Research on the Influence Mechanism of Supplier-Customer Relationship on Enterprise Innovation

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Abstract: The supplier-customer relationship has become a key element that affects the innovation capabilities of enterprises. Explore the influence mechanism of supplier-customer relationship on enterprise innovation from a theoretical perspective, and put forward corresponding research hypotheses. Using the panel data to empirically test the research hypothesis, the following conclusions are drawn. (1) There is a U-shaped relationship between customer concentration and the level of enterprise technological innovation. (2) The closer the supplier-customer relationship is, the more likely companies are to take on higher risks, thereby facilitating innovation. (3) The closer the supplier-customer relationship, the ease of corporate financing constraints, which will facilitate innovation. The research conclusions are of great significance for companies to assess the impact of customer concentration on R&D decisions and supply chain governance.

1. Introduction

Technological innovation of enterprises has always been a focus of academic circles. In recent years, relying on external suppliers to assume responsibility for R&D design and product development has become a development trend, which enables companies to reduce R&D budgets and improve innovation performance. This development trend has transformed the relationship between external suppliers and customers into an increasingly important source of innovation. Therefore, external entities have become the key influencing factors of enterprise technological innovation, such as the government, competitors and investors. Among them, as the most important external stakeholders for enterprise development, suppliers and customers are important external entities that also bring risks while providing resources. The research on its impact on innovation is not enough. Based on this, this question theoretically analyzes the influence mechanism of supplier-customer relationship on enterprise technological innovation and conducts empirical tests to provide a theoretical basis for supplier-customer relationship governance.

2. Theoretical analysis and research hypothesis

2.1 Analysis of the Influence of Supplier-Customer Relationship on Enterprise Innovation

In the open innovation environment, corporate technological innovation activities are increasingly affected by upstream and downstream companies in the supply chain, and even technological innovation requires the cooperation of upstream and downstream companies to complete [1]. As the supplier-customer relationship continues to grow closer, it will inevitably affect the technological innovation strategies of both companies. The supplier-customer relationship has always been in dynamic changes. When the customer concentration is low, the contact between the supplier and the customer is weaker, and the two parties are more of a transaction relationship. When customer concentration reaches a certain level, the supplier-customer relationship changes from a transactional relationship to a cooperative relationship, and the external conditions faced by the enterprise will also change accordingly.

In short, when the concentration of customers is low, under the influence of the risks brought by the concentration of customers and the impact of the decline in operational performance, it will

negatively affect the technological innovation of the enterprise. With the increase of customer concentration, the two parties will transform from a transactional relationship to a cooperative relationship, the synergy effect brought about by the concentration of customers has promoted enterprise technological innovation. Therefore, this paper proposes the following research hypotheses:

H1: There is a U-shaped relationship between customer concentration and the level of enterprise technological innovation.

2.2 Path Analysis of the Influence of Supplier-Customer Relationship on Enterprise Innovation

1) The supplier-customer relationship affects corporate innovation by affecting the level of risk-taking

Supplier companies can communicate with customers to understand the consumer market in a timely manner, to position technological innovation according to consumer needs [2], to reduce the cost of innovation of enterprises and to reduce risks, so as to promote enterprises to increase innovation enthusiasm. First of all, for supplier companies, establishing relationships with important customers can bring greater benefits to them. This is reflected in the unity of customer demand for products. By sharing valuable information, supplier companies can obtain a stable market share. Reduce corporate risk [1]. Secondly, supplier companies usually make joint investments with major customers, and this relationship-specific investment will lose its value once it is used for other purposes, and it will also bring financial risks to client companies to find other suppliers. In addition, customers have an important influence on the supplier's production and operation decisions, which can produce governance effects.

The supplier-customer relationship affects technological innovation by influencing the enterprise's risk-taking level. Generally speaking, the more frequent the relationship transactions between suppliers-customers is, the higher the supplier's enterprise risk-taking level will lead to higher R&D investment. Conducive to innovation. Accordingly, this article proposes the following research hypotheses:

H2: The closer the supplier-customer relationship is, the more likely a company is to take on higher risks, which will facilitate innovation.

2) The supplier-customer relationship affects corporate innovation by influencing financing constraints

The closer the supplier-customer relationship, the better the company's internal financing capabilities. Long-term supplier-customer relationship transactions can maintain a relatively stable financial situation, thereby alleviating financing constraints and Ultimately affect the company's R&D investment and thus affect innovation activities. Customers can urge supplier companies to improve management efficiency, reduce sales expenses, and achieve better long-term performance, thereby resulting in higher cash flow income [3], and financing constraints can be alleviated. First of all, the continuous and regular purchasing behavior of major customers effectively guarantees the stable source of operating income for supplier companies, helps suppliers improve inventory management efficiency and accounts receivable recovery rate, and reduces costs such as management expenses and sales expenses [4]; Secondly, the upstream and downstream of the supply chain are also stabilized due to the existence of major customers; in addition, companies with large customers have higher IPO premiums and better long-term performance, and supplier companies are also committed to improving their own operating efficiency , Improve profitability [5], to stabilize downstream large customers. Therefore, the supplier-customer relationship reduces the costs in the production and operation process due to the integration of the supply chain, which can ease the financing constraints between enterprises, which is conducive to the development of new products by supplier companies and improve the level of innovation. Accordingly, this article proposes the following research hypotheses:

H3: The closer the supplier-customer relationship is, the better the financing constraints of the enterprise can be eased, thereby facilitating technological innovation.

3. Research Design And Empirical Result Analysis

3.1 Sample Selection and Data Sources

This article explores the influence path of corporate customer relationships on corporate technological innovation, and selects listed companies as research samples from the determined list of innovative pilot companies and the Torch Program. The study period is set from December 31, 2010 to December 31, 2017. In order to make the conclusions true and reliable, this article tries to exclude the influence of relevant factors on the data in the sample selection. Therefore, consider the following points when selecting the sample: (1) Choose the company that only issues A shares to avoid the impact of the difference between B shares or H shares. (2) Exclude ST or *ST enterprises. The selected research sample included 475 listed companies, and finally got the annual unbalanced panel data of 3579 companies.

The patent data of the sample enterprises comes from the patent information database of the State Intellectual Property Office. Relevant data on supplier-customer relationship and control variables are derived from the annual reports of listed companies disclosed by the China Securities Regulatory Commission website, www.cninfo.com and other media, the Wind information database and the Guotaian database.

3.2 Variable Design and Model Setting

1) Variable design

This article draws on the existing research, based on theoretical analysis and research hypothesis, designs the following variables:

(1) Supplier-customer relationship (*CR*). Considering the disclosure of annual reports of listed companies, this article uses the ratio of customer sales to supplier company sales to characterize the supplier-customer relationship. This chapter draws on existing research [6] and measures the supplier-customer relationship in two ways: First, the proportion of the total sales of the top five customers to the total sales; second, the proportion of the sales of the first largest customer to the total sales. Obviously, the larger the ratio, the more the company relies on customer-based transactions for sales activities.

(2) Enterprise Innovation (*INNO*). This chapter focuses on considering the impact of customer relationships on the innovation output of a company, and selects the number of patents filed by the company in that year as the explained variable.

(3) Risk-taking level (*RISK*). As the purchasers and users of enterprise products, customers' trust in the enterprise and cooperation with the enterprise can accelerate the company's cash flow and reduce the uncertainty of cash flow, thereby reducing the company's business risks. The technological innovation capability of an enterprise is also closely related to the business risks it faces. Drawing lessons from research, this article uses the standard deviation of the company's main business income within 3 years to measure the company's operating risk.

$$STDROA_{it} = \sqrt{\frac{1}{N-1}\sum_{n=1}^{N}(ADJ\_ROA_{in}) - \frac{1}{N}\sum_{n=1}^{N}(ADJ\_ROA_{in})^2}$$

$$ADJ\_ROA_{in} = \frac{EBITDA_{in}}{ASSETS_{in}} - \frac{1}{X_n}\sum_{k=1}^{X}\frac{EBITDA_{kn}}{ASSETS_{kn}}$$

(model 1)

Among (model 1), N=3, *i* represents the enterprise, and *n* is the year in the observation period, with a value of 1~3. *X* is the total number of enterprises in a certain industry, and *k* is the *k-th* enterprise in the industry.

(4) Financing constraints (*FS*). With reference to existing research, the financing constraints faced by enterprises adopt the *KZ* measurement. Among them, OCF, Dividends and Cash are operating net cash flow, dividends, and cash holding levels, and they are all standardized with opening total assets. Lev and Tobin's Q represent asset-liability ratio and Tobin's Q value, respectively.

$$KZ = -1.001909*OCF/Asset + 3.139193*Lev - 9.3678*Dividends/Asset$$

$$-1.314759*Cash/Asset + 0.2826389*Tobin's\ Q$$

(model 2)

2) Model setting

In order to test the influence of supplier-customer relationship on enterprise innovation, this paper constructs (model3)- (model 6), and uses negative binomial regression model and panel fixed effects model for regression analysis. Among them, when the dependent variable is a count variable of the number of patent applications, the negative binomial regression method is adopted; when the dependent variable is transformed by the logarithmic method, the panel fixed effects model is used for analysis. Establish an econometric model as follows:

$$INNO1_{it} = \exp(\alpha + \beta_1 CR_{it} + Control\ variables) \qquad \text{(model 3)}$$

$$INNO1_{it} = \exp(\alpha + \beta_1 CR_{it} + \beta_2 CR_{it}^2 + Control\ variables) \qquad \text{(model 4)}$$

$$INNO2_{it} = \alpha + \beta_1 CR_{it} + Control\ variables + \varepsilon_{it} \qquad \text{(model 5)}$$

$$INNO2_{it} = \alpha + \beta_1 CR_{it} + \beta_2 CR_{it}^2 + Control\ variables + \varepsilon_{it} \qquad \text{(model 6)}$$

In order to empirically test the mechanism of the supplier-customer relationship affecting enterprise technological innovation, referring to the analysis method of intermediary effect summarized, the specific model is set as follows:

$$RISK_{it} = \alpha_3 + \beta_3 CR_{it} + Control\ variables + \varepsilon_{it} \qquad \text{(model 7)}$$

$$FS_{it} = \alpha_4 + \beta_4 CR_{it} + Control\ variables + \varepsilon_{it} \qquad \text{(model 8)}$$

$$INNO_{it} = \alpha_5 + \beta_5 CR_{it} + \eta_1 RISK_{it} + Control\ variables + \varepsilon_{it} \qquad \text{(model 9)}$$

$$INNO_{it} = \alpha_6 + \beta_6 CR_{it} + \eta_2 FS_{it} + Control\ variables + \varepsilon_{it} \qquad \text{(model 10)}$$

Among them, CR_{it} represents the customer relationship of the i-th company in year t; $INNO_{it}$ represents the number of patents of the i-th company in year t; $RISK_{it}$ represents the risk taken by the i-th company in year t; FS_{it} represents the financing constraints faced by the i-th company in year t.

3.3 Empirical Results and Analysis

1) Descriptive statistics

From the descriptive statistical results in Table 1, it can be seen that, the average value of patent applications by enterprises is 83.56, the minimum is 0, and the standard deviation is 445.924, which represents a large degree of dispersion of enterprise innovation output, indicating the existence of innovation among Chinese enterprises Big difference. In the description of the supplier-customer relationship, the average customer concentration reached 0.271, indicating that customer concentration does exist in the enterprise.

Table 1 Descriptive statistics of variables

Variable	Obs	Mean	Std.Dev.	Min	Max
cuscen	3579	0.271	0.177	0	0.999
big_cus	3579	0.110	0.105	0.001	0.805
roa	3557	0.049	0.089	-3.994	0.583
zf	3557	0.361	0.200	0.007	1.533
sg	3430	0.550	5.880	-1.626	277.256
age	3579	2.690	0.310	0.693	3.400
asset	3557	3.462	1.120	-0.852	8.161
mb	3479	4.304	16.562	-65.293	781.558
q	3466	2.494	3.358	.113	126.498
rd	3579	0.067	0.075	0	0.999
kz	3579	0.611	1.867	-16.884	35.735
stdroa	3579	0.028	0.063	0	2.018
inno1	3579	83.56	445.924	0	11324
inno2	3579	2.793	1.639	0	9.335

2) Research on supplier-customer relationship and innovation relationship

The results of multiple regression analysis of the impact of customer concentration on enterprise innovation are shown in Table 2. Among them, model (1) and model (2) adopt negative binomial regression model to analyze the linear and nonlinear relationship between the two. Model (3) and Model (4) use panel fixed effects models to test the linear and non-linear relationship between the two, and pass the F test and Hausman test.

Table 2 Regression results of the impact of customer concentration on enterprise innovation

Explanatory variables	model (1)	model (2)	model (3)	model (4)
cons	-0.0473 (-1.51)	-0.352* (-1.65)	2.216*** (6.62)	2.026*** (6.00)
zf	0.0693 (0.51)	0.0755 (0.55)	0.264 (1.15)	0.277 (1.21)
asset	0.0362 (1.35)	0.0454* (1.69)	0.205** (3.15)	0.218*** (3.37)
sg	-0.0225** (-2.13)	-0.0237** (-2.22)	-0.00385 (-1.24)	-0.00403 (-1.30)
q	-0.0608*** (-4.87)	-0.0610*** (-4.88)	-0.0281*** (-3.23)	-0.0252** (-2.88)
roa	1.261*** (3.69)	1.280*** (3.73)	0.509** (2.19)	0.492** (2.12)
age	0.252** (3.00)	0.274*** (3.25)	-0.0508 (-0.30)	-0.0326 (-0.19)
rd	0.407* (1.92)	0.414* (1.95)	0.616** (1.98)	0.603** (1.94)
cuscen	-0.0473 (-1.51)	-0.115 (-1.36)	-0.0699** (-2.12)	-0.0797** (-2.41)
cuscen2		0.763*** (4.30)		0.844*** (3.72)
N	3369	3369	3369	3369
Wald value	61.45	78.23		
F value			11.88	11.97
Loglikelihood	-12410.258	-12400.062		
LR value	3447.16	3465.84		

Note: The standardized regression coefficients are listed in the table, and the t-test value of the coefficient is in parentheses. *** means $p<0.001$, ** means $p<0.05$, * means $p<0.1$. Same below.

According to Table 2, model (1) and model (3) use negative binomial regression model and panel fixed effects model to analyze the impact of customer concentration on enterprise innovation from a linear perspective. The results show that the regression coefficients of customer concentration are -0.0473 and -0.0699 and statistically significant under the condition of 5%. This shows that customer concentration has a negative impact on corporate innovation. The model (2) and model (4) use negative binomial regression model and panel fixed effects model to analyze the impact of customer concentration on corporate innovation from a nonlinear perspective. The results show that the regression coefficients of the square term of customer concentration are 0.763 and 0.844, and both are statistically significant under the condition of 1%. It shows that there is a U-shaped relationship between customer concentration and enterprise innovation, and H1 has been verified.

3) Analysis of the influence path of supplier-customer relationship on enterprise innovation

a) Path 1: The supplier-customer relationship affects enterprise innovation by influencing enterprise risk-taking level

In Table 3, the smaller the volatility of earnings, the higher the level of corporate risk -taking, that

is, the smaller the risk faced. Among them, (1) and (2) are the regression results of the (model 7). The regression coefficients of *cuscen* and *big_cus* are negative at 5% and 1% significance levels, respectively, indicating that the closer the supplier-customer relationship is, the higher level of risk-taking; (3) and (4) are the regression results of the (model 9). Among them, the independent variable supplier-customer relationship regression coefficients are significantly positive at the 5% level, but the regression coefficient of the intermediary variable *stdroa* is not significant, so further Sobel intermediary factor test is needed. The z-values of Sobel test are 1.3342 and 1.3945, which are both greater than 0.97, indicating that risk-taking is an influence path, that is, the supplier-customer relationship promotes enterprise technological innovation by increasing the enterprise's ability to bear risks. The original research hypothesis H2 is established.

Table 3 Mediating effect test results of risk taking

Explanatory variables	stdroa		inno2	
	(1)	*(2)*	*(3)*	*(4)*
cuscen	-0.021912** (-2.75)		0.458424** (2.21)	
big_cus		-0.051813*** (-4.00)		0.6767224** (2.00)
stdroa			-0.7299143 (-1.53)	-0.7130303 (-1.49)
roa	-0.286121*** (-30.39)	-0.285195*** (-30.32)	0.5083313* (1.81)	0.5070122* (1.81)
zf	-0.070743*** (-8.24)	-0.070654*** (-8.24)	-0.0798985 (-0.35)	-0.0840732 (-0.37)
age	-0.027878*** (-4.34)	-0.027932*** (-4.35)	-0.657593*** (-3.93)	-0.657277*** (-3.93)
asset	-0.010221*** (-4.41)	-0.009939*** (-4.30)	0.300504*** (4.98)	0.294223*** (4.88)
rd	-0.030629** (-2.40)	-0.030565** (-2.40)	1.016143** (3.07)	1.018342** (3.07)
sg	0.0000169 (0.12)	0.000017 (0.13)	-0.0054392 (-1.54)	-0.005406 (-1.53)
cons	0.185478*** (14.15)	0.184290*** (14.29)	3.372699*** (9.59)	3.444399*** (9.93)
N	3430	3430	3430	3430
R2	0.2860	0.2880	0.1173	0.1254
F value	3.52	3.54	9.75	9.75
Sobel Z			1.33418802	1.394491775
Sobel p			(0.011988**)	(0.026493**)

b) Path 2: The supplier-customer relationship affects corporate innovation by influencing corporate financing constraints

In Table 4, the larger the *kz* index value, the greater the financing constraints faced by the enterprise. (1) and (2) are the regression results of the (model 8). When the financing constraint level is used as the dependent variable, both *cuscen* and *big_cus* are significantly negative at the 1% level, indicating that the supplier-customer relationship is closer. The financing constraints faced by enterprises can be alleviated; (3) and (4) are the regression results of the (model 10). The regression coefficients of the independent variables are significantly positive at the 5% level. The mediating variable *kz* index is significantly positive at the 5% level, and the sign is an opposite sign. That is, financing constraints (*kz* index) have a "masking effect" between the supplier-customer relationship and the level of enterprise innovation.

Table 4 Test results of the mediation effect of financing constraints

Explanatory variables	kz		inno2	
	(1)	*(2)*	*(3)*	*(4)*
cuscen	-1.037552*** (-4.27)		0.5516145** (2.71)	
big_cus		-1.83698*** (-4.62)		0.7392996** (2.22)
kz			0.0425504** (2.78)	0.0421672** (2.75)
roa	-3.203235*** (-5.97)	-3.15364*** (-5.88)	1.429228** (3.17)	1.409163** (3.13)
age	3.667842*** (18.36)	3.675149*** (18.41)	-0.570437*** (-3.24)	-0.572610*** (-3.25)
asset	-0.237018*** (-3.19)	-0.2257731** (-3.05)	0.255895*** (4.12)	0.248401*** (4.01)
rd	0.1631699 (0.40)	0.1574768 (0.38)	1.062901** (3.10)	1.066266** (3.11)
mb	-0.014524*** (-3.74)	-0.014342*** (-3.70)	0.0066686** (2.06)	0.0065771** (2.03)
q	0.256843*** (18.76)	0.255719*** (18.67)	-0.047064*** (-3.90)	-0.046858*** (-3.88)
cons	-8.593725*** (-21.68)	0.184290*** (14.29)	3.230962*** (9.08)	3.331731*** (9.47)
N	3446	3446	3446	3446
R2	0.3372	0.3379	0.1219	0.1332
F value	5.46	5.48	9.83	9.81

4. Conclusions and recommendations

Based on the above research findings, it can be seen that，relationship transactions between suppliers-customers can effectively reduce transaction costs and bring positive effects. Enterprises should actively manage customer resources, strengthen communication with customers, share information, etc., improve operating efficiency, effectively alleviate the financing constraints of supplier enterprises, and increase their risk-taking levels, in order to provide new space for independent innovation of enterprises.

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