



Does a firm's supplier concentration affect its cash holding?

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ABSTRACT

High supplier concentration (SC) of a firm can weaken the firm's bargaining power, which reduces its profitability and internal funds. Also, high SC likely increases the firm's exposure to supply shocks, which results in high costs of external financing. Consequently, high-SC firms will incline to hold more cash due to the precautionary concern. However, there is little research into the effect of SC on cash holdings. This paper investigates how SC affects cash holdings with Chinese firms over 2009–2016. We find that a firm's cash holding increases with its SC. Further investigations show that this positive relation stems from the unfavorable impact of SC on trade credit and equity financing. Our results are robust to different tests including the instrumental variable approach and the propensity score matching. Our findings are new to the literature and help to explain the cash holding puzzle. Our study also indicates that choosing supplier concentration adequately is important in maintaining a firm's financial health.

1. Introduction

A growing literature has examined the impacts of supplier-customer relationship on corporate decisions (Chu et al., 2018). These studies, however, focus particularly on how a firm's customer concentration affects its financing decision, and largely overlook the other side.¹ That is, there is little evidence showing how a firm's supplier concentration (SC) influences its financing decision. This paper attempts to fill the gap by examining the relation between a firm's supplier concentration and the firm's cash holding.

There are good reasons for focusing on the relation between a firm's SC and its cash holding. One stems from the SC risk, which we define it as the danger from the supply shocks including sudden break-down of supplies of materials and services, unfavorable changes in contract terms,

and costs of switching suppliers. The consequence of the SC risk is the reduction of trade credit, bank loan, and equity financing, and in turn leads to the exaggeration of financial constraints (Pal et al., 2012). The other one stems from the weakening of the firm's bargaining power, which harms the firm's profitability and exacerbates financial constraints. To deal with the worsening of financial constraints, high SC firms may have to increase their cash holdings. In addition, holding normal amount of cash is important, but studies (e.g., Bates et al., 2009) reveal that corporate cash holdings appear to be abnormal, i.e., the cash holding puzzle.² Therefore, considerable attention has been paid to study the puzzle (e.g., Opler et al., 1999; Dittmar et al., 2003; Harford et al., 2014; Shah and Shah, 2016). However, all existing studies largely ignore the SC impact on corporate cash holdings.³

Firms have a strong incentive to establish a long-term relationship

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¹ For instance, studies have investigated the impact of customer concentration on cost of equity capital (Dhaliwal et al., 2016), Capital structure (Banerjee et al., 2008), Loan contract terms (Campello and Gao, 2017), Corporate tax avoidance (Cen et al., 2017) and so on.

² Holding a certain amount of cash is the basis for enterprises to operate normal production activities and avoid payment crisis. Holding too much cash has two adverse effects. First, cash is the weakest profitability, holding too much cash will reduce the profitability. Second, it may lead to the increase of agency costs such as overinvestment. On the other hand, holding too little cash may fail to capture the profitable investment opportunities and/or to fulfill the needed payments.

³ One paper by Itzkowitz (2013) seems touch the supplier-customer relationship on cash holdings, but our study differs from his work, which focuses on the customer concentration rather than on supplier concentration. As to SC, the existing literature emphasizes solely on its relation to audit services (Pearson and Trompeter, 1994; Johnson et al., 1995; and Willekens and Achmadi, 2003).

with their suppliers (Dhaliwal et al., 2016). This is because suppliers of a firm are important external stakeholders and provide necessary raw materials and service to the firm (Kalwani and Narayandas, 1995). As a result, suppliers considerably affect the firm's operation (Kesavayuth and Zikos, 2012). To examine the relation between suppliers and the downstream firms, the Chinese stock market provides a good laboratory for testing the link. The China Securities Regulatory Commission (CSRC) requires that listed companies should disclose the information of their top five suppliers including the purchase amount, the proportion of purchase, and the names of suppliers.⁴ This disclosure requirement provides necessary data for our proposed study. In addition, it is commonly observed that many listed firms in China show high degree of supplier concentration. Over 2009 to 2016, nearly 56% of public firms rely largely on one major supplier, where the major supplier is the one that supplies more than 10% of the materials and services. The total purchase amount from the top five suppliers accounts for 36%.

However, relying on high degree of supplier concentration can be costly for the following reasons. First, high supplier concentration of a firm reduces the firm's bargaining power. For instance, suppliers can require spot payment or even pre-payment for the raw materials and service provided. In our sample, we do find that firms with high supplier concentration make prepayment for their purchases from their suppliers. This, in turn, reduces the firm's trade credit. Second, supplier concentration can lead to high costs of changing suppliers when unexpected supply shock happens. Third, sudden break down of the relationship between supplier and its downstream firm involves additional costs in relationship-specific investment and building a new supplier-customer network (Banerjee et al., 2008; Tran and Zikos, 2017). All the costs encountered inevitably result in the increase of financial constraints.

To further explain the argument that supplier concentration can lead to financial constraints, we consider the following channels. One is that supplier concentration decreases trade credit, as mentioned above. This is because high supplier concentration of a firm strengthens suppliers' bargaining power. Thus, suppliers may gain favorable contract terms, e.g., shortening the payment period, reducing the credit limit, charging for transportation and insurance fees, etc. These will cut down the commercial credit and deteriorate financing constraints for the downstream firm (Duchin, 2010). The other one is that banks may perceive the high supplier concentration as a risk. Intuitively, once a firm's suppliers encounter unfavorable business shocks, the firm's normal operation can be abrupted and suffer losses. This clearly increases the solvency constraints of the firm (Jorion and Zhang, 2009). Therefore, banks may set more restrictive loan terms with firms that exhibit high supplier concentration (Kalwani and Narayandas, 1995), and bank loan in China is the dominant way of debt financing. In addition, high SC can also lead to the difficulty of equity financing. Based on the CSRC requirement, applications for IPOs and SEOs may not be approved if SC is overly high.⁵ Similarly, shareholders may also care about the SC risk and require a higher risk premium. Because of the financial constraints caused and the precautionary consideration (Bates et al., 2009), we hypothesize that a firm's supplier concentration positively affects its cash holdings.

To test our hypothesis, we propose two measures to capture the degree of supplier concentration. One is the purchase proportion from the largest supplier and the other is the proportion from the top five suppliers. To ascertain the driving force behind the SC-cash holding relation, we explore different financial constraint channels. For robustness, we utilize different financial constraint measures in our tests.

We find supportive evidence to our hypothesis. Firms with higher SC tend to hold more cash. This relation is more pronounced when the firm

⁴ For detailed specification see the Contents and Format of Annual Report of Listed Companies.

⁵ For example, IPO applications of Shanghai Yi RuiGuang Electronic Technology and Beijing Guoke Huanyu Technology, etc., are not approved by CSRC due to their high SC.

experiences high financial constraints. Our findings are robust to alternative measures of cash holding, financial constraints, and SC definitions. Also, the SC-cash holding relation remains significant after controlling for the common determinants of cash holdings documented in the previous literature. To deal with the endogeneity issue, we apply the instrumental variable (IV) estimation procedure, as suggested by Hamilton and Nickerson (2003). We also use mergers and acquisitions (M&A) as exogenous shocks on SC to cope with the endogeneity concern. Overall, our results show that a firm's SC causes the reductions of the firm's trade credit, long-term bank loan, and equity financing capacity. The consequence is the deterioration of the firm's financial constraints and it in turn leads to the increase of corporate cash holdings.

The remainder of this paper is organized as follows. Section 2 describes the sample, variables, and empirical methodology. In Section 3, we present the main empirical results. Section 4 discuss the underlying mechanism driving our findings. Section 5 conducts the additional robustness tests. Section 6 concludes the paper.

2. Data and empirical methodology

Our sample contains all A-share firms listed in the Shanghai Stock Exchange and Shenzhen Stock Exchange. We collect data from the China Stock Market and Accounting Research Database (CSMAR). It includes detailed information on suppliers as well as accounting and stock market data for Chinese listed firms. Our sample period is from 2009 to 2016. This is because supplier information before 2009 in CSMAR is very limited, although Chinese regulator, CSRC, requires public companies to disclose information of major suppliers such as amount and proportion of purchase since 2007. We exclude financial firms and firms without supplier information. Our final sample contains 2121 firms with 8634 firm-year observations. Nevertheless, in most cases we use a common sample containing 7724 firm-year observations. To mitigate the effect of outliers, we winsorize the values of the relevant variables at the 1% level for both tails in conducting our empirical work.

We define our key variables used in this study as follows. We use two cash holding measures. One is the ratio of cash and cash equivalents to total assets minus cash and cash equivalents (*cash1*), similar to Opler et al. (1999), and the other one is the cash-to-sales ratio (*cash2*). We define two SC measures, inspired by the definition of customer concentration proposed by Itzkowitz (2013), Dhaliwal et al. (2016), and Campello and Gao, 2017. Our first SC proxy (SC1) is the purchase ratio from the largest supplier, and the second (SC2) is the purchasing ratio from the top five suppliers. For detailed descriptions of other variables such as return to asset (ROA), leverage, etc. See Appendix A.

Table 1 provides descriptive statistics of the major variables used in this study. The mean (median) value of the cash-to-asset ratio (*cash1*) is 0.31 (0.18). The corresponding figures for *cash2* are 0.50 (0.29). The mean (median) value of SC1 is 0.36 (0.31) and it is 0.36 (0.32) for SC2. That is, the average firm purchase 36% of the materials and service from the top five suppliers, implying that firms largely depend on their major suppliers. The average firm's total asset is 76.42RMB billion with

Table 1
Summary statistics.

variable	N	mean	sd	p25	p50	p75
cash1	8634	0.31	0.39	0.1	0.18	0.34
cash2	8634	0.50	1.05	0.15	0.29	0.56
SC1	8634	0.16	0.14	0.07	0.12	0.21
SC2	8634	0.36	0.21	0.21	0.32	0.49
lev	8634	0.41	0.21	0.24	0.39	0.57
roa	8634	0.04	0.06	0.01	0.04	0.07
Size(billion)	8634	76.42	216.52	13.87	26.82	57.72
tbq	8158	2.64	2.38	1.08	1.92	3.36
cflow	8569	0.07	0.18	0.00	0.06	0.14
g1	8038	0.21	0.62	-0.04	0.1	0.27
soe	8634	0.30	0.46	0.00	0.00	1.00
top1	8634	34.74	14.94	22.78	32.72	44.79

Table 2
Baseline regression of cash holdings on supplier concentration.

	(1)	(2)	(3)	(4)	(5)	(6)
	cash1	cash1	cash1	cash1	cash1	cash1
SC1	0.1183*** (3.41)	0.2325*** (4.85)	0.1035*** (3.06)			
SC2				0.1121*** (4.84)	0.2592*** (7.31)	0.0999*** (4.35)
lev	-0.5723*** (-18.853)	-0.9284*** (-22.218)	-0.5102*** (-17.763)	-0.5678*** (-18.813)	-0.9230*** (-22.143)	-0.5066*** (-17.702)
tbq	0.0085*** (3.255)	-0.0233*** (-8.986)	0.0139*** (5.087)	0.0081*** (3.098)	-0.0232*** (-8.960)	0.0133*** (4.857)
cflow	0.0418 (1.641)	0.1029*** (4.139)	0.1260*** (4.742)	0.0426* (1.680)	0.1042*** (4.203)	0.1278*** (4.828)
roa	0.6178*** (8.628)	0.4987*** (5.251)	0.3273*** (4.462)	0.6393*** (8.873)	0.5013*** (5.292)	0.3495*** (4.729)
soe	-0.0084 (-1.063)	0.0562 (1.232)	-0.0059 (-0.713)	-0.0078 (-0.992)	0.0543 (1.193)	-0.0045 (-0.549)
Firm FE	N	Y	N	N	Y	N
Ind/Year FE	N	N	Y	N	N	Y
District FE	N	N	Y	N	N	Y
Adjust-R ²	0.145	0.215	0.281	0.146	0.209	0.283
F	126.975***	118.529***	37.049***	127.531***	124.138***	37.160***
N	7724	7724	7724	7724	7724	7724

Numbers in parentheses are *t*-statistics, *, **, ***denote significance at the 10%,5%,1% level, respectively.

leverage 0.41 and return on asset 4%.

To test our hypothesis, the baseline model we use is:

$$\text{cashholding}_{i,t} = \beta_0 + \beta_1 SC_{i,t} + \gamma X_{i,t} + \beta_3 \text{Ind}_j + \beta_4 \text{Year}_t + \beta_5 \text{District}_t + \varepsilon_{i,t} \quad (1)$$

where *cashholding*_{*i,t*} stands for one of the two cash holding variables (i.e., *cash1* and *cash2*) of firm *i* in year *t*. The independent variable of *SC*_{*i,t*} is one of the two supplier concentration variables (i.e., *SC1* and *SC2*) defined above, *X*_{*i,t*} stands for a set of control variables commonly used in cash holdings studies (Opler et al., 1999; Liu and Mauer, 2011; Duchin, 2010), *Ind*, *Year* and *District* to capture the industry, year and district fixed effect. Industry classification are based on the 2011 CSRC definitions of the 20 industries. For testing the model parameters, we rely on the standard errors adjusted for firm clustering. For detailed variable definitions, see Appendix A.

3. Empirical results

In this subsection, we first run the baseline regression (1) using cash-to-asset (*cash1*) as the dependent variable. Then, we run a modified model by considering financing constraints.

3.1. Supplier concentration and corporate cash holdings

The first question we investigate is whether a firm's supplier concentration affects the firm's cash holdings. Table 2 presents the results of the regression (1). The results show clear evidence supporting our hypothesis that SC positively affects firm cash holdings regardless of which of the two SC definitions is used. The coefficients on SC1 and SC2 are positive and highly significant whether we control for firm, industry, year, and district fixed effects. For example, the coefficient on SC1 is 0.1183 (*t* = 3.41) when not adjusting for the fixed effects mentioned above, and the corresponding number on SC2 is similar at 0.1121 (*t* = 4.84). The results imply that one basis point increase in supplier concentration can lead to about 0.12 basis point increase in cash holdings after controlling other common determinants of corporate cash holdings found in previous studies. The results indicate that when a company's procurement is largely concentrated on one or several large suppliers, the company increases its cash holdings to avoid the supply risk/uncertainty.

Consistent with prior literature (Opler et al., 1999; Liu and Mauer, 2011; Duchin, 2010), Table 2 shows that leverage (*lev*), Tobin' q (*tbq*),

return on asset (*roa*) and cash flow (*cflow*) tend to have significant impact on corporate cash holdings. That is, firms with high leverage tend to hold less cash, whereas profitable firms tend to hold more cash. However, the key point is that these determinants of corporate cash holdings documented in the previous literature cannot subsume effect of the supplier concentration variable on firm cash holdings.

3.2. Supplier concentration, financial constraints, and corporate cash holdings

Above empirical evidence suggests a positive relation between SC and corporate cash holdings. This subsection investigates whether financial constraints play a significant role in explaining the positive relation. This is because a firm's supplier concentration likely reduces the firm's trade credit, bank loan, equity financing, which can enlarge the firm's financial constraints, as discussed earlier. The test uses the regression below:

$$\text{cash1}_{i,t} = \beta_0 + \beta_1 SC_{i,t} + \beta_2 SC_{i,t} \times FC_{i,t} + \beta_3 FC_{i,t} + \beta_4 X_{i,t} + \beta_5 \text{Ind}_j + \beta_6 \text{Year}_t + \varepsilon_{i,t} \quad (2)$$

where *FC*, a dummy variable, is equal to one for financially constrained firms and zero otherwise. If financial constraints affect the SC-cash holding relation, we expect to observe a positive estimate of β_2 . Financially constrained firms are classified with three different criteria based on the SA index of Hadlock and Pierce (2010).⁶ That is, the 50%, or 33%, or 25% of the firms are respectively referred to as financially constrained. There are other methods to measure financial constraints. Examples are the Kaplan and Zingales (KZ) index (1997), the Whited and Wu (WW) index (2006). For robustness tests, we also directly use KZ, WW, and SA measures of financial constraints in the regression. Nevertheless, we pay more attention to the SA measure, which is constructed based on size and age, and can avoid the endogenous issue compared with the KZ and WW measures, as discussed by Hadlock and Pierce (2010).

Table 3 reports the results of regression (2). When referring to 50% of

⁶ Following Hadlock and Pierce (2010), we calculate the SA measure of financial constraints as follows: $SA = -0.737\text{size} + 0.043\text{size}^2 - 0.04\text{age}$, where size is the natural logarithm of the book value of assets, and age is the firm age measured in years. The smaller the SA value, the lower the degree of financing constraints.

Table 3
Supplier concentration (SC), financial constraints, and corporate cash holdings.

	(1)	(2)	(3)	(4)	(5)	(6)
	median	median	tertiles	tertiles	quartiles	quartiles
SC1	0.0589 (1.316)		0.0396 (0.702)		0.0498 (0.713)	
SC2		0.0644** (2.172)		0.0343 (0.971)		0.0199 (0.487)
FC1	-0.0051 (-0.425)	-0.0173 (-1.089)				
SC1#FC1	0.1007* (1.760)					
SC2#FC1		0.0778* (1.704)				
FC2			-0.0224 (-1.420)	-0.0397* (-1.956)		
SC1#FC2			0.2014** (2.281)			
SC2#FC2				0.1355** (2.409)		
FC3					-0.0175 (-0.993)	-0.0497** (-2.127)
SC1#FC3					0.1821* (1.776)	
SC2#FC3						0.1683** (2.549)
CV	Y	Y	Y	Y	Y	Y
Ind/year FE	Y	Y	Y	Y	Y	Y
Adjust-R ²	0.283	0.284	0.294	0.295	0.293	0.294
F	35.046***	35.134***	24.649***	24.692***	17.760***	17.853***
N	7677	7677	5114	5114	3828	3828

Numbers in parentheses are *t*-statistics, *, **, ***denote significance at the 10%,5%,1% level, respectively.

firms as financially constrained, columns (1) and (2) of Table 3 show that the coefficient β_2 estimate of the interaction term is positive at the 10% significant level. When using the 33% and 25% breakpoints to identify financially constrained firms, β_2 estimate is positive and more statistically significant, as columns (3)–(6) show. For example, estimate of β_2 is 0.2014 ($t = 2.28$) with SC1 and 0.1355 ($t = 2.41$) with SC2 when 33% of firms are referred to as financially constrained. In addition, estimate of β_1 tends to be positive but insignificant. The results indicate that although the SC-cash holding relation remains positive, it is not statistically significant for non-financially constrained firms. Also, positive and significant β_2 estimate is in line with our prediction, meaning that the positive relation between SC-cash holding is more pronounced within financially constrained firms. The intuition is that comparing with non-financially constrained companies, companies with financial constraints are more difficult to raise funds so that they have a stronger preventive incentive to hold more cash. If using SA or other financial constraints measures such as KZ and WW indexes, we find qualitatively similar results, but less significant associated with KZ or WW measures, see Appendix B.

4. Further investigation on the relation between SC and financial constraints

To find the mechanism driving the positive relation between supplier concentration and corporate cash holdings, we examine whether SC increases financial constraints. Then, we further explore the possible channels on the relation between supplier concentration and financial constraints, which likely influence corporate cash holdings. Intuitively, the higher the supplier concentration, the greater the supply shock risk the firm may face. The SC risk exacerbates financial constraints as it can lead to lower trade credit and higher external financing costs.

4.1. Supplier concentration and financial constraints

To examine whether supplier concentration increases financial constraints, we run the regression below:

$$FinConstraints_{i,t} = \beta_0 + \beta_1 SC_{i,t} + \beta_2 X_{i,t} + \beta_3 Ind_j + \beta_4 Year_t + \epsilon_{i,t} \tag{3}$$

where $FinConstraints_{i,t}$ is one of the three financial constraints variables, SA, KZ and WW. Table 4 reports the regression results. With SA as the dependent variable, it shows that the coefficient on SC measure is positive and statistically significant at 0.0195 ($t = 2.25$) and 0.011 ($t = 2.12$) respectively on SC1 and SC2. This is consistent with our prediction that SC increases financial constraints. However, with KZ and WW measures of financial constraints, we find insignificant relation between SC and financial constraints. As discussed earlier, both KZ and WW are constructed based on cash flow, Tobin’s q, leverage, sales growth, etc., and suffer the endogenous issue. Therefore, we focus on the use the SA measure of financial constraints in the following analyses. Next, we attempt to figure out which channel(s) cause the relation between supplier concentration and financing constraints.

4.2. Possible channels behind the relation between SC and financial constraints

Our early discussion highlights three possible channels of trade credit, bank loan and equity financing on which SC can impact. To test whether SC can affect the three possible channels, we estimate the following model:

$$Channel_{i,t} = \beta_0 + \beta_1 SC_{i,t} + \beta_2 X_{i,t} + \beta_3 Ind_j + \beta_4 Year_t + \beta_5 District_t + \epsilon_{i,t} \tag{4}$$

where $Channel_{i,t}$ is the variable measuring one of the three possible channels. The received trade credit (*Credit*) is defined as the accounts payable plus notes payable minus prepayment. We measure bank loan separately using short-term bank loan (*Sloan*) and long-term bank loan (*Lloan*). We measure equity financing by the change of capital stock (*EF*).

4.2.1. Trade credit channel

Trade credit is an effective way to alleviate the financing constraints. However, the trade credit received by a firm depends on the relative bargaining power of the supplier and the firm in the supply chain.

Table 4
Supplier concentration affect the financial constraint.

	(1)	(2)	(3)	(4)	(5)	(6)
	SA	SA	KZ	KZ	WW	WW
SC1	0.0195*** (2.58)		0.2257 (1.583)		0.0265 (0.428)	
SC2		0.0111** (2.117)		0.1247 (1.318)		0.0091 (0.177)
lev	0.0329*** (4.353)	0.0328*** (4.327)	-0.4286** (-2.213)	-0.4291** (-2.199)	-0.0256 (-0.879)	-0.0251 (-0.865)
tbq	0.0158*** (17.131)	0.0158*** (17.301)	0.3914*** (5.873)	0.3913*** (5.865)	0.0169*** (3.913)	0.0168*** (3.709)
roa	-0.2614*** (-7.410)	-0.2606*** (-7.378)	4.2760 (0.836)	4.2683 (0.833)	-0.1457 (-1.217)	-0.1439 (-1.127)
soe	0.0088*** (3.508)	0.0089*** (3.564)	0.1051** (-2.348)	0.1067** (-2.390)	-0.0328* (-1.824)	-0.0328* (-1.785)
cflow	0.0154** (1.986)	0.0155** (1.993)	0.8171*** (2.702)	0.8169*** (2.703)	0.0443 (0.525)	0.0442 (0.528)
top1	0.0001 (1.404)	0.0001 (1.426)	0.0014 (0.681)	0.0014 (0.681)	-0.0011*** (-2.886)	-0.0011*** (-2.881)
g1	-0.0075*** (-3.124)	-0.0075*** (-3.120)	0.5186* (1.937)	0.5183* (1.936)	-0.0021 (-0.111)	-0.0022 (-0.118)
zbxl	0.0001*** (2.587)	0.0001*** (2.580)	-0.0001 (-0.156)	-0.0001 (-0.160)	-0.0000 (-0.027)	-0.0000 (-0.040)
pe	0.0115** (2.399)	0.0115** (2.404)	0.8804 (1.234)	0.8806 (1.234)	-0.0251*** (-3.547)	-0.0250*** (-3.518)
age	-0.0392*** (-170.722)	-0.0392*** (-170.573)	-0.0045 (-0.973)	-0.0046 (-0.982)	0.0009 (0.815)	0.0008 (0.802)
Cons.	-3.1242*** (-228.636)	-3.1251*** (-224.696)	-0.0417 (-0.151)	-0.0347 (-0.127)	-0.7934*** (-4.906)	-0.7948*** (-4.668)
Ind/year FE	Y	Y	Y	Y	Y	Y
Adjust-R ²	0.866	0.866	0.454	0.454	0.143	0.142
F	1282.333***	1275.151***	62.842***	62.733***	12.910***	13.031***
N	7034	7034	3853	3853	5335	5335

Numbers in parentheses are *t*-statistics, *, **, ***denote significance at the 10%,5%,1% level, respectively.

Theoretical and empirical results (Titman and Wessels, 1988; Banerjee et al., 2008) show that the bargaining power of suppliers has an important impact on a firm’s trade credit. The stronger the bargaining power of a supplier, the more difficult for the downstream firm to obtain trade credit from the supplier. For example, suppliers may shorten the payment period, reduce the credit limit, or even ask for cash payment. These requirements will cut down the trade credit and deteriorate financing constraints for the downstream firm. Therefore, we conjecture that trade credit is one of the channels through which supplier concentration

increases financing constraints.

Columns (1)–(2) of Table 5 presents the results of regression (4) with trade credit as the dependent variable. Consistent with our conjecture, supplier concentration is negatively and significantly correlated with received trade credit with the coefficient of -0.0563 (*t* = -7.6) and -0.0473 (*t* = -9.49) on SC1 and SC2. It implies that increasing supplier concentration reduces the trade credit received by the firm from its suppliers. The decrease in trade credit in turn aggravates downstream firms’ financial constraints and lead them to hold more cash for

Table 5
Channels analyses.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Credit	Credit	Sloan	Sloan	Lloan	Lloan	EF	EF
SC1	-0.0563*** (-7.600)		0.0571*** (7.378)		-0.0009 (-0.154)		-0.0789** (-2.094)	
SC2		-0.0473*** (-9.487)		0.0520*** (9.802)		0.0009 (0.219)		-0.0273 (-1.028)
lev	0.1966*** (31.050)	0.1955*** (30.916)	0.3202*** (42.976)	0.3218*** (42.945)	0.1184*** (21.608)	0.1185*** (21.589)	-0.0776** (-2.395)	-0.0757** (-2.334)
tbq	-0.0013** (-2.568)	-0.0011** (-2.171)	-0.0038*** (-6.294)	-0.0041*** (-6.707)	-0.0024*** (-5.682)	-0.0024*** (-5.767)	0.0024 (0.742)	0.0021 (0.662)
cflow	0.0358*** (4.560)	0.0353*** (4.504)	-0.0370*** (-4.082)	-0.0363*** (-4.025)	-0.0020 (-0.292)	-0.0020 (-0.287)	-0.171*** (-6.108)	-0.171*** (-6.111)
roa	0.0680*** (3.511)	0.0586*** (3.021)	-0.1768*** (-8.536)	-0.1658*** (-7.990)	-0.0034 (-0.187)	-0.0027 (-0.151)	0.9754*** (10.124)	0.9817*** (10.111)
soe	0.0050** (2.074)	0.0043* (1.794)	-0.0225*** (-8.915)	-0.0218*** (-8.652)	0.0081*** (4.128)	0.0081*** (4.135)	-0.160*** (-14.015)	-0.160*** (-14.049)
cons	-0.041*** (-3.524)	-0.0321*** (-2.721)	0.0301** (2.507)	0.0190 (1.577)	0.0318*** (3.332)	0.0312*** (3.230)	0.3254*** (6.003)	0.3194*** (5.857)
Ind/year FE	Y	Y	Y	Y	Y	Y	Y	Y
Adjust-R ²	0.336	0.338	0.422	0.425	0.358	0.358	0.094	0.093
F	96.817***	98.507***	151.441***	152.761***	66.267***	66.230***	28.566***	28.391***
N	7640	7640	8094	8094	7369	7369	7617	7617

Numbers in parentheses are *t*-statistics, *, **, ***denote significance at the 10%,5%,1% level, respectively.

precautionary concerns.

4.2.2. Bank loan channel

Bank loan is a dominated financing tool in China. The ability to obtain bank loan is important for enterprises to alleviate financing constraints and improve their competitiveness (Harford et al., 2014). To obtain bank loan, firms must show their operation health. However, high SC firms are sensitive to the supplier shocks, which affect firms' business conditions. Therefore, banks will impose more stringent terms on the loan contract with such high-SC companies. That is, high-SC firms are likely to face high financing costs in terms of bank financing channels, especially for the long-term loan.

In our test, we distinguish short-term bank loans from long-term bank loans. When using short-term loan as the dependent variable, columns (3)–(4) of Table 5 show that the SC1 and SC2 coefficients are 0.0571 ($t = 7.38$) and 0.052 ($t = 9.80$), indicating that high-SC firms tend to borrow more short-term loans. With long-term loan as the dependent variable, however, the corresponding figures shown in columns (5)–(6) of Table 5 are insignificant at -0.009 ($t = -0.15$) and 0.009 ($t = 0.22$). The results indicate that bank loan is not the driving force behind the SC-cash holding relation. Rather, high SC firms show more short-term.

4.2.3. Equity financing channel

In China, the regulatory procedures for equity financing are complicated and the transaction costs are high. The CSRC have a set of clauses for IPO and SEO, and one item is associated with suppliers.⁷ That is, regulators view high supplier concentration as risk. Once the major supplier goes to bankruptcy, for example, the sustainable operation of the downstream firm may suffer from the abrupt supply. Kolay et al. (2016) show that suppliers bankruptcy announcement causes the stock price of the downstream firms to decline. As a result, we conjecture that supplier concentration negatively affects equity financing.

With equity financing (i.e., change in capital stock) as dependent variable, we run the regression (4) and results are presented in columns (7)–(8) of Table 5. Consistent with our prediction, we observe a negative coefficient estimate on both SC1 and SC2 at -0.0789 ($t = -2.09$) and -0.0273 ($t = -1.03$). The evidence indicates that supplier concentration has an adverse influence on equity financing, which cause the firm to hold more cash.

To sum up, supplier concentration affects the financial constraints of a company mainly through trade credit and equity financing. The higher the financing constraints a company faces, the more cash it is likely to hold. Therefore, supplier concentration is positively correlated with corporate cash holdings.

5. Robust tests

In this subsection, we address the concerns of omitted variable issue and self-selection bias. Dhaliwal et al. (2016) argue that we are unable to observe: (1) whether different firm-supplier relationships are governed by implicit versus explicit contracts, and (2) the existence of managerial-specific relationships between firms and suppliers. The extent to which these factors are more prevalent among major suppliers and correlated with corporate cash holdings could bias our findings. To deal with the issue, we utilize the instrumental variable regression analysis. To cope with the self-selection bias, we rely on the propensity score matching approach.

5.1. Instrumental variables regressions

We adopt instrumental variables (IV) regression to solve the endogenous problem. We select instrumental variables based on Dhaliwal et al.

⁷ If a firm is overly relying on a few suppliers, it may not get the approval for issuing equity.

(2016), i.e., using the one- and the three-year lagged supplier concentrations as the instrumental variables. Before running the IV regression, we first test the validity of the selected IVs. Specifically, we perform the under-identification test, weak identification test, and overidentification test with results reported in Table 6. We find that the chosen instrumental variables pass the validity tests. For example, the p -value of the LM statistic for the under-identification test is close to zero, i.e., our supplier concentration measures do not suffer from the endogeneity issue. The weak identification and overidentification tests reported in Table 6 also show that the adequacy of the choosing IVs.

With the one-year lagged SC as the IV, Panel A of Table 7 presents the results of the first-stage regression of SC (SC1 and SC2) on IVs (i.e., the one-year lagged SC1, L1.SC1, and the one-lagged SC2, L1.SC2). The results show that SC is persistent with the coefficient of 0.784 ($t = 96.1$) on L1.SC1 and 0.762 ($t = 87.3$) on L1.SC2. Table 7, Panel B presents the results of the second-stage regression. Consistent with the findings from the baseline regression, the positive relation between the supplier concentration variables (SC1 and SC2) and corporate cash holdings remains significant at 0.111 ($t = 4.46$) and 0.142 ($t = 3.84$) after taking into account the endogenous issue (see Table 8).

Numbers in parentheses are t -statistics, *, **, ***denote significance at the 10%,5%,1% level, respectively.

Table 6
Validity test of instrumental variable.

Item	L(1/3).SC1	L(1/3).SC2
Under-identification test: Anderson canon. corr. LM statistic (P-value)	48.549 (0.000)	40.936 (0.000)
Weak identification test: Cragg-Donald Wald F statistic	16.722	14.012
Stock-Yogo weak ID test critical values: 5% maximal IV	13.91	13.91
Overidentification test: Sargan statistic (P-value)	2.520 (0.2836)	5.351 (0.0689)

Table 7
Instrumental variables regressions.

variables	SC1	SC2
Panel A: first-stage of instrumental variables regressions		
L1.SC1	0.784*** (96.12)	
L1.SC2		0.762*** (87.31)
Panel B: second-stage of instrumental variables regressions		
L1.SC1	0.111*** (4.46)	
L1.SC2		0.142*** (3.838)
lev	-0.300*** (-12.642)	-0.303*** (-12.746)
g1	-0.015** (-2.011)	-0.015** (-2.019)
cflow	0.106*** (4.735)	0.104*** (4.66)
roa	0.387*** (5.226)	0.369*** (5.005)
top1	0.000 (1.33)	0.000 (1.251)
tbq	0.018*** (8.49)	0.019*** (8.738)
soe	0.014 (1.502)	0.013 (1.386)
cons	0.189*** (6.094)	0.206*** (6.777)
Ind/Year FE	Y	Y
N	5519	5519
Adjust-R ²	0.199	0.198

Table 8
Logit regression.

	soe	gl	roa	yszk	top1	zbxl	tbq	ldbl	Cons.	N	p-R ²
sc	0.181*** (2.922)	0.188*** (3.852)	-4.188*** (-7.440)	-0.021*** (-7.485)	0.006*** (2.972)	0.001*** (2.618)	0.062*** (4.707)	0.060*** (5.621)	-0.351*** (-4.140)	5619	0.0303

The notation sc is a dummy variable, which is equal to one if SC1 of a firm is greater than the median, and zero otherwise. Numbers in parentheses are *t*-statistics, and *, **, and *** indicate the significance at the 10%, 5%, and 1% level, respectively.

5.2. Propensity score matched sample analysis

The choice of a firm’s supplier concentration (SC) may not be random, and it can be influenced by some unobservable factors. There may be inborn SC differences across firms. In order to mitigate the resulting bias caused by these differences, we use the propensity score matching (PSM) method to address this issue. We divide the sample into two groups: (1) the treatment group that contains firms having their SC1 measures greater than the median; (2) the control group that includes firms having their SC1 measures smaller than the median. The matching variables are the share proportion of the largest shareholder (*top1*), nature of ownership (*soe*), return on total assets (*roa*), the ratio of accounts receivable to operating income (*yszk*), corporate’s growth ability (*gl*), operational efficiency of assets (*zbxl*), tobin’s Q (*tbq*) and liquidity ratio (*ldbl*) (see Table 9).

We use the logit model to estimate the probability of a firm with high supplier concentration. Table 10 presents our logit regression results, which show that the chosen variables are significantly related to supplier concentration (SC1).

We then use the propensity scores (predicted probabilities) to perform the Mahalanobis matching. We estimate the average treatment effect for treat group (ATT), average treatment effect for the control

Table 9
Average treatment effect for PSM.

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
cash1	Unmatched	0.2843	0.2600	0.0243	0.0078	3.13
	ATT	0.2843	0.2572	0.0271	0.0095	2.86
	ATU	0.2600	0.2837	0.0238	0.0110	2.17
	ATE			0.0254	0.0090	2.83

Table 10
Other robust tests.

	(1)	(2)	(3)	(4)	(5)	(6)
	cash2	cash2	cash1	cash1	cash1	Cash2
SC1	0.2918** (2.245)		0.1796*** (5.279)			
SC2		0.2881*** (3.896)		0.1588*** (6.918)		
MA					0.0419*** (4.174)	0.0592*** (2.976)
lev	-1.0728*** (-11.926)	-1.0624*** (-11.986)			-0.5191*** (-18.880)	-1.0828*** (-12.249)
tbq	0.0233* (1.945)	0.0216* (1.792)			0.0143*** (5.444)	0.0257** (2.103)
cflow	-0.0752 (-1.038)	-0.0710 (-0.975)			0.1279*** (4.904)	-0.0776 (-1.057)
roa	-1.7239*** (-6.807)	-1.6567*** (-6.843)			0.2633*** (3.695)	-1.8002*** (-7.104)
soe	-0.0618** (-2.046)	-0.0576* (-1.911)			-0.0038 (-0.479)	-0.0615** (-2.037)
cons	1.1247*** (8.506)	1.0580*** (7.861)	0.3354*** (6.223)	0.3076*** (5.658)	0.5578*** (9.773)	1.1868*** (8.721)
Ind/year FE	Y	Y	Y	Y	Y	Y
Adjust-R ²	0.097	0.098	0.171	0.173	0.280	0.096
F	26.314***	26.199***	30.146***	30.198***	42.585***	26.121***
N	8096	8096	8634	8634	8096	8096

Numbers in parentheses are *t*-statistics, *, **, *** denote significance at the 10%,5%,1% level, respectively.

group (ATU), and the average treatment effect (ATE). Table 11 presents the results of the propensity score matching approach. It can be seen that our early finding is robust: high-SC firms tend to hold more cash than low-SC firms both with and without performing the propensity score matching.

5.3. Other robust tests

To perform further robustness checks of our results, we first use the ratio of cash to sales (*cash2*) as an alternative cash holding measure. We report the corresponding results in columns (1)–(2) of Table 10. With the alternative measure, the SC-cash holding relation remains significant and positive with the coefficient 0.2918 (*t* = 2.25) on SC1 and 0.2881 (*t* = 3.90) on SC2. We then conduct the univariate regression with year and industry fixed effects included. We find that cash holdings are positively associated with supplier concentration, see columns (3)–(4) of Table 10. Moreover, the positive SC-cash holding relation implies that corporate cash holdings may adjust for changes (e.g., increases) in SC. To investigate this, we use the merge events of suppliers as exogenous shocks/increases on supplier concentration. Specifically, we add a dummy variable, MA, in our regression to indicate whether suppliers have made M&As in the prior three years relative to an observation. We report the results in columns (5)–(6) of Table 10. The results imply that the change/increase in SC due to M&As of suppliers leads to the increase of cash holdings.

One may argue that while cash-rich firms may choose to concentrate on suppliers, to gain more credits, for cash-poor firms cash holdings could negatively affect SC (i.e., a reverse causality). To ascertain the possible asymmetric impact of the cash richness on the SC-cash holding relation, we divide the sample into cash-poor and cash-rich subsamples based on the median of corporate cash holdings. The subsample results reported in

Table 11
Grouping regressions.

	(1) cash-poor	(2) cash-rich	(3) cash-poor	(4) cash-rich
SC1	0.0167*** (3.189)	0.3138*** (6.275)		
SC2			0.0152*** (4.154)	0.2548*** (7.450)
lev	-0.0068 (-1.528)	-0.6564*** (-15.665)	-0.0072 (-1.621)	-0.6494*** (-15.520)
tbq	0.0006 (1.442)	0.0097*** (2.783)	0.0007* (1.720)	0.0092*** (2.633)
cflow	0.0001 (0.017)	0.2251*** (5.051)	-0.0003 (-0.069)	0.2241*** (5.041)
roa	0.0807*** (5.945)	0.0230 (0.174)	0.0773*** (5.676)	0.0681 (0.517)
soe	-0.0021 (-1.218)	-0.0069 (-0.398)	-0.0023 (-1.317)	-0.0024 (-0.140)
Ind/year FE	Y	Y	Y	Y
cons	0.1002*** (10.067)	0.7169*** (9.234)	0.1036*** (10.330)	0.6729*** (8.613)
Adjust-R ²	0.057	0.267	0.059	0.270
F	8.891***	40.561***	9.113***	41.207***
N	4401	3695	4401	3695

Numbers in parentheses are *t*-statistics, *, **, *** denote significance at the 10%,5%,1% level, respectively.

Table 12
Granger causality tests.

Equation	Excluded	chi2	df	Prob > chi2
cash1	SC1	0.047	1	0.829
	ALL	0.047	1	0.829
SC1	cash1	3.468	1	0.063
	ALL	3.468	1	0.063

Table 11 show that the positive SC-cash holding relation is present in both subsamples. Nevertheless, cash-rich firms appear to concentrate more on suppliers. For the SC1 measure, for example, the regression coefficient estimate on SC1 is 0.3138 (*t* = 6.27) for cash-rich firms, whereas it is 0.0167 (*t* = 3.19) for cash-poor firms.

To further address the possible reverse causality, we also perform an exercise of the Granger causality test. The test results of Table 12 show

Appendix A

Variables and definitions.

Variable	Definitions
cash1	is the ratio of cash and cash equivalents to total assets minus cash and cash equivalents
cash2	is the cash-to-sales ratio
SC1	is the proportion of purchase from the largest supplier
SC2	is the proportion of purchase from top5 suppliers
lev	equals to the book value of total debt divided total assets.
tbq	equals to the stock market value divide the equity book value.
size	is the natural logarithm of the book value of assets.
cflow	equal to the net cash flow from operating activities divided by net assets.
g1	is the sales growth rate
roa	equals to the book value of operating profit divided by assets.
soe	is a dummy variable equals to one if firm nature is state-owned enterprise and zero otherwise.
top1	is the equity proportion of the largest shareholder
zbxl	equals to sales revenue divided by the sum of fixed assets and projects under construction
Credit	equals to accounts payable plus notes payable minus prepayment
EF	is the change of capital stock to measuring equity financing
Sloan	is short-term bank loan
Lloan	is long-term bank loan

that we fail to reject the hypothesis that supplier concentration Granger causes corporate cash holdings ($\chi^2 = 0.047$ with *p*-value of 0.829). However, we reject the hypothesis at a 10% level that corporate cash holdings Granger causes supplier concentration ($\chi^2 = 3.468$ with *p*-value of 0.063). The evidence again corroborates the positive relation of supplier concentration to corporate cash holdings.

6. Conclusions

A firm generally has customers and suppliers. Previous studies focus particularly on how customer concentration affects firm financial decisions. The effect of supplier concentration (SC) on such decisions is largely neglected in the literature. In this paper, we study the relation between supplier concentration and corporate cash holdings. We find that a firm’s cash holding is positively associated with the firm’s supplier concentration. This finding is robust to the common determinants of corporate cash holdings documented in the literature.

This paper also investigates the mechanisms behind the positive SC-cash holding relation. We find that financial constraints play an important role in explaining the positive relation, which is more pronounced for firms with high financial constraints. We identify two possible channels causing the deterioration of financial constraints. One is that high SC of a firm can result in the decline of the firm’s trade credit. The other one is that high SC increases the difficulty of equity financing. Both channels exacerbate the financial constraints and compel firms to hold more cash for precautionary consideration. In sum, our results show that firms should choose an appropriate/optimal degree of supplier concentration. Overly relying on major suppliers appears an inadequate practice and likely leads to excessive cash holdings.

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Appendix B. Supplier concentration (SC), financial constraints, and corporate cash holdings

	(1)	(2)	(3)	(4)	(5)	(6)
	cash1	cash1	cash1	cash1	cash1	cash1
SC1	2.0659*** (2.804)		0.1594*** (3.368)		0.1228*** (3.065)	
SC2		1.5569*** (3.422)		0.1269*** (3.488)		0.0910*** (3.449)
SA	−0.0277 (−0.946)	−0.0839** (−2.199)				
SC1*SA	0.5136*** (2.681)					
SC1*SA		0.3820*** (3.240)				
KZ			−0.0105 (−1.642)	−0.0096 (−1.323)		
SC1*KZ			0.0085 (0.290)			
SC1*KZ				0.0079 (0.361)		
WW					−0.0000** (−2.280)	−0.0000** (−1.989)
SC1*WW					0.0000 (1.115)	
SC1*WW						0.0000 (0.395)
lev	−0.5136*** (−17.795)	−0.5092*** (−17.727)	−0.3982*** (−9.944)	−0.3933*** (−9.812)	−0.3210*** (−10.005)	−0.3205*** (−10.019)
tbq	0.0128*** (4.825)	0.0121*** (4.542)	0.0257*** (4.858)	0.0256*** (4.767)	0.0192*** (5.877)	0.0189*** (5.781)
cflow	0.1241*** (4.563)	0.1263*** (4.664)	0.1658*** (3.457)	0.1677*** (3.539)	0.1059*** (3.477)	0.1067*** (3.508)
roa	0.3313*** (4.523)	0.3497*** (4.726)	0.3798** (2.541)	0.4053*** (2.743)	0.3278*** (4.287)	0.3419*** (4.434)
soe	0.0006 (0.071)	0.0015 (0.173)	0.0157 (1.512)	0.0170 (1.633)	0.0111 (1.241)	0.0118 (1.313)
cons	0.4458*** (3.570)	0.2114 (1.337)	0.4762*** (6.026)	0.4545*** (5.591)	0.4455*** (7.182)	0.4321*** (6.899)
Adjust-R ²	0.286	0.287	0.225	0.226	0.199	0.200
F	35.436***	35.496***	17.751***	17.962***		
N	7677	7677	3973	3973	5519	5519

Numbers in parentheses are *t*-statistics, *, **, ***denote significance at the 10%,5%,1% level, respectively.

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