



Article

Customer Concentration and Corporate Innovation: Effects of Financing Constraints and Managers' Expectation of Chinese Listed Companies

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Abstract: Innovation capability of enterprises will greatly influence the current and future development of companies. This paper investigates the relationship between customer concentration and innovation capability of enterprises through the view of both the financing constraints and the expectation of managers. Based on the data of China's A-share listed companies over the period from 2012 to 2016, several methods including system GMM, threshold model of fixed effects, and PSM are applied for empirical analysis. The results show that the innovation capability of listed companies in China are negatively correlated with the customer concentration. Higher customer concentration brings about stronger constraints from large customers on enterprises and greater dependence of enterprises on large customers, which result in weaker demand for innovation and lower investment in innovation. Meanwhile, the results demonstrate the double-threshold effect of financing constraints. The effect of customer concentration on innovation can be different in companies with low, medium, or high-financing constraints. Furthermore, optimistic expectations are more conducive to the reduction of customer concentration and the improvement of innovation. In addition, based on the perspective of the manager's expectation, the research demonstrates the heterogeneous impact of manager's expectation on the relationship between customer concentration and innovation capability.

Keywords: customer concentration; innovation of enterprises; dynamic panel; threshold model; China

1. Introduction

Under current fierce market competition environment, the innovation capability of a company has gradually become one of the most indispensable capabilities of corporate development [1]. With the rise of the so-called digital economy in the 21st century, companies with stronger innovative capability will be more dominant in the market and will be able to gain higher excess returns [2]. Therefore, it is necessary to explore the factors that affects the innovation capability of the companies. The China Securities Regulatory Commission has clearly stated in the "Information Disclosure Standards No. 2 for Listed Companies" that listed companies should disclose relevant information of the top five customers, making customer concentration has once again attracted various attentions from the academia. Customer concentration indicates a company's degree of dependence upon customers [3], a more concentrated customer base provides stable sales channels, thus guarantees the operating efficiency of companies [4]; on the other hand, excessive customer concentration will have an impact

on development decisions such as product prices and R&D (Research and Development) investment, thereby affecting their business strategies [5,6].

With academia and practitioners paying more and more attention to corporate customer concentration and the innovation capability of enterprises [4,7], it makes sense to discuss the relationship from different angles of view, since this kind of research helps listed companies to more comprehensively assess the impact of customer concentration on innovation capability, so as to achieve dual improvement of both innovation capability and business performance.

The research method of this paper primarily combines theoretical analysis with empirical analysis and comprehensively uses qualitative analysis and quantitative analysis. As for theoretical analysis, hypotheses are put forward based on existing theories and research. As for empirical analysis, the dynamic panel model is used to measure the relationship between customers concentration and innovation capability of listed companies. Moreover, through system GMM estimation, a threshold model of fixed effects is established to explore the threshold effect of financing constraints. Finally, how different levels manager expectation affect the relationship between customer concentration and innovation capability is discussed through PSM models.

This paper is organized as follows. Section 2 clarifies the definitions of customer concentration and innovation of enterprises and relates our work to the existing literature. Section 3 lays out the theoretical analysis and our hypothesis. In Section 4, an empirical model is developed based on the data of Chinese listed companies. Fifthly, the empirical results of the correlation statistical analysis, generalized method of moments (GMM), threshold regression, and propensity score matching (PSM) method are presented to verify the proposed hypothesis. Finally, the paper summarizes the all the findings of the research and proposes policy suggestions in Section 6.

2. Literature Review

2.1. Innovation Capability of Enterprises

Schumpeter (1912) first proposed the concept of innovation by defining innovation as building a new production function, and believes that it includes five kinds of innovations: new products, new processes, new markets, new organizations, and new raw materials [8]. Here entrepreneurs play the role of introducing the “new combinations” of production factors and production conditions into the production system. On this basis, innovation will be transformed into productivity to sequentially achieve profit creation and economic development. Since then, corporate innovation has attracted the attention of more and more scholars and entrepreneurs. Burns and Stalker (1961) first put forward the concept of innovation capability and pointed out that the innovation capability of enterprises can promote the marketization of new products and new technologies [9]. Leonard-Barton (1992) pointed out that innovation capability is a system that contains knowledge, management, technology, norms, and values, while at the same time providing a competitive advantage for the company [10]. Nevertheless, innovation capability of enterprises has both broad and narrow meanings, for example, technological innovation capability is only a narrow innovation, the broad sense of innovation is reflected in the sum of various elements of enterprises [11,12]. In more recent researches, innovation may have an effect on the strategy of enterprises. Yun et al. (2016), based on an ABM model, in highly or less innovative situations the firm’s decision on technology openness and corresponding strategies can be different [13].

The positive significance of innovation to companies themselves should not be ignored. Innovation the core competence to ensure sustainable improvement of corporate performance and survival of enterprises in a highly competitive environment [14,15]. Therefore, researchers never give up exploring internal or external factors affecting corporate innovation. As for internal factors, Damanpour (1992) verified the positive relationship between company size and innovation [16]. Lee et al. (2003) verified the impact of market concentration, firm size, dividends, growth potential, and government policy on promoting corporate R&D activities [17]. Besides, organizational structure can also impact the process of

innovation [18]. As for external factors, government R&D subsidies will influence corporate innovation, but the effect can be different in consideration of different size of subsidies and different types of companies [19–21]. Girma et al. (2009) proved that inward FDI generate higher innovative activity in Chinese state-owned enterprises at the firm level, yet would have a negative impact on innovative activity in SOEs on average at the sector level [22]. Besides, agency risk can be a significant barriers of innovation activities [23]. From another perspective, the development of corporate innovation ability can be hindered by outdated mental models, risk-averse corporate environments, poor innovation management, inadequate follow-up capabilities, and the inability to develop mandatory internal or external infrastructure [24].

The process of innovation contains a series of changes in hardware, market environment, production facilities and knowledge, as well as the social contexts, thus innovation is inherently hard to measure [25]. Scholars have been trying to find out appropriate indicators, but as yet there is not a common set of indicators for innovation performance. Hagedoorn (2003) introduced several indicators like R&D inputs, patent counts and patent citations to new products to measure innovation performance of high-tech companies [26]. The study of Davila et al. (2006) offered the first authoritative guidance of metrics that can be applied during the process of innovation, including revenue of new products, R&D investment, time to market, satisfaction of customers and employees, and number of patents [27]. Edison et al. (2013) discussed various aspects of innovation measurement such as the assessment of innovation capability, output of innovation and its effect and factors that facilitate innovation activities [28].

From the existing abundant literature on innovation, it is obvious that scholars have already attached importance to the significance of innovation long before. Although scholars have proposed various definition of innovation, most of them agree that innovation of enterprise will increase competitiveness and create profits by increasing investment in R&D and introducing emerging technologies and knowledge. The importance of innovation capability has been recognized, researchers have discussed the positive effect of innovation on corporate performance from different perspectives and have discussed the correlation between internal and external factors and innovation from multiple dimensions. The existing research shows that the factors that affect innovation are comprehensive. As the innovation capability of enterprises gets more and more attention, the research on innovation of enterprises has been continuously enriched. On the one hand, different evaluation indexes of innovation capability are constructed and improved. On the other hand, the research on the correlation between innovation and other factors tends to be comprehensive and perfect. However, researchers usually focus more on the outcome of innovation, but ignore that the process of innovation may bring other benefits besides profitability. Erkut (2018) mentioned that the market success is not a necessary consequence of product innovation. Instead, the process of innovation plays an important role in the successful creation of a new market segment. This kind of argument bridges the research gap between marketing and the emergence of markets [29], and our research is trying to contribute through the aspect of customer concentration.

2.2. Customer Concentration

Customer concentration refers to the proportion of the sales amount of the company's top customers to the total sales [5,30,31]. In the regulations promulgated by the China Securities Regulatory Commission in 2007, enterprises are required to "disclose the total sales revenue of their top five customers and the proportion to the total sales revenue." This proportion is namely the customer concentration of listed companies. The customer concentration is not only a reflection of the sales policy of the company, but also reflects the bargaining power of customer and, consequently, has a considerable effect on corporate decisions, achievements, risks, market performance, and other aspects of the company [32].

Stable large customers can be conducive to firm performance. Customer concentration is positive correlated with the accounting rates of return [33]. Wang and Zhu (2017) proved in his research that

high customer concentration is conducive to integration of the supply chain, the release of favorable market signals, as well as lower audit fees [34]. Huang et al. (2015) provided an interesting empirical analysis on the manufacturing enterprises listed in the Shanghai and Shenzhen Stock Exchange Markets, and found out that the improvement of customer concentration can promote operating performance, while reducing business risks and, accordingly, bringing a positive capital market response [32]. Lin and Zhang (2017) conducted research on GEM (Growth Enterprises Market Board) companies in China, and the results show that high customer concentration provides stable market channels for enterprises, but the marginal utility of this stabilizing effect will decrease after the initial public offering (IPO) [35].

However, higher customer concentration may bring some negative impact. High customer concentration is risky, since losing big customers may quickly lead companies into crisis, and this kind of risk can provide customers with considerable bargaining power [36,37]. Itzkowitz (2013) indicated that when one customer occupies a large proportion of the supplier's sales volume, losing that customer will greatly damage the financial health of the supplier [38]. Moreover, the concentration and composition of customer can significantly impact corporate financing cost, thus generating higher cost of equity capital and debt [6]. Among existing researches, the main indicator of customer concentration is the ratio of the current sales amount of the company's largest customer or the top five customers to the current total sales revenue. Nevertheless, the Herfindal Index of the main customer is applied to measure the risk of customer concentration in some researches [33].

As proposed in most existing researches, high customer concentration will promote information sharing and strengthen the integration of industry chains, thus effectively improving the efficiency of the industry chain [39]. However, for listed companies with high customer concentration, higher risk of excessive volatility in either business strategy or business performance may appear to be due to the decision of large customers [40]. Therefore, there are completely different insights among the existing researches on whether the customer concentration of listed companies is beneficial.

2.3. The Relationship between Customer Concentration and Innovation

A negative correlation between customer concentration and the innovation capability of the company was proposed in most studies. On the one hand, excessive customer concentration is usually accompanied by the risk of operating cash flow, so the company has to reduce the capital input of innovation [41]. On the other hand, excessive customer concentration forces enterprises to make products in accordance with the expectations of large customers and may ignore the continuous demand of the market for innovation, thereby resulting in reduction of the innovation activities. In any case, excessive customer concentration may impair the innovation capability of listed companies.

Increasing customer concentration will reduce the profit margin and increase the risk of enterprises, thereby impairing their innovation capability. The relationship between customer and supplier will have an impact on firm innovation [42]. Taking the companies listed in GEM as an example, Lin and Zhang (2017) proved that the innovation capability is negatively correlated with customer concentration of enterprises [35]. Wu et al. (2017) also made an empirical analysis on companies listed in GEM, and the results show that the degree of customer concentration was not conducive to the R&D investment of enterprises [43]. The excessive concentration of customers will intensify financing constraints and consequently bring down the innovation activities of enterprises to a certain degree [41].

However, some researchers also clarified that when customer concentration is in a relatively low level, to fight for more customers resource, listed companies will unremittingly promote the degree of innovation activities for their products, so as to attract more customers. Therefore, at this stage, the innovation capability can be positively correlated with customer concentration. Xu et al. (2016) illustrated that the relationship between R&D investment intensity and customer concentration can be an inverted "U" shape [44]. Li et al. (2016), based on the datasets of small, medium, and GEM manufacturing companies, proved that the improvement of customer concentration was beneficial to the position of company in supply chain to a large extent, and consequently promoted the innovation capability of the company [39]. As for the outcome of innovation, Eggert et al. (2015) discussed the

moderating effect of customer concentrating which will affect the relationship between innovation and a firm's profitability. Their study found that a small customer base can promote the success of hybrid innovation, but this kind of knowledge benefit is not significant for other kinds of innovation [45].

It is evident that the existing researches on the relationship between customer concentration and innovation are not abundant and lack review from multiple perspectives. Since most of the existing studies are based on the data of listed companies in a certain industry or a certain sector, they may have certain limitations and may not be able to comprehensively discuss the correlation between customer concentration and innovation. Therefore, the major content of this paper is to discuss the relationship between customer concentration and innovation based on the whole dataset of A-share companies in recent five years. Furthermore, this paper extends the scope of research to explore the relationship between customer concentration and innovation from various perspectives including financing constraints and managers' expectations.

3. Theoretical Analysis

3.1. Customer Concentration and Innovation Capability of Listed Companies

Freeman (1984) proposed the stakeholder theory in his book "Strategic Management: A Stakeholder Approach", which argues that the management activities of a company carried out by managers should comprehensively balance the interest requirements of various stakeholders [46]. As a significant stakeholder of the company, the view of customers will have a great impact on various aspects of the corporate business decisions, so when managers make decisions they should consider the interests of customers or accept relevant constraints [33]. In 1996, Schmookler put forward the "demand pull hypothesis", which points out that the orientation and scale of demand will drive the innovation activities of the enterprises [47]. For listed companies, the demand of customers and the market will have an effect on their investment decisions of innovation. When innovation inputs shift into cost at the sacrifice of current interests of customers, they may force the managers to adjust the decision of innovation activities, so as to satisfy the demands of their profits. Therefore, if the customer concentration is too high, the bargaining power of customers will greatly increase, hence the compression of profits will lead to further reductions in the input of innovation activities and will become obstacles for the development of enterprise innovation [48].

In addition, for enterprises with high customer concentration, they only need to make efforts to meet the needs of the major customers, so their sensitivity to the demand of the market will be relatively lower, which is unfavorable for the development of innovation capabilities. As Christensen (1997) mentioned in his book, it is not always right to listen to customers when making investment decisions, because when firms invest aggressively in technologies that meet their customers' needs, they may ignore so-called "disruptive innovation", which is vital for these firms to survive in rapidly changing environment [49]. On account of the above discussion, the first hypothesis (H1) is proposed:

Hypothesis 1 (H1). *All other things being equal, customer concentration has negative impact on the corporate innovation capabilities of listed companies.*

3.2. Information Asymmetry: The Threshold Effect of Financing Constraint

Ju et al. (2013) measured the financing constraint degree of enterprises by the SA index method proposed by Hadlock Pierce (2009), and revealed the significant role of working capital in buffering the fluctuations of innovation investment; this effect is closely related to the degree of financing constraints of enterprises [50,51]. The degree of financing constraints will be affected by various factors [52], such as the external market, economy environment, and internal operating conditions [38]. The information asymmetry model assumes that, within the market and economic activities, the superiority of those who have better information will be obvious. Therefore, for companies with higher customer concentration,

the dominant position of key importance will be evidently superior to other customers. That is to say, high customer concentration may exacerbate the level of information asymmetry, thereby exacerbating corporate financing constraints [5].

Since the alteration of cooperation intention of large customers will bring about greater operational risks to companies with higher customer concentration, the concentration of customers will reduce the enterprises' capacity of risk-taking, which is not beneficial for enterprises to gain better external financing [53]. Meanwhile, there exist significant positive relationship between a firm's R&D expenditure and financing constraints [54]. Mentioned by robotics engineer Engelberger, financial support is one of the requirements for innovation [55], indicating the importance of money supply in innovation activities. Therefore, excessive customer concentration may lead to higher financial constraint, which generates a negative impact on internal cash flow, resulting in lower R&D investment. Based on the above discussion, the second hypothesis (H2) is proposed:

Hypothesis 2 (H2). *All other things being equal, there is a threshold effect of financing constraint between the innovation capability of listed companies and customer concentration. The impact of customer concentration on innovation capability varies with the level of financing constraint.*

3.3. Expectation Theory: The Heterogeneous Effect of Managers' Expectations

Manager's expectation is a psychological concept brought into focus of research in recent years by several Chinese scholars [56–58]. The expectation theory of Keynes (1923, 1930, 1936) proposed that future uncertainties make a decisive impact on the economic behavior of people [59–61]. Due to the uncertainty of corporate development in the future, managers of listed companies will naturally have different expectations, and accordingly play a decisive role in various business decisions. Furthermore, when managers are optimistic about the future of the companies, the corresponding corporate business strategy will be more aggressive [62], whereas pessimistic managers may tend to make relatively conservative business strategies [58]. Therefore, a heterogeneous effect of managers' expectations on the operation of listed companies will appear [63]. With optimistic expectations, managers will remain confidence in the market, thus they may try to increase various investment so as to upgrade product services, as well as actively look for customers and further expand the market [57]. Consequently, the level of innovation activities will be improved in all these efforts. Meanwhile, the number of target customers will increase [64]. On the basis of the above discussion, the third hypothesis (H3) is proposed:

Hypothesis 3 (H3). *All other things being equal, the correlation between customer concentration and innovation capability of listed companies is different as managers' expectations on the future of companies being different. Optimistic expectations are more conducive to the increase of investment in innovation capability, as well as the reduction of customer concentration.*

4. Data and Methods

4.1. Data Description and Variable Selection

4.1.1. Sample Selection and Sources of Data

This paper takes all A-share listed companies listed in China's Shanghai and Shenzhen Stock Exchanges between 2012 and 2016 as the research object. The main sample selection process is as follows; (1) Excluding the financial companies defined in the CSRC Industry Classification of Listed Companies (2012 edition). (2) Excluding companies that did not continuously operate from 2012 to 2016. (3) Excluding ST companies with abnormal financial status. (4) Excluding samples with missing data. Finally, 8229 firm-year observation samples were obtained. In order to minimize the influence of

outliers on the results of estimation, Winsorize treatment was performed on the 1% and 99% quantiles of all continuous variables. The data sources are as follows; (1) WIND database: R&D investment, the ratio of sales amount of the top five customers to total current sales of the company; (2) CSMAR database: all the rest data of listed companies. In addition, all the data processing and model testing in this paper are completed on EXCEL and STATA12.

4.1.2. Variables Selection

Dependent variable—investment in innovation (*RD*): the innovation capability of listed companies largely depends on their R&D investment. Generally speaking, the more R&D investment, the more R&D output, and consequently an improvement in the level of innovation activities and strengthening of innovation capability. Therefore, this paper chose quantitative R&D investment indicators to measure the degree of innovation capability of listed companies.

Independent variables: Variable of interest—customer concentration (*CUSTOMER*): this index can be measured by the proportion of the sales revenue of the top five customers to the total current sales of the company. The higher the proportion the more company dependence on the top five customers, so the corporate business will be more concentrated and more oriented to a certain group of customers.

Control variables—the measurement index of financing constraints (*SA*) and managers' expectations (*YUQI*) were introduced as control variables in the panel regression model. Meanwhile, since there are many factors that will influence the innovation capability of listed companies, control variables should not be susceptible to the problem of multicollinearity. Based on the principle of lower correlation coefficient, the scale of enterprise (*SIZE*), the leverage ratio (*LEV*), the business performance (*ROA*), the capital occupation of major shareholder (*OCCUPY*), the total asset turnover (*TATURN*), the property right characteristic (*STATE*), and the growth rate of enterprise (*GROWTH*) were introduced as control variable.

All the main variables are listed in Table 1.

Table 1. Main variables.

Classification	Symbol	Variable	Variable Definition
Dependent variable	<i>RD</i>	Investment in R&D	R&D input/operating income
Independent variable	<i>CUSTOMER</i>	Customer concentration	Sales revenue of the top five customers/the total current sales of the company
	<i>SA</i>	Size-Age index	$SA = -0.737 \text{ Size} + 0.043 \text{ Size}^2 - 0.04 \text{ Age}$
Control variables	<i>YUQI</i>	Managers' expectations on the future of the enterprise	Dummy variable: equals 1 when the operating income in period <i>t</i> -1 is greater than that in period <i>t</i> -2, the manager holds an optimistic expectation for the future in the period <i>t</i> ; otherwise equals 0
	<i>SIZE</i>	Scale of enterprise	Natural Logarithm of the total assets
	<i>STATE</i>	Property right characteristic	Dummy variable: equals 1 if the company is state-owned; otherwise equals 0
	<i>LEV</i>	Leverage ratio	Current asset-liability ratio
	<i>ROA</i>	Business performance	Net profit/total assets
	<i>OCCUPY</i>	Capital occupation of major shareholder	Other receivables/total assets
	<i>TATURN</i>	Total asset turnover	Operating income/total assets ending balance
	<i>GROWTH</i>	Growth rate of enterprise	(Current business income—business income of last year)/business income of last year
	<i>L.RD</i>	Investment in R&D one period lagged	Investment in R&D in <i>t</i> -1 period/operating income in <i>t</i> -1 period

4.2. Model Construction

4.2.1. The Panel Model

To verify H1, discussing the influence of customer concentration on the level of innovation of listed companies, this paper applies the variable intercept panel regression model. First of all, the form of intercept term in the model was determined by Hausman test. Since the p -value in the results of the test is less than 0.05, we can reject the null assumption of random effects at the 95% significant level, and hence the fixed effects model is applied; we set-up the following panel data model.

$$RD_{it} = \beta_0 + \beta_1 CUSTOMER_{it} + \beta_2 \sum_j \theta_j X_{it} + \varepsilon \quad (1)$$

In Equation (1), RD reflects the level of innovation capabilities of the listed company and $CUSTOMER$ represents the degree of customer concentration. X is the control variable and ε is the random disturbance term. The subscript i indicates the company, t indicates the year, j indicates the kinds of the control variable, and β is the coefficient of the independent variable.

4.2.2. Model Modification and Estimating Methods

Considering that there will be a reaction lag concerning the impact of current customer concentration on innovation capability, the first-order lagged term of the dependent variable is introduced, and accordingly the dynamic panel data model was established:

$$RD_{it} = \beta_0 + \beta_1 RD_{it-1} + \beta_2 CUSTOMER_{it} + \beta_3 \sum_j \theta_j X_{it} + \varepsilon \quad (2)$$

In Equation (2), RD_{it-1} refers to the first-order lagged variable of innovation capabilities.

Because the impact factors of innovation capability of listed companies vary from four perspectives—financing constraints, managers, scale, and financial status of the company—this paper introduces several control variables mentioned above, and simultaneously controls the effect of year and industry. Finally, the fixed effects dynamic panel model was determined as follows

$$RD_{it} = \beta_0 + \beta_1 RD_{it-1} + \beta_2 CUSTOMER_{it} + \beta_3 SA_{it} + \beta_4 YUQI_{it} + \beta_5 SIZE_{it} + \beta_6 STATE_{it} + \beta_7 LEV_{it} + \beta_8 OCCUPY_{it} + \beta_9 TATURN_{it} + \beta_{10} GROWTH_{it} + \beta_{11} ROA_{it} + \sum YEAR + \sum IND + \varepsilon \quad (3)$$

Due to the existence of a first-order lagged term of dependent variables in the model, it is easy for the model to generate endogeneity, which will lead to a deviation in coefficient estimation. Therefore, the generalized method of moments (GMM) was adopted.

4.3. Threshold Model of Financing Constraint

In order to verify H2, the threshold regression method proposed by Hansen (1999) [65] is adopted in this paper. To examine the existence of the nonlinear threshold effect of financing constraints between customer concentration and innovation capability, and to avoid subjective threshold division, here the financing constraint is regarded as the threshold variable, and the following single-threshold panel model is established.

$$INNOV_{it} = \alpha_i + \beta_1 X_{it} + \beta_2 CUSTOMER_{it} \cdot I(q_{it} \leq \gamma) + \beta_3 CUSTOMER_{it} \cdot I(q_{it} > \gamma) + e_{it} \quad (4)$$

$(1 \leq i \leq n, 1 \leq t \leq T)$

In Equation (4), X_{it} stands for the control variables, Q_{it} stands for threshold variable, γ stands for threshold value to estimate, α_i stands for individual fixed effects, and e_{it} stands for residual term. I is the indicator function. When the condition on q_{it} is true, I equals 1, otherwise I is equal to 0.

4.4. PSM Model of Managers' Expectations

For the purpose of verifying H3, this paper adopts the Propensity Score Matching method proposed by Rosenbaum to estimate the impact of managers' expectations on the innovation capability and customer concentration [66]. The samples are divided into two groups according to different managers' expectations. Group one is the treatment group, containing the companies whose managers have optimistic expectations on future development, and are denoted as $YUQI_i = 1$. Group two is the control group, containing the companies whose managers have pessimistic expectations on future development, and are recorded as $YUQI_i = 0$. The average treatment effect for the treated is

$$\begin{aligned} ATT_1 &= E[RD_{1i} - RD_{0i} | YUQI_i = 1] \\ &= E\{E[RD_{1i} | YUQI_i = 1, p(X_i)] \\ &\quad - E[RD_{0i} | YUQI_i = 0, p(X_i)] | YUQI_i = 1\} \end{aligned} \quad (5)$$

$$\begin{aligned} ATT_2 &= E[CUSTOMER_{1i} - CUSTOMER_{0i} | YUQI_i = 1] \\ &= E\{E[CUSTOMER_{1i} | YUQI_i = 1, p(X_i)] \\ &\quad - E[CUSTOMER_{0i} | YUQI_i = 0, p(X_i)] | YUQI_i = 1\} \end{aligned} \quad (6)$$

In the above equations, RD_{1i} and RD_{0i} represent the innovation capability of company I with optimistic manager expectation and pessimistic manager expectation, respectively. $CUSTOMER_{1i}$ and $CUSTOMER_{0i}$ represent the degree of customer concentration with optimistic and pessimistic manager expectations, respectively. In this PSM model, the outcome variables are innovation capability and customer concentration. The confounding variable is whether company I is the company with optimistic managers' expectations, and accordingly 1 refers to optimistic expectation, 0 refers to pessimistic expectation. The background variable set X_{it} is the feature of given sample, namely the control variable. Multiple features of listed companies are used to estimate the propensity score of Logit model, and the conditional probability of treatment, namely the PS value, is the propensity score. Here the conditional probability that the manager has optimistic expectation of company I is

$$P(X_i) = \Pr(YUQI_i = 1 | X_i) = E(YUQI_i | X_i) \quad (7)$$

5. Results

5.1. Descriptive Statistics

The sample contains the data of listed companies from 2012 to 2016, covering 17 different industries of A-share, among which manufacturing enterprises accounted for the largest proportion. The descriptive statistics of each variable of the sample companies is listed in Appendix A Table A1. It can be seen from table that the proportion of R&D investment to the total operating income of listed companies is 3.99%. According to existing researches, this figure shows that the level of innovation capability of listed companies has improved in recent years compared with past years. However, compared with mature companies in developed markets, it is still at a relatively low level. The average customer concentration of the whole sample is 29.54%, which is at a normal level, yet with big differences among different companies. In addition, managers of listed companies are more likely to have optimistic expectations on the future of enterprises.

5.2. Pearson Correlation

Pearson correlation coefficients among the variables are listed in Appendix A Table A2. The results show that customer concentration is positively correlated with innovation capabilities at the significant level of 5%, which is inconsistent with Hypothesis 1. However, further verification should be carried out considering the influence of control variables. In addition, the absolute value of the correlation

coefficient between each variable does not exceed 0.6, which means that there is no strong correlation between variables and the problem of multicollinearity cannot be avoided.

5.3. Result of the Dynamic Panel Model

Prior to regression, the unit root test was conducted on the variables to examine the stationarity of the sequence. The fisher-pp unit root test was used here, and all variables pass the test, indicating that these variables are stable. Table 2 lists the results of system GMM (SYS-GMM). The results of fixed effects (FE) and ordinary least squares (OLS) are listed in Appendix A Table A3. However, the endogeneity of independent variables cannot be neglected. There are three main sources of endogeneity: the omitted variables, which are hard to observe; the measuring error of variables; and the mutual effect between independent variables and dependent variable. To be specific, some characteristics of the board of director or the managers may affect customer concentration and R&D investment simultaneously. Besides, the FE model assumes that the covariance of the independent variable and the error term is zero, and that there is no heteroscedasticity. However, in reality, error terms usually have sequence correlation, are not independent, and do not have identical distribution. Therefore, this paper applies the system GMM estimation method proposed by Blundell and Bond (1998) to estimate model (3), which can control the endogeneity and heteroscedasticity problems that may occur in the model. Compared with Diff-GMM, SYS-GMM can better solve the problem of the endogeneity and weak instrumental variable. In addition, the sample in this paper is a short panel, so the outcome of system GMM estimation will be better.

Table 2. Results of model (3).

Model	(3)		
Method	SYS-GMM		
Variables	Coefficient	Std. Dev.	
<i>L.RD</i>	0.0083	(0.0100)	
<i>CUSTOMER</i>	−0.0522 ***	(0.0163)	
<i>SA</i>	0.0140	(0.0113)	
<i>SIZE</i>	−0.0033 **	(0.0016)	
<i>ROA</i>	−0.0349 ***	(0.0089)	
<i>OCCUPY</i>	−0.0237	−0.0187 (0.0178)	(0.0152)
<i>LEV</i>	−0.0141 ***	(0.0039)	
<i>TATURN</i>	−0.0130 ***	(0.0026)	
<i>STATE</i>	0.0025	(0.0028)	
<i>YUQI</i>	−0.0009 *	(0.0005)	
<i>GROWTH</i>	−0.0047 ***	(0.0012)	
<i>_cons</i>	0.0223	(0.0830)	
<i>AR(1)</i>	-	0.014	
<i>AR(2)</i>	-	0.508	
<i>Hansen Test</i>	-	0.503	

Notes: (1) Dummy variables of industry and year are introduced in SYS-GMM and OLS regression, which were not listed in the limit of article length. FE estimation automatically excluded the influence of industry and year. (2) Figures in the parentheses are the standard deviation. (3) ***, **, and * represent significant at 1%, 5%, and 10% levels, respectively.

The lagged term of innovation capability is selected as an instrumental variable for model (3). According to the results of SYS-GMM, the associated probability values of AR(2) and Hansen Test are both greater than 0.5, indicating that the instrumental variables of the model are reasonable. Moreover, the second-order autocorrelation of the disturbance term does not exist, so the SYS-GMM estimation method is effective.

The results of GMM show that the customer concentration of listed companies is negatively correlated with the innovation capability at the 1% significance level, and the coefficient of customer concentration is −0.0522, indicating that the increase of customer concentration will have a negative effect on the innovation capability of listed companies. That is to say, higher customer concentration

is not conducive to the development of the innovation capability of listed companies. Therefore, Hypothesis 1 of this paper is verified.

Furthermore, corporate performance and growth of the enterprises are negatively correlated with innovation capability. Traditional research generally believes that the better the corporate performance, the higher its growth will be, and accordingly the investment in R&D will increase, so as to maintain sufficient innovation capacity for efficient development. However, the results show that this positive correlation is not significant for enterprises in China's A-share market, indicating that the consciousness of R & D input of listed companies needs to be strengthened.

5.4. Result of the Threshold Model

Test and estimation. This paper applies the command "xtptm" in Stata12 to complete the estimation of the panel threshold model. First of all, the number of thresholds is determined. Then the single-threshold, double-threshold, and triple-threshold are assumed, respectively, and the result of p constructed by 3000 times sampling through Bootstrap is demonstrated in Table 3.

Table 3. Test of thresholds effect.

H ₀	None	Single	Double
H _a	Single	Double	Triple
F	17.2725	7.3733	5.5949
p	0.0003	0.0053	0.0150
Threshold value	−3.2635	−3.7866/−3.2635	−3.7487/−3.7866/−3.2635
Result	Reject	Reject	Accept

As seen in the above table, model (4) is not significant concerning single-threshold and triple-thresholds. The *p*-value for double-threshold is 0.0150 > 0.01, thus the null hypothesis with double-thresholds cannot be rejected at the 1% significance level. The double-thresholds values are −3.7866 and −3.2635, respectively, with the 95% confidence intervals of the threshold being [−3.9155, −3.7563] and [−3.2711, −3.2332], respectively. Based on the results, the model was modified to the following double-threshold model.

$$\begin{aligned}
 INNOV_{it} = & \alpha_i + \beta_1 X_{it} + \beta_2 CUSTOMER_{it} \cdot I(SA_{it} \leq -3.7866) \\
 & + \beta_3 CUSTOMER_{it} \cdot I(-3.7886 < SA_{it} \leq -3.2635) \\
 & + \beta_4 CUSTOMER_{it} \cdot I(SA_{it} > -3.2635) + e_{it}
 \end{aligned} \tag{8}$$

The regression results of the double-threshold model are shown in Table 4.

Table 4. Results of double-threshold model.

	Variables	Coefficient	t	Obs.
Controlled Variables	SIZE	−0.0018 **	−2.0100	6750
	LEV	−0.0203 ***	−6.2084	6750
	ROA	−0.0657 ***	−6.7256	6750
	OCCUPY	−0.0160	−0.9774	6750
	TATURN	−0.0156 ***	−8.9917	6750
	L.RD	−0.0015	−0.1012	6750
	STATE	−0.0016	−0.8075	6750
	YUQI	−0.0008	−1.4705	6750
	GROWTH	−0.0046 ***	−5.7349	6750
Independent Variable	CUSTOMER (SA ≤ −3.7866)	−0.0178 ***	−4.3464	983
	CUSTOMER (−3.7866 < SA ≤ −3.2635)	−0.0091 ***	−2.6261	4069
	CUSTOMER (SA > −3.2635)	−0.0006	−0.1589	1698

Note: ***, and * represent significant at 1%, and 10% levels, respectively.

The *SA* index proposed by Hadlock and Pierce indicates that, when the value of *SA* is negative, the greater the absolute value is, and the more severe the financing constraint of the company will be. In combination with reality economic significance, listed companies with *SA* -3.7866 in this sample are classified as high-financing constraint companies, while those with *SA* greater than -3.7866 and less than -3.2635 are classified as medium financing constraint, and those with *SA* greater than -3.2635 are subject to low-financing constraint companies. According to the results, most of the current A-share listed companies are suffering medium or high-financing constraints, and only ~25% of the listed companies are in low financing constraints. Meanwhile, Hypothesis 2 is proved, demonstrating the obvious threshold effect of financing constraints between customer concentration and innovation capability. Although for companies suffering different financing constraints, the negative correlation between customer concentration and innovation capability is relatively constant and, due to the decrease in financing constraints, this negative effect will be weakened.

5.5. Result of the PSM Model

According to the results in Table 5, the following conclusions can be drawn; (1) When the managers of listed companies hold optimistic expectations for the company's operation, the investment in innovation activities will increase, thus improving the company's innovation capability. (2) The customer concentration of listed companies with optimistic expectations is lower than that of companies with pessimistic expectations. (3) When managers are optimistic about the future operation of the company, they will continuously expand the market and actively develop new customers by increasing innovation activities, which will result in the improvement of innovation capability and the decrease of customer concentration.

Table 5. Result of treatment group and control group.

	Treatment Group (<i>YUQI</i> = 1)	Control Group (<i>YUQI</i> = 0)
Obs.	5797	2432
Outcome variable	Average	Average
<i>RD</i>	0.0408	0.0378
<i>CUSTOMER</i>	0.2871	0.3151
Background variable set		
<i>SA</i>	-3.4767	-3.5170
<i>SIZE</i>	8.2931	8.2614
<i>LEV</i>	0.4134	0.4338
<i>ROA</i>	0.0444	0.0181
<i>OCCUPY</i>	0.0143	0.0161
<i>TATURN</i>	0.6528	0.5576
<i>GROWTH</i>	0.1856	0.1297
<i>L.RD</i>	0.0402	0.0340
<i>STATE</i>	0.3317	0.4202
<i>YUQI</i>	1	0

Firstly, the propensity value of the sample company is obtained through the Logit model (Table 6). The pseudo- R^2 of the PSM model is 0.0704, and LR χ^2 equals 703.45, indicating that the regression result of the model is good and the variables are all significant at the 1% significant level except for *SIZE* and *GROWTH*.

Table 6. Result of the Logit model.

Independent Variables	Coefficient	Independent Variables	Coefficient
SA	0.4328 *** (3.89)	OCCUPY	−3.2205 *** (−2.64)
SIZE	0.0076 (0.29)	TATURN	0.6110 *** (8.41)
LEV	0.9764 *** (5.71)	STATE	−2861 *** (−4.58)
ROA	12.4914 *** (18.83)	L.RD	3.8021 *** (5.41)
GROWTH	−0.0671 (2.66)	_cons	1.1666 *** (2.66)
Pseudo R ²		0.0704	
LR chi2(8)		703.45	

Note: (1) Figures in the parentheses are the value of z. (2) ***, **, and * represent significant at 1%, 5%, and 10% levels, respectively.

In order to minimize the difference of control variables between the treatment group and the control group, data balancing was carried out. The results (Table 7) show that the standardized bias of all control variables after matching was less than 5%, meeting the balance requirements. On this basis, three methods, including Mahalanobis matching, Radius matching, and Kernel matching, are adopted to calculate ATT values. The results are as follows.

Table 7. Average treatment effect of managers' expectations.

	Mahalanobis Matching		Radius Matching (0.01)		Kernel Matching	
	ATT	t	ATT	t	ATT	t
RD	0.0408	2.57 ***	0.0408	2.53 ***	0.0408	2.45 ***
CUSTOMER	0.2871	−1.73	0.2871	−3.22	0.2872	−3.32

Note: *** represent significant at 1% levels.

In model (5), ATT_1 is positive under all three matching methods, indicating that the managers' optimistic expectation can significantly improve the level of innovation activities of listed companies. In model (6), ATT_2 is negative. Therefore, it is evident that managers' optimistic expectations will have a certain negative effect on customer concentration, which is consistent with the results estimated by Logit regression above, and Hypothesis 3 is verified.

5.6. Robust Test

In order to examine the relationship between the innovation capability of listed companies and customer concentration, based on the dynamic panel regression model we established in Section 4, different estimating methods, including system GMM, threshold regression, and PSM, were applied. Different regression methods all come to the same conclusion of negative correlation in between, confirming the robustness of the results. In addition, in order to prevent the influence of data outliers on the results, this paper conducted Winsorize processing on the data, the empirical result of the test on the substituted samples is basically consistent with the previous conclusion. Therefore, the robustness of the results can once again be proved.

6. Conclusions

As mentioned in previous sections, scholars have discussed the relationship between customer concentration and corporate innovation. Our research has obtained a similar result to most studies that focused on the Chinese market, but this study also provides some new insights regarding the following aspects; (1) The empirical analysis are based on full sample data of A-share listed companies, not only on small or GEM companies. (2) This study explored how customer concentration affects the innovation activities of enterprises, considering both an internal factors (managers' expectation) and an external factor (financial constraint).

The main contributions are as follows; an empirical research on the correlation between customer concentration and innovation capability of listed companies in China was developed, which will enrich the subjects of customer concentration and innovation capability and offer suggestions for different stakeholders. For example, from the perspective of listed companies, they need to correctly understand the relationship between customer concentration and innovation capability so that they can make various business decisions more cautiously and control their customer base appropriately; from the perspective of the securities regulatory authority, they need to have a correct view of the supervision of customer concentration and better formulate regulatory policies to promote the healthy development of listed companies, while from the perspective of government, further improvement of the financial market is beneficial for listed companies to better implement China's development strategy of indigenous innovation.

Based on the data of A-share listed companies from 2012 to 2016, this paper discusses the relationship between customer concentration and innovation capability through the dual perspectives of financing constraints and managers' expectations. The results show that (1) the innovation capability of listed companies in China is negatively correlated with their customer concentration. The higher the customer concentration, the stronger the constraints from key accounts on listed companies. The reliance on large customers weakens the demand of listed companies for innovation, thus their investment on innovation activities will be reduced, which leads to a decline of innovation capability. (2) The empirical results illustrated the dual-threshold effect of financing constraints between customer concentration and innovation capability. For companies with low, medium, and high-financing constraints, the effect of customer concentration on innovation capability will be different. For highly financially constrained companies, customer concentration will have relatively stronger restraints on innovation capability. (3) The innovation capability of listed companies will also be influenced by managers' expectation on the future of the companies. Optimistic manager expectations are therefore more conducive to the reduction of customer concentration and the improvement of innovation capabilities.

However, on account of accessibility of data, the sample of this study only covers A-share listed firms in China. A large number of nonlisted companies in China have not been studied and remain further investigation. Besides, this paper does not further discuss the difference effect among companies in different industries. These are the limitations of this research, but can also be the target of future research.

According to the results of this research, excessive customer concentration is not beneficial to the innovation capability of listed companies, especially for those companies with higher financing constraints or pessimistic managers' expectations. In the process of implementing the development strategy of indigenous innovation, enterprises should pay more attention to control the risk of customer concentration. Accordingly, this paper put forward the following suggestions. (1) Listed companies should attach enough importance to manage the risk of customer concentration and maintain customer concentration at an appropriate level. As said by Christensen (1997), always listening to customers is not a good choice for enterprises that pursue sustainable development. Excessive dependence on large customers should be avoided so as to prevent the aggravation of the financing constraints and management risk, as well as prevent the negative impact on the key elements of corporate long-term development. (2) Securities regulatory authorities need to ameliorate relevant policies and regulations. It makes sense to set risk disclosure of listed companies with high customer concentration as a mandatory requirement, and give them an appropriate reminder and warning if necessary, so as to urge listed companies to pay close attention to the risk of customer concentration, as well as maintain the stability of financial market. (3) Government ought to further make efforts on the perfection of financial market, attempt to enhance the efficiency of resource allocation, and ensure the sound operation of the economy for the purpose of reducing the cost of corporate external financing, reducing the level of financing constraints, and thus reducing the negative impact of customer concentration on the innovation capability. (4) As for the managers of listed companies, they should actively adjust their expectations and make effective and reasonable predictions on the current operating conditions on

the basis of performance at the early stage. Having reasonably optimistic expectations contributes to reasonable management strategy and development tactics, and consequently reduces the risk of excessive customer concentration, and improves the level of innovation capabilities.

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Appendix A

Table A1. Descriptive statistics.

Variables	Mean	Std. Dev.	Median	Min	Max	Obs
<i>RD</i>	0.0399	0.0419	0.0322	0.0002	0.2560	8229
<i>CUSTOMER</i>	0.2954	0.2016	0.2412	0.0221	0.9274	8229
<i>SA</i>	−3.4887	0.2610	−3.4115	−4.0518	−2.9407	8229
<i>YUQI</i>	0.7045	0.4563	1	0	1	8229
<i>SIZE</i>	8.2837	1.2261	8.0917	6.0648	12.1491	8229
<i>STATE</i>	0.3579	0.4794	0	0	1	8229
<i>LEV</i>	0.4195	0.2070	0.4061	0.04787	0.8868	8229
<i>ROA</i>	0.0366	0.0490	0.0320	−0.1475	0.1851	8229
<i>OCCUPY</i>	0.0148	0.0203	0.0079	0.0002	0.1216	8229
<i>TATURN</i>	0.6246	0.4044	0.5334	0.1088	2.4709	8229
<i>L.RD</i>	0.0384	0.0421	0.0314	0	0.2570	8229
<i>GROWTH</i>	0.1691	0.4487	0.0906	−0.4811	3.0048	8229

Table A2. Pearson correlation matrix.

	<i>RD</i>	<i>CUSTOMER</i>	<i>SA</i>	<i>YUQI</i>	<i>SIZE</i>	<i>STATE</i>	<i>LEV</i>	<i>ROA</i>	<i>OCCUPY</i>	<i>TATURN</i>	<i>LRD</i>	<i>GROWTH</i>
<i>RD</i>	1											
<i>CUSTOMER</i>	0.024 **	1										
<i>SA</i>	0.253 ***	0.015	1									
<i>YUQI</i>	−0.035 ***	−0.034 ***	0.048 ***	1								
<i>SIZE</i>	−0.272 ***	−0.115 ***	−0.183 ***	0.134 ***	1							
<i>STATE</i>	−0.207 ***	0.036 ***	−0.436 ***	0.040 ***	0.372 ***	1						
<i>LEV</i>	−0.359 ***	−0.050 ***	−0.321 ***	0.065 ***	0.521 ***	0.348 ***	1					
<i>ROA</i>	0.063 ***	−0.072 ***	0.075 ***	0.028 **	−0.005	−0.151 ***	−0.376 ***	1				
<i>OCCUPY</i>	−0.046 ***	−0.055 ***	−0.062 ***	0.018 *	0.040 ***	0.002	0.197 ***	−0.094 ***	1			
<i>TATURN</i>	−0.287 ***	−0.144 ***	−0.175 ***	0.110 ***	0.106 ***	0.141 ***	0.206 ***	0.098 ***	0.010	1		
<i>LRD</i>	0.536 ***	0.0170	0.270 ***	−0.0140	−0.242 ***	−0.206 ***	−0.271 ***	0.072 ***	−0.042 ***	−0.176 ***	1	
<i>GROWTH</i>	0.008	0.064 ***	0.052 ***	0.002	0.028 **	−0.118 ***	−0.006	0.218 ***	0.027 **	0.021 *	0.062 ***	1

Note: ***, **, and * represent significant at 1%, 5%, and 10% levels, respectively.

Table A3. Results of Model (3).

Model	(3)	(3)
Method	FE	OLS
<i>L.RD</i>	−0.0006 (0.0069)	0.3557 *** (0.0091)
<i>CUSTOMER</i>	−0.0070 *** (0.0023)	0.0020 (0.0018)
<i>SA</i>	0.0171 *** (0.0035)	0.0061 *** (0.0016)
<i>SIZE</i>	−0.0021 *** (0.0006)	−0.0004 (0.0004)
<i>ROA</i>	−0.0549 *** (0.0065)	−0.0298 *** (0.0085)
<i>OCCUPY</i>	−0.0247 * (0.0146)	−0.0187 (0.0178)
<i>LEV</i>	−0.0211 *** (0.0025)	−0.0325 *** (0.0024)
<i>TATURN</i>	−0.0145 *** (0.0015)	−0.0178 *** (0.0010)
<i>STATE</i>	−0.0020 (0.0023)	0.0007 (0.0009)
<i>YUQI</i>	0.0004 (0.0005)	0.0015 * (0.0008)
<i>GROWTH</i>	−0.0034 *** (0.0006)	−0.0022 ** (0.0008)
<i>_cons</i>	0.1406 *** (0.0151)	0.0568 *** (0.0068)
<i>AR(1)</i>	-	-
<i>AR(2)</i>	-	-
<i>Hansen Test</i>	-	-

Notes: (1) Dummy variables of industry and year are introduced in SYS-GMM and OLS regression, which were not listed due to the limit of article length. FE estimation automatically excluded the influence of industry and year. (2) Figures in the parentheses are the standard deviation. (3) ***, **, and * represent significant at 1%, 5%, and 10% levels, respectively.

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