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# Technological Innovation and The Scale of User Base of High-Tech Enterprises: The Moderating Effect of The of Ownership

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**Abstract:** Based on the data of listed companies in Shanghai and Shenzhen A-share electronic information technology industry from 2015 to 2020, this paper investigates the effect mechanism and difference of two types of technological innovation modes (progressive technological innovation and abrupt technological innovation) on user scale of high-tech enterprises with different ownership nature. The results show that there is a positive linear relationship between incremental and abrupt technological innovation and user scale, and the abrupt technological innovation plays a greater role in promoting user scale growth than the gradual technological innovation. The relationship between technological innovation and user scale is significantly adjusted by the nature of enterprise ownership, and the gradual technological innovation is suitable for state-owned enterprises to increase user scale, while the abrupt technological innovation is suitable for non-state-owned enterprises to increase user scale.

**Keywords:** User Base Scale; progressive technological innovation; breakthrough technological innovation; enterprise ownership nature.

## 1. Introduction

High-tech enterprises are one of the main driving forces of social and economic development and an important carrier of innovation development in China at the present stage. Their innovation process is characterized by high technology, high investment and high risk, etc. Technological innovation based on market demand is the driving force of sustainable development of high-tech enterprises. Market demand is the social condition for technological innovation, and low technological input will restrict the level of market application. Without market demand as the basis, enterprises will lack the motivation for technological R&D [1]. Studies have found that the number of users will have an impact on the value of high-tech enterprises, which is the source of vitality of enterprise value [2]. The increase of enterprise users can bring economies of scale into play and bring the best economic benefits for enterprises [3]. According to the customer value theory, the value of an enterprise's products or services is not measured by the enterprise itself or the society, but by customers' personal experience and experience. Therefore, the lack of users will affect the effectiveness of the enterprise's products, and thus affect the enterprise's technological innovation. How does technological innovation in turn affect user size?

As for the influence of technological innovation on user scale, scholars mostly analyze it from the aspects of network effect and product complexity. When studying the communication industry, J.Rohlfs , a foreign scholar, proposed that "the utility obtained by a user from communication services depends on the number and scale of other users", that is, communication service products have network effects [4].On this basis, some scholars found through the construction of local network effect model that the quality of technology can determine whether the user scale can break through the critical capacity point. When the technical value of the product is insufficient, it can be made up by increasing the initial installation base, but the effect is limited [5]. Product complexity was first proposed by Lenk, who believed that product complexity reflected the heterogeneity of product attributes in industry sales [6]. Gil bride and Allenby believe that the higher the product complexity, the more consumers tend to choose to simplify the decision-making search process [7]. When product complexity is high, more users will simplify their search and will be more likely to develop into loyal consumers of low product complexity brands. This paper chooses a new perspective, that is, technological innovation is classified into incremental technological innovation and abrupt technological innovation according to the innovation scale, and analyzes the impact of technological innovation on user scale from these two modes.

According to the resource dependence theory, under China's national conditions, the nature of ownership will affect the resources owned by enterprises and the ability to obtain external resources, so that enterprises of different ownership have different R&D investment in innovation activities, thus affecting the innovation ability of enterprises. In previous studies, there is a lack of analysis on the impact of different ownership enterprises on the relationship between technological innovation and user scale. Therefore, this paper divides high-tech enterprises into state-owned enterprises and non-state-owned enterprises, and studies the moderating effect of enterprises with different ownership nature on the relationship between technological innovation and user scale.

Based on this, this paper mainly solves the following questions: What is the impact of gradual technological innovation and abrupt technological innovation on the user scale of high-tech enterprises? What technological innovation mode should different ownership enterprises choose in order to expand user scale? Does the nature of enterprise ownership have a moderating effect on the relationship between the two technological innovation models and user size?

## 2. Research Hypothesis

This paper defines the progressive technological

innovation and the breakthrough technological innovation from the micro level, that is, from the enterprise level. Progressive technological innovation refers to the innovation of making small local improvements on products or technologies [8] on the basis of existing enterprise knowledge in order to meet the needs of existing mainstream markets and users, and gradually improve the technical performance of products. However, breakthrough technological innovation refers to those innovations that are not improved according to the needs of mainstream users of enterprises, which are not dependent on the design and development centered on enterprise users, but can greatly improve product performance or create new products [9]. Progressive technological innovation is a bridge connecting technology and market, which faces little uncertainty and low risk and enables enterprises to obtain stable income. Enterprises can better serve users by identifying the direction of market demand and introducing improved products [10].Breakthrough type of technological innovation with long cycles, single source of innovation, unpredictability and high risk, at the beginning of the innovation, technology innovation breakthrough "product may temporarily do not meet the demand of the user even can not meet the technical performance of the existing products, the user scale low level (new customer base, general for low-end users) [9].When the technology achieves a breakthrough, it is proved to be more superior than the existing products, has different functional attributes from the existing technology, and is more likely to be unanimously recognized by users, so as to achieve user scale. Based on this, the following hypotheses are proposed in this study:

H1a: Incremental technological innovation is positively correlated with the size of user base.

H1b: Abrupt technological innovation is positively correlated with the size of user base.

High-tech enterprises can help them make breakthrough technological innovation by acquiring external heterogeneous resources [11], while enterprises of different ownership have different abilities to acquire and absorb external resources. State-owned enterprises are led by the government, controlled by the central government and the state, and have a large number of innovative resources such as R&D capital and scientific and technological talents [12]. They are highly tolerant of risks and less sensitive to capital cost and return [13]. Compared with non-state-owned enterprises, they are more likely to obtain external funds through debt financing. However, there is an inverted U-shaped relationship between the leverage ratio of State-Owned enterprises, innovation input and innovation output, and too high leverage ratio will affect the innovation output of enterprises [14], and then affect the user scale. However, breakthrough technological innovation is high risk and high input. State-owned enterprises' abrupt technological innovation will strengthen their dependence on external resources, thus may increase the leverage ratio of enterprises and affect the innovation output. Moreover, for the managers of State-Owned enterprises, risk reduction is better than income increase, which is more to maximize personal interests, which also makes the managers of state-owned enterprises lack innovation enthusiasm for breakthrough innovation with long investment cycle, high risk and large investment [15]. Therefore, state-owned enterprises are more likely to achieve user scale growth through incremental technological innovation.

On the other hand, the non-state-owned enterprises leverage its innovation output had no significant relationship between [14], higher leverage will not have a large influence on enterprise innovation output, and non-state-owned companies tend to pursue profit maximization, the managers more adventurous spirit, have to strengthen profit-driven, mutations of high investment, high risk type innovation [15] are more willing to try. Therefore, non-state-owned enterprises are more likely to achieve user scale growth through abrupt technological innovation. Based on this, the following hypothesis is proposed in this study:

H2a: For state-owned enterprises, incremental technological innovation is more conducive to achieving user scale than abrupt technological innovation.

H2b: For non-state-owned enterprises, abrupt technological innovation is more conducive to user scale than incremental technological innovation.

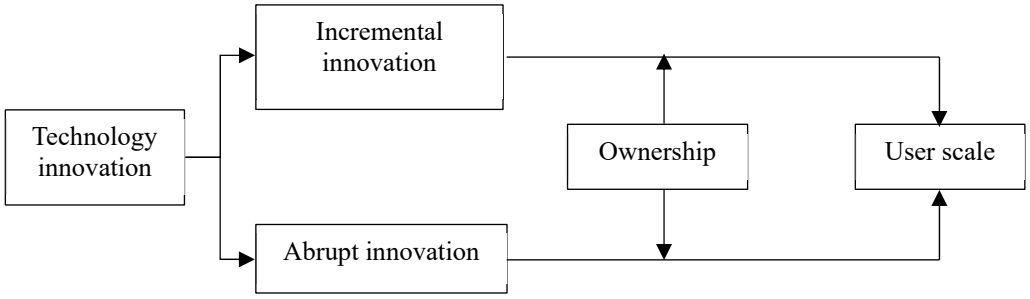


**Figure 1.** Theoretical Model

## 3. Study Design

China's high-tech enterprises not only include enterprises producing high-tech products, but also enterprises adopting high-tech technological processes in some traditional industries. Compared with other industries, electronic information technology industry pays more attention to technological innovation [16]. Therefore, this paper selects listed companies in China's electronic information technology industry from 2015 to 2020 as the research object. According to the industry classification of China Securities Regulatory Commission 2012, listed companies under the classification of computer, communication and other electronic equipment manufacturing are selected as research samples, mainly involving two parts of data, namely, enterprise patent application data and operation data. Among them, the enterprise patent application data comes from the Patent retrieval platform of the State Intellectual Property Office and the enterprise operation data CSMAR economic and financial research database. In addition, in order to avoid the adverse impact of the differences between B shares and H shares on the study, this study only selected the a-share listed companies

in Shenzhen and Shanghai, excluded ST companies, and finally obtained the data of 183 sample enterprises.

## 3.1. Variable Selection and Measurement

The scale of high-tech enterprise user base represents the demand situation of users and is the motivation for enterprises to innovate. Following Katz and Shapiro [2], this paper uses revenue as the measure of user base scale.

Technological innovation capability is crucial for enterprises to achieve core competitiveness and win over users. Previous studies have typically used the sum of utility model patents and design patents granted to represent incremental technological innovation, and the number of invention patents granted to represent radical technological innovation [17].

As for the moderating variable of ownership nature, enterprises are divided into state-owned and non-state-owned categories to analyze the moderating effect of ownership nature on technological innovation.

To accurately study the impact of technological innovation on user scale, it is necessary to control for other variables. This paper selects enterprise size and years in operation as control variables.

**Table 1.** Variable Definitions and Measurement Methods

| Variable Code, | Variable Measurement |
|---|---|
| Scale | Business Operating Revenue (in billion) |
| LNFIV | Sum of Utility Model Patents and Design Patents |
| LNIV | Granted Number of Invention Patents |
| Owner | Granted State-Owned Enterprise=1, Non-State-Owned Enterprise=0 |
| Size | Total Assets of the Company at the End of the Year |
| Age | Year of establishment of the company |

## 3.2. Empirical model design

### 3.2.1. Main effects model

$$Scale_{i,t} = \beta_0 + \beta_1 LNIV_{i,t} + \beta_2 LNFIV_{i,t} + \beta_3 \sum control_{i,t} + \varepsilon_{i,t} \quad (1)$$

In Equation (1): Scale represents the user base scale; LNFIV stands for incremental technological innovation; LNIV stands for radical technological innovation; β0 represents the constant term; ε represents the error term; i represents the enterprise; t represents the year.

### 3.2.2. Moderation effects model

$$Scale\ i,t = \beta 0 + \beta 1\ LNIVi,t + \beta 2\ LNFIVi,t + \beta 3 Owner\ i,t + \beta 4 LNFIV \times Owner\ i,t + \beta 5 LNIV \times Owner\ i,t + \beta 6 \sum controli,t + \varepsilon i,t \quad (2)$$

By introducing the interaction terms between the nature of ownership (Owner) and incremental technological innovation (LNFIV), radical technological innovation (LNIV) into Model 1 as explanatory variables, we can obtain econometric Model 2 to further examine the moderating effect of the nature of ownership on technological innovation.

## 3.3. Empirical analysis

### 3.3.1. Descriptive statistics and correlation analysis

The descriptive statistics and correlation analysis results of each variable are shown in Table 2. It can be seen that the average level of the scale of state-owned enterprise users is slightly higher than that of non-state-owned enterprises. In terms of technological innovation level, the level of incremental technological innovation in state-owned enterprises is much higher than that in non-state-owned enterprises, and the level of radical innovation is slightly higher than that in non-state-owned enterprises, indicating that non-state-owned enterprises may have insufficient technological innovation capabilities. The correlation analysis uses Pearson correlation coefficient to analyze the degree of association between variables. The results show that there is a significant correlation between incremental technological innovation, radical technological innovation, and user scale, indicating that regression analysis can be conducted.

**Table 2.** Descriptive statistics and correlation analysis

| Variables | | sample size | Min | Max | Mean | Standard | Scale | LNIV | LNFIV | Size | Age |
|---|---|---|---|---|---|---|---|---|---|---|---|
| State-Owned | Scale | 294 | 1.480 | 944.480 | 101.980 | 168.050 | 1 | | | | |
| | LNIV | 294 | 0 | 1007 | 57.170 | 113.480 | 0.595** | 1 | | | |
| | LNFIV | 294 | 0 | 1180 | 86.140 | 159.430 | 0.742** | 0.362** | 1 | | |
| | Size | 294 | 20.070 | 25.210 | 22.660 | 1.180 | 0.713** | 0.515** | 0.527** | 1 | |
| | Age | 294 | 7.520 | 40.280 | 20.700 | 5.300 | 0.108 | 0.010 | 0.011 | -0.009 | 1 |
| Non-State-Owned | Scale | 804 | 0.11 | 1355.53 | 63.950 | 161.810 | 1 | | | | |
| | LNIV | 804 | 0 | 2561 | 53.720 | 243.900 | 0.827** | 1 | | | |
| | LNFIV | 804 | 0 | 1058 | 60.650 | 112.720 | 0.699** | 0.552** | 1 | | |
| | Size | 804 | 19.68 | 26.770 | 22.110 | 1.220 | 0.695** | 0.492** | 0.585** | 1 | |
| | Age | 804 | 6.01 | 45.530 | 17.920 | 6.370 | 0.099** | 0.063 | 0.106** | 0.129** | 1 |

Note: ** Significant correlation at the 0.01 level (two-tailed).

In order to prevent multicollinearity issues, this study conducted collinearity diagnostics on the independent variables. The tests revealed that the variance inflation factors (VIF) for each variable were below the critical standard value

of 10, indicating the absence of multicollinearity issues.

## 3.4. Regression results

Table 3 presents the hierarchical regression results for the computer, communication, and other electronic equipment manufacturing industry. Model 1 includes only control variables, Model 2 adds control variables and the main effects of the independent variables, while Models 3-5 incorporate moderator variables and interaction effects in a full effects regression model.

### 3.4.1. Principal effect test

The results show that the regression coefficients of incremental and abrupt technological innovation on user scale are 0.462 (P <0.01) and 0.325 (P <0.01) respectively, indicating that there is a positive correlation between incremental and abrupt technological innovation and user scale. Enterprises can improve their user base through incremental or abrupt innovation, that is, H1a and H1b are supported and the main effect test is verified.

### 3.4.2. Moderating effect test

Models 3-5 are used to test the moderating effect of ownership nature on the relationship between technological innovation and user base scale. These models build upon Model 2 by adding moderator variables and interaction terms. The results of Model 4 indicate a significant positive relationship between ownership nature and the interaction term of incremental technological innovation with user scale ($\beta$=0.085, p<0.01), suggesting that the positive relationship between incremental technological innovation and user scale is positively moderated by ownership nature. Additionally, there is a significant positive relationship between ownership nature and the interaction term of radical technological innovation with user scale ($\beta$=0.051, p<0.01), indicating that the positive relationship between radical technological innovation and user scale is positively moderated by ownership nature.

**Table 3.** Regression Results

| Variables | Scale | | | | |
|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
| Age | -0.017<br>（-0.778） | -0.026*<br>(-1.854) | -0.026*<br>(0.068) | -0.028*<br>(-2.011) | -0.024*<br>（-1.738） |
| Size | 0.705***<br>（32.411） | 0.306***<br>（17.557） | 0.303***<br>(17.047) | 0.298***<br>（16.703） | 0.308***<br>（17.379） |
| LNIV | | 0.462***<br>（28.479） | 0.464***<br>(28.414) | 0.498***<br>（24.750） | 0.499***<br>（25.116） |
| LNFIV | | 0.325***<br>（18.768） | 0.325***<br>(18.762) | 0.322***<br>（18.602） | 0.283***<br>（15.168） |
| Owner | | | 0.011<br>(0.760) | 0.011<br>（0.806） | 0.006<br>（0.458） |
| LNIV╳Owner | | | | 0.051***<br>（2.907） | |
| LNFIV╳Owner | | | | | 0.085***<br>（5.273） |
| $R^2$ | 0.494 | 0.793 | 0.793 | 0.795 | 0.8 |
| Adjusted $R^2$ | 0.493 | 0.792 | 0.792 | 0.794 | 0.799 |
| F-value | 534.214*** | 1048.296*** | 838.428*** | 704.867*** | 622.986*** |

Note: ***:P＜0.01;**:P＜0.05; *:P ＜ 0.1.

To identify the moderating effect of ownership nature, this study conducted grouped regressions based on ownership nature (state-owned enterprises/non-state-owned enterprises). Firstly, in Table4, it is observed that both incremental technological innovation and radical technological innovation have significant positive impacts on user scale for both state-owned and non-state-owned enterprises. The test command was used to examine the differences in coefficients between the groups. The results show that in incremental technological innovation (LNIFV), the empirical p-value for the two groups is significant (p=0.0278), allowing for a comparison of the coefficients. Specifically, $\beta_{state\text{-}owned}$=0.4991>$\beta_{non\text{-}state\text{-}owned}$=0.3139, indicating that incremental technological innovation is more beneficial for achieving user scale in state-owned enterprises than radical technological innovation, thus supporting hypothesis H2a. Additionally, it can be concluded that for non-state-owned enterprises, radical technological innovation is more beneficial for achieving user scale than incremental technological innovation, thus supporting hypothesis H2b.

**Table 4.** Moderating effect

| Variables | User scale | |
|---|---|---|
| | state-owned | non-state-owned |
| LNIV | 0.370***<br>（7.21） | 0.374***<br>（30.41） |
| LNIFV | 0.499***<br>（13.57） | 0.314***<br>（10.98） |
| Age | 3.269***<br>（3.50） | 0.069<br>（0.18） |
| Size | 47.637***<br>（8.83） | 38.472***<br>（15.13） |
| $R^2$ | 0.750 | 0.821 |
| Adjusted $R^2$ | 0.746 | 0.820 |
| F-value | 216.430*** | 915.800*** |

Note: ***:P＜0.01;**:P＜0.05; *:P ＜ 0.1.

## 3.5. Robustness test

To ensure the stability of the results and taking into account the differences between different products, it is necessary to conduct regression tests on sample data grouped by product.

The results are shown in Table 6. The product-specific test results indicate that the regression results for all product categories pass the F-test, indicating that the equation is statistically significant as a whole. The technical innovation and user scale of each product category are consistent with the overall sample regression results. This enhances the persuasiveness of the conclusions of this study, indicating the robustness of the regression results and the validity of the conclusions mentioned above.

**Table 4.** Product inspection results

| Variables | User scale | | | | |
|---|---|---|---|---|---|
| | Traditional manufacturing | optoelectronic components and new energy | services and communications | smart hardware | advanced manufacturing and transportation |
| Age | 0.063 | 0.012 | 0.037 | 0.071*** | 0.300*** |
| Size | 0.498*** | 0.236*** | 0.504*** | 0.357*** | 0.503*** |
| LNIV | 0.089 | -0.104** | 0.609*** | 0.383*** | -0.053 |
| LNFIV | 0.146** | 0.504*** | -0.063 | 0.283*** | 0.237*** |
| Owner | 0.103* | -0.014 | -0.088** | -0.019 | -0.015 |
| LNIV╳Owner | 0.052* | 0.257*** | 0.097* | -0.069** | 0.011* |
| LNFIV╳Owner | 0.179*** | 0.170** | -0.103** | 0.024* | -0.167*** |
| $R^2$ | 0.366 | 0.880 | 0.843 | 0.861 | 0.731 |
| Adjusted $R^2$ | 0.348 | 0.875 | 0.837 | 0.858 | 0.721 |
| F-value | 20.125*** | 186.329*** | 132.306** | 237.506* | 76.058*** |

Note: ***:P＜0.01;**:P＜0.05; *:P ＜ 0.1.

# 4. Conclusion

From the micro level of enterprises, this study verifies the effect mechanism of two innovation modes of gradual technological innovation and abrupt technological innovation on the scale of high-tech enterprises' user base, and draws the following conclusions.

In the main effect, the effect of abrupt technological innovation on the growth of user scale is greater than that of gradual technological innovation. The reason is that the incremental technological innovation is a small local innovation aimed at users' needs, which has limited improvement on product performance. On the other hand, abrupt technological innovation is the use of new technology to innovate, which deepens the level of product complexity and affects the user's use decision. In the initial stage of product launch to the market, compared with the products of sudden technological innovation, the products of progressive technological innovation are more in line with users' usage habits, can reduce their search and evaluation costs, and are more easily accepted by users. However, in the long run, the product of abrupt technological innovation has better technical attributes and functions than the product of gradual technological innovation. With the continuous penetration of these functions to users' cognition, it can better meet the diversified needs of users and achieve user scale. Therefore, based on the long-term development of enterprises, abrupt innovation plays a stronger role in promoting the growth of user scale.

Among the moderating effects, the nature of firm ownership moderates the impact of technological innovation on user scale to a large extent, and the moderating effects of gradual technological innovation and abrupt technological innovation are different. Non-state-owned enterprises have a more significant moderating effect on user scale in the abrupt technological innovation mode, while state-owned enterprises have a more significant moderating effect on user scale in the gradual technological innovation mode. This may be determined by the nature of state-owned enterprises, which are controlled by the state and most of which have achieved monopoly status in the industry, lack motivation for independent innovation and are far less willing to innovate than non-state-owned enterprises, so most of them use progressive technological innovation mode. Non-state-owned enterprises have to rely on innovation to seek for enterprise development and market position, so most of them use the abrupt technological innovation mode.

In order to help enterprises expand user scale and enhance economic strength, the following suggestions are given. On the one hand, the state-owned enterprises can reflect a country's economic strength, needs to improve its supervision of governance, to promote state-owned enterprise innovation resources advantage into innovation advantages, high technology enterprise appropriate incentives to the high risk, long cycle, technical strength of the mutation type transformation of technological innovation, enhance the user scale, improve enterprise competitiveness. On the other hand, too high leverage ratio will inhibit the development of enterprises, and non-state-owned enterprises face innovation resource barriers, which will restrict their innovation motivation. Therefore, the government should increase R&D funding for non-state-owned enterprises, reduce arbitrary discrimination, and stimulate the competitiveness and creativity of non-state-owned enterprises.

This paper also has some limitations, only based on the data of computer, communication and other electronic equipment manufacturing listed companies for empirical study, the future can select other high-tech industry for more comprehensive research.

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