. Prior literature documents that, when a major customer experiences financial distress or declares bankruptcy, it cuts its future purchases of the supplier firm's products and even defaults on its outstanding accounts payable to the supplier firm (Olsen and Dietrich, 1985; Itzkowitz, 2013). In this case, the supplier firm suffers from a significant loss of revenue (Jarrow and Yu, 2001; Giesecke and Weber, 2004) and then its cash flow risk could soar. Thus, we should observe that the positive effect of customer concentration on the supplier firm's cash flow risk is more evident when major customers' probability of experiencing financial distress and bankruptcy is high.

We employ whether a major customer is listed or not to proxy for its probability of experiencing financial distress or bankruptcy. According to existing literature, going public could help the firm to expand its external financing significantly, so a listed firm is less likely to be in financial distress or bankruptcy compared with an unlisted one (Frank and Goyal, 2003; Hotchkiss, Smith, and Strömberg, 2021). Then, we calculate the percentage of listed major customers, denoted as *Listed Customer %*, for the supplier firm to measure the average probability of experiencing financial distress or bankruptcy of its major customers. The higher the value, the lower the probability. Further, to test our expectation, we insert the interaction term *Customer Sales (or Customer HHI)\* Listed Customer %* into our baseline model and rerun the regressions.

The empirical results showing the variation in the major customers' probability of experiencing financial distress or bankruptcy are exhibited in Table 9. The coefficients of the interaction term *Customer Sales (or Customer HHI)\* Listed Customer %* are negative and significant at the 10% level or above across the table. The results indicate that the positive relation between customer concentration and the supplier firm's cash flow risk is moderated by the increase in the supplier firm's

percentage of listed major customers. Namely, the positive relation between these two factors is amplified with the increase in major customers' probability of experiencing financial distress or bankruptcy. This finding supports our evidence and interpretation that customer concentration brings about the potential risk of losing a large amount of sales at once and then enhances the supplier firm's cash flow risk. It strengthens our evidence and interpretation that customer concentration intensifies the contagion effect of financial distress or bankruptcy along the supply chain and then raises the supplier firm's cash flow risk.

**[Insert Table 9 here]**

#### **6.4. Concentration on different customers and the supplier firm's cash flow risk**

Lastly, we investigate whether the positive effect of customer concentration on the supplier firm's cash flow risk varies with different types of major customers, including government customers, foreign customers, and local customers, to further support our story. According to prior literature, compared with firm customers, government customers are far less likely to become financially distressed or declare bankruptcy (Dhaliwal, Judd, Serfling, and Shaikh, 2016). Additionally, since government customers are required to sign long-term procurement contracts, they are less likely to change their suppliers or cancel their orders in the future (Banerjee, Dasgupta, and Kim, 2008; Goldman, Rocholl, and So, 2013; Cohen and Li, 2020). Therefore, when doing businesses with major government customers, the supplier firm faces less potential risk of losing major customers or being negatively affected by major customers' poor financial conditions. As a result, the positive relation between customer concentration and the supplier firm's cash flow risk may be moderated by having more major government customers.

Compared with domestic customers, foreign customers may be more likely to both involuntarily and voluntarily switch their suppliers. Firstly, political and economic policy uncertainties across borders could interrupt or cancel purchasing orders from foreign customers (Julio and Yook, 2016; Crowley, Meng, and Song,

2018). Secondly, the geographical distance and cultural difference create additional barriers to effective and prompt communications between foreign customers and the supplier firm (Coval and Moskowitz, 2001; Masulis, Wang, and Xie, 2012), disturbing continuous and stable purchases from foreign customers. Therefore, when doing businesses with major foreign customers, the supplier firm faces a higher potential risk of losing major customers. Consequently, the positive relation between customer concentration and the supplier firm's cash flow risk would be intensified by having more major foreign customers.

Compared with non-local customers, local customers may be more likely to maintain their current suppliers for a long time. Firstly, a short distance encourages timely communications and facilitates soft information exchange between two parties through on-site and face-to-face interactions (Chu, Tian, and Wang, 2019). Secondly, when the customer and the supplier are located close to each other, they might share items that are vital in production processes, such as intermediate inputs, human resources, and natural resources, creating the agglomeration effect (Orlando, 2004). Thirdly, due to their close location, managers of the customer firm and the supplier firm might have personal connections, or, due to shared culture, be able to easily build social connections with each other (McPherson, Smith-Lovin, and Cook, 2001; Zhu, Pan, Qiu, and Xiao, 2022). These three advantages embedded in the closeness could contribute to a long-lasting and strong supply-chain relationship between these two parties, indicating a lower potential risk of being switched. Thus, the positive relation between customer concentration and the supplier firm's cash flow risk would be weakened by having more major local customers.

Consistent with prior literature of Cohen and Li (2019) and Cao, Dong, Ma, and Sun (2021), we create three dummy variables to proxy for major government customers, foreign customers, and local customers respectively. Specifically, *Government Customer* is equal to 1 for a supplier firm with the government as at least one of its major customers, and 0 otherwise. *Foreign Customer* is equal to 1 for a supplier firm with at least one foreign company as a major customer, and 0 otherwise.

*Local Customer* is equal to 1 for a supplier firm with at least one major customer located in the same province or city as the supplier firm, and 0 otherwise. To test these expectations, we insert the interaction term *Customer Sales (or Customer HHI)\*Government Customer*, *Customer Sales (or Customer HHI)\*Foreign Customer* or *Customer Sales (or Customer HHI)\*Local Customer* in our baseline model respectively and rerun our regressions.

The regressions results considering these three kinds of customers are presented in Tables 10, 11 and 12 respectively. In Table 10 and Table 12, the coefficients of the interaction term *Customer Sales (or Customer HHI)\*Government Customer* or *Customer Sales (or Customer HHI)\*Local Customer* are negative and significant across the tables. This indicates that the positive relation between customer concentration and the supplier firm's cash flow risk is moderated with the presence of major government or local customers. In Table 11, the coefficients of the interaction term *Customer Sales (or Customer HHI)\*Foreign Customer* are positive and significant across the table. This indicates that the positive relation between customer concentration and the supplier firm's cash flow risk is moderated with the presence of major foreign customers. In line with our expectations, these findings reflect that major government and local customers are relatively stable and reliable major customers, mitigating the potential operating and cash flow risk for the supplier firm. On the other hand, major foreign customers are relatively unstable, increasing the potential operating and cash flow risk for the supplier firm.

**[Insert Table 10 here]**

**[Insert Table 11 here]**

**[Insert Table 12 here]**

## **7. Conclusion**

Our study examines how customer concentration impacts the supplier firm's cash flow risk in China. We firstly propose that customer concentration reduces the

supplier firm's cash flow risk. This is because the long-lasting and strong relationship between the supplier firm and its major customers could motivate the information sharing and the strategic collaboration along the supply chain and provide the supplier firm with monitoring and certification effects. We secondly propose that customer concentration increases the supplier firm's cash flow risk. This is because large customers usually squeeze the supplier firm's profit margin, require relation-specific investments, bring about the potential risk of losing them or pass their poor financial conditions onto the supplier firm.

Using a merged database containing 1,503 Chinese firms for the period 2007-2020, we find that customer concentration increases the supplier firm's cash flow risk, thereby providing support for hypothesis 2 (H2). Our findings are also economically important. Our baseline results still hold when we conduct a battery of endogeneity tests and robustness checks. We also find that customer concentration increases the supplier firm's trade credits and relation-specific investments and reduces its profit margin and receivables turnover. The positive relation is more pronounced when the supplier firm's probability of being switched and its major customers' probability of experiencing financial distress and bankruptcy are high. We also find the positive relation is moderated with major government and local customers, while it is augmented with major foreign customers. These cross-sectional tests further strengthen our baseline findings.

Our study adds to the strand of literature on the drivers of cash flow risk or earnings volatility. Our study also extends the rapidly growing literature on how major customers as one type of the most important stakeholders affect the supplier firm's financial and investment policies, and economic outcomes. By investigating this topic in the context of China, our study could draw management researchers' attention to this growing stream of research by showing that customer concentration increases the supplier firm's cash flow risk in China. Our findings can provide guidelines to practitioners and policy makers in China and other emerging economies.

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**Table 1**  
**Summary Statistics**

Panel A of this table reports the distribution of industries with the highest and lowest proportions of sales contributed by the top five major customers in China. Panel B of this table reports the descriptive statistics for the variables used in our regressions during the period of 2007 to 2020. Definitions of all variables are provided in Appendix A. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% level, respectively.

***Panel A: Distribution of industries with highest and lowest proportions of sales contributed by the top five major customers in China***

Rank	Industry	Proportion
Highest		
1	Metal Mining	62.42%
2	Oil & Gas Extraction	61.20%
3	Transportation Equipment Manufacturing	56.97%
4	Coal Mining	53.01%
5	Electric and Gas Services	52.74%
Lowest		
1	Restaurant and Food Service	14.99%
2	Retailing	15.34%
3	Hotels & Other Lodging Places	15.56%
4	Public Administration Service	17.87%
5	Agricultural Production	22.13%

***Panel B: Descriptive statistics of main variables***

Variable	Full sample			Subsample with major customers accounting for 50% or above sales			Subsample with major customers accounting for less than 50% sales			Mean Difference
	N	Mean	SD	N	Mean	SD	N	Mean	SD	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<b><i>Dependent Variables</i></b>										
ROAVol	11,832	0.1839	0.3180	3,194	0.1998	0.3288	8,638	0.1780	0.2954	0.0218***
CFVol	11,832	0.0599	0.0658	3,194	0.0650	0.0680	8,638	0.0580	0.0603	0.0070***

CashShort	11,832	0.0239	0.0737	3,194	0.0312	0.0745	8,638	0.0212	0.0716	0.0100***
<b><i>Independent Variables</i></b>										
Customer Sales	11,832	0.3175	0.2304	3,194	0.7043	0.2526	8,638	0.1745	0.2266	0.5298***
Customer HHI	11,832	0.0634	0.1336	3,194	0.0969	0.1539	8,638	0.0510	0.1231	0.0459***
<b><i>Controls</i></b>										
Size	11,832	21.9492	9.9901	3,194	21.7913	10.2345	8,638	22.0076	9.8284	-0.2163***
Sales Growth	11,832	0.1836	0.4802	3,194	0.1920	0.4969	8,638	0.1805	0.4484	0.0115
Capital Expenditures	11,832	-0.0568	0.0841	3,194	-0.0566	0.0859	8,638	-0.0569	0.0804	0.0003
Scaled Debts	11,832	0.0577	0.0829	3,194	0.0574	0.0854	8,638	0.0578	0.0779	-0.0004
Tangibility	11,832	0.2335	0.1697	3,194	0.2365	0.1706	8,638	0.2324	0.1675	0.0041***
R&D Expenditures	11,832	0.0519	0.1255	3,194	0.0570	0.1248	8,638	0.0501	0.1280	0.0069***
Profitability	11,832	0.0270	0.0746	3,194	0.0224	0.0790	8,638	0.0287	0.0650	-0.0063***
Stock Return Volatility	11,832	0.1344	0.0615	3,194	0.1385	0.0623	8,638	0.1329	0.0595	0.0056***

**Table 2**

**Customer concentration and supplier cash flow risk: Baseline results**

This table reports panel regression results of the supplier firm's cash flow risk on customer concentration for Chinese firms during the sample period of 2007 to 2020. In terms of dependent variables, *ROAVol* is operating profit volatility calculated as the standard deviation of operating rate of return (i.e., operating income/total assets) over the past five years including the current fiscal year. *CFVol* is cash flow volatility calculated as the standard deviation of the ratios of operating cash flow to total assets for the previous five years. *CashShort* is cash flow shortfall measured as expected investment plus expected dividend minus available cash flow. As to explanatory variables, *Customer Sales* is the proportion of a supplier's annual sales to the top five major customers over the supplier's total sales. *Customer HHI* is a Herfindahl-Hirschman index, measured by the sum of squared sales to the top five customers scaled by the supplier's total sales. Definitions of all variables are provided in Appendix A. In all columns, industry and year fixed effects are controlled. The heteroscedasticity robust standard errors are clustered at the firm level and standard errors are shown in parentheses. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% level, respectively.

**Panel A: Customer Sales**

Dependent Variables	<b>ROAVol</b>	<b>CFVol</b>	<b>CashShort</b>	<b>ROAVol</b>	<b>CFVol</b>	<b>CashShort</b>
	(1)	(2)	(3)	(4)	(5)	(6)
<b>Customer Sales</b>	<b>0.1578***</b>	<b>0.0322***</b>	<b>0.0114***</b>	<b>0.0713***</b>	<b>0.0159***</b>	<b>0.0111***</b>
	(0.009)	(0.002)	(0.002)	(0.010)	(0.002)	(0.002)
Size				-0.1511***	-0.0307***	-0.0047***
				(0.003)	(0.001)	(0.001)
Sales Growth				0.1613***	0.0224***	0.0061***
				(0.003)	(0.001)	(0.001)
Capital Expenditures				0.0936***	0.0207***	0.1041***
				(0.017)	(0.003)	(0.004)
Scaled Debts				0.0242	0.0080	0.0785***
				(0.024)	(0.005)	(0.006)
Tangibility				-0.1271***	-0.0223***	-0.0347***
				(0.015)	(0.003)	(0.004)
R&D Expenditures				0.0591	0.2522***	0.0106
				(0.218)	(0.044)	(0.049)
Profitability				-0.2866***	-0.0223***	-0.1623***
				(0.021)	(0.004)	(0.005)
Stock Return Volatility				0.0129	0.0143***	0.0182***
				(0.024)	(0.005)	(0.006)
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	11,832	11,832	11,832	11,832	11,832	11,832
R-sq	0.244	0.246	0.181	0.285	0.283	0.241

**Panel B: Customer HHI**

Dependent Variables	ROAVol (1)	CFVol (2)	CashShort (3)	ROAVol (4)	CFVol (5)	CashShort (6)
<b>Customer HHI</b>	<b>0.1962***</b> <b>(0.022)</b>	<b>0.0390***</b> <b>(0.004)</b>	<b>0.0111***</b> <b>(0.000)</b>	<b>0.0773***</b> <b>(0.024)</b>	<b>0.0154***</b> <b>(0.005)</b>	<b>0.0119***</b> <b>(0.000)</b>
Size				-0.1629*** (0.005)	-0.0320*** (0.001)	-0.0044*** (0.001)
Sales Growth				0.1748*** (0.004)	0.0223*** (0.001)	0.0057*** (0.001)
Capital Expenditures				0.1137*** (0.028)	0.0218*** (0.006)	0.0891*** (0.007)
Scaled Debts				0.0720* (0.044)	0.0063 (0.009)	0.0903*** (0.011)
Tangibility				-0.0988*** (0.027)	-0.0220*** (0.005)	-0.0258*** (0.007)
R&D Expenditures				0.7397* (0.381)	0.4118*** (0.076)	-0.0978 (0.082)
Profitability				-0.2570*** (0.038)	-0.0182** (0.008)	-0.1317*** (0.009)
Stock Return Volatility				0.0153 (0.042)	0.0088 (0.008)	0.0093 (0.010)
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	11,832	11,832	11,832	11,832	11,832	11,832
R-sq	0.239	0.253	0.173	0.283	0.284	0.227

**Table 3****Customer concentration and supplier cash flow risk: PSM analyses**

This table reports regression results of the supplier firm's cash flow risk on customer concentration using a matched sample of customer-concentrated firms and non-customer-concentrated firms during the sample period of 2007 to 2020. Panel A provides details on the matched sample between customer-concentrated firms and non-customer-concentrated firms. Firms with major customers contributing to 50% or above of their sales are regarded as those with concentrated customer bases and are assigned to the treatment group and the rest into the control group. Using a one-to-one matching method without replacement, for each customer-concentrated firm, we select one non-customer-concentrated firm that is closest to this customer-concentrated firm based on observable firm characteristics. Panel B reports regressions results using the matched sample. Definitions of variables are provided in Appendix A. In all columns, industry and year fixed effects are controlled. The heteroscedasticity robust standard errors are clustered at the firm level and standard error s are shown in parentheses. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% level, respectively.

**Panel A: PSM results**

	Treat Group (1)	Control Group (2)	Mean Difference (3)	P-value (4)
Size	22.039	22.025	0.014	0.383
Sales Growth	0.190	0.191	-0.001	0.844
Capital Expenditures	0.062	0.061	0.001	0.218
Scaled Debts	0.056	0.052	0.004	0.881
Tangibility	0.222	0.237	-0.015	0.223
R&D Expenditures	0.040	0.041	-0.001	0.325
Profitability	0.031	0.030	0.001	0.562
Stock Return Volatility	0.138	0.137	0.001	0.281

**Panel B: Regressions results using PSM**

Dependent Variables	ROAVol (1)	CFVol (2)	CashShort (3)	ROAVol (4)	CFVol (5)	CashShort (6)
<b>Customer Sales</b>	<b>0.0653***</b> <b>(0.015)</b>	<b>0.0158***</b> <b>(0.003)</b>	<b>0.0098**</b> <b>(0.004)</b>			
<b>Customer HHI</b>				<b>0.0762***</b> <b>(0.027)</b>	<b>0.0221***</b> <b>(0.005)</b>	<b>0.0113**</b> <b>(0.005)</b>
Size	-0.1603*** (0.005)	-0.0297*** (0.001)	-0.0038*** (0.001)	-0.1666*** (0.006)	-0.0325*** (0.001)	-0.0051*** (0.002)
Sales Growth	0.1676*** (0.004)	0.0220*** (0.001)	0.0058*** (0.001)	0.1795*** (0.005)	0.0226*** (0.001)	0.0049*** (0.001)
Capital Expenditures	0.1036*** (0.029)	0.0253*** (0.006)	0.1073*** (0.007)	0.1100*** (0.034)	0.0249*** (0.007)	0.0894*** (0.009)
Scaled Debts	0.0121 (0.040)	0.0012 (0.008)	0.0869*** (0.010)	0.0301 (0.051)	0.0088 (0.010)	0.0956*** (0.013)
Tangibility	-0.0772***	-0.0285***	-0.0321***	-0.0921***	-0.0246***	-0.0172**

	(0.025)	(0.005)	(0.006)	(0.032)	(0.006)	(0.008)
R&D Expenditures	0.2586	0.3141***	-0.0302	0.8031*	0.4361***	0.1070
	(0.375)	(0.073)	(0.095)	(0.459)	(0.091)	(0.118)
Profitability	-0.2530***	-0.0098	-0.1458***	-0.2859***	-0.0205**	-0.1322***
	(0.036)	(0.007)	(0.009)	(0.043)	(0.008)	(0.011)
Stock Return Volatility	0.0591	0.0135*	0.0160	0.0217	0.0081	0.0176
	(0.041)	(0.008)	(0.010)	(0.048)	(0.009)	(0.012)
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	6,368	6,368	6,368	6,368	6,368	6,368
R-sq	0.266	0.274	0.220	0.270	0.273	0.211

**Table 4**

**Customer concentration and supplier cash flow risk: IV analyses**

This table presents panel regression results of the supplier firm's cash flow risk on customer concentration using 2SLS instrumental variables method. *Industry\_Customer Sales* and *Industry\_Customer HHI*, measured as the lag of the industry-year median customer concentration measures, are used as the instrumental variables. For brevity, we do not report the estimated parameters of control variables. Definitions of all variables are provided in Appendix A. In all columns, industry and year fixed effects are controlled. The heteroscedasticity robust standard errors are clustered at the firm level and standard errors are shown in parentheses. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables	(1)	(2)	ROAVol (3)	CFVol (4)	CashShort (5)	ROAVol (6)	CFVol (7)	CashShort (8)
<i>First-stage</i>								
Industry_Customer Sales	0.2431*** (0.020)							
Industry_Customer HHI		0.1171*** (0.016)						
<i>Second-stage</i>								
<b>Customer Sales</b>			<b>0.1474*** (0.016)</b>	<b>0.0415*** (0.013)</b>	<b>0.0358*** (0.013)</b>			
<b>Customer HHI</b>						<b>0.1802*** (0.015)</b>	<b>0.0395*** (0.015)</b>	<b>0.0351*** (0.013)</b>
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
N	11,832	11,832	11,832	11,832	11,832	11,832	11,832	11,832
F-statistic	22.37	29.82						

**Table 5**

**Customer concentration and supplier cash flow risk: Alternative measures of customer concentration**

This table presents panel regression results of the supplier firm's cash flow risk on customer concentration using alternative measures of customer concentration. *Major Customer* is a dummy variable that equals to 1 if a supplier firm discloses at least one customer that accounts for 10% or more of its total sales, and 0 otherwise. *Major Customer Max* is defined as the highest percentage sales to the top one major customer. *Major Customer Count* is the total number of a supplier firm's customers that account for 10% or more of its total sales. For brevity, we do not report the estimated parameters of control variables. Definitions of all variables are provided in Appendix A. In all columns, industry and year fixed effects are controlled. The heteroscedasticity robust standard errors are clustered at the firm level and standard errors are shown in parentheses. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables	ROAVol	CFVol	CashShort	ROAVol	CFVol	CashShort	ROAVol	CFVol	CashShort
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<b>Major Customer</b>	<b>0.0165***</b> <b>(0.006)</b>	<b>0.0051***</b> <b>(0.001)</b>	<b>0.0031***</b> <b>(0.001)</b>						
<b>Major Customer Max</b>				<b>0.1435***</b> <b>(0.020)</b>	<b>0.0311***</b> <b>(0.007)</b>	<b>0.0220***</b> <b>(0.000)</b>			
<b>Major Customer Count</b>							<b>0.0089**</b> <b>(0.004)</b>	<b>0.0025**</b> <b>(0.001)</b>	<b>0.0020***</b> <b>(0.000)</b>
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	11,832	11,832	11,832	11,832	11,832	11,832	11,832	11,832	11,832
R-sq	0.255	0.263	0.198	0.255	0.264	0.193	0.256	0.264	0.190



Table 6

**Customer concentration and supplier cash flow risk:**

**Excluding the smallest suppliers and the 2007-2009 financial crisis period**

This table presents panel regression results of the supplier firm's cash flow risk on customer concentration after excluding the smallest 10% suppliers in terms of sales and the 2007-2009 financial crisis period, respectively. For brevity, we do not report the estimated parameters of control variables. Definitions of all variables are provided in Appendix A. In all columns, industry and year fixed effects are controlled. The heteroscedasticity robust standard errors are clustered at the firm level and standard errors are shown in parentheses. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% level, respectively.

***Panel A: Excluding the smallest 10% suppliers based on sales***

Dependent Variables	ROAVol (1)	CFVol (2)	CashShort (3)	ROAVol (4)	CFVol (5)	CashShort (6)
<b>Customer Sales</b>	<b>0.0670***</b> (0.014)	<b>0.0166***</b> (0.003)	<b>0.0095***</b> (0.001)			
<b>Customer HHI</b>				<b>0.0826***</b> (0.025)	<b>0.0158***</b> (0.005)	<b>0.0098***</b> (0.001)
Controls	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	10,648	10,648	10,648	10,648	10,648	10,648
R-sq	0.245	0.275	0.194	0.266	0.277	0.201

***Panel B: Excluding the 2007-2009 financial crisis period***

Dependent Variables	ROAVol (1)	CFVol (2)	CashShort (3)	ROAVol (4)	CFVol (5)	CashShort (6)
<b>Customer Sales</b>	<b>0.0678***</b> (0.015)	<b>0.0133***</b> (0.003)	<b>0.0076**</b> (0.003)			
<b>Customer HHI</b>				<b>0.0670**</b> (0.027)	<b>0.0132***</b> (0.005)	<b>0.0082***</b> (0.003)
Controls	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	9,385	9,385	9,385	9,385	9,385	9,385
R-sq	0.266	0.278	0.197	0.263	0.290	0.206

**Table 7**

**Customer concentration, supplier trade credits and relationship-specific investments**

Panel A of this table presents panel regression results of the supplier firm's trade credits, receivables turnover and profit margin on customer concentration and Panel B presents those of the supplier firm's relationship-specific investments on customer concentration. *Trade Credits* is the ratio of accounts receivables to total assets of the supplier firm. *Profit Margin* is the ratio of operating income to total sales. *Receivables Turnover* is the ratio of total sales to receivables. As the proxy of relationship-specific investments, *R&D Expenditures* is calculated as R&D expenditures scaled by total assets. In Panel B, *R&D Expenditures* is not included in control variables. For brevity, we do not report the estimated parameters of control variables. Definitions of all variables are provided in Appendix A. In all columns, industry and year fixed effects are controlled. The heteroscedasticity robust standard errors are clustered at the firm level and standard errors are shown in parentheses. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% level, respectively.

**Panel A: Supplier trade credits, receivables turnover and profit margin**

Dependent Variables	Trade Credits (1)	Receivables Turnover (2)	Profit Margin (3)	Trade Credits (4)	Receivables Turnover (5)	Profit Margin (6)
<b>Customer Sales</b>	<b>0.0265***</b> <b>(0.003)</b>	<b>-16.8684***</b> <b>(0.902)</b>	<b>-0.1582***</b> <b>(0.013)</b>			
<b>Customer HHI</b>				<b>0.0241***</b> <b>(0.005)</b>	<b>-10.2471***</b> <b>(1.692)</b>	<b>-0.0776***</b> <b>(0.025)</b>
Controls	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	11,832	11,832	11,832	11,832	11,832	11,832
R-sq	0.342	0.376	0.249	0.338	0.358	0.248

**Panel B: Supplier relationship-specific investments**

Dependent Variables	R&D Expenditures	
	(1)	(2)
<b>Customer Sales</b>	<b>0.0169***</b> <b>(0.001)</b>	
<b>Customer HHI</b>		<b>0.0146***</b> <b>(0.002)</b>
Controls	YES	YES
Industry FE	YES	YES
Year FE	YES	YES
N	11,832	11,832
R-sq	0.217	0.201

**Table 8**

**Customer concentration and supplier cash flow risk: The supplier's probability of being switched**

This table presents panel regression results of the supplier firm's cash flow risk on the dynamics of customer concentration and the supplier firm's probability of being switched. The supplier firm's probability of being switched is proxied by the supplier firm's market share, calculated as the ratio of the supplier firm's total sales to its industry's total sales using CSRC classification. The lower the supplier firm's market share indicates higher probability of being switched. The interaction term *Customer Sales* (or *Customer HHI*)\**Market Share* represents the dynamics of customer concentration and the supplier firm's probability of being switched on cash flow risk. For brevity, we do not report the estimated parameters of control variables. Definitions of all variables are provided in Appendix A. In all columns, industry and year fixed effects are controlled. The heteroscedasticity robust standard errors are clustered at the firm level and standard errors are shown in parentheses. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables	ROAVol (1)	CFVol (2)	CashShort (3)	ROAVol (4)	CFVol (5)	CashShort (6)
<b>Customer Sales* Market Share</b>	<b>-0.0283***</b> (0.002)	<b>-0.0103**</b> (0.005)	<b>-0.0064***</b> (0.001)			
<b>Customer HHI* Market Share</b>				<b>-0.0653***</b> (0.004)	<b>-0.0203**</b> (0.009)	<b>-0.0115***</b> (0.001)
Customer Sales	0.0960*** (0.008)	0.0302*** (0.004)	0.0198*** (0.004)			
Customer HHI				0.1126*** (0.032)	0.0344*** (0.006)	0.0214*** (0.008)
Market Share	-0.0225** (0.010)	-0.0024 (0.002)	-0.0081*** (0.002)	-0.0013 (0.008)	-0.0004 (0.002)	-0.0041** (0.002)
Controls	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	11,832	11,832	11,832	11,832	11,832	11,832
R-sq	0.372	0.369	0.266	0.368	0.373	0.237

**Table 9**

**Customer concentration and supplier cash flow risk:**

**Major customers' probability of experiencing financial distress or bankruptcy**

This table presents panel regression results of the supplier firm's cash flow risk on the dynamics of customer concentration and major customers' probability of experiencing financial distress or bankruptcy. Whether a major customer is listed or not is used to proxy for its probability of experiencing financial distress or bankruptcy. *Listed Customer %* is the ratio of listed major customers to all major customers. The interaction term *Customer Sales (or Customer HHI) \*Listed Customer %* represents the dynamics of customer concentration and major customers' probability of experiencing financial distress or bankruptcy on cash flow risk. For brevity, we do not report the estimated parameters of control variables. Definitions of all variables are provided in Appendix A. In all columns, industry and year fixed effects are controlled. The heteroscedasticity robust standard errors are clustered at the firm level and standard errors are shown in parentheses. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables	ROAVol (1)	CFVol (2)	CashShort (3)	ROAVol (4)	CFVol (5)	CashShort (6)
<b>Customer Sales Listed *</b>	<b>-0.0408***</b>	<b>-0.0012***</b>	<b>-0.0018*</b>			
<b>Customer %</b>	<b>(0.003)</b>	<b>(0.000)</b>	<b>(0.001)</b>			
<b>Customer HHI * Listed Customer %</b>				<b>-0.0314***</b>	<b>-0.0010***</b>	<b>-0.0015***</b>
				<b>(0.001)</b>	<b>(0.000)</b>	<b>(0.000)</b>
Customer Sales	0.0900*** (0.010)	0.0179*** (0.002)	0.0091*** (0.002)			
Customer HHI				0.1050*** (0.018)	0.0250*** (0.004)	0.0079** (0.004)
Listed Customer %	0.0145 (0.014)	-0.0030 (0.003)	0.0040 (0.003)	-0.0012*** (0.000)	0.0000 (0.000)	-0.0002** (0.000)
Controls	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	11,832	11,832	11,832	11,832	11,832	11,832
R-sq	0.292	0.290	0.267	0.293	0.297	0.244

**Table 10****Customer concentration and the supplier's cash flow risk: the effect of major government customers**

This table presents panel regression results of the supplier firm's cash flow risk on the dynamics of customer concentration and major government customers. As a dummy variable, *Government Customer* is equal to 1 for a supplier firm with the government as at least one of its major customers, and 0 otherwise. The interaction term *Customer Sales* (or *Customer HHI*) \* *Government Customer* represents the dynamics of customer concentration and major government customers on cash flow risk. For brevity, we do not report the estimated parameters of control variables. Definitions of all variables are provided in Appendix A. In all columns, industry and year fixed effects are controlled. The heteroscedasticity robust standard errors are clustered at the firm level and standard errors are shown in parentheses. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables	ROAVol (1)	CFVol (2)	CashShort (3)	ROAVol (4)	CFVol (5)	CashShort (6)
<b>Customer Sales*</b>						
<b>Government Customer</b>	<b>-0.0525**</b> (0.022)	<b>-0.0120**</b> (0.006)	<b>-0.0179**</b> (0.007)			
<b>Customer HHI*</b>						
<b>Government Customer</b>				<b>-0.0884**</b> (0.039)	<b>-0.0278***</b> (0.008)	<b>-0.0146**</b> (0.007)
Customer Sales	0.0978*** (0.011)	0.0193*** (0.002)	0.0312*** (0.002)			
Customer HHI				0.1306*** (0.023)	0.0375*** (0.005)	0.0232*** (0.001)
Government Customer	0.0107 (0.019)	-0.0064* (0.004)	-0.0079** (0.004)	0.0022 (0.010)	-0.0012 (0.002)	-0.0040* (0.002)
Controls	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	11,832	11,832	11,832	11,832	11,832	11,832
R-sq	0.294	0.292	0.266	0.296	0.293	0.245

**Table 11****Customer concentration and the supplier's cash flow risk: the effect of major foreign customers**

This table presents panel regression results of the supplier firm's cash flow risk on the dynamics of customer concentration and major government customers. As a dummy variable, *Foreign Customer* is equal to 1 for a supplier firm with at least one foreign company as a major customer, and 0 otherwise. The interaction term *Customer Sales (or Customer HHI) \* Foreign Customer* represents the dynamics of customer concentration and major foreign customers on cash flow risk. For brevity, we do not report the estimated parameters of control variables. Definitions of all variables are provided in Appendix A. In all columns, industry and year fixed effects are controlled. The heteroscedasticity robust standard errors are clustered at the firm level and standard errors are shown in parentheses. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables	ROAVol (1)	CFVol (2)	CashShort (3)	ROAVol (4)	CFVol (5)	CashShort (6)
<b>Customer Sales* Foreign Customer</b>	<b>0.0687**</b> (0.034)	<b>0.0127***</b> (0.004)	<b>0.0034*</b> (0.002)			
<b>Customer HHI* Foreign Customer</b>				<b>0.1064**</b> (0.047)	<b>0.0169**</b> (0.008)	<b>0.0106*</b> (0.006)
Customer Sales	0.0418*** (0.010)	0.0061*** (0.002)	0.0087*** (0.002)			
Customer HHI				0.0349** (0.016)	0.0024** (0.001)	0.0087** (0.004)
Foreign Customer	-0.0270* (0.014)	-0.0081*** (0.003)	-0.0001 (0.003)	-0.0098 (0.009)	-0.0033* (0.002)	-0.0003 (0.002)
Controls	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	11,832	11,832	11,832	11,832	11,832	11,832
R-sq	0.294	0.296	0.265	0.293	0.298	0.243

**Table 12**

**Customer concentration and the supplier's cash flow risk: the effect of major local customers**

This table presents panel regression results of the supplier firm's cash flow risk on the dynamics of customer concentration and major local customers. As a dummy variable, *Local Customer* is equal to 1 for a supplier firm with at least one major customer located in the same province or city as the supplier firm, and 0 otherwise. The interaction term *Customer Sales* (or *Customer HHI*) \* *Local Customer* represents the dynamics of customer concentration and major local customers on cash flow risk. For brevity, we do not report the estimated parameters of control variables. Definitions of all variables are provided in Appendix A. In all columns, industry and year fixed effects are controlled. The heteroscedasticity robust standard errors are clustered at the firm level and standard errors are shown in parentheses. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% level, respectively.

**Panel A: Mutual Province**

Dependent Variables	ROAVol	CFVol	CashShort	ROAVol	CFVol	CashShort
	(1)	(2)	(3)	(4)	(5)	(6)
<b>Customer Sales* Local Customer</b>	<b>-0.0011*** (0.000)</b>	<b>-0.0163*** (0.004)</b>	<b>-0.0135** (0.006)</b>			
<b>Customer HHI* Local Customer</b>				<b>-0.0070** (0.003)</b>	<b>-0.0095** (0.004)</b>	<b>-0.0112* (0.007)</b>
Customer Sales	0.0350** (0.016)	0.0251*** (0.003)	0.0064** (0.003)			
Customer HHI				0.0419*** (0.013)	0.0163** (0.007)	0.0098*** (0.001)
Local Customer	-0.0364*** (0.008)	-0.0020 (0.002)	-0.0031* (0.002)	-0.0287*** (0.005)	-0.0074*** (0.001)	-0.0022** (0.001)
Controls	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	11,832	11,832	11,832	11,832	11,832	11,832
R-sq	0.291	0.305	0.227	0.290	0.304	0.227

**Panel B: Mutual City**

Dependent Variables	ROAVol	CFVol	CashShort	ROAVol	CFVol	CashShort
	(1)	(2)	(3)	(4)	(5)	(6)
<b>Customer Sales* Local Customer</b>	<b>-0.0349** (0.016)</b>	<b>-0.0084*** (0.003)</b>	<b>-0.0100*** (0.003)</b>			
<b>Customer HHI*Local Customer</b>				<b>-0.0734*** (0.027)</b>	<b>-0.0217*** (0.006)</b>	<b>-0.0106** (0.005)</b>

Customer Sales	0.0881*** (0.013)	0.0175*** (0.003)	0.0032 (0.003)			
Customer HHI				0.1246*** (0.024)	0.0298*** (0.005)	0.0188*** (0.005)
Local Customer	-0.0164** (0.007)	-0.0018 (0.001)	-0.0056*** (0.001)	-0.0224*** (0.004)	-0.0071*** (0.001)	-0.0036*** (0.001)
Controls	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	11,832	11,832	11,832	11,832	11,832	11,832
R-sq	0.291	0.306	0.226	0.290	0.304	0.226



**Appendix A**  
**Definitions of variables**

<b>Variable Name</b>	<b>Definition</b>
<b><i>Dependent Variables</i></b>	
ROAVol	The standard deviation of operating rate of return (i.e., operating income/total assets) over the past five years including the current fiscal year.
CFVol	The standard deviation of the ratios of operating cash flow to total assets for the past five years.
CashShort	Expected investment plus expected dividend minus available cash flow. Expected dividend equals to dividend paid in the previous year. Expected investment is the median value of industry investment scaled by total assets, where industry investment includes capital expenditure for fixed assets, intangible assets, and other long-term assets.
<b><i>Independent Variables</i></b>	
Customer Sales	The fraction of a supplier's annual total sales to the top five major customers.
Customer HHI	Customer concentration Herfindahl-Hirschman index, measured by the sum of squared sales to the top five customers scaled by the supplier firm's total sales.
Major Customer	A dummy variable that equals to 1 if a supplier firm discloses at least one customer that accounts for 10% or more of its total sales, and 0 otherwise.
Major Customer Max	The highest percentage sales to the top one major customer.
Major Customer Count	The total number of a supplier firm's customers that account for 10% or more of its total sales.
<b><i>Controls</i></b>	
Firm Size	The logarithm of total assets.
Sales Growth	The difference of current sales and lagged sales divided by lagged sales.
Capital Expenditures	Capital expenditures scaled by total assets.
Scaled debts	Long-term debts scaled by total assets.
Tangibility	Tangible assets scaled by total assets.
R&D Expenditures	R&D expenditures scaled by total assets.
Profitability	Return on assets (ROA).
Stock Return Volatility	The standard deviation of monthly stock returns.