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Supplier geographical concentration and corporate innovation

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ABSTRACT

Firms should stabilize their supply-chain relationships and rely more on innovation-driven development strategies in the post-pandemic period. This study explores the effect of suppliers' geographical concentration on corporate innovation. Using data on A-share listed firms in China from 2007 to 2020, we find that suppliers' geographical concentration significantly and negatively affects corporate innovation. Furthermore, the channel test results show that suppliers' geographical concentration restrains corporate innovation primarily through their strong bargaining power and by exacerbating the firm's financing constraints.

1. Introduction

Innovation is the primary source of a firm's growth. The COVID-19 pandemic has imposed more significant uncertainty on the survival and growth of firms. Therefore, firms need long-lasting supply chain relationships and a nearby cluster economy to survive and thrive. Suppliers are critical to firm innovation, providing direct inputs for a firm's products. When a firm depends on a few large suppliers located adjacent to the firm, how do these large suppliers affect firm innovation?

Existing studies have explored the impact of suppliers on corporate innovation from the perspective of supplier–buyer business relationships (Mooi and Frambach, 2012), supplier cluster characteristics (Pillai and Bindroo, 2020), and suppliers' portfolio concentration (Chen et al., 2022). However, there is limited research on suppliers' geographical concentration. Moreover, the research on the subject and the economic effects of geographic concentration has focused on industrial concentration and regional economic impact (Jofre-Monseny et al., 2011; Figueiredo et al., 2015; Sun and Li, 2022). There is scarce research on the geographical concentration of market segment suppliers and their economic effects on firms. We attempt to analyze the effect of suppliers' geographical concentration on corporate innovation from the perspective of the geographical concentration of market segment suppliers and its economic effects on a firm.

Proximity of suppliers to a focal firm motivates them to use formal or informal contact networks to obtain private information from the firm at lower costs (Liu et al., 2017). As a result, a firm's suppliers gain more bargaining power, which they use to raise the sales price, reduce product quality, and impose stricter supply terms. These behaviors reduce the focal firm's profits and financial performance and damage the speed and quality of the firm's technological innovation. In addition, adjacent concentration facilitates frequent face-to-face communication and decreases information asymmetry between suppliers and firms (Ganesan et al., 2005). These can help stabilize the supply-chain relationships and establish long-term strategic cooperation (Gu et al., 2022). Long-term collabora-

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tion with nearby suppliers may lead the firm to increase its investment in relationship-specific assets (Prajogo and Olhager, 2012). When a firm expands its relationship-specific investments, it becomes more vulnerable to opportunistic behavior from suppliers (Handley and Benton, 2012). The probability of suppliers crowding out the firm's quasi-rent increases, which reduces the firm's investment and willingness to innovate. Therefore, we propose that suppliers' geographical concentration inhibits corporate innovation.

As China is the world's largest emerging market, a study based on a sample of Chinese firms helps compare with similar studies from other developing countries. Our sample covers all listed A-shares in the China stock markets between 2007 and 2020. We find that suppliers' geographical concentration significantly inhibits corporate innovation. Our results remain robust even after conducting several robustness tests. Furthermore, we find that suppliers' geographical concentration undermine corporate innovation primarily through their high bargaining power and exacerbate the focal firm's financing constraints.

Our study makes the following contributions. First, the literature indicated that supplier characteristics, such as supplier–buyer business relationships (Mooi and Frambach, 2012), supplier cluster characteristics (Pillai and Bindroo, 2020), and supplier portfolio concentration (Chen et al., 2022) influence corporate innovation. Our study provides a new perspective on supply–chain relations based on suppliers' geographical concentration. Second, existing studies have mainly focused on the geographical concentration of industry and regional economic effects of geographical concentration (Jofre-Monseny et al., 2011; Figueiredo et al., 2015; Sun and Li, 2022). Our study expands the literature on the geographical concentration of suppliers and the economic consequences of geographical concentration.

The rest of this paper is organized as follows. Section 2 introduces the data, variables, and research design. Section 3 presents the baseline results and robustness checks. Section 4 discusses the channel test, and Section 5 concludes.

2. Data and empirical design

2.1. Data

Our sample includes all listed A-shares in China stock markets between 2007 and 2020. We obtain a firm's number and type of patents granted from the China Research Data Services database (CNRDS). Other firms' financial data are obtained from the CSMAR database.

We manually collect the geographical distance between a listed firm and its suppliers. First, according to the firm's disclosure, we identify a firm's suppliers' names and addresses using the Baidu search engine. Then, we estimate the geographical distance between a firm and its suppliers, relying on the longitude and latitude of suppliers' addresses using Baidu Maps.

We exclude the following firms from the sample: (1) financial firms; (2) special treatment firms; and (3) firms with missing financial data. All continuous variables are winsorized at the 1st and 99th percentiles to eliminate the effect of outliers. Finally, our sample has 3730 observations.

2.2. Variables

2.2.1. Corporate innovation

Following the literature (e.g., Chemmanur et al., 2014; He et al., 2022), we used patent-based metrics to capture corporate innovation. Three types of patents are granted under the Chinese Patent Law: invention patents, utility model patents, and design patents. Of these, invention patents better reflect a firm's substantive innovation ability than utility model and design patents. Considering that the disclosure of financial data of listed companies is based on consolidated statements and listed companies also need to rely on subsidiaries for innovation, it is reasonable to assume that corporate innovation capability should include listed companies and their subsidiaries. Therefore, we use the invention patent grants to the firm and its subsidiaries to measure corporate innovation (Lninvent). To avoid missing values when taking the logarithm, we add 1 to the number of invention patent grants and then take the logarithm.

2.2.2. Suppliers' geographical concentration

We separate adjacent suppliers from non-adjacent suppliers by taking a 100-km radius following Coval and Moskowitz (2001). And then, we refer to Jofre-Monseny et al. (2011) for selecting the number of firms to measure concentration. Consequently, we employ a number of large suppliers within 100 km of the firm's headquarter to measure suppliers' geographical concentration (Sup100). We also utilize a dummy variable (Supdum) to highlight the effect of proximity to large suppliers on corporate innovation, which equals one if a firm's major suppliers are located within 100 km of the firm's headquarter; otherwise, zero.

2.2.3. Control variables

According to the majority of the literature, a firm's size, debt level, tangible assets, age, return on assets, and sales growth all have an impact on a firm's potential to innovate (Cornaggia et al., 2015; Krolikowski and Yuan, 2017; Chu et al., 2019). Furthermore, it has been shown that the largest shareholder (Zhang et al., 2018), non-controlling large shareholder (Wan et al., 2021), independent directors (Balsmeier et al., 2017), board size (Kang et al., 2018), and executive compensation (Ederer and Manso, 2013) all have an effect on innovation. As a result, we control for these factors. Table 1 defines all control variables.

Table 1
Variables definition.

Variables	Definition
Lninvent	Log of one plus the annual number of invention patents granted to the firm and its subsidiaries
Sup100	The number of large suppliers within 100 km of a firm
Supdum	A dummy variable equals one if a firm's major suppliers are located within 100 km of the firm's headquarters; otherwise, zero
Size	Log of the firm's total assets at the end of the year
Lev	The ratio of a firm's debt to total assets
Roa	The ratio of a firm's net profit to total assets at the end of the year
PPE	The ratio of a firm's net fixed assets to total assets at the end of the year
Age	Log of one plus the current year minus the year in which firm i was listed
Growth	The current year's revenue growth of a firm divided by the previous year's revenue
Top1	The shareholding ratio of a firm's largest shareholder at the end of the year
Top2–5	The sum of the shareholding ratios of the second-, third-, fourth-, and fifth-largest shareholders
Boardsize	Log of the total number of directors
Indenp	The ratio of independent directors to total directors
Lnpay	Log of the total salary of the top three executives

2.3. Model setup

We set up the following model to explore our research question:

$$\text{Lninvent}_{i,t} = \alpha + \beta \times \text{Sup}_{i,t} + \gamma \times \text{Controls}_{i,t} + \text{Industry}_j + \text{Year}_t + \varepsilon_{i,t} \quad (1)$$

where $\text{Lninvent}_{i,t}$ represents corporate innovation and $\text{Sup}_{i,t}$ acts as a proxy for suppliers' geographical concentration, including Sup100 and Supdum. $\text{Controls}_{i,t}$ represents the control variables, and $\varepsilon_{i,t}$ denotes the residual of the model. We also control for year and industry-fixed effects.

3. Empirical results

3.1. Descriptive statistics

Fig. 1 illustrates the distance distribution between the sample firms and their major suppliers. The horizontal axis shows the distribution of the geographical distances between the firms and their large suppliers. The left vertical axis represents the number of large supplier–firm pairs, and the right vertical axis represents the proportion of pairs. There are 14,552 large supplier–firm pairs during the sample period, 4802 of which are located within 100 km of the firms, accounting for 33% of the sample. This shows a trend toward greater concentration in the location of Chinese firms and their major suppliers, providing the practical foundation for this study.

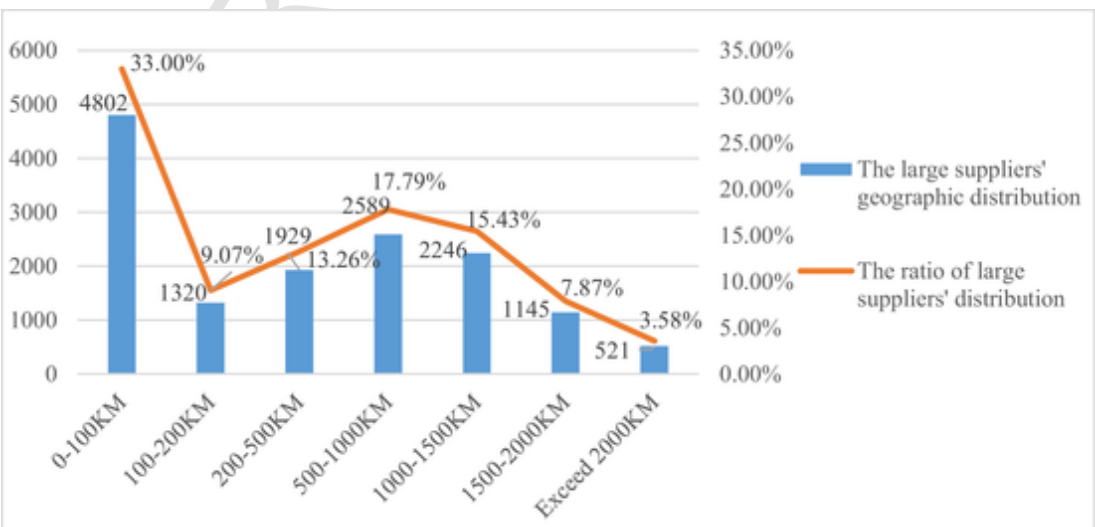

Fig 1. . Distribution of geographical distance between the firms and their large suppliers.

Table 2 shows the descriptive results of the main variables. The mean value of Lninvent is 0.778, ranging between 0 and 6.232, indicating significant differences in firms' innovation capabilities. The maximum (minimum) value of Sup100 is 5 (0)[1], and the mean value is 1.076, suggesting apparent differences in the distribution of large suppliers within 100 km of different firms.

3.2. Baseline regression

Columns (1) and (2) of Table 3 show the results of the univariate regression, and columns (3) and (4) report the effect of suppliers' geographical concentration on corporate innovation after controlling for all variables. We observe a significant negative relationship between a firm's innovation capacities and its suppliers' geographical concentration measured by either Sup100 or Supdum, regardless of control or without control variables. For example, the coefficient of Sup100 reported in column (3) is -0.027, indicating that when the number of large suppliers within 100 km of a firm increases, corporate innovation ability decreases by 2.7%.

3.3. Robustness checks

3.3.1. Replacement of the dependent variable and firm fixed effects

We use alternative measures of corporate innovation to re-estimate our baseline regression: the dependent variable lagged by one period (F.Lninvent) and the natural logarithm of 1 plus invention patent applications (Lnainvit). Additionally, we control for firm fixed effects. Columns (1) to (6) of Table 4 report the regression results, which show that the coefficients of Sup100 and Supdum remain significant and negative, indicating that our main findings are robust.

3.3.2. Instrumental variable regression

We perform a two-stage least squares (2SLS) regression to mitigate potential endogeneity concerns. We employ the average industry's Sup100 as the first instrumental variable (Sup100_mean) by following Dhaliwal et al. (2016). Moreover, we lag the endogenous explanatory variable by one period as the second instrumental variable (L.Sup100).

Table 5 shows the 2SLS regression results. Columns (1) and (2) present the first-stage regression results, which show that the coefficients of Sup100_mean and L.Sup100 are positive and significant at the 1% level. Columns (3) and (4) show the results of the second-stage regression, in which the coefficients of Sup100 and Supdum are both significant and negative, consistent with the main regression results.

4. Channel test

4.1. Suppliers' bargaining power

Concentration in close proximity can reduce the problem of information asymmetry and lower transportation costs. This will increase suppliers' bargaining power and inhibit corporate innovation. Gu et al. (2022) indicate that the larger the proportion of a firm's purchases from its large suppliers, the greater the suppliers' negotiating power. Furthermore, long-term collaboration increases the focal firm's investment in relationship-specific assets and strengthens suppliers' bargaining power (Prajogo and Olhager, 2012).

We use a dummy variable BP to denote suppliers' bargaining power, which equals one if the average length of cooperation between the firm and its suppliers is more than two years; in the meantime, if the average proportion of purchases from the suppliers is above the median value; otherwise is zero. We divide the sample into firms with strong or weak supplier bargaining power.

Table 6 reports the regressions results. The coefficients of Sup100 and Supdum are significant and negative for firms with strong supplier bargaining power only, but changed to insignificant for firms with weak supplier bargaining power. These results suggest that suppliers' geographical concentration inhibits corporate innovation depending on the suppliers' bargaining power.

4.2. Financial constraints

Suppliers' geographical concentration may force the focal firm to increase the proportion of cash payments, shorten the credit collection period, and raise the purchase price. Consequently, this will minimize the focal firm's profits, exacerbate the firm's financing constraints and inhibit innovation (Guariglia and Liu, 2014). We use the WW index introduced by Whited and Wu (2006) to measure a firm's financing constraints. The larger the value of the WW index, the higher the financing constraints a firm faces. We divide sample firms into two groups based on the median value of financial constraints and re-perform Eq. (1) in each group.

Table 7 shows the results. The coefficients of Sup100 and Supdum remain negative and significant at the 1% level for firms facing a high level of financing constraints but turn insignificant for firms with low financing constraints. This shows suppliers' geographical concentration exacerbates a firm's financing constraints and thus inhibits corporate innovation.

[1] Because the listed firms only disclose their top five suppliers, thus, the maximum number of *Sup100* is 5.

Table 2
Descriptive statistics.

Variables	N	mean	sd	min	p50	max
Lninvent	3730	0.778	0.984	0	0	6.232
Sup100	3730	1.076	1.231	0	1	5
Supdum	3730	0.574	0.495	0	1	1
Size	3730	22.06	1.221	19.65	21.90	25.71
Lev	3730	0.439	0.214	0.051	0.428	0.900
Roa	3730	0.032	0.058	-0.259	0.032	0.183
PPE	3730	0.229	0.177	0.001	0.191	0.716
Age	3730	2.152	0.898	0.000	2.303	3.296
Growth	3730	0.179	0.550	-0.635	0.083	3.864
Top1	3730	34.05	14.90	3.885	30.85	89.99
Top2–5	3730	18.38	11.49	0.000	16.99	56.25
Boardsize	3730	2.151	0.191	1.609	2.197	2.708
Indenp	3730	0.368	0.047	0.333	0.333	0.556
Lnpay	3730	14.21	0.663	12.67	14.19	16.13

Table 3
Baseline regression.
The table shows the regression results from Eq. (1). Columns (1) and (2) report the results of the univariate regression. Columns (3) and (4) present the effect of supplier geographical concentration on corporate innovation with a full set of control variables. Control variables are defined in Table 1. We control for the industry and year-fixed effect. Robust t-statistics are in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Lninvent	Lninvent	Lninvent	Lninvent
Sup100	-0.038***		-0.027**	
	(-3.07)		(-2.30)	
Supdum		-0.110***		-0.084***
		(-3.55)		(-2.81)
Size			0.237***	0.237***
			(13.35)	(13.32)
Lev			-0.139*	-0.137
			(-1.65)	(-1.62)
Roa			0.196	0.213
			(0.80)	(0.86)
PPE			-0.383***	-0.369***
			(-3.37)	(-3.24)
Age			-0.079***	-0.079***
			(-3.59)	(-3.61)
Growth			0.002	0.000
			(0.08)	(0.01)
Top1			0.000	0.000
			(0.15)	(0.12)
Top2–5			-0.005***	-0.005***
			(-3.41)	(-3.43)
Boardsize			-0.046	-0.055
			(-0.48)	(-0.57)
Indenp			-0.451	-0.486
			(-1.20)	(-1.29)
Lnpay			0.134***	0.135***
			(5.31)	(5.35)
Constant	-0.652***	-0.663***	-6.653***	-6.631***
	(-4.73)	(-4.88)	(-13.74)	(-13.67)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	3730	3730	3730	3730
Adj.R^2	0.253	0.254	0.329	0.329

5. Conclusions

This study examines the effect of suppliers' geographical concentration on corporate innovation. Our results show that the geographical concentration of suppliers has an inhibitory effect on corporate innovation. The results of channel analysis show that suppliers' geographical concentration weaken corporate innovation primarily through their strong bargaining power and by exacerbating firms' financing constraints. The main results survived after alleviating the endogeneity concerns.

Table 4
Replacement of the dependent variable and firm fixed effects.
The table shows the regression results by using the alternative dependent variables and controlling firm fixed effects. Columns (1) to (4) report the results using the new dependent variables. Columns (5) and(6) present the results with controlling for the firm fixed effect. Control variables are defined in Table 1. Robust t-statistics are in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	F.Lninvent	F.Lninvent	Lnainvit	Lnainvit	Lninvent	Lninvent
Sup100	-0.037***		-0.039**		-0.066***	
	(-2.62)		(-2.45)		(-3.31)	
Supdum		-0.082**		-0.108***		-0.180***
		(-2.18)		(-2.72)		(-3.49)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-6.546***	-6.479***	-9.847***	-9.818***	-2.461***	-2.391**
	(-10.74)	(-10.67)	(-14.40)	(-14.35)	(-2.59)	(-2.47)
Industry FE	Yes	Yes	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	2514	2514	3730	3730	3730	3730
Adj.R^2	0.351	0.351	0.369	0.370	0.078	0.079

Table 5
2SLS regression.
The table shows the results of the 2SLS regression. Columns (1) and (2) report the results of the instrument variables on suppliers' geographical concentration. Columns (3) and (4) show the results of the second-stage regression of 2SLS. Control variables are defined in Table 1. All columns control for the industry and year-fixed effect. Robust t-statistics are in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Sup100	Supdum	Lninvent	Lninvent
Sup100			-0.049***	
			(-2.68)	
Supdum				-0.180***
				(-2.68)
Sup100_mean	0.561***	0.145***		
	(10.47)	(5.93)		
L.Sup100	0.721***	0.198***		
	(40.49)	(29.69)		
Controls	Yes	Yes	Yes	Yes
Constant	0.141	0.584*	-6.189***	-6.091***
	(0.27)	(1.90)	(-10.92)	(-10.75)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	2514	2514	2514	2514
Adj.R^2	0.607	0.355	0.359	0.358

Future research could consider the following three aspects. First, to conduct a moderating analysis of the effect of suppliers' geographical concentration on corporate innovation. Second, to evaluate the factors that contribute to the geographical concentration of suppliers. Finally, to investigate the impact of suppliers' geographical concentration on investment efficiency or trade credit.

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Author statement

CRediT author contributions: Yurong Xiong: Investigation, Software, Formal analysis, Data curation, Writing - original draft, Writing - review & editing, Visualization. Haomin Wu: Conceptualization, Methodology, Formal analysis, Resources, Writing - review & editing, Supervision, Funding acquisition. Xin Ding: Writing - review & editing, Resources. Ji Wu (George): Writing - review & editing, Visualization.

Uncited references

Kang et al., 2018, Coval et al., 2001.

Table 6
Suppliers' bargaining power heterogeneity.
The table shows the results of subsamples classified by suppliers' bargaining power. Columns (1) and (3) report the results for firms with strong supplier bargaining power. Columns (2) and (4) present the results for firms with weak supplier bargaining power. Control variables are defined in Table 1. We control for the industry and year-fixed effect. Robust t-statistics are in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Strong	Weak	Strong	Weak
Sup100	-0.056**	-0.012		
	(-2.53)	(-0.82)		
Supdum			-0.213***	-0.048
			(-2.95)	(-1.38)
Controls	Yes	Yes	Yes	Yes
Constant	-5.017***	-6.787***	-5.014***	-6.777***
	(-5.22)	(-11.73)	(-5.25)	(-11.70)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1021	2709	1021	2709
Adj.R^2	0.357	0.326	0.359	0.326
Suest test	chi2(1) = 2.82		chi2(1) = 4.59	
	Prob > chi2 = 0.0932		Prob > chi2 = 0.0321	

Table 7
Heterogeneous effect of financial constraints.
This table shows the results of subsamples classified by the firm's financing constraints. Columns (1) and (3) report the results for firms with high financing constraints. Columns (2) and (4) present the results for firms with low financing constraints. Control variables are defined in Table 1. We control for the industry and year-fixed effect. Robust t-statistics are in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1) High	(2) Low	(3) High	(4) Low
Sup100	-0.053***	0.007		
	(-3.44)	(0.39)		
Supdum			-0.136***	-0.030
			(-3.43)	(-0.66)
Controls	Yes	Yes	Yes	Yes
Constant	-6.001***	-6.680***	-6.002***	-6.640***
	(-8.13)	(-8.83)	(-8.11)	(-8.73)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1847	1883	1847	1883
Adj.R^2	0.289	0.372	0.290	0.372
Suest test	chi2(1) = 6.45		chi2(1) = 3.29	
	Prob > chi2 = 0.0111		Prob > chi2 = 0.0697	

Declaration of Competing Interest

None

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