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An empirical study on the influencing factors of technological innovation ability of chip listed enterprises

Dan Xu[1], Xi Ying[2]

[1]*Shenzhen University, Shenzhen, 518060, China*
[2]*University of Shanghai for Science and Technology, Shanghai, 201210, China*

Abstract: *Taking China's major chip listed enterprises as the research object, this paper makes an empirical analysis on the technological innovation ability of those enterprises from 2016 to 2020 by using ridge regression model, and puts forward assumptions on the influencing factors of R&D and financial status. The analysis conclusion is that the technological innovation ability of enterprises is positively correlated with the proportion of R&D personnel and operating revenue. The proportion of R&D capital investment in operating revenue, total assets, operating costs and asset liability ratio have little impact on technological innovation ability.*

Keywords: *Chip listed enterprises, Technological innovation ability, Ridge regression model*

1. Introduction

Since the reform and opening up, China has always advocated improving the innovation ability of all walks of life. Influenced by COVID-19, the global trade situation in recent years is not optimistic. As early as March 22, 2018, the signing of the US trade memorandum with China officially opened the prelude to the Sino US trade dispute[1]. Among them, the most striking is the chip sanctions against Chinese enterprise Huawei. In order to get rid of the chip sanctions of the United States and realize the transformation of Chinese design into made in China, the market puts forward higher requirements for the technological innovation ability of Chinese chip enterprises. Therefore, the research on the influencing factors of technological innovation ability of China's major chip listed enterprises is of great significance for enterprises to improve their technological innovation ability and get rid of chip technology sanctions.

2. Literature review

As for the research on the influencing factors of enterprise innovation ability, the priority financing theory proposed by Myeis and Majhuf (1984) points out that companies with higher profits generally have lower debt ratio. Such enterprises generally have stronger innovation ability, because higher profitability will make the management pay more attention to the existence of their enterprise's innovation ability. Nikolaos and Zoe frangouli (2002) believe that the higher the debt ratio of the company, the lower the profitability. Such enterprises are generally small enterprises, trying to use high debt to invest in innovation, trying to reverse the market share obtained by their low innovation ability. Titman and Wessels (1988) analyzed the financial data of more than 460 listed companies in the United States and concluded that there was a negative correlation between asset liability ratio and profitability[2]. In addition, scholars of traditional school believe that large-scale enterprises have stronger innovation ability than small-scale enterprises. Schumpeter put forward this view in 1942, which was also supported by scholars. However, some domestic scholars believe that smaller enterprises have more innovative advantages (Li Ping, Xing Lina, 2007; Dong Xiaoqing, 2013), and there is an inverted U-shaped relationship between enterprise scale and innovation ability (Ma Ning, 2011; Li Zhengwei, 2003; Gao liangmou, etc., 2008). Other scholars have also made analysis from many angles. Shao Jungang (2001) believes that different enterprises have their own innovation advantages in different aspects such as organization, industry and strategy. Cai Shaohong (2019)'s research shows that innovation policy is negatively correlated with enterprise scale, and enterprise scale is positively correlated with innovation achievements[3].

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Besides, no scholars have conducted special research on the influencing factors of technological innovation ability of chip listed enterprises so far. Therefore, based on the existing research methods and experience, this paper brings 35 chip listed enterprises into the research scope, collects the data from 2016 to 2020 for empirical analysis, in order to find out the key factors affecting the technological innovation ability, and provide reference for chip listed enterprises to improve their technological innovation ability.

3. Research design and data selection

(1) Research design

The factors affecting the technological innovation ability of chip listed enterprises are roughly divided into two categories: the first is the influencing factors of R&D status, including the proportion of R&D personnel and the proportion of R&D capital investment in operating revenue; The second category is the influencing factors of financial situation, including operating revenue, operating cost, asset liability ratio and total assets. Therefore, variables are defined as follows:

(1) Enterprise technological innovation ability (TIA) is the explained variable;

(2) The proportion of R&D personnel (POP) and the proportion of R&D capital investment in operating revenue (POCI) are the explanatory variables of R&D status;

(3) Operating revenue (RE), total assets (TA), operating cost (OC) and asset liability ratio (ALR) are explanatory variables of financial status;

Influence of R&D related variables on technological innovation ability

R&D personnel are the main body for enterprises to realize technological innovation. Within a certain range, without considering the decline of marginal labor productivity, the more R&D personnel, the stronger the enterprise's technological innovation ability. Therefore, the proportion of R&D personnel is positively related to technological innovation ability.

R&D capital investment is the condition for enterprises to realize technological innovation. The more capital investment, the better R&D conditions, and the more conducive to technological innovation. Therefore, the proportion of R&D capital investment in operating revenue is positively correlated with technological innovation ability.

Therefore, hypothesis 1 is put forward.

H1: technological innovation ability is positively correlated with the proportion of R&D personnel and the proportion of R&D capital investment in operating revenue.

Influence of financial status variables on technological innovation ability

The operating revenue represents the operation and development of the enterprise. The more revenue, the larger the development scale of the enterprise and the greater the potential of technological innovation. Therefore, operating revenue is positively correlated with technological innovation ability.

Operating costs include cost of sales and other operational costs. The greater the operating costs, the less funds available for R&D and the weaker the technological innovation ability. Therefore, there is a negative correlation between operating cost and technological innovation ability.

Asset liability ratio, that is, the ratio of assets to liabilities, is not only a comprehensive indicator reflecting the company's debt level, but also an indicator measuring the company's ability to use creditor funds for business activities. Therefore, the asset liability ratio can be used as one of the evaluation indicators to measure whether an enterprise has the ability of technological innovation and the possibility of paying for action. The asset liability ratio is related to the ability of technological innovation.

Total assets is an important indicator of enterprise scale. The larger the enterprise scale, the more resources that can be used for technological innovation, and the stronger the technological innovation ability. Therefore, total assets is positively correlated with technological innovation ability.

Therefore, hypothesis 2 is put forward.

H2: technological innovation ability is positively correlated with operating revenue and total assets; Negatively correlated with operating costs; There is a correlation between technological innovation ability and asset liability ratio.

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According to the analysis and assumptions, this paper uses the regression method to establish the model, and considering the collinearity between explanatory variables, uses the ridge regression method to establish the model to test the impact of their variables on the technological innovation ability of dependent variables.

Firstly, this paper analyzes the impact of two R&D explanatory variables, the proportion of R&D personnel and the proportion of R&D capital investment in operating revenue, on technological innovation ability, and constructs model(1):

$$TIA = C + \alpha_1 POP + \alpha_2 POCI + \varepsilon \quad (1)$$

Based on the model (1), the financial status variables are introduced to analyze their impact on technological innovation ability, and build the model (2):

$$TIA = C + \alpha_1 POP + \alpha_2 POCI + \alpha_3 RE + \alpha_4 TA + \alpha_5 OC + \alpha_6 ALR + \varepsilon \quad (2)$$

C is a constant term, α is the variable coefficient, and ε is a random perturbation term.

(2) Data Selection

Taking the chip listed enterprises in China as the research object, considering the availability of data, this paper excludes the enterprises that have been listed for less than 3 years and selects 35 of them. The relevant data of these 35 enterprises from 2016 to 2020 are obtained from CSMAR database and Aiqicha database as statistical samples for empirical analysis.

In the above variable data, the proportion of R&D personnel (POP), the proportion of R&D capital investment in operating revenue (POCI), operating revenue (RE), total assets (TA) and operating cost (OC) are obtained from CSMAR database. The asset liability ratio is calculated by the ratio of total assets to liabilities. The data of total assets and liabilities are also from CSMAR database. Considering that the values of operating revenue (RE), total assets (TA) and operating cost (OC) are too large, their pair values will be used for analysis. Besides, the technological innovation ability (TIA) of enterprises is replaced by the development rate of the number of patents publicized by enterprises every year which is calculated by the ratio of the number of patents publicized in that year to the number of patents publicized last year. The number of patents comes from Aiqicha database.

4. Empirical analysis

(1) Descriptive statistics and correlation analysis

Using SPSS 26.0 software to analyze the sample data. The results of descriptive statistical analysis are shown in Table 1. The slowest development rate of patents of chip listed enterprises each year is 9%, the fastest rate is 333%, and the average rate is 114.7%. The difference between samples is obvious.

Table 1: Descriptive statistics

Value	Minimum	Maximum	Mean	Std.Dev.	Median
TIA	0.090	3.330	1.147	0.590	1.065
POP	5.830	92.360	38.549	24.311	29.675
POCI	1.870	47.480	13.483	9.687	10.425
TA	8.840	10.770	9.593	0.475	9.485
ALR	0.030	1.170	0.330	0.218	0.260
RE	8.010	10.420	9.203	0.574	9.120
OC	7.780	10.350	9.020	0.622	8.965

The sample data is unbalanced panel data. The collinearity problem is tested below, and the results are shown in Table 2.

It can be seen from table 2 that the independent variables RE and OC are highly correlated. In order to avoid collinearity problems, ridge regression method is used for analysis. The specific regression results are shown in Table 3.

ISSN 2616-5902 Vol. 3, Issue 10: 82-86, DOI: 10.25236/AJBM.2021.031015

Table 2: Coefficient

Variables	Unstandardized coefficient		Standardized Coefficients	t	Significance	Collinearity statistics	
	B	Std. Error	Beta			Tolerance	VIF
(constant)	0.377	1.232		0.306	0.760		
POP	0.004	0.003	0.150	1.346	0.180	0.460	2.175
POCI	0.003	0.006	0.057	0.544	0.587	0.523	1.911
TA	-0.622	0.283	-0.502	-2.202	0.029	0.110	9.090
ALR	-0.383	0.291	-0.142	-1.318	0.189	0.492	2.032
RE	1.472	0.841	1.434	1.750	0.082	0.008	117.680
OC	-0.761	0.731	-0.804	-1.014	0.299	0.010	104.568
Dependent variable: TIA							

Table 3: Ridge regression analysis results

Variables	Model (1)	Model (2)
(Constant)	0.931** (10.536)	0.406 (0.376)
POP	0.007** (3.767)	0.005* (2.496)
POCI	-0.005 (-1.064)	0.001 (0.208)
TA		-0.332 (-1.821)
ALR		-0.388 (-1.468)
RE		0.318** (2.815)
OC		0.100 (0.893)
n	158	158
R^2	0.086	0.126
Adjusted R Square	0.074	0.091
F	F(2,155)=7.283,p=0.001	F(6,151)=3.618,p=0.002
Dependent variable: TIA		
*p<0.05 **p<0.01 T value in parentheses, k=0.05		*p<0.05 **p<0.01 T value in parentheses, k=0.04

(2) Analysis of regression results

According to the regression results of model (1), the model formula is: $TIA = 0.931+0.007POP - 0.005POCI + \varepsilon$. The R-square value of the model is 0.086, which means that the proportion of R&D personnel (POP) and the proportion of R&D capital investment in operating revenue (POCI) can explain 8.59% change of TIA. The regression coefficient of the proportion of R&D personnel (POP) is 0.007, indicating that the proportion of R&D personnel (POP) will have a significant positive impact on the enterprise's technological innovation ability (TIA), that is, the more R&D personnel, the stronger the technological innovation ability. The regression coefficient of the ratio of R&D capital investment to operating revenue (POCI) is -0.005, but the p value is greater than 0.05, which means that the ratio of R&D capital investment to operating revenue (POCI) has little impact on the enterprise's technological innovation ability (TIA). The reason may be that the proportion of R&D funds in operating revenue cannot effectively represent the amount of R&D funds invested by enterprises. Different enterprises have different sizes and operating revenue, but the amount of R&D funds invested may be similar. Perhaps it will be better to use R&D funds as independent variables for regression analysis and fitting. Therefore, hypothesis 1 is not completely true.

According to the regression results of model (2), the model formula is: $TIA = 0.406+0.005POP + 0.001POCI - 0.332TA - 0.388ALR + 0.318RE + 0.100OC + \varepsilon$. The R-square value of the model is 0.126, which means that all independent variables can explain 12.57% of the change of enterprise technological innovation ability (TIA). The regression coefficient of the proportion of R&D personnel (POP) is 0.005, indicating that the proportion of R&D personnel (POP) will have a significant positive impact on the enterprise's technological innovation ability (TIA). The regression coefficient of operating revenue (RE) is 0.318, which means that operating revenue (RE) will also have a significant positive impact on enterprise technological innovation ability (TIA). That is, the increase in the

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proportion of R&D personnel (POP) or operating revenue (RE) will enhance the technological innovation ability of enterprises. The P values of other variables are greater than 0.05, indicating that they have little impact on the dependent variable. Therefore, hypothesis 2 is not completely true.

5. Conclusion

This paper makes an empirical study on 35 chip listed enterprises from 2016 to 2020, and comes to the conclusion that the technological innovation ability of enterprises is positively correlated with the proportion of R&D personnel and operating revenue. The proportion of R&D capital investment in operating revenue, total assets, operating costs and asset liability ratio have little impact on technological innovation ability.

This paper only selects chip listed enterprises as the research object, and there are many unlisted chip enterprises in reality. Therefore, the description in this paper cannot truly represent the overall situation of the chip industry. This paper also has some limitations on the selection of variables. In the follow-up, we still need to expand the sample range, identify more comprehensive explanatory variables, and conduct more in-depth research on the factors affecting the technological innovation ability of chip enterprises.

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