



The effects of age, size and management characteristics of university science and technology parks on the performance of science and technology conversion

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Abstract. In the context of promoting high-quality development of university science and technology parks in the new era and accelerating the achievement of higher level of self-sufficiency and self-improvement, this paper explores which characteristics of university science and technology parks can effectively contribute to the transformation of university science and technology achievements by systematically analyzing the relationship between the characteristics of university science and technology park management organizations and the performance of university science and technology achievement transformation. Based on this, three hypotheses are proposed and least squares regression analysis is used to control for year fixed effects and verify the hypotheses. The following conclusions were obtained: the age and size of university science and technology parks and the capacity of practitioners in university science and technology park management organizations have mechanisms that promote the performance of university science and technology achievement conversion.

Keywords: Technology Innovation and Management, University Technology Park Management, Innovation and Entrepreneurship, Technology Management

1 Introduction

The efficiency of the transformation of scientific and technological achievements in universities is an important factor affecting the level of China's innovation capacity. In order to accelerate the transformation of scientific and technological achievements in universities, China has created several university science and technology parks since 1983, and has re-emphasized that one of the five core functions of university science and technology parks is the transformation of scientific and technological achievements.

Previous research has demonstrated that USTPs are more effective in promoting entrepreneurial output in universities than incubators, and that regional economic development helps to reinforce this role [1], but studies have only examined the impact

on entrepreneurial outcomes in universities, and they have mainly collected evidence from UK universities and technology parks, and are not applicable to China. The extent to which university science and technology parks contribute to or fail in their mission of technology transfer from universities is also a topic of interest in several literature reviews on science and technology parks [2].

To this end, this paper aims to analyze the practical role played by university science and technology parks in the process of technology transfer in universities. By collecting and compiling relevant data from the Compilation of Science and Technology Statistics of Higher Education Institutions and China Torch Statistical Yearbook for the past five years, the influence of age characteristics, scale characteristics and management capacity characteristics of university science and technology parks on the transformation of technological achievements in universities is discussed.

2 Conceptual framework

2.1 The impact of the age of the University Technology Park

The age and size of the organization are often factors related to organizational performance[3]. In firms, but little literature has focused on the impact of the age of establishment of science and technology parks, especially university science and technology parks, on innovation behavior in universities. In the long run, older organizations may also be at risk of managerial rigidity and conservatism, which will lead to lower performance and negatively affect the organization. Therefore, the following hypothesis is given in this paper:

H1: There is an inverted U-shaped relationship between the number of years of establishment of university science and technology parks and the efficiency of the transformation of university science and technology achievements.

2.2 Impact of the size of the University Technology Park

There may be a non-linear relationship between the size of a technology park and the innovation performance of its firms. A study focusing on Chinese science and technology parks also suggests that the negative impact of the "congestion effect" within the park may outweigh the positive impact of economies of scale on productivity. However, there is no research that quantitatively explores the relationship between the size of university science and technology parks and the efficiency of university science and technology conversion, therefore, the following hypothesis is given in this paper:

H2: The size of university science and technology parks has an inverted U-shaped relationship with the efficiency of the transformation of university science and technology achievements.

2.3 Impact of the management characteristics of the University Technology Park

About one-fifth of the provinces in China have negative talent effectiveness of NUSSP management organizations, and the talent effectiveness of NUSSP management organizations varies significantly among provinces and is not consistent with the level of regional economic development [4]. The management organizations of some science and technology parks provide business planning and intellectual property services to companies through self-management or external cooperation, but existing studies disagree on whether such services positively contribute to the innovation performance of the companies in the parks (Albahari et al., 2018; Löfsten & Lindelöf, 2005). Therefore, the following hypothesis is given in this paper:

H3: The management capacity of university science and technology parks positively contributes to the efficiency of the transformation of university science and technology results.

3 Data, variables and methods

3.1 Data

In order to complete the empirical analysis, two types of data sources are selected in this paper. On the one hand, this paper selects data related to the transformation of scientific and technological achievements in universities from the Compilation of Science and Technology Statistics of Higher Education Institutions published by the Ministry of Education of China every year; on the other hand, this paper uses some data about national university science and technology parks from the China Torch Statistical Yearbook of the Ministry of Science and Technology. The data are compiled once a year and recorded in detail the basic economic indicators of local university science and technology parks, as well as the indicators of incubated enterprises, enterprises in the park and graduated enterprises. Since the university-based science and technology statistics and torch statistics are not publicly available and difficult to obtain, in the subsequent analysis, this paper argues that university science and technology parks have a radiating effect on universities in their regions, and considers that university science and technology parks in the same province have an equally effective impact on the transformation of university science and technology achievements [5].

3.2 Variable definitions

Explained variables. In this paper, we use the data of logarithm of actual income (licensing_income) and logarithm of the number of contracts (num_licenses) in the year of science and technology achievements and technology transfer in universities from 2015-2020 in the Compilation of Science and Technology Statistics of Higher Education Institutions, and select actual income as the indicator of the explanatory variable in the baseline regression, and the number of contracts as the proxy indicator

of the explanatory variable in the robustness test. The number of contracts is used as a proxy for the explanatory variable in the robustness test.

Explanatory variables. This paper uses provincial panel data on national university science and technology parks from the 2015-2020 China Torch Statistical Yearbook. Three main areas of data are included: first, the age of university science and technology parks. This paper considers the number of years elapsed since the establishment of the university science and technology park to the time of the indicator statistics (*park_age*), and also focuses on the quadratic term of age (*park_agesq*) to explore the possible inverted U-shaped relationship. The second is the size of the university science and technology park. In this paper, we first consider the logarithm of the number of firms incubated in the previous year (*park_firms*) and use the logarithm of the total area of the incubation site (*park_area*) as a proxy for the size of the university science and technology park in the robustness test; third, the management capacity of the university science and technology park. Consider the proportion of graduate degree holders among the management staff (*park_staff*) and whether the park brings in returnees (*park_ros*).

Control variables. As there are many other important factors affecting the transformation of scientific and technological achievements in universities besides the characteristics of university science and technology parks, which can be summarized as the R&D strength, the ability to transform achievements and the financial strength of universities in general, this paper draws on previous studies and selects the following control variables: first, research and development staff (*uni_staff_r&d*), which are teaching and research staff who are engaged in research and development work accounting for more than 10% of their total teaching and research time. The second variable is internal expenditure on R&D funds, which includes government funds, funds entrusted by enterprises and institutions and foreign funds received by universities in the year; the third variable is the number of scientific and technological projects (*uni_proj*), which refers to the sum of horizontal and vertical research projects hosted by university researchers in the year. The above variables can reflect more comprehensively the basic scientific research capability, applied research capability, the level of supporting services for the transformation of scientific and technological achievements as well as the level of fund of universities, which can control the main factors affecting the efficiency of the transformation of scientific and technological achievements of universities.

3.3 Methods and models

This paper constructs three models (1)-(3) and uses least squares regression analysis, controlling for year fixed effects, for studying the relationship between the age, size and management characteristics of university science and technology parks and the efficiency of the conversion of university science and technology achievements.

$$Y_{it} = \beta_0 + \beta_1 park_age_{it} + \beta_2 park_agesq_{it} + \beta_3 \sum Z_{it} + \tau_t + \varepsilon_{it} \quad (1)$$

$$Y_{it} = \beta_0 + \beta_1 park_firms_{it} + \beta_2 park_firmsq_{it} + \beta_3 \sum Z_{it} + \tau_t + \varepsilon_{it} \quad (2)$$

$$Y_{it} = \beta_0 + \beta_1 park_staff_{it} + \beta_2 park_ros_{it} + \beta_3 \sum Z_{it} + \tau_t + \varepsilon_{it} \quad (3)$$

Where Y_{it} are the explanatory variables, indicating the efficiency of the transformation of scientific and technological achievements in universities, the $park_age_{it}$ and $park_agesq_{it}$ denote the age of the university science and technology park in the current period and its quadratic terms, and $park_firms_{it}$ and $park_firmsq_{it}$ denotes the number of incubatees in the university science and technology park in the current period and its quadratic term, and $park_staff_{it}$ denotes the proportion of employees with graduate degrees in the management organization of the university science and technology park in the current period, and $park_ros_{it}$ is a 0-1 variable indicating whether or not the management body of the science and technology park has returnees from abroad, and $\sum Z_{it}$ denotes a series of control variables, specifically indicating the factors in the university that may affect the transformation of scientific and technological achievements.

3.4 Descriptive statistics

Table 1 below shows the descriptive statistical results of the data used in this paper. The average age of the current national university science and technology parks in China is about 13 years, and about 27% of the employees in the university science and technology park management bodies have a postgraduate degree. In addition, the control variables indicate that the average annual R&D personnel invested in China's universities in recent years is 14,446, the average annual R&D expenditure is \$4.5 billion, and the average total number of topics conducted per year is approximately 33,639.

Table 1. Descriptive statistics

VARIABLES	N	mean	sd	min	max
<i>year</i>	186	2,018	1.712	2,015	2,020
<i>lnnum_license</i>	186	1.804	0.893	0	3.626
<i>lnlicensing_income</i>	186	2.838	1.237	0	4.761
<i>park_age</i>	186	12.97	5.016	0	21
<i>park_agesq</i>	186	193.2	112.5	0	441
<i>lnpark_firms</i>	186	2.235	0.589	0	3.274
<i>lnpark_firms2</i>	186	5.339	2.178	0	10.72
<i>lnpark_area</i>	186	4.887	1.035	0	6.172
<i>park_staff</i>	186	0.270	0.149	0	0.792
<i>park_ros</i>	186	0.522	0.501	0	1
<i>uni_staff_rd</i>	186	14,446	11,419	253	68,297
<i>uni_fund</i>	186	455,579	499,204	3,545	2.808e+06
<i>uni_proj</i>	186	33,639	26,157	966	122,153

4 Results

The empirical analysis of this paper was done using stata15 software and the results are shown in Table 2. The coefficient of the explanatory variable "park_age" in the model is 0.110, and it is significantly positive at 1% confidence level, which indicates that the

age of university science and technology park has a significant effect on the performance of university science and technology conversion. The coefficient of the explanatory variable "park_agesq" is -0.003, and it is negative at 10% confidence level, which further indicates that the age of university science and technology park has an inverted U-shaped effect on the performance of university science and technology conversion. Hypothesis 1 is verified.

Table 2. Regression results

VARIABLES	model(1) lnlicensing_income	model(2) lnlicensing_income	model(3) lnlicensing_income
<i>park_age</i>	0.110*** (2.71)		
<i>park_agesq</i>	-0.003* (-1.69)		
<i>lnpark_firms</i>		1.138*** (4.17)	
<i>lnpark_firms2</i>		-0.176** (-2.11)	
<i>park_staff</i>			0.995*** (2.68)
<i>park_ros</i>			0.329** (2.55)
<i>uni_staff_rd</i>	0.000*** (3.27)	0.000*** (2.73)	0.000** (2.55)
<i>uni_fund</i>	-0.000*** (-4.99)	-0.000*** (-3.93)	-0.000*** (-4.14)
<i>uni_proj</i>	0.000*** (6.83)	0.000*** (6.08)	0.000*** (6.45)
<i>Constant</i>	0.561** (2.44)	-0.149 (-0.53)	0.928*** (5.43)
<i>Observations</i>	186	186	186
<i>R-squared</i>	0.712	0.733	0.702
<i>F test</i>	0	0	0
<i>r2_a</i>	0.695	0.718	0.685
<i>F</i>	43.20	48.01	41.17

t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

The coefficient of the explanatory variable "lnpark_firms" in model (2) is 1.138, and it is significantly positive at 1% confidence level, which indicates that the size of university science and technology park has a significant effect on the performance of university science and technology conversion. The coefficient of the explanatory variable "lnpark_firms2" in model (2) is -0.176, and it is negative at 5% confidence level, which further indicates that the size of university science and technology park has an inverted U-shaped influence on the performance of university science and technology conversion. Hypothesis 2 is verified.

The regression coefficient of the explanatory variable "park_staff" in model (3) is 0.995, which is significant positive at 1% confidence level, and the coefficient of the explanatory variable "park_ros" in model (3) is 0.995. The coefficient of "park_ros" in model (3) is 0.329, and it is positive at 5% confidence level, which indicates that the ability of managers in university science and technology park has effect on the performance of university science and technology conversion.

5 Conclusion

In the context of promoting the high-quality development of university science and technology parks in the new era and accelerating the achievement of higher level of self-reliance and self-improvement, this paper analyzes the practical role and operation mechanism of university science and technology parks in terms of age, scale and management characteristics in promoting the performance of university science and technology achievement conversion. The main findings of this paper are as follows: Firstly, the age and scale of university science and technology parks have the mechanism to promote the performance of university science and technology achievement conversion, and the relationship with university science and technology achievement conversion is inverted U-shaped. Secondly, the ability of university science and technology park management personnel has a mechanism to promote the performance of university science and technology conversion, and their high education and overseas study experience have a significant positive effect on the performance of university science and technology conversion.

6 Reference

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