Subtheme: S5.2 Good practice, bad practice: learning from evaluations

Government role in supporting the commercialization of university research- From the perspective of Chinese government R&D investment

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Abstract: Triple helix theory stresses co-evolution and interaction among governments, enterprises and universities, and is paid great attention by governments, universities and enterprises worldwide. The role that governments play in the interaction between enterprises and universities has become a hot issue of Triple Helix theory. From this perspective, basing on provincial panel data of Chinese universities from 2004-2010, the impact of government R&D investment on patent technology transfer activities of Chinese universities is studied by empirical analysis. The study finds that the amount of government S&T funding and the number of 973 Program in one region have significantly increased the number and the revenue of patent technology transfer contracts in that region. Moreover, the number of National S&T Pillar Programs, 863 Program and National Natural Science Foundation Program are also determinants of the number of patent technology transfer contracts. This study not only enriches the researches on Triple Helix theory, but also provides a reference for decision-makers in governments, industries and universities in the practice of Triple Helix theory.

Keywords: Government; R&D investment; Chinese universities; Patent technology transfer; Triple Helix

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Keywords: Government; R&D investment, Chinese universities; Patent technology transfer; Triple Helix

1. Introduction

The concept of "Triple Helix" stresses the need for strengthening effective interaction among governments, enterprises and universities in order to achieve sustainable development of regional economy (Etzkowitz and Leydesdorff, 2000; Xu and Wu, 2006). Since its inception, it has been paid great attention by governments, universities, enterprises and academia worldwide. As a typical interaction channel of enterprise-universities, university patent technology transfer activities have drawn general attention from academia worldwide. Based on the Triple Helix Theory, although governments aren't direct players in university technology transfer activities, owing to the strong overlapping among governments, enterprises and universities, its role during the procedures of university patent technology

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transfer has become a hot issue with wide concern.

Nowadays, there are a large number of researches discussing the success factors of university technology transfer activities from the perspectives of universities' rules and regulations (Lach and Schankerman, 2008; Calderaa and Debandeb, 2010), characteristics of university technology transfer intermediaries (Belenzon and Schankerman, 2009; Calderaa and Debandeb, 2010), universities' characteristics (Lach and Schankerman, 2008; Belenzon and Schankerman, 2009; Yuan, 2009; Wu and Dong, 2010; Zhou and Zhu, 2007), R&D funding from enterprises on universities (Zhou and Zhu, 2007; Powers, 2004; Bolli and Somogyi, 2011) and enterprises characteristics (Powers, 2004). As for the impact of government R&D investment on patent technology transfer activities, only a few quantitative (Zhou and Zhu, 2007; Powers, 2004; Bolli and Somogyi, 2011)and qualitative researches (Salmenkaita and Salo, 2002; Vavakova, 2006; Tomes, 2003; Rasmussen, 2008)can be found. Although their methodologies may vary, these studies all points out the important influence of government R&D investment on university patent technology transfer activities. Taking some of the most active countries such as Finland(Salmenkaita and Salo, 2002), France(Vavakova, 2006), Switzerland(Bolli and Somogyi, 2011), U.K.(Tomes, 2003) and Canada (Rasmussen, 2008)as the examples, they not only invest heavily in education and research in general, but also launch several competing S&T projects (funds) to specifically fund university technology transfer activities. However, the current researches on the impact of government R&D investment on patent technology transfer activities are mainly focused on Western countries. Few researches are investigating this for Chinese universities and these researches are often qualitative (Liu, 2007; Chen., et al, 2007; Liu and Fu, 2010; Zhang and Liu, 2007). The few quantitative researches on Chinese universities' patent technology transfer are focusing on the characteristics of enterprises and universities, which are the direct players in the procedures of university technology transfer. However, according to the research of Chinese authors, the model of Chinese Triple Helix is quiet different from the models of Western countries (Niu and Xie, 2010). It is transforming from Etatistic model (government-led model) to Over-lapping model. Hence, in this transitional phase, the role that Chinese government is playing is assumed to be more important than the governments of Western countries. Therefore, the study of the impact of Chinese government R&D investment on the university patent technology transfer activities becomes a question with theoretical and practical significance.

From this perspective, the paper studies the impact of government R&D investment, including government S&T funding and government R&D projects, on patent technology transfer activities of Chinese universities. Based on Triple Helix theory and some relevant literatures, section 1 proposes some hypothesis about the impact of government S&T funding and S&T projects on the number of university technology transfer contracts and their revenue. Section 2 describes the methodology and the model used in the paper. Section 3 presents the research results and section 4 is an analysis and discussion. Section 5 checks for results' robustness. At last, section 6 concludes the paper.

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2. Theoretical background and research hypothesis

The “Triple Helix” theory was proposed by Etzkowitz and Loet in 2000. The theory argues that the overlap among governments, enterprises and universities is the core of innovation system. Interaction among these three players is the important determinant of knowledge production and dissemination. During this process, active interaction among these three players promotes the rising spiral of innovation. Thus, although government isn’t neither supply nor demand side of new knowledge and new technologies, it can promote effective enterprise-university interaction in order to facilitate university technology transfer by institutional arrangements, policy making and so on.

In general, there are two aspects of government R&D investment: one is government S&T funding which indirectly promote university technology transfer activities by supporting teaching and research activities of Chinese universities; the other is specialized government R&D programs (foundation) which directly support university technology transfer activities. Thus, based on the Triple Helix theory, government R&D investment, including government S&T funding and government S&T programs, can influence university patent technology transfer activities.

Currently, a large number of studies on universities in Western countries have shown government R&D investment has significant positive impact on university technology transfer activities. O'Shea et al (2005) found that university S&T funding from both industry and government for scientific and engineering disciplines can enhance university technology transfer activities. Landry et al (2007) studied the key factors for university technology transfer activities in Canada, and found significant positive correlation between S&T funding from government and industry with university knowledge transfer. Bolli and Somogyi (2011) also found that there was significant positive correlation between S&T funding and universities technology transfer activities. Rasmussen (2008) studied the impact of Canadian government on the commercialization of Canadian university research results. He pointed out that Canadian government greatly stimulated university technology transfer activities by establishing several projects for promoting university-industry cooperation. Lehrer and Asakawa (2004) strengthened the importance of governmental R&D programs reform for the performance of university research results commercialization by the case study of Japan and Germany. As for researches on Chinese universities, Zhou & Zhu (2007) studied 58 Chinese universities from 2000 to 2004, but they found the role of government S&T funding in commercial activities of Chinese universities was not significant. Considering the research duration of Zhou & Zhu (2007) is from 2000 to 2004, it almost coincides with the time the concept of "entrepreneurial university” and "triple helix" were firstly proposed. Ministry of S&T of China and Ministry of Finance of China also promulgated some relevant laws and regulations such as “Some Regulations on Intellectual Property Management of the National Research Programs’ Research Results” during this period. Therefore, at that time the government role is limited in pursuing patent technology transfer activities. Wu & Dong (2010) pointed out a negative correlation between university S&T funding and revenue of university technology transfer. However, if this negative correlation holds true in a larger

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database at national level and the impact of different S&T programs on university technology transfer activities deserve further studies. Therefore, the time period of this study is updated to 2004-2010 and the paper focuses on the impact of government R&D investment on university patent technology transfer activities.

In general, as for the indicators measuring university patent technology transfer activities, two are widely used (Fukugawa, 2009). One is the number of patent technology transfer contracts, representing the interests from enterprises in university patents, and can be seen as the early stage of university technology transfer process. The other is the revenue of patent technology transfer contracts, which represents real demand from enterprises for university patent. It can be seen as the middle and late stages of university technology transfer process. According to Triple Helix theory, the experience of western countries and actual situation of Chinese universities, some hypotheses can be made:

H1: Government S&T funding has a significant positive influence on the number of patent technology transfer contracts of Chinese universities

H2: Government S&T funding has a significant positive influence on the revenue of patent technology transfer contracts of Chinese universities

H3: The number of 973 program has a significant positive influence on the number of patent technology transfer contracts of Chinese universities

H4: The number of 973 program has a significant positive influence on the revenue of patent technology transfer contracts of Chinese universities

H5: The number of National Natural Science Foundation program has a significant positive influence on the number of patent technology transfer contracts of Chinese universities

H6: The number of National Natural Science Foundation program has a significant positive influence on the revenue of patent technology transfer contracts of Chinese universities

H7: The number of National S&T Pillar program has a significant positive influence on the number of patent technology transfer contracts of Chinese universities

H8: The number of National S&T Pillar program has a significant positive influence on the revenue of patent technology transfer contracts of Chinese universities

H9: The number of 863 program has a significant positive influence on the number of patent technology transfer contracts of Chinese universities

H10: The number of 863 program has a significant positive influence on the revenue of patent technology transfer contracts of Chinese universities

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2. Methodology

2.1 Sample and data sources

Considering that universities' merging basically happens in the same province, municipality and autonomous region, provincial level data can be used. All data are sourced from each year of "S&T Statistics Compilation of High Education" published by Science and Technology Department of Ministry of Education of China. 28 provinces, municipalities and autonomous

regions in the period 2004-2010 (196 in total) are selected to build provincial panel database. As universities in Tibet, Xinjiang and Qinghai only account for a tiny percent of all Chinese universities, and their technology transfer activities are far behind the national average, the paper excludes them.

2.2 Variables

Dependent variables are indicators of patent technology transfer performance. Following the western literatures, the number of patent technology transfer contracts (in items) and their revenue (in millions Yuan) are selected as dependent variables. In order to accurately estimate the impact of R&D investment on technology transfer activities of Chinese universities, according to the "China Statistical Yearbook" of National Bureau of Statistics of China, R&D funding and patent technology transfer revenue are deflated on the 2004 base.

As for the independent variables, two groups are selected. One group is the amount of government R&D funding (in billions Yuan), which includes general research expenses, special funding from administrative departments and R&D funding from non-administrative departments. Deflation of R&D funding is done according to the research of Zhu & Xu (2003) based on the "China Statistical Yearbook" of National Bureau of Statistics of China. The other independent variables group is the number of major national S&T projects (in items). According to "Science and Technology Statistics Report, issue 24" of Development and Planning Division of Ministry of Science and Technology in December 2009, 973 Program, National Science and Technology Pillar Program, 863 Program place much emphasis on the university-industry cooperation projects. Therefore, these three programs are selected as independent variables. Programs of the National Natural Science Foundation represent the highest level of scientific research, and patenting-licensing activities are also considered for programs acceptance. Therefore, it is also studied as independent variable.

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2.3 Regression models

To test the hypotheses in the paper, when dependent variable is the number of patent technology transfer contracts, as this variable is a discrete non negative integer, Poisson regression fits well. Then, specific model of Poisson regression shows as follow:

$$Log(Y_{it}^{'}) = \beta_0 + \beta_1 GOV_{it} + \beta_2 NBRP_{it} + \beta_3 NSF_{it} + \beta_4 NPP_{it} + \beta_5 NHT_{it} + \alpha_i + \varepsilon_{it} \quad (1)$$

When dependent variable is the revenue of patent technology transfer contracts, it is possible to choose between fixed and random effects panel data models. Then, specific model of panel data shows as follow:

$$Y_{it}^{''} = \beta_0 + \beta_1 GOV_{it} + \beta_2 NBRP_{it} + \beta_3 NSF_{it} + \beta_4 NPP_{it} + \beta_5 NHT_{it} + \alpha_i + \varepsilon_{it} \quad (2)$$

In model 1 and 2, the dependent variable Y_{it} attempts to measure the number of licensed patents ($Y_{it}^{'}$) or commercial value of inventions ($Y_{it}^{''}$) in region i at year t. Independent

variables GOV_{it} is the amount of government R&D funding in region i at year t. $NBRP_{it}$、NSF_{it}、NPP_{it} and NHT_{it} represent the number of 973 program, National Natural Science Research program, National S&T Pillar Program and 863 program and respectively. α_i represents the fixed effect from regional difference to avoid omitted variable bias.

3. Research results and analysis

3.1 Descriptive Statistics & Correlation Analysis

The descriptive statistics of each variables and the correlation analysis between government R&D investment and patent technology transfer activities of Chinese universities are shown in Table 1. It reveals the largest S&T program source for Chinese universities is 863 Program. 973 Program is the national S&T program with least participation from Chinese universities. In addition, the correlation coefficients among four major national S&T programs are between 0.31-0.56. Taking into account that all of them are scientific R&D programs, these correlation coefficients can explain that layout of Chinese national R&D projects is basically reasonable. From the National Natural Science Foundation program which focuses most on basic research to National S&T Pillar program which focuses most on research results commercialization, these 4 national R&D projects are scattered into various stages of scientific research results commercialization.

Table 1. Means, Standard Deviations and Pearson Correlation Coefficients of Variables

Variables	Mean	Std	1	2	3	4	5	6	7
1、$Y^{/}$	32.88	43.48	1.00						
2、$Y^{//}$	14.96	30.68	.56***	1.00					
3、GOV	8.33	10.47	.70***	.61***	1.00				
4、NBRP	6.68	11.62	.68***	.44***	.58***	1.00			
5、NSF	15.13	22.68	.51***	.33***	.60***	.54***	1.00		
6、NPP	10.44	14.46	.45***	.34***	.52***	.63***	.45***	1.00	
7、NHT	27.01	42.83	.60***	.49***	.77***	.72***	.52***	.79***	1.00

***P<0.01, **P<0.05, *P<0.1

3.2 Regression results

The paper uses Stata 10 to model and analyze the panel data. As for the impact of government R&D investment on the number of Chinese universities' patent technology transfer contracts, due to the loglikelihood comparison between Poisson random effect regression and Poisson

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fixed effect regression, fixed effect model of Poisson regression is selected in this section. As for the impact of government R&D investment on the revenue of Chinese universities' patent technology transfer contracts, after Hausman test, random effects model of panel data is selected. The regression results are shown in Table 2. The numbers in brackets represent the standard deviation of explanatory variables. In order to exclude the possibility of multicollinearity, Table 2 uses the method of introducing independent variables into the regression model one by one and observing the changes of independent variables' significance and coefficients.

Table 2. The Effect of Government R&D Investment on Patent Technology Transfer Contracts Number and Revenues

Variables	(1)		(2)		(3)		(4)		(5)	
	$Y^{/}$	$Y^{//}$	$Y^{/}$	$Y^{//}$	$Y^{/}$	$Y^{//}$	$Y^{/}$	$Y^{//}$	$Y^{/}$	$Y^{//}$
GOV	0.029***	1.753***	0.033***	1.552***	0.034***	1.682***	0.037***	1.691***	0.040***	1.753***
	(0.002)	(0.181)	(0.002)	(0.214)	(0.002)	(0.236)	(0.002)	(0.241)	(0.003)	(0.296)
NBRP			0.012***	0.329*	0.013***	0.403**	0.012***	0.444**	0.014***	0.474**
			(0.001)	(0.188)	(0.001)	(0.196)	(0.001)	(0.222)	(0.001)	(0.235)
NSF					-0.001*	-0.137	-0.001**	-0.134	-0.001**	-0.138
					(0.001)	(0.100)	(0.001)	(0.101)	(0.001)	(0.102)
NPP							0.002**	-0.069	0.004***	-0.021
							(0.001)	(0.163)	(0.001)	(0.207)
NHT									-0.001***	-0.037
									(0.001)	(0.096)

***P<0.01, **P<0.05, *P<0.1

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4. Discussion

The regression results support part of the theoretical hypothesis (H1, H2, H3, H4, H7), while some (H5, H6, H8, H9, H10) are not supported.

From models 1-5 of Table 2, it shows that the impact of government S&T funding has a significant positive influence on the number of local universities' patent technology contracts and their revenue at the level of 1% significance. These results support the model's hypothesis H1 and H2. The results are also consistent with the findings of Thursby and Kemp (2002), O'Shea et al (2005), Landry et al (2007), Siegel et al (2008). Although government often does not directly participate in the patent technology transfer activities between university and enterprises, it has significant impact. Two aspects can be used to explain the result. On one hand, the social contract among governments, enterprises and universities has evolved into a triple helix model (Etzkowitz and Leydesdorff, 2000). In order to effectively carry out R&D activities and establish industrial innovation system, strong interaction and collaborative relationship are formed among government, university and industry. Especially in Chinese context, government occupies a dominant position in the Triple Helix model. The impact of Chinese government on universities, enterprises and their interaction are greater than the Western counterparts. Thus, the influence of Chinese government is very significant. On the other hand, government S&T funding includes general research expenses, special funding from administrative department and R&D funding from non-administrative departments. All

these three types of S&T funding don't require matching funding from university or industry. So government funding is more conducive to carry out scientific research activities, which increase the number of new inventions and new technologies, thus eventually increasing the potential of university patent technology transfer eventually. From the point of view of Scott (1995), higher education can be seen as an institutional industry. Due to governmental continuous policies and funding inspiration, Chinese universities are more inclined to make full use of their new inventions and new technologies, and turn the potential of university patent technology transfer activities into high returns.

From Table 2, it also reveals that programs of National Natural Science Foundation have a significant negative influence on the number of university patent technology transfer contracts at the level of 5% significance. The theoretical hypothesis (H5) is not supported. Because the main goal of National Natural Science Foundation are funding basic research and some applied research, when the university researchers who are funded by NNSF choose between patenting-licensing and publishing the research results, many of them are inclined to publish them in academic society. Thus, patent technology transfer activities significantly decrease. 863 Program has a significant negative influence on the number of university patent technology transfer contracts and National S&T Pillar Program has a significant positive influence on the number of university patent technology transfer contracts both at the level of 1% significance. The theoretical hypothesis (H7) is tested and the theoretical hypothesis (H9) is not supported. These results may be explained in two aspects: on one hand, 863 Program and National S&T Pillar Program are the two programs with the highest percent of university-enterprise cooperation programs (Development Division of Ministry of Science and Technology of China, 2009). These two programs are always undertaken by both university and enterprise. Thus, as for the patents funded by these two programs, a large percent of patents is shared by university and enterprise. So there is no need for enterprise to sign license contracts with university. On the other hand, 863 Program and National S&T Pillar Program stress the practical application of research results. The research results of both programs have more direct commercial values. Part of them are transferred to industry rapidly after obtaining patent right. The regression results show that 863 Program has more cases of the former, which results in significant negative influence on the number of university patent technology transfer contracts, while National S&T Pillar Program has more case of the latter, which results in significant positive influence on the number of university patent technology transfer contracts. The impact of 973 Program on the number of university technology transfer contracts and their revenue is significantly positive at the significance level of 1% and 5%, respectively. The results support H3 and H4. It is attributed to the relatively low proportion of university-industry cooperation S&T programs. The aim of 973 Program is to strengthen original innovation (in the first three years of "Eleventh Five-Year" Plan university-industry cooperation R&D programs accounted for only 9.8% of all 973 Programs). But comparing with National Natural Science Foundation Program, 973 Program are relatively more inclined to commercialize the research results (Development Division of Ministry of Science and Technology of China, 2009). Thus, 973 Program promotes large quantities of new inventions and new technologies with commercial potential, and it isn't always involved in technology transfer contracts with enterprise in advance. So, research

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results of 973 Program are more inclined to be transferred by patenting-licensing. Hypothesis (H6, H8 and H10) are not supported. This means that these national programs are able to have significant influence during early stages of patent technology transfer, but they can't fully express their influence in middle and late stages. Many scholars (Thursby and Kemp, 2002; Siegel et al., 2008; Fukugawa, 2009; Caldera & Debande, 2010) study the technology transfer activities of public institutions in U.S., U.K., Japan, and Spain. They also mention the inconsistency between the number of patent technology transfer contracts and their revenue.

5. Robustness check

To further check the models' robustness and effectiveness, as for the impact of government R&D investment on the number of patent technology transfer contracts of Chinese universities, Poisson regression model with random effects (model 2), negative binomial regression with fixed effects (model 3), negative binomial regression with random effects (model 4) and OLS model (model 5) are all chosen for robustness check. Results are shown in Table 3.

Table3. Robustness Check of the Effect of Government R&D Investment on Patent Technology Transfer Contract Numbers

Variables	Y				
	Model 1	Model 2	Model 3	Model 4	Model 5
GOV	0.040***	0.040***	0.042***	0.046***	2.299***
	(0.003)	(0.003)	(0.007)	(0.007)	(0.325)
NBRP	0.014***	0.014***	0.017***	0.019***	1.839***
	(0.001)	(0.001)	(0.006)	(0.006)	(0.255)
NSF	-0.001**	-0.001**	-0.000	-0.000	0.027
	(0.001)	(0.001)	(0.003)	(0.003)	(0.113)
NPP	0.004***	0.004***	0.009**	0.011***	-0.034
	(0.001)	(0.001)	(0.004)	(0.004)	(0.230)
NHT	-0.001***	-0.001***	-0.003	-0.004**	-0.182*
	(0.001)	(0.000)	(0.002)	(0.002)	(0.108)

***P<0.01, **P<0.05, *P<0.1

These results verify all the conclusions of Table 2. All regression models have shown that government S&T funding and the number of 973 Program can significantly increase the number of university patent technology transfer contracts both at the level of 1% significance, indicating that the impact of these two on the number of university patent technology transfer contracts is very significant. 4 models reveal that the number of National S&T Pillar Program and 863 Program have significant positive and negative influence on the number of university patent technology transfer contracts respectively. Moreover, Poisson regression model with random effects also shows a significant negative impact of National Natural Science Foundation Program on the number of university patent technology transfer contracts, which is consistent with the results of Table 2.

As for the impact of government R&D investment on the revenue of patent technology transfer contracts of Chinese universities, fixed effects panel data model (model 7), OLS model (model 8), between estimator model (model 8), Polled FGLS model (model 10) are used to check the results of random effects panel data model (model 6). All regression results

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are shown in Table 4.

Table 4. Robustness Check of the Effect of Government R&D Investment on Patent Technology Transfer Contract Revenues

Variables	$Y^{//}$				
	Mode 6	Model 7	Model 8	Model 9	Model 10
GOV	1.753***	0.880*	1.801***	2.245**	1.753***
	(0.296)	(0.468)	(0.289)	(0.932)	(0.317)
NBRP	0.474**	0.373	0.475**	0.530	0.474*
	(0.235)	(0.284)	(0.227)	(0.479)	(0.273)
NSF	-0.138	-0.084	-0.141	-0.185	-0.126**
	(0.102)	(0.113)	(0.101)	(0.270)	(0.051)
NPP	-0.021	-0.273	-0.003	0.184	-0.049
	(0.207)	(0.244)	(0.204)	(0.554)	(0.210)
NHT	-0.037	-0.055	-0.040	-0.170	-0.026
	(0.096)	(0.101)	(0.096)	(0.337)	(0.073)

***P<0.01, **P<0.05, *P<0.1

These results can support all the conclusions of Table 2. All five regression models show the significant positive effect of government S&T funding on the revenue of university patent technology transfer contracts. Model 7, model 8 and model 10 reveal the significant positive impact of 973 Program on the revenue of university patent technology transfer contracts. Moreover, Table 4 shows National S&T Pillar Program and 863 Program don't have significant influence on the revenue of university patent technology transfer contracts, which verifies the results of Table 2. As for the hypotheses not verified by Table 2, model 10 points out the significant negative influence of National Natural Science Foundation Program on the revenue of university patent technology transfer contracts.

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6. Conclusion

The impact of government R&D investment on patent technology transfer activities of Chinese universities is studied in the paper. Through provincial data within the period 2004 -2010, empirical research is done to analyze the influence of government S&T funding and different national government S&T projects on university technology transfer activities. The hypotheses are proposed based on theoretical analysis and are tested by regression models. Then the regression results are analyzed and rechecked. The main research results are as follows:

(1) Government R&D investment on universities in one region has an important influence on university patent technology transfer activities in the same region. But owing to the different nature and source of various R&D investments, their influences on patent technology transfer activities are not always the same. Government S&T funding and 4 national government S&T programs can significantly influence the number of university patent technology transfer contracts. The revenue of university patent technology transfer contracts only depends on the government S&T funding and 973 Program.

(2) Government S&T funding of one region has a significant positive impact on university patent technology transfer activities in that region, from the perspectives of both the number of university patent technology transfer contracts and their revenue. Therefore, government should increase S&T funding on Chinese universities and fully exploit its role

in university patent technology transfer activities. Through strengthening university-enterprise active interaction, high efficiency of university patent technology transfer activities can be achieved.

(3) 973 Program has significant positive impact on the number of university patent transfer contracts and their revenue in that region. The number of National S&T Pillar Program in one region can significantly increase the number of university patent transfer contracts. The number of 973 Program and National Natural Science Foundation Program significantly decrease the number of university patent transfer contracts. Therefore, as for the national S&T programs which focus on research and innovation such as 973 Program and National Natural Science Foundation Program, government should not only increase the number of these two programs, but also encourage university researchers to perform technology transfer activities. As for the national S&T programs which focus on commercialization of research results such as 863 Program and National S&T Pillar Program, government should enhance university researchers' awareness of IPR protection. Based on patent protection of research results, patenting-licensing can be used for university technology transfer activities.

References

Belenzon, S., Schankerman, M (2009). University knowledge transfer: private ownership, incentives, and local development objectives. Journal of Law and Economics, 52 (1): 111-144

Bolli T., Somogyi F (2011). Do competitively acquired funds induce universities to increase productivity? Research Policy, 40 (1): 136-147

Calderaa A., Debandeb O (2010). Performance of Spanish universities in technology transfer: An empirical analysis. Research Policy, 39 (9): 1160-1173

Chen H Q. Song Z Q, Yang M (2007). The analysis and study on the status of Chinese university licensing activities. R&D Management, (4): 101-106(in Chinese)

Development Division of Ministry of Science and Technology of China. Science and Technology Statistics Report (2009), [EB/OL]. http://www.most.gov.cn/kjtj/tjbg/201003/P020100316383104438789.pdf, 2009-12-24

Etzkowitz H., Leydesdorff L (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university-industry-government relations. Research Policy, 29 (2): 109 - 123

Friedman, J., Silberman, J (2003). University technology transfer: do incentives, management and location matter? Journal of Technology Transfer, 28: 17-30

Fukugawa N (2009). Determinants of licensing activities of local public technology centers in Japan. Technovation, 29 (12): 885-892

Lach, S., Schankerman, M (2008). Incentives and inventions in universities. The Rand Journal of Economics, 39(2): 403-433

Landry, R., Amara, N., and Ouimet, M (2007). Determinants of Knowledge Transfer: Evidence from Canadian University researchers in Natural Sciences and Engineering. Journal of Technology

Unregistered

Transfer, 32 (6): 561 -592
Lehrer, M. and K. Asakawa (2004). Rethinking the public sector: idiosyncrasies of biotechnology commercialization as motors of national R & D reform in Germany and Japan. Research Policy, 33: 921-938
Liu Y (2007). The development of Chinese university technology transfer. China Science and Technology Forum, (3): 99-104(in Chinese)
Liu Z Z, Fu Z H (2010). The factors of local universities' technology transfer. Scientific Management, 2010, 28 (3): 26-29(in Chinese)
Niu P Q., Xie F J (2010). A study of knowledge ba se on economy in our country's three large economic regions. Studies in Science of Science, 28(2): 221-226
O'Shea et al (2005). Entrepreneurial orientation, technology transfer and spinoff performance of US universities. Research Policy, 34 (7): 994-1009
Powers J B (2004). R & D Funding Sources and University Technology Transfer: What Is Stimulating Universities to Be More Entrepreneurial?. Research in Higher Education, 45 (1): 1-23
Rasmussen E (2008). Government instruments to support the commercialization of university research: Lessons from Canada. Technovation, 28 (8): 506-517
Salmenkaita, J.-P., Salo, A (2002). Rationales for government interventions in the commercialization of new technologies. Technology Analysis & Strategic Management, 14 (2): 183–200
Siegel D., Wright M., Chapple W., Lockett A (2008). Assessing the relative performance of university technology transfer in the US and UK: a stochastic distance function approach. Economics of Innovation and New Technology, 17 (7-8): 717-729.
Thursby J., Kemp S (2002). Growth and productive efficiency of university intellectual property licensing. Research Policy, 31: 109-124
Tomes, A (2003). UK government science policy: the 'enterprise deficit' fallacy. Technovation, 23(10): 785–792
Tu J., Wu G. (2006). Triple Helix model and its application in China. Research Management, 27(3):75-80
Vavakova, B (2006). Reconceptualizing innovation policy. The case of France. Technovation, 26 (4): 444–462
Wu F, Dong Z Y (2010). The determinants and empirical analysis on technology transfer of high educations. Science and Technology Progress and Policy, 27 (10): 137-140(in Chinese)
Yuan C H., et al (2009). The impact of Chinese university institutionalism on university knowledge transfer: an analysis based on resource-based view. Science of Science and Technology Management, (7): 134-138
Zhang Y H, Liu L Q (2007). The role of patent in university technology transfer-based on the interface theory. R&D Management, (5): 95-99(in Chinese)
Zhou F H, Zhu X Z (2007). Resource factors and university technology transfer performance. R&D Management, 19 (5):87-94(in Chinese)
Zhu P F, Xu W M (2003). Government's science and technology policies on the R&D investment and patent activites of large and medium-sized of industrial enterprises-An empirical Study of Shanghai. Economic Research, (6): 45-52(in Chinese)
UnRegistered