
Individual and organizational factors affecting faculty technology transfer*

Lee Jaeheon**, Lee Seongsang***, Cho Keuntae****

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** Department of Management of Technology, Sungkyunkwan University.

*** Department of Intellectual Property, Mokwon University.

**** Corresponding author, Department of Management of Technology, Sungkyunkwan University.

초 록

The role of faculty is critical to university-industry technology transfer. Also, faculty motivation to engage in entrepreneurial activities is inevitably influenced by the system, policies, and environment of university to which the faculty belong. This study analyzes empirically the importance and effects of two sets of factors (the individual contexts and the organizational contexts) in faculty's technology transfer activities. A data set from 475 faculty members and 84 universities to which they belong is studied.

The results show that overall both the characteristics of faculty members and the characteristics of universities influence faculty technology transfer. In the individual contexts, a faculty member's research capability and commercial orientation have a significant impact on faculty technology transfer. In the organizational contexts, faculty members in the universities which market their technologies more actively and have a searchable technology DB are highly likely to make performance in technology transfer. This study shows that we can better understand the differences among faculty members in their technology transfer performance by considering the characteristics of universities to which they belong as well as the faculty's characteristics.

주제어

Technology transfer, Royalty revenue, Faculty characteristic, University characteristic, Entrepreneurial activity

I . Introduction

Universities and faculties are expected to contribute to the development of industries and local communities using their inventions and technologies. Although there are concerns about universities experiencing a cultural and institutional transformation to become the entrepreneurial entities, there clearly is a societal advantage when universities and faculties strive to strengthen their association with industries and seek the market that would optimize the value of their inventions and technologies. Among various forms of entrepreneurial activities that are being carried out by universities, technology transfer has a special significance in that it not only brings monetary rewards but also creates benefits for the general public through technology diffusion.¹⁾

The role of faculty is critical to university-industry technology transfer. Faculty researchers are making key decisions that affect the outcome of the technology transfer process.²⁾ The faculty not only produce inventions but also play an important role in transferring the inventions to an industry or developing them commercially.³⁾ Many theoretical and empirical studies identified that demographic characteristics of faculty such as age, gender, reputation, experience in industry, and faculty

1) In the research of Thursby et al.(2001), unlike the private sector which is interested in the profit through technology transfer, universities are expected to contribute to economic development as well as royalty income.

2) Renault, C. S., "Academic capitalism and university incentives for faculty entrepreneurship", *The Journal of Technology Transfer*, Vol.31 No.2(2006).

3) Thursby, J. G. et al., "Objectives, characteristics and outcomes of university licensing: A survey of major US universities", *The Journal of Technology Transfer*, Vol.26 No.1-2(2001); Lach, S. & Schankerman, M., "Incentives and invention in universities", *The RAND Journal of Economics*, Vol.39, No.2(2008).

quality affect their engagement in entrepreneurial activities such as technology transfer. In the university context, the decision to engage entrepreneurial activities is primarily taken on an individual level.⁴⁾ However, faculty motivation to engage in entrepreneurial activities is inevitably influenced by the system, regulations, and environment of university to which the faculty belong. This makes it necessary to consider simultaneously the characteristics of faculty members and the characteristics of universities to which they belong. Nevertheless, only a few studies analyzed the factors related to organizational context along with the features of individual faculty members as determinants of faculty's entrepreneurial activities such as technology transfer.

The fundamental hypothesis of this study is that characteristics of both faculty members and their universities affect the faculty involvement and performance in technology transfer. This study analyzes empirically the importance and effects of two sets of factors (the individual contexts and the organizational contexts) in faculty's technology transfer activities using a data set of 475 faculty members and 84 universities to which they belong. This paper is organized as follows. Section 2 briefly reviews previous studies that analyzed the factors affecting faculty's entrepreneurial activities with an emphasis on technology transfer, and discusses the analytical framework of this study. Section 3 describes the data and variables. We provide our main findings in Section 4, and conclude in Section 5.

4) Perkmann, M. et al, "Academic Engagement and Commercialisation: A Review of the Literature on University-Industry Relations", *Research Policy*, Vol.42 No.2(2013).

II. Background and analytical framework

Many previous empirical studies which looked at the factors influencing faculty entrepreneurial activities (e.g. spin off, technology transfer, patent with industry, collaborative research, consulting) focused primarily on the faculty's demographic characteristics such as age, gender, reputation, experience in industry, and faculty quality.

Individual characteristics play an important role in predicting academic engagement such as collaborative research, contract research, and consulting.⁵⁾ Louis et al. (1989) showed that faculty members' characteristics and attitudes are the most important predictors of their involvement in large-scale scientific research (externally funded) and that faculty members involved in consulting generate more publications than their non-consulting colleagues. Thursby and Thursby (2011) found that faculty age and tenure affect funding from the government and industry. According to Link et al. (2007), male and tenured faculty members are more likely to engage in three types of informal university technology transfer—knowledge transfer, joint publications with industry scientists, and consulting. Similarly, Azagra-Caro (2007), Boardman (2008) and Giuliani et al. (2010) found significant gender effects in academic engagement with men more likely to engage formal and informal interactions with industry. However, faculty's age has an ambiguous effect.

With respect to invention disclosure and patent, there is some evidence that individual characteristics of faculty have an impact. Allen et al. (2007)

5) Perkmann, M. et al., "Academic Engagement and Commercialisation: A Review of the Literature on University-Industry Relations", *Research Policy*, Vol. 42 No. 2 (2013).

found that older male faculty members with tenure are more likely to patent in industry than younger female faculty members without tenure. There are several studies⁶⁾ that found the differences between male and female researchers in patent performance. Thursby and Thursby (2011) examined invention disclosure as a measure of faculty participation in licensing and showed that recent and repeated disclosures increased the faculty member's publication count and number of citations. They also found that faculty age and tenure affect the rate of publication. Thursby and Thursby (2005) also found significant gender effects in disclosures with men more likely to disclose.

Technology transfer is one of the most important entrepreneurial activities of the faculty. And previous literatures indicate that faculty's characteristics are largely related to technology transfer. Bercovitz and Feldman (2011) analyzed relationship between the composition of academic scientists and academic commercialization such as patents, licenses and royalties. They found the experience of team leaders and diverse external networks have a positive and significant effect on commercial outcomes. Previous studies linking an individual faculty member's features to technology transfer activities, as measured by the direct results of technology transfer such as the number of licenses and the amount of revenues from licensing, were mostly conducted at a university level rather than at an individual level. For example, Fukugawa

6) Whittington, K. B. & Smith-Doerr, L., "Gender and commercial science: Women's patenting in the life sciences", *The Journal of Technology Transfer*, Vol.30 No.4(2005); Frietsch, R. et al., "Gender-specific patterns in patenting and publishing", *Research Policy*, Vol.38 No.4(2009); Ding, W. W. et al., "Gender differences in patenting in the academic life sciences", *Science*, Vol.313(5787)(2006); Stephan, P. E. et al., "Who's patenting in the university? Evidence from the survey of doctorate recipients", *Econ. Innov. New Techn.*, Vol.16 No.2(2007).

(2009) examined the factors facilitating licensing activities of the local public technology centers in Japan and found that the scientists' understanding of firms' technological needs affects both number of patent licenses and license revenue. Chukumba and Jensen (2005) also analyzed the factors affecting the technology transfer performance of 110 universities using the AUTM data. They found that the quality of engineering faculty as inventor is positively related to licensing to both start-ups and established firms. Similar results pointing to the positive relationship between faculty quality and involvement in commercialization activities of university were found by Di Gregorio and Shane (2003), Powers (2003) and O'Shea et al. (2005).

The system, regulations, and the environment of universities to which faculty belong have a major influence on the faculty's entrepreneurial activity. Bercovitz and Feldman (2004) focused on the institutional effects. They found that the medical school researchers' propensity to file invention disclosures is influenced by norms of the institutions where the researchers were trained and disclosure behaviors of their department chairs and peers. Xie and Shauman (2003) argued that if the differences in available resources such as space, equipment, and time are taken into account, productivity difference between male and female scientists is negligible. University's incentive system related to its faculty's entrepreneurial activities can be regarded as a factor which has a direct influence on the faculty's motivation and willingness to do entrepreneurial activities. For example, Belezon and Schankerman (2009) showed that monetary incentives for university inventors increase the average quality of inventions. Lerner and Wulf (2007) also showed that relatively longer-term incentives are associated with more heavily cited patents and patents of greater originality.

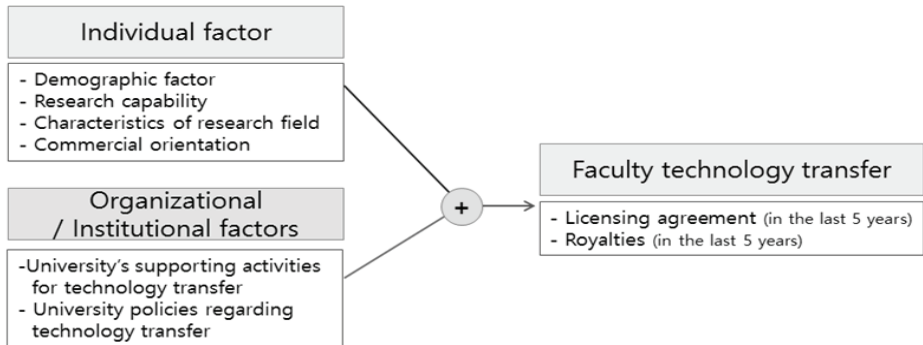
Giuliani et al. (2010) considered the characteristics of organizational contexts along with the researchers' demographic characteristics, educational background, publication performance and reputation as the factors influencing the formation of university-industry linkages in wine sector. They found that demographic characteristics, such as age and sex, as well as institutional specificity are related to the propensity to form university-industry linkages. Stephan et al. (2007) considered the characteristics of university along with faculty member's characteristics such as gender, research field, and tenure as factors that affect the number of faculty's patent applications. Their analysis revealed that the patenting culture and effectiveness of the university TTO (Technology Transfer Office) affect the number of patent applications as do the demographic characteristics of the faculty member. Renault (2006) showed that some institutional policies, notably revenue splits as well as the beliefs of professors about the proper role of universities in commercializing technology and academic quality are critical factors in faculty's entrepreneurial behavior including patenting and spinning off companies. Chang et al. (2009) examined the effects of organizational factors (institutional legitimacy and organizational supports) along with individual factors (personal entrepreneurial capabilities and personal networking) on faculty's patent grants, license agreements and spin-offs. They found both types of factor are complementary in patenting and licensing.

[Table 1] Two sets of factors affecting faculty's entrepreneurial activities

	Faculty's entrepreneurial activities	
	Academic engagement (collaborative/contract research, consulting)	Research commercialization (patenting, technology transfer, spin off)
Individual factors	Louis et al.(1989) Thursby & Thursby(2011) Link et al.(2007) Azagra-Caro(2007) Boardman (2008) Giuliani et al.(2010)	Thursby & Thursby(2005) Whittington & Smith-Doerr(2005) Ding et al.(2006) Allen et al.(2007) Stephan et al.(2007) Frietsch et al.(2009) Thursby & Thursby (2011) Bercovitz & Feldman(2011)
(Individual +) Organizational factors	Giuliani et al.(2010)	Bercovitz and Feldman(2004) Renault(2006) Stephan et al.(2007) Belezon & Schankerman(2009) Chang et al.(2009)

In summary, faculty members' individual characteristics and institutional specificity may affect the faculty's entrepreneurial activities. However, to our knowledge, only a few studies analyzed the influence of both factors simultaneously. Especially, in the studies which analyzed technology transfer performance as a type of entrepreneurial activities, only a few studies analyzed the factors related to organizational context along with the features of individual faculty members as determinants of faculty's entrepreneurial activities. In this study, we examine at the individual level the influence of the characteristics of both faculty members and their universities on technology transfer activities. We exploit a unique database of technology transfer and royalty revenue of 475 faculty members at 84 universities over a five-year period to empirically analyze the importance and effects of two sets of factors in faculty's technology transfer activities.

〈Figure 1〉 Analytical framework of factors affecting faculty technology transfer



III. Data and variables

1. Data collection

The purpose of this study is to analyze the impact of the characteristics of faculty members and their universities on the faculty's technology transfer activities. Firstly, we use the data sets and variables on the following characteristics of faculty members that may affect the faculty's technology transfer activities: a faculty member's demographic factors, research capability, commercial orientation, and the characteristics of research field. The data used in this study are collected by the survey conducted in October 2012 on the faculty members who participated in national R&D programs. The survey includes the faculty's cognition and current status of activities related to collaborative research with the firms, technology transfer and business start-up. After the elimination of the responses with missing values, our data set contains 475 respondents out of 502 faculty members who answered the survey. For information on a

faculty member's technology transfer performance and number of patent applications and research papers in the recent five years, we use data from the National Research Foundation of Korea. In order to measure the research capability of a researcher more accurately, we calculated the number of patents and articles by multiplying them by the contribution rate of each faculty member.

And secondly, as measures of the characteristics of universities that could affect the faculty's technology transfer performance, we use the data and variables on the university's technology transfer support programs and university policies regarding technology transfer. The data on the universities' characteristics are based on the Survey on Technology Transfer and Commercialization of Public Research Institutions. This survey is carried out each year on about 275 universities and research institutions. As the response rate is over 90% each year, it is possible to review the current status and result of technology transfer activities of Korea's universities and public research institutions. The data set used in our analysis contains 475 faculty members of 84 universities.

2. The variables

A dependent variable takes the value of 1 if a faculty member participated in the technology transfer to a private firm over the last 5 years (2007-2011) and 0 otherwise. Another dependent variable assumes the value of 1 if a faculty member received royalty revenue from technology transfer over the last 5 years (2007-2011) and 0 otherwise. As shown in Table 3, out of 475 faculty members in our data set 70 faculty members carried out technology transfer in the recent 5 years (14.7% of all faculty members in our data set) and 56 faculty members (11.8%) received

the revenue from technology transfer.

The explanatory variables used in this study include 15 variables representing 6 factors that potentially affect the faculty's technology transfer performance (4 characteristics of faculty members and 2 characteristics of universities) and a control variable (indicator for public university). For a faculty member's demographic factor, age and age squared are included. To analyze the relationship between a faculty member's research capability and technology transfer performance, we use the number of patent applications and SCI research papers by a faculty member in the recent 5 years as a measure of faculty's research capability. Particularly, to obtain a more accurate measure of the faculty's research capability, we multiplied the number of patent applications and research papers by the faculty member's rate of contribution in each category.

We include faculty's commercial orientation as another factor because a commercially oriented faculty member is more likely to participate actively in technology transfer activities. As a measure of a faculty member's commercial orientation, we use the variables that reflect a faculty member's experience in university-industry joint research, business start-up, and technology marketing. For the extent to which a faculty member participates in technology marketing activities, we use a dummy variable which equals 1 if a faculty member acknowledges that faculty needs to cooperate in finding demand for technology and creating marketing materials. Lastly, for the characteristics of a faculty member's current research field, we differentiate the basic research from the applied research and include a variable reflecting the extent of technology convergence on a 5-point scale.

To examine the impact of university characteristics on its faculty member's technology transfer activities, we include the interesting

variables related to two sets of university characteristics. As for the variables that represent how actively a university supports technology transfer, we use the number of technology marking events by a university and the frequency with which a university outsources technology transfer to an external institution. The external institutions refer to domestic and international firms (banks and investment institutions), patent (technology) consulting firms, and professional technology transfer institutions (including technology marketing firms).

We also include a variable representing whether a university has their own technology DB which can be searched by an external firm or potential technology buyer. Three variables that represent the university policies regarding technology transfer are used, and each of the three variables corresponds to a different incentive influencing the technology transfer activities. First variable used is the university policy regarding the amount of compensation (calculated as a fixed proportion of the amount of technology revenue generated) paid to a researcher (an inventor) when the technology revenue occurred. A percentage of technology revenue paid to a researcher as compensation varies depending on the amount of the technology revenue generated, and we calculate the compensation assuming the technology revenue of \$40,000. A second variable is the weight with which technology transfer activity is taken into account in the evaluation of a researcher's performance. This variable is calculated as a percentage with the weight of a researcher's submission of SCI-level research papers in his performance score set at 100. Third variable measures whether a TTO staff member's contribution to a technology transfer is counted towards the evaluation of his performance. Lastly, we use a dummy for public university as a control variable to differentiate public university from private university.

[Table 2] Definitions of variables

Variables	Definition and measurement
〈Individual contexts〉	
-Demographic factor-	
Sex	male=1, female=0
Age (age and age squared)	Age of a faculty member
-Research capability-	
Number of patent applications in the last 5 years	Number of patent applications by a researcher multiplied by the researcher's contribution rate
Number of SCI research papers in the last 5 years	Number of SCI research papers by a researcher multiplied by the researcher contribution rate
-Characteristics of research field-	
Characteristics of research field	Applied research=1, basic research=0
Extent of technology convergence	Measured on a 5-point scale with 1 being the extent of technology convergence being very low and 5 being very high
-Commercial orientation-	
Experience in industry-university joint research	Has experience=1, No experience=0
Experience in business start-up	Has experience=1, No experience=0
Participation in technology marketing activities	A researcher acknowledges the need for active cooperation in finding demand for technology and creating technology marketing materials=1 otherwise=0
〈Organizational contexts〉	
-University's supporting activities for technology transfer-	
Technology marketing events	Number of marketing events such as publication of online newsletters, booklets, etc.
Outsourcing technology transfer activities to an external institution	Number of cases in which university outsourced technology transfer activities to an external institution
Searchable technology DB	Whether university has a technology DB in which external firms can search for detailed information about the university's technologies
-University policies regarding technology	

transfer-	
Distribution of revenues from technology transfer to a faculty member (inventor)	Distribution of revenues from technology transfer to a faculty member (inventor) assuming the technology revenue of \$40,000
Evaluation of a faculty member's technology transfer performance	The weight of technology transfer performance in the evaluation of a researcher's overall performance.
Evaluation of the performance of a TTO member who contributed to technology transfer	Whether a TTO staff member's contribution to technology transfer is considered in evaluation of his performance
-Control Variables-	
University type	Public university=1, Private university=0

The descriptive statistics of the variables used in our analysis are presented in Table 3. Table 4 describes the relationships among the explanatory variables used in our analysis.

[Table 3] Statistical summary of variables

Variables	Mean	Std. Dev.	Min	Max
Licensing agreement (in the last 5 years)	0.1473	0.3548	0	1
Royalties (in the last 5 years)	0.1178	0.3228	0	1
age	49.4821	6.8655	35	68
sex	0.8989	0.3017	0	1
Number of patent applications (in the last 5 years)	1.7589	3.9065	0	30.35
Number of SCI research papers (in the last 5 years)	4.7038	4.7835	0	33.414
Characteristics of research field	0.6105	0.4881	0	1
Extent of technology convergence	3.3242	0.9301	0	5
Experience in industry-university joint research	0.6336	0.4881	0	1
Experience in business start-up	0.0863	0.2811	0	1
Participation in	0.16	0.3669	0	1

technology marketing activities				
Technology marketing events	26,0715	61,0137	0	300
Searchable technology DB	0,5031	0,5005	0	1
Outsourcing technology transfer activities to an external institution	10,3221	22,0355	0	160
Distribution of revenues from technology transfer to a faculty member (inventor)	63,383	11,950	50	90
Evaluation of a faculty member's technology transfer performance	49,8058	56,1418	0	300
Evaluation of the performance of a TTO member who contributed to technology transfer	0,3410	0,4745	0	1
Public Univ.	0,4	0,4904	0	1

[Table 4] Correlation matrix of variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) age	1															
(2) age squared	0,9970*	1														
(3) sex	0,0908*	0,0882	1													
(4) Number of patent applications in the last 5 years	0,1115*	0,1069*	0,0641	1												
(5) Number of SCI research papers in the last 5 years	0,1953*	0,1935*	0,0989*	0,3965*	1											
(6) Characteristics of research field	0,0074	0,0692	0,0760	0,2007*	0,0222	1										
(7) Extent of technology convergence	0,0102	0,0152	0,0493	0,2339*	0,1326*	0,2694*	1									
(8) Experience in industry-university joint research	0,1076*	0,1095*	0,0930*	0,2341*	0,0935*	0,3426*	0,1854*	1								
(9) Experience in business start-up	0,0582	0,0556	0,0284	0,0662	0,0652	0,1686*	0,1187*	0,1403*	1							
(10) Participation in technology marketing activities	0,1251*	0,1241*	0,0130	0,0258	0,0294	0,1955*	0,0949*	0,1173*	0,0908*	1						
(11) Technology marketing events	0,0014	-0,0005	0,0372	0,0264	0,0740	0,0016	0,0567	0,0185	-0,0197	0,0283	1					
(12) Technology DB	0,0404	0,0387	0,0301	0,0932*	-0,0029	0,0698	0,0431	0,0398	0,0056	0,0317	0,2856*	1				
(13) Outsourcing technology transfer activities	-0,0408	-0,0386	0,0265	0,0534	0,0751	0,0421	0,0269	-0,0323	0,1351*	0,0502	0,1006*	0,0042	1			
(14) Distribution of revenues from technology transfer to an inventor	-0,0980*	-0,1049*	-0,0624	-0,0742	-0,0859	-0,0008	-0,0571	-0,0514	0,0215	0,0375	0,0865	0,0551	-0,0121	1		
(15) Evaluation of a faculty member's technology transfer performance	0,0085	0,0078	0,0608	-0,0121	-0,0531	-0,0362	-0,0579	-0,0049	0,0297	0,0194	0,0463	0,3352*	0,0476	0,0611	1	
(16) Evaluation of the performance of a TTO member	-0,0169	-0,0136	0,0497	0,0871	0,0538	0,0282	0,0501	0,0861	-0,0946*	0,0131	-0,0152	0,0754	0,2477*	-0,1555*	-0,0169	1
(17) Public Univ.	0,1011*	0,1062*	0,1027*	-0,0469	0,0008	0,0441	0,0157	-0,0749	0,0551	0,0188	0,1029*	0,1496*	-0,0299	-0,1745*	0,2006*	-0,1070*

* Significant at 0,05; Pearson correlation.

IV. Empirical results

Result of our analysis is presented in Table 5 and Table 6. Summing up the results of Table 5 and Table 6, we found that overall both the characteristics of a faculty member and the characteristics of a university to which the faculty member belongs influence faculty technology transfer. In the individual contexts, a faculty member's research capability and commercial orientation have a significant impact on faculty technology transfer. In the organizational contexts, faculty members in the universities which market their technologies more actively and have a searchable technology DB for potential licensee are highly likely to make performance in technology transfer.

As found in existing literature, there is a close association between a faculty member's capability and technology transfer performance whether the technology transfer performance is measured at an individual level or at a university level. This study used the number of research papers and patent applications as measures of faculty's capability, and found in all analyses that the number of patent applications (multiplied by the researcher's contribution rate) has an impact on faculty's technology transfer performance. While the previous studies often used the number of SCI research papers as a measure of a faculty member's research capability, we found a larger effect of a faculty member's research capability on technology transfer performance when the research capability is measured by the number of patent applications than by the number of research papers. The reason is that a large number of patent applications is associated with a high quality of faculty and also indicates that university (or the faculty) has its own technology which can potentially

lead to the creation of licenses and revenues arising from the licenses. It is in the same sense that many previous studies such as Thursby and Thursby (2011) used faculty patenting or invention disclosures as a measure of faculty's engagement in technology transfer.

As for the faculty's commercial orientation factors, as in the previous studies, the faculty's industry-university joint research experience was found to have a statistically significant positive effect on their technology transfer performance. A faculty member with an industry-university joint research experience has a better understanding of firms' technological needs than a faculty member without such experience. And this result shows that the university-industry linkages built through the joint research can be utilized as an important channel of technology transfer. On the other hand, the faculty member's participation in technology marketing activities and experience in business start-up have positive but statistically insignificant effects on faculty's technology transfer performance in the model specifications except column (2). No significant effects may have been found because a faculty member's business start-up or engagement in technology marketing is not prevalent.

In the specification that includes only the characteristics of faculty members (the individual contexts) as explanatory variables, as found in Allen et al.(2007) and Link et al.(2007), male faculty was more likely to participate in technology transfer activities, but the relationship was statistically insignificant in the specification which includes the characteristics of university (the organizational contexts) as well. Likewise, age does not have a significant effect on technology transfer activities. Similar results pointing to the no relationship between age and engagement in entrepreneurial activities were found by a number of other studies.⁷⁾

Regarding the effects of the characteristics of the university to which a faculty member belongs, university's supporting activities for technology transfer are positively correlated with faculty's technology transfer. Faculty members in the universities which market their technologies more actively through online newsletters and booklets are highly likely to make performance in technology. Also, in all specifications, whether the university has searchable technology DB which can be utilized by external potential technology buyer for detailed information about its technology was found to have significant effect on faculty member's technology transfer performance. These results support the basic hypothesis of this study that both the characteristics of faculty members and the characteristics of universities to which they belong affect the faculty technology transfer. In addition, the results imply that we can better explain the differences among faculty members in their technology transfer performance by considering the support programs, policies, environment regarding technology transfer of universities to which they belong as well as the faculty's demographic characteristics, commercial orientation and faculty quality.

On the other hand, in terms of university policies regarding technology transfer, distribution of royalty revenues to a faculty member has a significantly positive impact on faculty technology transfer as measured only by royalties in the last 5 years, and no other factors are associated with a significant influence. It is necessary to consider that although the university's incentive schemes regarding the faculty's entrepreneurial

7) Boardman, P. C. & Ponomarev, B. L., "University researchers working with private companies", *Technovation*, Vol.29 No.2(2009); Gulbrandsen, M. & Smeby, J. C., "Industry funding and university professors' research performance", *Research Policy*, Vol.34 No.6(2005); Renault, C. S., "Academic capitalism and university incentives for faculty entrepreneurship", *The Journal of Technology Transfer*, Vol.31 No.2(2006).

activity directly affect the faculty's motivation or willingness to participate in technology transfer, most of the universities in Korea, in accordance with Technology Transfer and Commercialization Promotion Act, are already paying over 50% of the technology revenues to an inventor (faculty member). Another reason may be found in Lam (2011). Lam (2011) employed the three concepts of gold (financial rewards), ribbon (reputational rewards) and puzzle (intrinsic satisfaction) to examine the extrinsic and intrinsic aspects of scientists' motivation for pursuing commercial activities and found there is a diversity of motivations for commercial engagement, and that many do so for reputational and intrinsic reasons and that financial rewards play a relatively small part. Lam (2011) concluded that policy initiatives focusing narrowly on providing financial rewards might be inadequate or even misplaced if academics are motivated by a complex mix of extrinsic and intrinsic rewards.

[Table 5] Determinants of faculty technology transfer (Licensing agreement)

Variables	Licensing agreement (in the last 5 years)	
	(1)	(2)
-demographic factor-		
age	0.39725 (0.31603)	0.40525 (0.33162)
age squared	-0.00330 (0.00301)	-0.00327 (0.00315)
sex	1.33907* (0.79008)	1.25915 (0.80312)
-Research capability-		
Number of patent applications in the last 5 years	0.16932*** (0.04355)	0.17915*** (0.04607)
Number of SCI research papers in the last 5 years	-0.01159 (0.03095)	-0.00788 (0.03156)

-Characteristics of research field-		
Characteristics of research field	0,36860 (0,38808)	0,45280 (0,40411)
Extent of technology convergence	0,19964 (0,17912)	0,15639 (0,18656)
-Commercial orientation-		
Experience in industry-university joint research	2,10917*** (0,61864)	2,21138*** (0,63505)
Experience in business start-up	0,60626 (0,43052)	0,81645* (0,46354)
Participation in technology marketing activities	0,49592 (0,35106)	0,39881 (0,37429)
-University's supporting activities for technology transfer-		
Technology marketing events		0,00553** (0,00228)
Searchable technology DB		0,59999* (0,36011)
Outsourcing technology transfer activities to an external institution		-0,01314 (0,00920)
-University policies regarding technology transfer-		
Distribution of revenues from technology transfer to a faculty member (inventor)		0,01821 (0,01570)
Evaluation of a faculty member's performance		0,00100 (0,00304)
Evaluation of the performance of a TTO member who contributed to technology transfer		-0,02465 (0,36863)
-Control variable-		
Public Univ.		-0,23515 (0,35719)
Constant	-17,76008 (8,37748)	-19,73951 (8,92922)
No. of observations	475	475
LR chi2	102,93 (0,0000)	121,06 (0,0000)

The standard errors are reported in parentheses.

Coefficients marked with ***, ** and * are significant at 0,01, 0,05 and 0,10 level respectively.

[Table 6] Determinants of faculty technology transfer (Royalty revenue)

Variables	Royalties (in the last 5 years)	
	(1)	(2)
-demographic factor-		
age	0,28712 (0,32563)	0,25355 (0,35114)
age squared	-0,00242 (0,00311)	-0,00191 (0,00335)
sex	1,74136* (1,04995)	1,60622 (1,05885)
-Research capability-		
Number of patent applications in the last 5 years	0,10688*** (0,03483)	0,11002*** (0,03813)
Number of SCI research papers in the last 5 years	-0,00137 (0,03126)	0,00945 (0,03265)
-Characteristics of research field-		
Characteristics of research field	0,51988 (0,43258)	0,69529 (0,46450)
Extent of technology convergence	0,27621 (0,19212)	0,26260 (0,21069)
-Commercial orientation-		
Experience in industry-university joint research	2,29450*** (0,74415)	2,47967*** (0,77281)
Experience in business start-up	0,37703 (0,45343)	0,65332 (0,50288)
Participation in technology marketing activities	0,41442 (0,37428)	0,16461 (0,41755)
-University's supporting activities for technology transfer-		
Technology marketing events		0,00624*** (0,00238)
Searchable technology DB		1,02671** (0,40621)
Outsourcing technology transfer activities to an external institution		-0,00776 (0,00909)
-University policies regarding technology transfer-		
Distribution of revenues from technology transfer to a faculty member (inventor)		0,03297* (0,01833)
Evaluation of a faculty member's performance		0,00310

		(0,00318)
Evaluation of the performance of a TTO member who contributed to technology transfer		-0,00715 (0,40629)
-Control variable-		
Public Univ.		-0,53094 (0,41225)
Constant	-15,56969 (8,62837)	-18,25808 (9,44807)
No. of observations	475	475
LR chi2	76,16 (0,0000)	106,87 (0,0000)

The standard errors are reported in parentheses.
Coefficients marked with ***, ** and * are significant at 0,01, 0,05 and 0,10 level respectively.

V. Conclusions

Technology transfer is one of the most important entrepreneurial activities of a university. The revenues arising from technology transfer can be used as investment funds needed for the development of the faculty and university, and the industry-university-government network built in the process of technology transfer can become an important resource for the development and utilization of the university's technology later. The role of faculty as a member of university is crucial in helping the university contribute to the development of local community and country as a whole through the creation and spread of innovative technology. Therefore, many previous empirical studies which looked at the factors influencing technology transfer activities, whether it is measured at an individual level or at a university level, focused primarily on the faculty's demographic characteristics, experience in

industry, and faculty quality. At the same time, because faculty members are influenced by the environment of the university in which they work, the characteristics of the university may have impact on the technology transfer. Therefore, we can enhance our understanding of the disparities among faculty members in their technology transfer performance by considering the support programs, policies, environment regarding technology transfer of universities to which they belong as well as the faculty's demographic characteristics, commercial orientation and faculty quality.

This study is meaningful in that it provides a positive analysis of the importance and effects of the two sets of factors in the individual faculty member's technology transfer performance: the characteristics of individual faculty member and the characteristics of university to which the faculty member belongs. The results of this study show that overall both the characteristics of faculty members and the characteristics of universities influence faculty technology transfer. In the individual contexts, a faculty member's research capability (number of patent applications in the recent 5 years), and commercial orientation (industry-university joint research experience) have a significant impact on faculty technology transfer. In the organizational contexts, university's supporting activities for technology transfer (technology marketing events, searchable technology DB) are found to have effects on faculty's technology transfer performance.

Although the utilization of research products by Korea universities has grown in the last 10 years, it cannot be seen as enough. This means that there is need for university and its TTO to accumulate more experience and expertise in technology transfer. From the beginning stage of technology transfer to the stage in which certain market size is obtained,

the role of a faculty member is very important. Therefore, in the absence or shortage of personnel with experience or expertise in technology transfer and of a highly capable TTO, a faculty member who has the best knowledge of technology and the cooperative relation with industry naturally becomes a core player of the technology transfer process. However, with only the industrial network, technology transfer activity will encounter the limitation upon entering a larger technology market and a full-scale development stage. The roles of university or its TTO become important inevitably. Currently, the technology transfer activity of Korea universities is in the period of transition from the faculty-based system to the TTO-based system. Technology transfer activities in some universities are led by TLOs who are equipped with experience and expertise in technology transfer while other universities rely on an individual faculty member's network in their technology transfer activities. Considering such differences between universities will help us better understand the effects of the characteristics of a faculty member and of a university to which he belongs on his technology transfer performance. We leave this matter for the subject of future research.

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대학 교수의 기술이전 성과에 미치는 개인 및 조직 요인

이재현, 이성상, 조근태

대학의 기술이전 활동에 있어 대학 교수의 역할은 매우 중요하다. 또한 대학 교수의 기술이전 활동과 그 성과는 개별 연구자의 특성뿐만 아니라 그들이 속한 대학의 특성에 영향을 받는다. 본 연구에서는 84개 대학, 475명의 대학 교수를 대상으로 대학 교수의 개인적 특성과 조직(대학)의 특성이 교수의 기술이전 활동 성과에 어떠한 영향을 미치는지를 분석하였다.

실증 분석 결과 대학 교수의 기술이전 성과에 연구자의 특성과 연구자가 소속된 기관의 특성이라는 두 가지 요인이 모두 영향을 미친다는 것을 확인할 수 있었다. 개별 연구자 특성 측면에서는 특허 출원 건수로 대표되는 연구 역량과 산학협력 경험과 같은 시장 지향성이 기술이전 성과에 영향을 미치는 것으로 나타났다. 기관 특성 측면에서는 기술마케팅 활동, 기술 정보 DB 운영 등 기술이전 지원 활동이 활발한 대학에 속한 연구자의 기술이전 성과가 높게 나타났다. 본 연구의 결과는 연구 수행 주체로서 개별 연구자의 특성뿐만 아니라 연구자가 속한 각 대학의 기술이전 활동, 관련 규정, 기술이전 환경 등을 함께 고려한다면 대학 연구자의 기술이전 활동 및 성과의 차이를 보다 심층적으로 이해할 수 있다는 것을 보여 준다.

Keyword

기술거래, 기술이전 수익, 교수 특성, 대학 특성, 기업가적 활동