The Influential Factors of the High-tech Enterprises Technological Innovational Income

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Abstract

Based on the data of Jinan high-tech enterprises, the paper studies the influential factors of the income of high-tech enterprises technological innovation. We establishe an econometric model and give regression analysis, and found that R&D capital has a significant positive effect on technological innovation income. The positive effect of R&D capital is much higher than total assets. The intensity of R&D capitals has significant negative effects on innovation income. The effect of R&D personnel number and quality of enterprise employees on innovation income have difference between Jinan city and High-tech Zone, the number of personnel of R&D has positive effect on technology innovation income of Jinan city, while its effect is not significant to High-tech Zone. The quality of enterprise employees has a positive effect on the technological innovation income of High-tech Zone, while it has no significant effect on the technological innovation income of Jinan city.

Keywords

High-tech Enterprises, Technological Innovation, Effect Factors.

1. Introduction

In recent years, many enterprises develop or restructure to high-tech industrial to adapt to the rapid development of information technology. And the major high-tech fields supported by China are electronic information technology, high technology to transform traditional industries, bio-medicine and new technology, new energy and energy-saving technology, high-tech services,ect.. More and more researchers are put effort on high-tech enterprises technological innovation. Edison et al. [1] found the following definition to be the most complete: "Innovation is: production or adoption, assimilation, and exploitation of a value-added novelty in economic and social spheres; renewal and enlargement of products, services, and markets; development of new methods of production; and establishment of new management systems. It is both a process and an outcome." This definition was given by Crossan and Apaydin [2]and it builds on the OECD manual's definition.

And more and more scholars studied the influencing factors of technological innovation product, Hanel, P. & St-Pierre [3] studied 278 firms from the COMPUSTAT II database explores the relationship between a firm's profitability and other variables, notably its own R & D capital, knowledge and market spillovers and appropriability. Helson Braga and Larry Willmore [4] found that firm size positively related to innovation, Kraft [5] thought firm size and innovation did not have significant relationship. Scherer [6] found that there is an inverse U-shaped relationship between firm size and innovation. Zhou Yahong [7] make the R&D's cumulative effect on production as the knowledge capital, studied the self-selection in the firm's R&D inputs, and chose the fitted IV to study the innovation production. Ouyang Qiu-zhen [8] constructed the dynamic panel model and used the SYS-GMM method in order to empirically study the impact of innovation network structure on the technological innovation performance of high-technology industries. Hu Yidong [9] made an empirical analysis of influencing factors of technological innovation in high-tech enterprises. LI Guangyu [10] found that there is an inverse U-shaped relationship between firm size and innovation output, and market concentration has a positive effect on innovation output.

In this paper we empirical study the influential factors of the income of technological innovation of High-tech enterprises based on the data of Jinan High-tech enterprises, and analyze the differences of various factors' effect on high-tech enterprises between High-tech zone and overall Jinan City. In section 2, the variable selection and model building is presented; in section 3, we present the data sources and the descriptive statistics; in section 4, we give the regession analyses; the conclusion is presented in the final.

2. Variable Selection and Model Building

2.1 Variable Selection

The dependent variable: Y. Based on the input-output theory, currently, granted patents [11] and output value of new products (services) are mainly used to measure innovation output. In this issue the main output is the income of high-tech products (services), denoted by Y. High-tech products (services) income refers to the income of high-tech enterprises through technical innovation and research and development of new products (and services) acquired, together with enterprise technical income. Technical income includes: (1) technology transfer income, (2) technical contract income, (3) revenue in technology services, (4) commissioned research income.

Explanatory variables: According to the input-output analysis, the main technical inputs are research and development capital F, the number of research and development staff L, as well as the intensity of research and development capital G, the ratio of research and development personnel M reflected the emphasis on innovation, research and development. Research and development capital F are used in the cumulative costs. Because the research and development costs have a cumulative effect and the lag effect, so we make the cumulative of investment in research and development capital in the nearly three years as input variables. Research and development capital input intensity G represented by the sum of research and development capital divided total sales the last three years. The number of staff L employed in research and development was the stock, the number of research and development personnel is the number of staff involved in research and development in 2012. The ratio of research and development personnel M is the number of research and development staff accounted for the total number of employees.

The size of enterprise: the total number of employees N and total assets S. Total assets and total number of employees are the stock; those are the total assets and the total number of employees in 2012 respectively.

The quality of employees T: the variable is represented by the staff number of junior college or above in science and technology in each one hundred employees.

2.2 Model Building

By the endogenous growth theory and Cobb-Douglas [12] production function:

$$Y = A * L^{\beta_1} * M^{\beta_2} * F^{\beta_3} * G^{\beta_4} * N^{\beta_5} * S^{\beta_6} * T^{\beta_7} * e^{\varepsilon} \quad (1)$$

we obtain the regression model by logarithmic on both sides of the above function:

$$\ln Y = \alpha + \beta_1 \ln L + \beta_2 \ln M + \beta_3 \ln F + \beta_4 \ln G + \beta_5 \ln N + \beta_6 \ln S + \beta_7 \ln T + \varepsilon \quad (2)$$

where Y is the dependent variable, represents high-tech products (services) revenues, A is comprehensive technical level, L is the number of research and development personnel, M is the proportion of research and development personnel, F is the capital of research and development, G is the research and development capital input intensity, N is the total number of employees of enterprises, S is the total asset, T is the quality of employees of enterprises, $\alpha = \ln A$, ε is a random error term.

3. Data Sources and Descriptive Statistics

3.1 Data Sources

The data comes from the survey of high-tech industries in Jinan city of Shandong China from 2010-2012; it covers 7 fields, such as electronic information technology (123 companies), high technology to transform traditional industries (125 companies), bio-medicine and new technology (43 companies), new energy and energy-saving technology (25 companies), new material technology (45 companies), high-tech services (10 companies), resources and environmental technology (17 companies). And it covers 11 areas, such as High-tech Zone (180 companies), Lixia District (39 companies), Huaiyin District (18 companies), Licheng District (35 companies), Shizhong District (9 companies), Tianqiao District (20 companies), Changqing District (17 companies), Zhangqiu City (39 companies), Jiyang County (12 companies), Shanghe County (4 companies), Pingyin County (15 companies).

Observed the collected data, it can be found that Jinan is mainly focus on the development of electronic information technology industries and high-tech to transform traditional industries. The high-tech companies are mostly focused on High-tech Zone, which is related to the development policy. Jinan High-tech Zone is one of the first state-level high-tech zones approved by the State Council. High-tech Zone has the unique advantages, such as low cost, convenient transportation, economic concessions, a beautiful environment, convenient policies and others, which have attracted many enterprises to establish and develop in High-tech Zone.

3.2 Descriptive Statistics

Table 1. the results of descriptive statistics of each variable

variable	mean	Std. Dev.	median	min	max
high-tech products (services) revenues(unit: Ten thousand Yuan)	16392.73	40241.24	4275	0	489913.5
the number of research and development personnel(unit: person)	76.71059	103.886	40	2	879
the proportion of research and development personnel(unit: 1)	0.3428163	0.2009878	0.2943603	0	1
the capital of research and development(unit: Ten thousand Yuan)	3444.287	9154.726	1146.5	0	148068.9
the research and development capital input intensity(unit: 1)	0.1348518	0.7614751	0.067809	0	14.87294
the total number of employees(unit: person)	299.0309	491.381	122.5	8	4794
the total asset (unit: Ten thousand Yuan)	36203.23	112011.7	7978.91	185.86	1523459
the quality of employees of enterprises(unit: person)	55.54351	22.85107	50	0	100

Table 1 shows that the mean value of the proportion of research and development personnel achieved 0.3428163, which indicates that high-tech enterprises in Jinan City attach great importance to the introduction of technology research and development person, R & D person investment is in high levels. And the research and development capital input intensity reached to 0.1348518, indicating sales of high-tech enterprises will get back into research and development in high proportion in Jinan City.

4. Regression Analysis

4.1 Data Regression Results of Overall Jinan

Table 2. Data regression results of overall Jinan

Model	(1)	(2)	(3)	(4)
dependent variable	$\ln Y$	$\ln Y$	$\ln Y$	$\ln Y$
$\ln L$	0.0596 (0.95)	0.0596 (0.95)	0.0616 (1.18)	0.0820* (2.06)

$\ln M$	0 (.)			
$\ln F$		0.835*** (17.70)	0.834*** (17.81)	0.839*** (18.18)
$\ln G$		-0.785*** (-17.56)	-0.787*** (-17.77)	-0.796*** (-19.07)
$\ln N$	0.835*** (17.70)	0.0355 (0.52)	0.0340 (0.60)	
$\ln S$	-0.785*** (-17.56)	0.0956* (2.55)	0.0958* (2.57)	0.101** (2.79)
$\ln T$	0.00754 (0.10)	0.00754 (0.10)		
_cons	-0.870* (-2.36)	-0.870* (-2.36)	-0.837*** (-5.35)	-0.848*** (-5.46)
N	367	367	368	368
R-squared	0.9149	0.9149	0.9151	0.9150
Adj R-squared	0.9135	0.9135	0.9139	0.9140
Prob > F	0.0000	0.0000	0.0000	0.0000

Notes: t statistics in parentheses;* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Through regression analysis, in Model (1) $\ln M$ was deleted because of co-linearity, and the Model (2) t statistics of $\ln T$ is 0.10, the coefficient of variables is not very significant, we remove the variable and do regression analysis again. Model (3) t statistics of $\ln N$ is 0.60, coefficient of variable is very insignificant, so it can be removed, and then regress get Model (4). The overall regression effect is very significant, R^2 is 0.9150 and the adjusted R^2 is 0.9140. The coefficient of $\ln L$ is 0.082, t statistics is 2.06; the coefficient is very significant, indicating that the number of research and development personnel positively related to income of technical innovation. The coefficient of $\ln F$ is 0.839, t statistics is 18.18; the coefficient is very significant, indicating that the capital of research and development positively related to income of technological innovation. The coefficient of $\ln S$ is 0.101, t statistics is 2.79; the coefficient is very significant, indicating that the total asset and the income of technological innovation have positive correlation. Just the potency of research and development capital is much higher than the number of research and development personnel and total assets of enterprises. The coefficient of $\ln G$ is -0.796, t statistics is -19.07, the coefficient is very significant, indicating that there is a negative relationship between the research and development capital input intensity and income of technological innovation, high-tech enterprises in Jinan has the performance of exceed pursue R & D investment intensity, but it will not help to improve business innovation output. Constant term is -0.848, t statistics is -5.46, it is very significant. Then we get the regression model is:

$$\ln Y = 0.0820 \ln L + 0.839 \ln F - 0.796 \ln G + 0101 \ln S - 0.848 \quad (3).$$

4.2 Data Regression Results of High-tech Zone

Table 3. Data regression results of High-tech Zone

Model	(1)	(2)	(3)	(4)
dependent variable	$\ln Y$	$\ln Y$	$\ln Y$	$\ln Y$
$\ln L$	0.00558 (0.06)	0.00558 (0.06)		
$\ln M$	0 (.)			

$\ln F$	0.816*** (11.26)	0.816*** (11.26)	0.817*** (11.48)	0.889*** (15.07)
$\ln G$	-0.913*** (-15.15)	-0.913*** (-15.15)	-0.912*** (-15.40)	-0.937*** (-16.19)
$\ln N$	0.109 (1.06)	0.109 (1.06)	0.114 (1.78)	
$\ln S$	0.100* (2.04)	0.100* (2.04)	0.100* (2.05)	0.111* (2.28)
$\ln T$	0.245* (1.98)	0.245* (1.98)	0.249* (2.58)	0.213* (2.25)
_cons	-2.192*** (-3.58)	-2.192*** (-3.58)	-2.213*** (-4.51)	-2.190*** (-4.44)
N	176	176	176	176
R-squared	0.9059	0.9059	0.9059	0.9041
Adj R-squared	0.9025	0.9025	0.9031	0.9019
Prob > F	0.0000	0.0000	0.0000	0.0000

Notes: t statistics in parentheses;* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Through regression analysis, in Model (1) $\ln M$ was deleted because of co-linearity, and the Model (2) t statistics of $\ln L$ is 0.06, the coefficient of variables is not very significant, we remove the variable and do regression analysis again. Model (3) t statistics of $\ln N$ is 1.78, coefficient of variable is very insignificant, so it can be removed, and then regress get Model (4). The overall regression effect is very significant, R^2 is 0.9041 and the adjusted R^2 is 0.9019. The coefficient of $\ln F$ is 0.889, t statistics is 15.07; the coefficient is very significant, indicating that the capital of research and development positively related to income of technical innovation. The coefficient of $\ln G$ is-0.937, t statistics is -16.19; the coefficient is very significant, indicating that there is a negative relationship between the research and development capital input intensity and income of technological innovation, high-tech enterprises in Jinan High-tech Zone has the performance of exceed pursue R & D investment intensity, but it will not help to improve business innovation output. The coefficient of $\ln S$ is 0.111, t statistics is 2.28; the coefficient is very significant. The coefficient of $\ln T$ is 0.213, t statistics is 2.25, the coefficient is very significant. It indicates that the total asset and the quality of workers of enterprises have promoted the income of technological innovation. Constant term is -2.190, t statistics is -4.44, and it is very significant. Then we get the regression model is:

$$\ln Y = 0.889\ln F - 0.937\ln G + 0.111\ln S + 0.213\ln T - 2.190 \quad (4).$$

5. Conclusion

In this paper, we studied the influencing factors of technological innovation performance of the high-tech enterprises in Jinan City. And enterprise data in Jinan High-tech Zone and the overall Jinan were analyzed respectively, the study found:

(1) R&D investment. Total research and development capital is promote income of technological innovation, but the intensity of investment in research and development capital has a negative effect on income of technological innovation, which is agreed with the conclusions of Zhong Weijun and Hu Yidong[9]. This requires enterprise need to strengthen investment in research and development capital, but should be modest investment. That is to avoid adversely effect on technological innovation because of redundant investment. In addition to that, article found that the number of the research and development staff has different impact on technological innovation in different areas. The R&D personnel has a positive role in promoting revenue of technological innovation on High-tech Zone of high-tech enterprises, but it is not very significant, while for the entire high-tech enterprises in Jinan City, its positive effect is remarkable.

(2) Firm size. The study found that the total number of employee's positive impact on the income of technological innovation is not significant, which is inconsistent to the conclusions of Zhong Weijun and Hu Yidong[9]. But the firm's total asset has a significant positive role in promoting revenue of technological innovation. The reason is that Hu Yidong and Zhong Weijun[9] constructed the regression model with two groups, one group reflected the relationship between output and R&D investment, another group reflected the relationship between the output and the size of the firm. And we combined firm size and R &D investment on a regression analysis model.

(3) The quality of enterprise employees. We also found that quality of enterprise employees have different impact on different areas. Positive impact of quality of enterprises employees on the income of technological innovation was not significant in entire Jinan, but for the High-tech Zone, it has a significant positive role in promoting income of technical innovation.

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