

Summer 5-28-2021

Enterprise Technology Innovation and Customer Concentration under the Uncertainty of Market Environment

Wendi Wang

School of Economics and Management, China University of Geosciences, Wuhan, 430078, China

Wenbin Qu

School of Economics and Management, China University of Geosciences, Wuhan, 430078, China,
quwenbin@cug.edu.cn

Xiaofeng Wang

Hubei Key Laboratory of Intelligent Geo-Information Processing, China University of Geosciences, Wuhan, 430078, China

Follow this and additional works at: <https://aisel.aisnet.org/whiceb2021>

Recommended Citation

Wang, Wendi; Qu, Wenbin; and Wang, Xiaofeng, "Enterprise Technology Innovation and Customer Concentration under the Uncertainty of Market Environment" (2021). *WHICEB 2021 Proceedings*. 10.
<https://aisel.aisnet.org/whiceb2021/10>

This material is brought to you by the Wuhan International Conference on e-Business at AIS Electronic Library (AISeL). It has been accepted for inclusion in WHICEB 2021 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

Full Research Paper

Enterprise Technology Innovation and Customer Concentration under the Uncertainty of Market Environment

Wendi Wang¹, Wenbin Qu^{1*}, Xiaofeng Wang²

¹School of Economics and Management, China University of Geosciences, Wuhan, 430078, China

²Hubei Key Laboratory of Intelligent Geo-Information Processing, China University of Geosciences, Wuhan, 430078, China

Abstract: Digital technology has brought new technological changes to economic development and has become one of the important factors affecting the uncertainty of the market environment. It also provides a new direction for enterprises' technological innovation. In the past two years, the spread of COVID-19 has further aggravated the uncertainty of the market environment. In this context, this article uses China's Shanghai and Shenzhen A-share listed companies as a sample to empirically test the impact of corporate technological innovation on customer concentration and the impact of market environment uncertainty on the relationship between the two. Then further explored whether the effect of market environment uncertainty has differences on enterprises with different property rights. The study found that enterprise technological innovation has a significant positive effect on customer concentration, the product market competition has a positive adjustment effect on both. In contrast, environmental uncertainty has a negative adjustment effect on both. The uncertainty of the market environment has a different impact on enterprises with different property rights.

Keywords: product market competition, environmental uncertainty, technological innovation, customer concentration, property rights.

1. INTRODUCTION

With the advent of the digital economy era, emerging technologies such as big data, cloud computing, blockchain, artificial intelligence, and 5G have brought a series of changes to the modern economy and society. Digital technology is being integrated into the production, sales, service, and other processes, and at the same time enriches the mode of enterprise technological innovation. China is also facing new economic transformation requirements, and the technological innovation by enterprises is an essential manifestation of enterprises' transformation. The market environment's uncertainty has become a crucial factor affecting enterprises' investment in technological innovation and restricting their development. In a highly uncertain market environment, the customer preferences, technological development, and competitive situation in the industrial environment where the enterprise is located have significantly changed, and the market has a shorter waiting time^[1]. Enterprises face a high uncertainty and ambiguity level because they do not have complete confidence and accurate predictions about new technologies, new products, and market reactions^[2].

On the one hand, in order to achieve long-term growth, enterprises need to increase investment in technological innovation, which would be of great help for differentiating products, building a moat around business, and gaining enough market share. As The Accenture Technology Outlook 2020 report points out, people will increase expectations of technology application as digital advances become normal. Thus, if the enterprises continue to create new technology-driven products and services traditionally, there will be a rising tension between the customers and the companies. Therefore, only by technological and product innovation can enterprises get

* Corresponding author. Email: quwenbin@cug.edu.cn (Wenbin Qu)

their own place in the digital economy's increasingly competitive market.

On the other hand, customers are the service objects of business activities and the basis for realizing business results. Customer service, which is the core competitiveness of enterprises, is also facing digital transformation. Enterprises need to achieve higher quality and smarter customer service through technological innovation to ensure a stable source of customers and achieve sustainable business operations^[3]. Technological changes have changed people's way of production and life and have also improved people's ability to understand and transform the world. Nowadays, customers and consumers pay more and more attention to the subsidiary value of products brought by services and even regard the quality of services as an essential part of measuring product value and corporate value. Therefore, in addition to attracting customers and consumers by enhancing the product's value, companies also need to focus on innovation in customer service. Through technological innovation to achieve online, platform-based, intelligent, and transparent customer service, so as to enhance the customer's good experience of the company's products.

Previous studies mostly analyzed the impact of customer concentration on corporate innovation, mainly from the perspective of corporate innovation in a passive state. However, in today's digital economy era, technological change has become an important factor affecting the market environment's uncertainty. Companies increasingly choose to actively carry out technological innovations to stabilize existing customers and expand customer sources to ensure that they operate in a highly uncertain market environment. Moreover, with the addition of force majeure factors represented by COVID-19 in recent years, the market environment's uncertainty has reached an unpredictable height, and the stability of major corporate customers has become an important guarantee for most companies to continue their operations. Therefore, this article studies how companies can influence customer concentration through technological innovation in an uncertain market environment, further exploring how the market environment's uncertainty impacts the relationship between technological innovation and customer concentration for companies with different property rights. It is expected to provide ideas for preventing the loss of essential customers under the high uncertainty of the market environment, and further enrich the relevant content of product market competition, environmental uncertainty, technological innovation, and have specific innovation and research value.

2. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESIS

2.1 The impact of technological innovation on customer concentration

Excellent customer value depends on efficient operations, close customer relationships and leading products, which in turn often depend on capabilities such as new product development, customer relationship management, and supply chain management. Among them, the research and development of new products is a way for enterprises to carry out technological innovation. It can create and enhance customer value by improving product innovation, improved product quality and faster research and development cycles. The technological innovation activities of enterprises are gradually regarded as a special promise that enterprises give to customers in order to achieve and maintain long-term cooperation^{[4]-[5]}. The main purpose of enterprises for technological innovation is to improve product quality and competitiveness to meet customers' diversified needs, thereby improving customer service satisfaction, which has the characteristics of value, uniqueness, and risk. Porter's five forces model points out that the market competition faced by enterprises comes from five aspects, including the competitive ability to existing competitors in the same industry, the ability of potential competitors to enter, the substitution ability of substitutes, the bargaining power of suppliers and the bargaining power of buyers, among which the customer concentration mainly responds to the bargaining power of buyers. For one thing, enterprises continue to reduce their own products' substitutability through technological innovation, thereby reducing buyers' bargaining power and increasing the cost of finding new suppliers for customers, who are increasingly dependent on enterprises and

thus more willing to establish long-term and stable relationships. Inderst and Wei^[6] found by constructing a bargaining model that customers with more robust asset size will attract more attention from firms, and companies will take the initiative to adopt innovations such as improved products to enhance the irreplaceability of their own products, so as to gain an advantageous position when negotiating with critical customers. And for another, companies improve existing products through R&D innovation in order to reduce product material and labor costs and achieve low-cost advantages for their own products. By strengthening R&D investment in new products, they convert R&D ideas into research results to meet customers' needs for new and diversified products and attract major customers with cost advantages and innovative advantages. Zhang Feng^[7] found that technological innovation can also attract more new customers by creating new customer value. At the same time, it can better maintain the relationship with existing customers and help companies gain closer contact with customers. It is conducive to creativity and demand for product innovation and improves customer acceptance of new products. Simultaneously, the company's technological innovation can be spread among consumers and customer groups through mass media, interpersonal communication, etc.^[8]. Companies provide customers with better products and services through technological innovation to increase customers' trust and dependence on the company. Therefore, the following hypothesis is proposed in this paper:

H1: There is a significant positive relationship between technological innovation and customer concentration.

2.2 The impact of market environment uncertainty on the relationship between technological innovation and customer concentration

2.2.1 The moderating effect of product market competition

To survive and develop in a fiercely competitive market, companies need to continuously create and provide new customer value, establishing leading innovative advantages. This is an important guarantee for companies to win customers and obtain sustainable income. The ability and level of technological innovation of an enterprise determine whether it can launch new products or services faster and in higher quality, thereby establishing an innovative advantage in the market. The theory of effective competition shows that when the market is in a state of effective competition, under the uncertainty of market structure changes, companies will choose to increase technological innovation under the pressure of high product price sensitivity and the loss of external resources, thereby improving production technology and product quality^[9]. Aghion et al.^[10] put forward the "escape effect" and "Schumpeter effect." As the degree of competition in the product market increases, companies will choose to increase innovation in order to escape the current competitive situation, which is manifested as the "escape effect." Current product market competition is conducive to the enhancement of technological innovation. However, when the degree of product market competition reaches a certain threshold, the enterprise will gradually reduce the marginal value of innovation revenue brought by technological innovation while taking innovation risks, which is manifested as the "Schumpeter effect." At this time, the enterprise will choose to reduce R&D and innovation investment. But the protection of enterprise innovation results can suppress the "Schumpeter effect." When an enterprise intends to carry out technological innovation activities, the future income of new products can be more reasonably estimated, which reduces the risk of innovation to a certain extent^[11]. Under the situation of increasing competition in the product market, the life cycle of products will become shorter and shorter, and the speed of product upgrading will accelerate. If the investment in innovation and R&D is not accelerated to improve their core competitiveness, then companies will face elimination^{[12]-[13]}; This competition is becoming the norm in today's era of digital economic transformation. The degree of product market competition reflects the company's market position in the industry. Companies with a strong market position tend to have poorer product substitutability and less competitive pressure. Thus less attention is paid to strengthening technological innovation to improve customer concentration. And in a market with low product market competition, corporate managers are more likely to exhibit "agent" behavior that avoids risks, preserves existing positions, and prioritizes personal

interests^[14]. Managers are often not motivated to make highly uncertain long-term investments, such as technological innovation R&D investments. However, when the product market competition becomes fiercer, to occupy a particular market share and take the initiative in negotiations with customers, companies will further increase R&D investment and reduce the substitutability of products and customers' bargaining power. At the same time, product market competition can alleviate the degree of information asymmetry between corporate management and shareholders, investors and customers, thus shareholders and investors will have a better understanding of management. The reputation mechanism of the manager's market will play a better role, and the management is more motivated to reduce production costs and seize the market initiative by increasing R&D and innovation, and then win greater customer resources. Based on this, the following hypothesis is proposed in this paper:

H2: Product market competition will promote the positive effect of technological innovation on customer concentration; the more intense the product market competition, the stronger the positive impact of technological innovation on customer concentration.

2.2.2 The moderating effect of environmental uncertainty

The uncertainty of the environment faced by enterprises comes from the dynamics and unpredictability of multiple aspects such as consumers, competitors, collaborators, and government policies, while customers' choice of enterprises is often based on a combination of factors such as product quality, product price, corporate reputation, and service. The higher the environmental uncertainty a company faces, the higher its business risk, strategic risk, and decision risk. The more likely it is that its products and image will be negatively affected, which will harm customer concentration. As environmental uncertainty increases, it becomes more difficult for decision-makers to predict the future of the business. On the one hand, higher environmental uncertainty can exacerbate the degree of information asymmetry. Customers cannot obtain valid cognition and value perception of the enterprise's R&D work, making the subsequent promotion of the new products developed by the enterprise more difficult and reduces the acceptability of the R&D results to customers and consumers. Simultaneously, information asymmetry will also result in investors not being able to make accurate assessments and the company's measurements. Auditors will be more inclined to issue non-standard audit reports under high environmental uncertainty, which will further increase the difficulty of financing for enterprises; and which will not be conducive to the survival of business and reputation image of enterprises and will eventually lead to a decrease in the trust of major customers in enterprises. On the other hand, environmental uncertainty will increase the uncertainty of product material supply. The delivery quality and delivery time of the product material supplier is uncertain; this will lead to the untimely supply of products to miss the time to win the market, while the uncertainty of supply will also bring additional costs of repeated inspection of materials, which will ultimately harm the timely fulfillment of contracts with customers and reduce corporate reputation. Finally, environmental uncertainty also makes the business risk rise; enterprises need to continually update the budget to respond to the changing external environment. Short-term strategic planning and frequent budget plan changes will harm long-term development, increasing enterprises' business risk. As a result, customers often receive unfavorable feedback about the company's low financial position and reduced cash flow earnings, leading to significant customer loss. Joseph^[15] pointed out that companies will choose to invest limited resources in business activities to improve their response speed and ability to respond to the dynamic environment when environmental uncertainty is high. Tung^[16] believes that companies tend to formulate short-term strategic plans. Shen Huihui^[17] found that environmental uncertainty would increase the degree of volatility in firms' surplus and that firm management would be reluctant to take on the additional risk associated with technological innovation. Therefore, the following hypothesis is proposed in this paper:

H3: Environmental uncertainty weakens the positive effect of technological innovation on customer

concentration, and the higher the environmental uncertainty, the weaker the contribution of technological innovation to customer concentration.

2.3 The impact of property rights on the regulation

According to the system theory, in the economic transition environment, system factors significantly influence business operations development^[18]. China's economic development is currently in a transitional period, the government's role in resource allocation still cannot be ignored. At the same time, enterprises need a lot of financial support for technological innovation, so they often need to carry out external financing to obtain financial aid. Compared to non-SOEs, SOEs can rely on government and political connections to allocate resources due to their government-enterprise solid linkages. Thus SOEs often enjoy a certain amount of soft budget constraints in financing. In a highly uncertain market environment, SOEs can still obtain sufficient financial support from banks and other financial institutions or even relief from the government, which will signal investors and customers that corporate risks are under control in times of high economic volatility economic downturn. However, the financing cost of non-SOEs will be much higher than that of SOEs in the face of bank credit policies subject to government intervention. This financing constraint will be more serious when the market environment is highly uncertain, which will send a signal to investors, customers, and consumers that the company's economy is in the doldrums and its survival risk is great.

There is also heterogeneity in the strength of the impact of product market competition and environmental uncertainty on firms with different property rights, which leads to varying effects of market environment uncertainty on the relationship between technological innovation and customer concentration. It can obtain customers, investors, and other resources at lower transaction costs in business for state-owned enterprises, often showing stronger operational capabilities and occupying a strong position in the market; thus, they are less dependent on significant customers^[19]. The environmental uncertainty comes from the uncertainty of macro policy environment and micro market environment and the uncertainty of any force majeure factors. The variability and unpredictability of these many external factors exert many uncontrollable environmental coping pressures on SOEs, so the impact of environmental uncertainty on technological innovation and customer concentration of SOEs will be stronger than the competition in product markets with advantages. For non-state enterprises, their main business goal is to obtain greater economic benefits and maintain their survival and development^[20]. The incentive mechanism of non-state enterprises are linked to the economic benefits of the enterprise, which will motivate the management of the enterprise to increase R&D investment to improve the innovation performance of the enterprise, so the enterprises will pay more attention to the role they play in the product market and adjust the level of R&D investment for the degree of market competition in order to improve their market position and product pricing ability, while the product price is often one of the primary factors for customers to consider the supplied object. Therefore, the measurement of the level of technological innovation by non-state-owned enterprises and the customers' choices of private enterprises are often more affected by the fierce competition in the product market. Based on this, the following hypotheses are proposed in this paper:

H4: The contribution of technological innovation to customer concentration is more pronounced for SOEs under uncertain market conditions than for non-SOEs.

H4a: Compared with the positive adjustment effect of product market competition, environmental uncertainty weakens the positive impact of SOEs technological innovation on customer concentration is more obvious.

H4b: Compared with the negative adjustment effect of environmental uncertainty, product market competition has a more apparent positive impact on customer concentration by promoting technological innovation of non-SOEs.

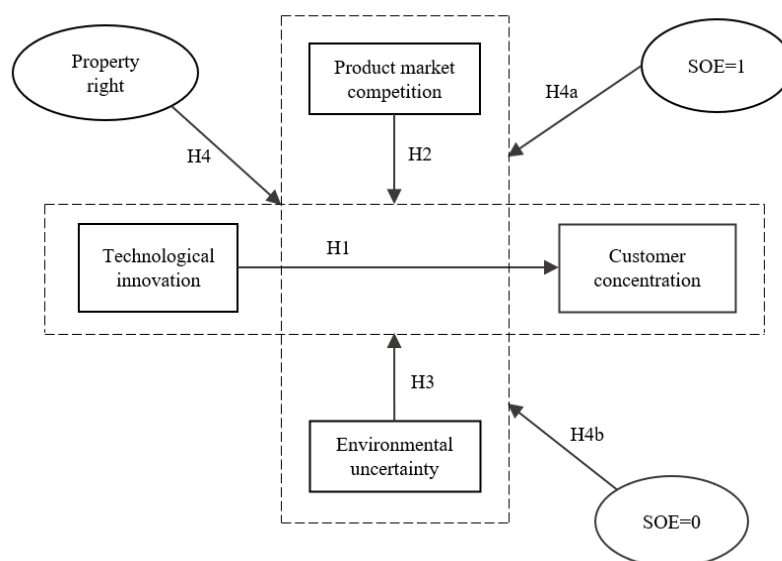


Figure 1. Research Framework

3. RESEARCH DESIGN

3.1 Variable description

(1) Customer concentration (*Customer*): The share of the top five sales of an enterprise can reflect the degree of concentration at the customer level to a certain extent. The logarithmic value of the sum of the purchase amount of the top five customers of a listed company as a proportion of the operating revenue is used to measure the customer concentration, and the larger the value is, the higher the customer concentration is.

(2) Technological innovation investment (*RD*): Technology R&D innovation investment usually includes the investment of tangible and intangible assets, and intangible assets such as technology and knowledge are also based on the support of tangible resources (such as capital, personnel, equipment, etc.), so this paper uses the logarithm of the ratio of R&D expenditure to operating revenue to measure the level of technology innovation investment.

(3) Product market competition (*FEPCM*): In this paper, the opposite of the industry-adjusted Lerner index (*EPCM*) is used to measure the degree of product market competition, which reflects the product market competition among different enterprises in the same industry. A larger value of *FEPCM* means that the weaker the pricing power of the enterprise in the industry it is in, the more inferior the competitive position it is in the market and the greater degree of product market competition it faces, and vice versa. The calculation formula is shown below:

$$FEPCM = -EPCM = \sum_{i=1}^{N_{jt}} \frac{S_{ijt} OI_{it} - OC_{it} - SE_{it} - MF_{it}}{S_{jt} OI_{it}} - \frac{OI_{it} - OC_{it} - SE_{it} - MF_{it}}{OI_{it}} \quad (1)$$

Where S_{ijt} denotes the operating revenue of enterprise i in industry j in year t , S_{jt} denotes the total operating revenue of industry j in year t , N_{jt} denotes the total number of enterprises in industry j in year t , OI_{it} , OC_{it} , SE_{it} , MF_{it} denote the operating revenue, operating cost, selling expense, and administrative expense of enterprise i in year t , respectively.

(4) Environmental uncertainty (*EU*): The measurement of environmental uncertainty in this paper draws on the method of Shen Huihui^[13] and uses the volatility of corporate sales revenue to measure. First, the least-squares method (*OLS*) is used to estimate the company's abnormal sales revenue in the past five years. The specific Model is as follows:

$$Sale = \varphi_0 + \varphi_1 Year + \varepsilon \quad (2)$$

Where *Sale* is the sales revenue, *Year* is the annual variable. The observation is the current year, *Year* takes 5; if it is the past year, it takes 4, and so on, when the observation is the past fourth year, *Year* takes 1; ε is the residual of the Model (2), which is the requested abnormal sales revenue; Next, calculate the standard deviation of the abnormal sales revenue of the enterprise in the past five years, and divide it by the average sales revenue of the past five years to get unadjusted environmental uncertainty, and the median of the non-industry-adjusted environmental uncertainty of all firms in the same industry in the same year is the industry environmental uncertainty. The larger the value of the *EU*, the higher the environmental uncertainty faced by the firm.

(5) The nature of property rights (*SOE*): The nature of property rights is a dummy variable. When the enterprise is a state-owned enterprise, the value of *SOE* is 1; otherwise, the value is 0.

(6) Control variables set: reference to relevant previous studies of customer concentration, and select enterprise asset size (*Size*), financial leverage (*Lev*), companies listed age (*Age*), return on assets (*ROA*), and book capitalization ratio (*BM*) constitute the set of control variables in this article; at the same time, this article also controls the fixed effects of industry (*Ind*) and year (*Year*).

3.2 Model construction

The model construction of this article is mainly composed of four parts:

In order to test the relationship between technological innovation and customer concentration, verify *H1*. and establish Model (3):

$$Cus_{it} = \alpha_0 + \alpha_1 RD_{it} + \beta_1 Con_{it} + \beta_2 \sum Ind_{it} + \beta_3 \sum Year_{it} \quad (3)$$

In model (3), the explained variable Cus_{it} is the customer concentration of firm *i* in year *t*, the explanatory variable RD_{it} is the technological innovation level of firm *i* in year *t*, Con_{it} is the set of control variables, Ind_{it} and $Year_{it}$ are industry and year fixed effects respectively; if α_1 is significantly positive, then *H1* is supported.

In order to test the impact of market environment uncertainty on the relationship between innovation and customer concentration, verify *H2*. and *H3*., establish model (4) and model (5):

$$Cus_{it} = \alpha_0 + \alpha_1 RD_{it} + \alpha_2 FEPCM_{it} + \alpha_3 RD \times FEPCM_{it} + \beta_1 Con_{it} + \beta_2 \sum Ind_{it} + \beta_3 \sum Year_{it} \quad (4)$$

$$Cus_{it} = \alpha_0 + \alpha_1 RD_{it} + \alpha_4 EU_{it} + \alpha_5 RD \times EU_{it} + \beta_1 Con_{it} + \beta_2 \sum Ind_{it} + \beta_3 \sum Year_{it} \quad (5)$$

In model (4), $RD \times FEPCM_{it}$ represents the crossover term between technological innovation and product market competition, If α_3 is significantly positive, then *H2* holds; In model(5), $RD \times EU_{it}$ represents the cross-product term of technological innovation and environmental uncertainty, if α_5 is significantly negative, then *H3* is supported.

In order to test the influence of the nature of property rights on the adjustment effect, verify *H4* and establish a model (6):

$$Cus_{it} = \alpha_0 + \mu_{SOE} RD_{it} + \gamma_{m_{SOE}} RD \times FEPCM_{it} + \gamma_{n_{SOE}} RD \times EU_{it} + \beta_1 Con_{it} + \beta_2 \sum Ind_{it} + \beta_3 \sum Year_{it} \quad (6)$$

In model (6), $SOE=1$ when *i* is a state-owned enterprise and $SOE=0$ when *i* is a non-state-owned enterprise. If the significance degree of μ_1 is greater than μ_0 , it means that *H4* is supported; *H4a* is supported when the significance degree of γ_{m_1} is less than γ_{n_1} ; *H4b* is supported when the significance degree of γ_{m_0} is greater than γ_{n_0} .

4. RESULTS

4.1 Descriptive statistics

The results of descriptive statistical analysis of all variables in the Model are shown in Table 1. As can be seen from Table 1, the minimum and maximum values of enterprise customer concentration are -7.13089 and 0, respectively, with a standard deviation of 0.82158, indicating that there is a large difference in customer

concentration among different enterprises, and the mean value is -1.50741, which is smaller than the median -1.43801, with a left-skewed distribution, indicating the existence of some enterprises with low customer concentration; The mean value of enterprise technological innovation is -3.76471, the median is -3.36665, the difference between them is small, the minimum value is -16.14030, the maximum value is 0.23039, and the standard deviation is 1.49925, indicating that the technological innovation of Chinese listed companies shows a good normal distribution overall, but there are large differences in the technological innovation levels of different companies; The mean value of product market competition is -0.52189, the minimum and maximum values are -0.39581 and 3.96186, respectively, and the median is -0.04747, indicating that there is a big difference in the level of product competition among different enterprises; The mean value of environmental uncertainty is 1.31802, the minimum and maximum values are 0.11282 and 23.43730, respectively, indicating that Chinese enterprises generally have environmental uncertainty, and there are large differences in the uncertainty of external business environment faced by different enterprises.

Table 1. Descriptive statistics

| Variable | Mean | Std. Dev | Min | Med | Max | N |
|----------|----------|----------|-----------|----------|----------|------|
| Customer | -1.50741 | 0.82158 | -7.13089 | -1.43801 | 0 | 8158 |
| RD | -3.76471 | 1.49925 | -16.14030 | -3.36665 | 0.23039 | 8158 |
| FEPCM | -0.52189 | 0.08772 | -0.39581 | -0.04747 | 3.96186 | 8158 |
| EU | 1.31802 | 1.34228 | 0.11282 | 0.97738 | 23.43730 | 8158 |
| SOE | 0.34298 | 0.47473 | 0 | 0 | 1 | 8158 |
| Size | 22.52339 | 1.25674 | 19.56033 | 22.35974 | 27.46772 | 8158 |
| Lev | 0.42715 | 0.19489 | 0.05362 | 0.41962 | 0.99075 | 8158 |
| Listage | 2.45627 | 0.50695 | 0 | 2.39790 | 3.33221 | 8158 |
| ROA | 0.03344 | 0.07298 | -0.51721 | 0.03437 | 0.22093 | 8158 |
| BM | 1.11855 | 1.25119 | 0.04810 | 0.73636 | 12.53083 | 8158 |

4.2 Regression results

Before the regression model test, the variables are tested for multicollinearity in this paper, and the results are shown in Table 2. It can be seen that the mean value of the VIF value of each variable is 1.49, and the maximum value is 2.08, which is much less than 10, indicating that there is no effect of multicollinearity in the variables in the regression analysis.

Table 2. Collinear Results

| Variables | VIF | 1/VIF |
|-----------|------|---------|
| Size | 2.08 | 0.47971 |
| BM | 1.99 | 0.50374 |
| Lev | 1.75 | 0.57129 |
| Listage | 1.40 | 0.71320 |
| SOE | 1.39 | 0.72157 |
| ROA | 1.36 | 0.73716 |
| RD | 1.24 | 0.80425 |
| FEPCM | 1.23 | 0.81564 |
| EU | 1.02 | 0.97953 |
| Mean VIF | 1.49 | |

The specific model regression results are shown in Table 3, where models (3), (4), and (5) are full-sample regression results, and model (6) is a sub-sample regression result.

Table 3. Regression Results

| Variables | Modle (3) | Modle (4) | Modle (5) | Modle (6) | | |
|------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| | Full sample | | | | SOE=1 | SOE=0 |
| RD | 0.020** (0.008) | 0.022*** (0.008) | 0.030*** (0.009) | 0.032*** (0.009) | 0.039*** (0.014) | 0.022* (0.014) |
| FEPCM | | 0.086 (0.070) | | 0.082 (0.070) | 0.164 (0.443) | 0.092 (0.072) |
| RD×FEPCM | | 0.066* (0.039) | | 0.065* (0.039) | 0.025 (0.101) | 0.086* (0.047) |
| EU | | | -0.045*** (0.010) | -0.044*** (0.010) | -0.065*** (0.017) | -0.025* (0.013) |
| RD×EU | | | -0.005*** (0.002) | -0.005** (0.002) | -0.010*** (0.003) | -0.002 (0.003) |
| Size | -0.049*** (0.017) | -0.050*** (0.017) | -0.034* (0.018) | -0.035** (0.018) | -0.080** (0.033) | 0.003 (0.021) |
| Lev | 0.057 (0.060) | 0.055 (0.060) | 0.058 (0.060) | 0.056 (0.060) | 0.133 (0.117) | 0.067 (0.071) |
| Listage | -0.281*** (0.072) | -0.277*** (0.072) | -0.280*** (0.072) | -0.276*** (0.072) | -0.128 (0.175) | -0.165* (0.093) |
| BM | -0.023*** (0.008) | -0.022** (0.008) | -0.023*** (0.008) | -0.021** (0.008) | -0.022** (0.011) | -0.035*** (0.013) |
| ROA | 0.07 (0.073) | 0.032 (0.080) | 0.052 (0.073) | 0.014 (0.080) | -0.045 (0.234) | 0.010 (0.087) |
| Industry fixed effects | Controlled | | | | | |
| Time fixed effects | Controlled | | | | | |
| N | 8158 | | | | | |

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; standard errors reported in parentheses.

From the full-sample regression results, we can see that Model (3) verifies the influence relationship between technological innovation and customer concentration, and the regression results show that enterprise technological innovation and customer concentration are significantly positive at the 5% level, indicating that technological innovation has a significant promotion effect on customer concentration, and H1 is supported that increased investment in technological innovation by companies can significantly improve customer concentration.

Model (4) verifies product market competition's influence on the relationship between technological innovation and customer concentration. The regression results show that there is a significant positive correlation between the cross-product multiplier (RD×FEPCM) of technological innovation and product market competition and customer concentration, indicating that product market competition can promote the positive effect of technological innovation on customer concentration, and H2 is supported that when product market competition becomes more and more intense, enterprises will adopt more technological innovation in order to occupy a certain market share to improve the competitiveness of their products to attract customers.

Model (5) verifies the impact on the relationship between technological innovation and customer concentration under environmental uncertainty. The regression results show a significant negative relationship

between the cross-product of technological innovation and environmental uncertainty (RD×EU) and customer concentration, indicating that environmental uncertainty will weaken the positive effect of technological innovation on customer concentration, and H3 holds that under higher environmental uncertainty, firms' attention to R&D innovation will be diverted, and customers' trust in the firm will be reduced.

Model (6) is a sub-sample regression based on the heterogeneity of property rights nature, and the total sample is classified according to whether it is state-controlled or not. The regression results show that: among state-owned enterprises, the effect of technological innovation on customer concentration is significantly positive at the 1% level, while the effect of technological innovation on customer concentration among non-state-owned enterprises is significantly positive at the 5% level, and $\mu_1 > \mu_0$, H4 holds that under the uncertainty of the market environment, the promotion effect of technological innovation on customer concentration is more obvious among state-owned enterprises, and different property rights nature has different coping abilities under the uncertainty of the market environment. Meanwhile, the moderating effects of product market competition and environmental uncertainty on the relationship between technological innovation and customer concentration also differ in intensity depending on the nature of property rights. The regression results find that the moderating effect of environmental uncertainty on the relationship between technological innovation and customer concentration is more significant in state-owned enterprises. At the same time, the moderating effect of product market competition on the relationship between technological innovation and customer concentration is more significant in non-state-owned enterprises, then H4a and H4b are supported. The results of the regression models for hypothesis testing are shown in Table 4.

Table 4. Hypotheses Test Results in Regression Model

| Model | Hypothesis | Path | Test Coef. | Regression Coef. | Std. Err. | T-values | P-values | Support |
|-------|------------|-----------------------------|----------------|------------------|-----------|----------|----------|---------|
| (3) | H1 | RD → Customer | α_1 | 0.02019 | 0.00800 | 2.52 | 0.012 | yes |
| (4) | H2 | RD×FEPCM → Customer | α_3 | 0.06688 | 0.03907 | 1.71 | 0.087 | yes |
| (5) | H3 | RD×EU → Customer | α_5 | -0.00546 | 0.00204 | -2.68 | 0.007 | yes |
| (6) | H4 | RD → Customer (SOE=1) | μ_1 | 0.03880 | 0.01391 | 2.79 | 0.005 | yes |
| | | RD → Customer (SOE=0) | μ_0 | 0.02234 | 0.01353 | 1.65 | 0.099 | |
| | H4a | RD×FEPCM → Customer (SOE=1) | γ_{m_1} | 0.02505 | 0.10058 | 0.25 | 0.803 | yes |
| | | RD×EU → Customer (SOE=1) | γ_{n_1} | -0.01019 | 0.00300 | -3.40 | 0.001 | |
| | H4b | RD×FEPCM → Customer (SOE=0) | γ_{m_0} | 0.08650 | 0.04672 | 1.85 | 0.064 | yes |
| | | RD×EU → Customer (SOE=0) | γ_{n_0} | -0.00030 | 0.00290 | -0.10 | 0.918 | |

5. CONCLUSION

This paper selects A-share listed companies in Shanghai and Shenzhen from 2015-2019 as the research object empirically tests the impact of corporate technological innovation on customer concentration under an uncertain market environment and further analyzes the impact of different property rights nature on the moderating effect. The main research findings are as follows: The higher the level of investment in technological innovation, the higher the customer concentration of enterprises, i.e., technological innovation and customer concentration are significantly positively correlated; The more intense the product market competition, the more pronounced the positive effect of technological innovation on customer concentration, i.e., product market competition positively

regulates the relationship between technological innovation and customer concentration; While environmental uncertainty negatively regulates the relationship between technological innovation and customer concentration, the higher the environmental uncertainty, the weaker the promotion effect of technological innovation on customer concentration of enterprises. It is further found that the contribution of technological innovation to customer concentration is more significant for SOEs than for non-SOEs under market environment uncertainty, and the moderating effects of product market competition and environmental uncertainty on the relationship between technological innovation and customer concentration are heterogeneous depending on the nature of property rights, with the moderating effect of environmental uncertainty being more pronounced for SOEs and the effect of product market competition being more pronounced for non-SOEs.

The research in this paper has certain implications: First, in the era of the digital economy, enterprises face the process of digital transformation to comply with the changes in the market environment, and technological innovation is the primary means for enterprises to carry out digital transformation. In order to occupy a place in the market and maintain a higher market position, enterprises must pay attention to technological innovation and meet the diversified and differentiated needs of customers. The core of product innovation lies in the full use of technologies. Hence, companies in technological innovation need to add digital technology to product innovation according to market customers' expectations to produce innovative products that meet the market environment's needs. Second, different from previous studies, product market competition plays a significant role in promoting technological innovation's positive effect on customer concentration. So that firms should not actively abandon long-term investment in innovation in the face of fierce product market competition but should instead increase technological innovation investment to improve their products' irreplaceability and customer service satisfaction levels. Finally, firms with different property rights react differently to the uncertainty of the market environment. Still, in general, technological innovation under such uncertainty can significantly increase customer concentration, only that the motivation and effect of technological innovation by firms with different property rights are not entirely consistent. Non-SOEs need to invest in innovation to improve their pricing power and increase the cost of switching suppliers in a competitive environment. In contrast, SOEs need to invest in technological innovation to meet their customers' diversified needs based on financing advantages under the uncertainty of the environment, especially when many force majeure factors lead to unpredictable and uncontrollable environmental uncertainties.

ACKNOWLEDGEMENT

This research was supported by the Open Research Project of The Hubei Key Laboratory of Intelligent Geo-Information Processing (KLIGIP-2019B08).

REFERENCES

- [1] Lin Zhonggao, Zhang Chunyan. Environmental Uncertainty, Customer Concentration and Enterprise Innovation Capability: Based on the Perspective of Changes in Major Customers Before and After the Listing of GEM Companies[J]. *Accounting Friends*,(2017)(16):47-53.(in Chinese)
- [2] Matt C., Hess T., Benlian A. Digital Transformation Strategies[J]. *Business & Information Systems Engineering*, (2015), 57(5): 339-343.
- [3] Sheikh Shahbaz. The Impact of Market Competition on the Relation Between CEO Power and Firm Innovation[J]. *Journal of Multinational Financial Management*, (2018)(44): 36-50.
- [4] Allen, JW, Phillips, GM Corporate Equity Ownership, Strategic Alliances, and Product Market Relationships [J]. *Journal of Finance*, (2000), 55(6): 2791-2815.

- [5] Kale, JR, Shahriar, H. Corporate Capital Structure and the Characteristics of Suppliers and Customers [J]. *Journal of Financial Economics*, (2007), 83(2): 321-365.
- [6] Inderst, R., Wey, C. Countervailing Power and Dynamic Efficiency [J]. *Journal of the European Economic Association*, (2011), 4: 702-720.
- [7] Zhang Feng. The Interactive Effects of New Product Development, Customer Relationship Management, and Supply Chain Management Capabilities [J]. *Journal of Management Engineering*, (2016), 30(03): 44-53. (in Chinese)
- [8] Rogers EM. *Diffusion of Innovations*[M]. New York: The Free Press,(1995).
- [9] Wang Jingyu, Fu Jianing, Zhang Hongliang. Product Market Competition and Enterprise Innovation: A Quasinatural Experiment [J]. *Modern Finance and Economics*, (2019), 39 (12): 52-66. (in Chinese)
- [10] AGHIONP, HOWITT. Revisiting the Relationship between Competition, Patenting, and Innovation [J]. *Advances in Economics and Econometrics*, (2013)(6):451-455.
- [11] Peters, J. Buyer Market Power and Innovative Activities[J]. *Review of Industrial Organization*, (2000), 1: 13-38.
- [12] ALLEN F, GALED. Financial Contagion[J]. *Journal of Political Economy*, (2000), 108(1):1-33.
- [13] JIANG FX, KIMKA, NOFSINGERJR, et al. Product Market Competition and Corporate Investment: Evidence from China[J]. *Journal of Corporate Finance*, (2015), 35(6):196-210.
- [14] INDUSTRIAL ENGINEERING, Liu Nan, Xiang Hui. Managerial Entrenchment, Product Market Competition, and Innovation Investment [J]. *Accounting Monthly*, (2020) (23): 91-98.
- [15] JOSEPH LC, et al. Organizational Slack and Response to Environmental Shifts: The Impact of Resource Allocation Patterns [J]. *Journal of Management*, (1997), 23 (1) :1-18.
- [16] Tung R L. Dimensions of Organizational Environments: An Exploratory Study of Their Impact on Organization Structure[J]. *Academy of Management Journal*, (1979), 22(4):672-693.
- [17] Shen Hui Hui. The Impact of Environmental Uncertainty on Earnings Management [J]. *Audit Research*, (2010) (1): 91-98. (in Chinese)
- [18] Ghosh D, Olsen L. Environmental Uncertainty and Managers' Use of Discretionary Accruals[J]. *Accounting Organizations and Society*, (2009), 34(2):188-205.
- [19] Zhang Ye, Lan Fengyun, Shen Huayu. Customer Concentration and Corporate Innovation Investment——Based on the Perspective of Customer Bargaining Power[J]. *China Circulation Economy*,(2019),33(04):76-88.(in Chinese)
- [20] Zhao Lu, Liu Heng, Zhang Jianqi. Degree of Market Perception, the Spirit of Innovation and Enterprise Property Right System: State-owned and Private Enterprises Comparative Study of Industry [J] *South. Economic*, (2014) (5): 25-41. (in Chinese)