
Empirical Study on the Success of Technology Commercialization Projects of Firms

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초 록

Although numerous literature has proposed conceptual models and empirical evidence regarding technology commercialization of firms, prior research has not provided sufficient evidence-based implications about the success possibilities of technology commercialization projects within firms. To replenish related researches, this paper empirically investigates the factors that determine the success of the technology commercialization projects of firms based on the unique novel dataset from survey for Korean firms. To obtain policy implications of enhancing technology commercialization within firms, we conducted the research focusing on both environments surrounding firms pursuing technology commercialization and policy aspects rather than on internal factors of firms. The empirical results show that factors related to demands for the new technologies and products targeted by the projects, such as authentication, improve the success of technology commercialization projects within firms. In addition, the results show evidence that the government supports should be focused on the stage of product development among the commercialization process.

주제어

Technology Commercialization, Commercialization Project, Technological Innovation, Success Factor

I . Introduction

To obtain the economic value from the technologies acquired from in-house or outsides like universities or public research institutes, etc. firms as principal entities of commercializing technologies have to manage technology commercialization projects efficiently. Defining technology commercialization depends on researchers' interests, but it is defined as development, production, and sales of products making use of the technologies or as enhancement of relevant technologies involved in commercialization processes in Korea.¹⁾ For a long time the technology commercialization has been an important research theme in management and economics in developed economies because it is the key stage of generating economic value with technologies resulted from R&D which took lots of resources.

However, when we see the actual situations of technology commercialization by private firms as major entities commercializing technology, 53.5% of Korean firms failed to secure the future source of income, and more than a half R&D performed in research center within firms would not be linked to new products by technology commercialization(Lee, 2009). This reveals low level commercialization capabilities of Korean firms. Moreover, even actual situations of technology commercialization activities within Korean firms are not enough apprehended although the importance of technology commercialization is well recognized among policy communities and nationwide resources investments in enhancement of technology

1) Korean Acts on Promotions for Technology Transfer and Commercialization, Article 2.

commercialization have been gradually increased.

Researches on technology commercialization in Korea so far have been focused mainly on supply side such as establishing infrastructure for technology commercialization in public sector, enforcing technology offering capabilities of government-supported research institutes²⁾. After the 3rd promotion plans for technology transfer and commercialization ('09~'11), Korea governments reorganized public infrastructure-oriented policy supporting technology commercialization into firm-oriented one by carrying forward various programs including development and management of technological resources, establishment of supporting system along life cycle of commercialization process, offering differentiated technology financing along growth stages of firms, and overseas expansion of technology-based firms, etc. However, it appears that nationwide technology commercialization activities are still poorer than governments' expectation.

Under this situation, the paper investigates the technology commercialization projects within firms for getting implications in terms of public policies for enhancing technology commercialization because R&D projects within private firms are often closely linked to a variety set of governmental programs supporting R&D and commercialization in Korea. This study is expected to supplement existent research centered on technology transfer activities of universities and public research institutes in the view point of technology supply and to draw policy implications for nationwide technology commercialization by empirically examining success factors of private firms' technology commercialization

2) Kwon, Y. K., New Paradigm of Technology Commercialization viewed in Perspective of Industrial Technology Ecosystem, ISSUE PAPER 11-6, KIAT, 2011, In Korean.

projects which are linked to governmental programs supporting technology commercialization based on unique survey in Korea.

Thus we tried to test and shed lights on effectiveness of ways that governments support technology commercialization by focusing on firms' contextual factors in terms of external interactions and environmental factors rather than internal factors. To put it concretely, we examined impacts of governmental policy tools intending technology commercialization which could affect the success of firms' technology commercialization at the project level. To do so, we categorized the governmental policy tools into three categories in connection with governmental programs. One is the programs that affect demands on products, services, or processes which is going to be commercialized. Another is the programs regarding the financial aids for technology commercialization projects. The third is specially designed governmental programs for technology commercialization. We examined the relation between each program and the success of projects for commercializing technologies. In addition, we investigated how contextual factors of target markets where technologies are commercialized could be related to the success of technology commercialization projects.

II. Theoretical Backgrounds & Literature Review

Survival of firms in competitive markets can heavily depend upon successful technology commercialization that allows firms to satisfy various needs of their customers(Cooper, 2000; Zahra and Nielsen, 2002). Technology commercialization of firms under uncertainty of environments can be influenced by both internal and external factors of

firms. In particular, given internal organizational contexts of firms, technology commercialization activities of firms can be conditioned by their external contexts such as institutions, characteristics of technological fields, appropriability conditions that are conditioned by governments mainly.

NSI(National Systems of Innovation) approach gives us an important theoretical background regarding external contextual factors for technology commercialization at firm level even though the approach was emerged in the 1980s in order to explain the differences in the innovative performance of industrial countries(Freeman, 1987; Lundvall, 1992; Nelson, 1993). NSI could be defined by “the system of interacting private and public firms (either large or small), universities and government agencies. … Interaction among those units may be technical, commercial, legal, social and financial …”(Niosi et al., 1993, p.212). This suggests that the interplay between private firms and governments affects the success probability of technology commercialization activities of firms. In general, governments have an important role in forming the institutions, an element of any systems of innovation, which include norms, routines, common habits, established practices, rules, laws, standards, etc. and influence in agents’ cognition, actions, and interactions in the innovation systems(Malerba, 2002). In addition, the technological regime, which is the complex of scientific knowledge, skills and procedures, various practices and technologies, and institutions and infrastructures making up the totality of a technology, can direct the technological change and the adoption and exploitation of new technologies(Malerba and Orsenigo, 1997; Caerteling et al., 2008, p.146) and also influence the appropriability conditions(Shane, 2001). As a result, the role of the contexts including market environments and the institutions and more direct intervention of

governments in technology commercialization activities in private firms deserves to be investigated in detail.

Literatures on factors affecting technology commercialization have been steadily conducted from 1970s. They can be divided into two big streams depending on researchers' interests; one is focused on the commercialization through technology transfers by public entities (universities, public research institutes, etc.) and the other is targeted to technology commercializing activities of private firms as principals.

Researches centered on public sector have mainly explored factors determining technology transfers by universities and public research institutes.³⁾ Related literatures shows that the transfers and diffusions of technologies developed in universities and public research institutes are affected by various factors such as attributes of technology itself, strategies and capabilities of TTOs specialized in technology commercialization, internal and external contextual factors of universities and public research institutes, etc. Characteristics of technology itself include technological uncertainty, maturity, complexity, interaction with other technologies, etc. And success probability of technology commercialization is heavily dependent on the strategy of specialized technology commercialization unit within organizations(Bandarian, 2007). In addition, although an entity developing technologies have recognized their commercial potential, internal and external factors of the entity could affect the success of technology commercialization. For example, they include features of target markets for developed technologies,

3) Min, J.-W. and Kim, Y., A Study of Success Factors in Public Technology Transfer: The Implications of Licensee's Motivation, *The Journal of Intellectual Property*, 10(2), 2015, pp.225-256; Cho, H., A Study on the Performance Factors of Technology Commercialization of Universities in Korea in terms of the Resource-based View, *The Journal of Intellectual Property*, 7(3), 2012, pp.217-245.

characteristics of potential customers, relationship with suppliers, etc. There are lots of factors that affect technology commercialization, but there are not enough cumulated empirical evidences for them.

Besides, there are various accumulations of literatures for technology commercialization by private firms who are the principal to conduct technology commercialization. After seminal researches by Cooper(1979), Maidique and Zirger(1984), diverse empirical researches regarding success of technology commercialization have been conducted, focusing on the attempts to identify factors which have positive relationship with commercialization of products or services which embed the developed technologies. These studies could be classified into several flows; ones are the researches focused on organizational situations within the process of commercialization such as a new product developing, the others are the researches focused on environments surrounding organizations. Especially, the latter has been continuous interests for researchers (Balachandra and Friar, 1997; Cooper, 2001; Montoya-Weiss and Calantone, 1994).

The important factors for firms to commercialize technologies include the experiences and willingness of their developer, collaboration and interaction among entities pursuing technological innovation attributes of technology itself, relationship and integration with existing technology and business, market orientation of organization, inter-organizational factors, diverse interaction with environmental factors such as markets and government policies. More specifically, developers' experiences of commercializing technologies(McEachron, 1978), commercialization willingness of developers(Baer et al., 1976), insights of developers(Radosevich and Smith, 1997) are reported to be important factors of technology commercialization. Also, collaboration and linkage with other technology

suppliers can affect technology commercialization (Souder and Padmanabhan, 1989; Samsom and Gurdon, 1993). Particularly, the integration of resources(human, tangible, financial) is critical for success of technology commercialization projects. In addition, teamwork among different functional units within companies, sharing of organizational culture, and proficient communication are recognized as important factors. Galbraith et al.(1991) showed collaboration among different functional units such as R&D, marketing, manufacturing, etc. is critical for success of technology commercialization.

Besides, technological attribute is also important factor that affects success of technology commercialization. In general, the degree of maturity of technology affects the success of technology commercialization(Brown et al., 1991), and how the technology is feasible also is revealed as an important success factor of technology commercialization(Rothwell, 1992). Some scholars argued that characteristics of technology like its radicalness, whether it is core technology and platform technology, durability of technology itself affect the success of technology commercialization(Cooper, 2001; Watkins, 1990).

Given that technology being commercialized is not totally novel, it relates to existing technologies at certain degree, as well as to incumbent business which firm has been running. As a result, the technology being commercialized and its relatedness or linkage with incumbent technology and business is understood as a critical factor which affects technology commercialization(Cooper, 2001; Ettlie, 1982; Radosevich and Smith, 1997). Cooper(2001) showed that successfully commercialized technologies meet needs in markets and technically delicate, leading to positive synergy effects with existing businesses and technologies, and the competitive advantage, etc.

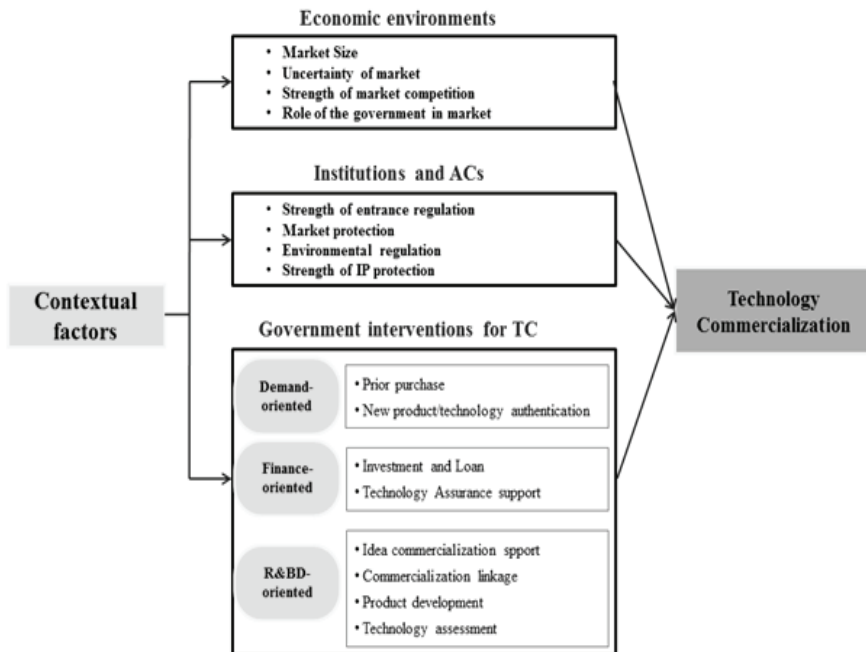
Although it is well recognized that characteristics of technology itself and contextual factors of technology developing entities is understood to be important for the success of technology commercialization, market environments and government policy are also closely related to technology commercialization of firms. Characteristics of markets with transactions of products or services embedding the technology subjected to be commercialized have been traditionally considered as a significant object for empirical researches from the beginning. Cooper(1979) took it into account potential market size, anticipated market share, profitability of new products as factors for technology commercialization. The characteristics of markets are important not only for the process of commercializing developed technologies but also for the planning phase of technology commercialization projects(Cooper, 1981; Rubenstein et al., 1976; Mansfield and Wagner, 1975). There is also an opinion which contends that there has to be a related market for the success of technology commercialization(Balachandra, 1984; Carter, 1982; Hopkins, 1981).

Government policy plays the key role in shaping environments of technology commercialization(Ring et al., 2005), as well as financing technology commercialization by firms(Lerner, 1999). In fact, governments develop and execute various agenda for achieving socio-economic development through technological progress(Norberg-Bohm, 2000). Thus governmental programs pursuing technology development and its commercialization could affect technology commercialization activities of firms(Rothwell, 1992; Ettlie, 1982; Lester, 1998). In Korea, technology commercialization projects within firms are generally connected with various programs supported by governments.

Despite various existing theoretical and empirical studies provide

multidimensional implications for technology commercialization, there are lacks of literatures directly exploring influential contextual factors of technology commercialization projects at the project level within firms. Thus there is a limitation to give implications for government policies regarding technology commercialization at the project level where actual technology commercialization activities are taking place and for influential factors for the success of firms' technology commercialization to project managers. This is because prior studies have investigated technology commercialization at the firm level, instead of targeting individual project of technology commercialization. So the conceptual model of this paper can be summarized as in 〈Figure 1〉.

〈Figure 1〉 Conceptual model framework



III. Methodology

1. Data and Measurement of Variables

(1) Data Collection

It is difficult to find prior worldwide research regarding technology commercialization based on data at the project level of firms' technology commercialization. In this study, we surveyed firms in the private sector from July to September 2011 to collect data regarding individual technology commercialization projects.

The survey was conducted in firms that had performed research application and development by taking part in technology innovation program and R&BD program targeting technology commercialization sponsored by Korea's Ministry of Knowledge Economy. The survey was administrated to 1,723 firms which had engaged in technology commercialization projects within 5 years, 374 firms(21.7% responding rate) completed the survey. After removing incomplete answers, there were 491 projects of technology commercialization for analysis.

(2) Measurement of Variables

The dependent variable was measured by a binary dummy indicating whether the projects of technology commercialization performed for the past 5 years succeed or not. According to the commercialization model by Jolly(1997), whether a technology commercialization project succeeds was judged by whether the prototype is developed and demonstrated during 5 years after the projects launch. Commercial success presumes that products (or services) and/or processes embedding developed

technologies are introduced into markets and profits from the new innovations are realized. However, this study does not take the commercial success resulting from technology commercialization into account because the focus is on if the technology commercialization projects succeed on the basis of the commercialization model by Jolly(1997).⁴⁾

In addition, this study focuses on environmental factors like markets and government programs and policies which are directly related to the technology commercialization projects and their success potential. Thus the independent variables could be classified into the variables indicating market characteristics and its related environments, institutional environments, governmental programs supporting technology commercialization, all of which are linked to technology commercialization projects performed. More specifically, important characteristics of markets which a technology commercialization project is targeting include market size(MKSIZE), market risk(MKRISK), degree of market competition(MKCOMP), importance of market regulations(MKRG). We measure these independent variables by a 5 point likert scale. In addition, firms' technology commercialization activities are affected by government regulations, and this study employed these independent variables like the degree of strength of the entrance regulations for markets related to technology commercialization projects; the degree of strength of market protection of relative business area; the degree of strength of environment regulation and the degree of strength of intellectual property protection by measuring 5 point likert scales. Finally, we categorized

4) For review of the commercialization model for public researches, see Ryu, T.-K., Park, J.-B., and Lee, J.-D., The Commercialization Model For Public Researches, The Journal of Intellectual Property, 2(1), 2007, pp.57-82

government support that firms got for their technology commercialization projects as follows: Demand promotion programs, financial supporting programs, and commercialization-specific supporting programs. More concretely, the demand promotion programs⁵⁾ include purchase priority(BUY), authentication of new products or new technology (AUTHEN). And the financial supporting programs encompass the governmental investment and loan programs for enhancing technology commercialization(INVLOAN), technology assurance(TASSUR). Besides, governments have programs specialized in technology commercialization like the idea commercialization promotion program(IDEA), commercialization linkage supporting program(COMLINK), product development supporting program(PRODEV), technology assessment supporting program(TASSESS). We employed independent variables for each governmental program and measured them as dummies in order to examining how those governmental programs could affect the success probabilities of technology commercialization projects of firms.

(3) Control Variables

In addition to the independent variables listed above, there are other factors which might affect the success probabilities of technology commercialization projects of firms. In this study, therefore, we tried to control these factors by assessing period of time of the project(MONTH), numbers of technology developers for the project(INPUT1), numbers of

5) According to the survey, there are three more types, industry-university-GRI collaboration supports, human resource supports, and tax supports that governments provide for firms' technology commercialization activities. However, they are vague to be classified into the three types such as demand promotion, financing supporting, commercialization-specific supports, as well as indirect weak linkage to commercialization projects of firms. Thus we excluded those types in this study.

professionals for technology management(INPUT2), phase of technology life cycle where the technology commercialization project started(BASIC, APPLY, TESTP).⁶⁾ This study also controlled for the age of firms(AGE), background of CEO(CEO), and whether a firm has a unit specialized in technology commercialization(MOTSPE). The industrial classification of firms turned out not to be significant for the success of technology commercialization at preliminary analysis, so it was not used as control variable. Finally, it is well recognized that size of firms relates to innovation outcomes(Schumpeter, 1942; Kamien and Schwartz, 1982; Scherer, 1965). In our sample, however, the size of firms has high correlation with the firm age, so we employed only the firm age as the control variable. The older firms are the more experiences of both related technological fields and businesses firms have. Thus we included the firm age as a control variable.⁷⁾

〈Table 1〉 summarizes the definitions of variables and their measurements.

6) The phase of making new products for launch was set up as a basis.

7) The estimation results of Pearson's correlation coefficients between the size of firms (SIZE) and their age(AGE) showed high significant and positive correlation coefficient under 1% significance level. Therefore, we used only the firm age(AGE) as a control variable in order to avoid the multicollinearity by using both variables in estimating models. The other reason is that the firm age(AGE) is closely related to experience of technology commercialization of firms. It is hard to assert that larger organizations must have more abundant experiences for technology commercialization.

〈Table 1〉 Definition of variables

Variables			Definition of Variables (measure)		
Dependent Variable		SUCCESS	Whether the commercialization project succeeded		
Control Variables	Organization al Level	AGE	Age of the firms(year)		
		CEO	Whether the CEO is from engineering field(Dummy)		
		MOTSPE	Whether the firm has Commercialization specified department(Dummy)		
	Project Level	Phase of Commercialization process	BASIC	Basic research phase(Dummy)	
			APPLY	Applied research phase(Dummy)	
			TESTP	Prototype manufacturing phase(Dummy)	
		MONTH	Duration of project performance(Month)		
		INPUT1	R&D human resource input(log transformation)		
		INPUT2	MOT human resource input(log transformation)		
Independent Variables	Target Market	MKSIZE	Targeted market size(5 scale Likerts)		
		MKRISK	Uncertainty of target market(5 scale Likerts)		
		MKCOMP	Strongness of target market competition(5 scale Likerts)		
		MKRG	Role of the government in target market (5 scale Likerts)		
	Regulation Environment	ENTRG	Strongness of entrance regulation(5 scale Likerts)		
		MKPROT	Targeted market protection(5 scale Likerts)		
		ENVRG	Environmental regulation(5 scale Likerts)		
		IPRST	Strongness of IP protection(5 scale Likerts)		
	Government Promotional Policy	Demand	BUY	Prior buying policy(Dummy)	
			AUTHEN	New product/technology authentication policy(Dummy)	
		Finance	INVLOAN	Investment and Loan support/promotion policy(Dummy)	
			TASSUR	Technology assurance support/promotion policy(Dummy)	
		Commercial-ization	IDEA	Idea commercialization support/promotion policy(Dummy)	
			COMLINK	Commercialization linkage support/promotion policy(Dummy)	
			PRODEV	Product development support/promotion policy(Dummy)	
			TASSESS	Technology assessment support/promotion policy(Dummy)	

* Note: Both the dependent variable and the independent variables were measured at a project level.

2. Model

The number of technology commercialization projects which are used in the analysis is total 491, where 353 projects(72%) succeeded meanwhile 138 projects failed. Sample composes of commercialization projects in various fields of technology as follows: Pharmaceuticals(9.9%), electric and electronic components(12.9%), IT devices(16.3%), chemicals(16.3%), general machinery(21.2%), precision instruments(7.9%), automobile (10.1%), and other transportation vehicles(5.4%).

We classified the factors influencing the success of firms' technology commercialization projects into attributes of the projects themselves, external environments(characteristics of target markets, institutions) surrounding the projects, governmental programs supporting technology commercialization projects on commercialization process, and other control factors. We specified following model for exploring the effects of those factors on the success of technology commercialization projects.

$$BS_i = \alpha + M_i\beta_{mi}' + R_i\beta_{ei}' + G\beta_{\alpha}' + O_i\beta_{\alpha i}' + \epsilon_i \quad (1)$$

In equation (1), dependent variable BS_i is a dummy variable that represents the success of firm i 's technology commercialization project, M_i the set of variables which is related to market characteristics and environments that the projects are facing, R_i the set of variables related to government regulation which is the non-market environments that the projects are facing in this study. Also, G is the group of the independent variables representing the governmental programs for supporting technology commercialization projects. Finally, O_i is the set of control variables including a variety set of factors which might affect the success probability of the technology commercialization projects.

(Table 2) Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
(1) SUCCESS	1																									
(2) AGE	-.079	1																								
(3) CEO	.015	-.138	1																							
(4) MOTSPE	-.012	.137	.067	1																						
(5) BASIC	-.659	.078	.038	.070	1																					
(6) APPLY	-.263	-.041	-.003	-.030	-.197	1																				
(7) TESTP	.112	-.015	.014	-.071	-.197	-.169	1																			
(8) MONTH	.259	.149	.007	.042	-.190	-.104	.035	1																		
(9) INPUT1	.076	.126	.022	.048	-.048	-.033	-.010	.101	1																	
(10) INPUT2	.063	.055	.029	.055	-.038	-.023	-.030	.104	.868	1																
(11) MKSIZE	.274	.065	.111	.125	-.163	-.078	.001	.164	-.008	-.014	1															
(12) MKRISK	-.101	-.017	-.096	-.035	.026	.039	.065	-.035	.062	.059	-.224	1														
(13) MKCOMP	.108	.017	.123	.013	-.056	-.031	.029	.064	-.007	-.010	.433	-.017	1													
(14) MKRG	.101	-.027	.071	.083	-.076	.001	.101	.034	.062	.044	.228	.002	.243	1												
(15) ENTRG	.106	.096	.007	.175	-.102	-.032	.008	.027	.039	.017	.164	-.093	.162	.337	1											
(16) MKPROT	.054	.063	.011	.187	-.043	-.073	.008	.054	-.022	-.026	.159	-.053	.134	.265	.572	1										
(17) ENVRG	-.067	.096	-.070	.114	.062	.004	-.055	.008	.038	.005	.230	-.006	.204	.197	.425	.422	1									
(18) IPRST	.025	.027	-.056	.008	-.022	-.022	-.015	.047	-.053	-.028	.236	-.013	.199	.128	.291	.331	.439	1								
(19) BUY	.051	.074	-.041	-.103	-.066	.030	.030	.080	.010	-.008	-.007	-.019	-.083	.062	.073	.061	.012	.069	1							
(20) AUTHEN	.223	-.051	-.031	-.074	-.173	.037	.037	.049	.001	-.017	.009	-.053	-.032	.080	.024	.073	.077	.114	.197	1						
(21) INVLOAN	.127	-.071	.024	-.009	-.063	-.038	-.015	-.019	-.011	-.001	.035	-.011	.100	-.061	-.008	-.003	-.014	.003	-.086	.004	1					
(22) TASSUR	.140	-.073	.018	.034	-.121	-.075	.043	.159	-.011	.051	.234	-.101	.130	.148	.057	.062	.053	.108	-.044	.173	.110	1				
(23) IDEA	.068	-.056	.060	.026	-.076	.085	.047	-.020	.000	-.011	.026	.023	.045	.024	-.007	.004	.030	.009	-.022	.155	.012	.038	1			
(24) COMLINK	.197	-.005	-.053	-.029	-.167	.047	.019	.160	.032	-.022	.106	-.028	-.034	-.031	-.011	-.073	-.002	.076	.074	.202	-.041	.078	.139	1		
(25) PRODEV	.179	-.012	-.124	.021	-.149	.015	.040	.051	.072	.050	.037	.043	-.016	.088	.035	.062	.064	.032	.045	.179	-.079	.049	.101	.068	1	
(26) TASSSESS	.090	-.069	.015	-.035	-.083	.047	.126	.026	-.018	-.025	.038	-.018	.014	.036	-.008	-.037	.045	.094	-.044	.255	.085	.252	.175	.099	.177	1

We estimated the effects of individual independent variable on the success of technology commercialization projects which is the dependent variable in equation (1) by probit model. In general, the estimation by the probit model is different from conventional OLS(Ordinary Least Square), and it is estimated by MLE(Maximum Likelihood Estimation Method) or WLSE(Weighted Least Square Estimation). Thus we used MLE for the estimation which is commonly applied.

〈Table 2〉 shows the correlations among the variables which were used to estimate the model. Overall, the correlation coefficients among variables were very low except few cases. However, the number of technology development employees(INPUT1) and the number of employees with specialty in management of technology(MOT) showed high correlation, which is natural and expectable because the more number of technology developers are put into the projects, the more number of MOT staffs are put into there too. Besides, the correlation coefficients among variables representing the governmental regulations to targeted markets of commercialization projects were also relatively high. That is, the variables among the role of the governmental regulation in targeted market, entrance regulations, market protection, environmental standards, and strength of IPRs property protection had relatively high correlation.

IV. Empirical Findings

The results of the probit estimation in order to examine factors influencing the success probability of technology commercialization projects implemented by firms, based on the equation (1), are summarized in following 〈Table 3〉. From the estimation results of model

1, we can see the point that the success of technology commercialization projects is largely related to the age of firms, i.e. the older firms is unlikely to be successful in technology commercialization projects. In general, we could predict the likelihood of the success of technology commercialization projects to be higher when the firms get older because they have more accumulated experiences or know-how of the commercialization. In contrast to our expectation, the estimation results reported totally different outcome. This suggests that there may be some obstacles negatively affecting technology commercialization within organizations

〈Table 3〉 Probit estimation results for the success of technology commercialization projects (1)

		Model 1	
		Coeff.	Std. Error
Explanatory Variables	AGE	- 0.01438**	0.00706
	CEO	0.48923*	0.28324
	MOTSPE	0.11236	0.21623
	MONTH	0.01522**	0.00686
	INPUT1	0.04083**	0.02030
	INPUT2	0.07930**	0.03888
	BASIC	- 3.65295***	0.32595
	APPLY	- 2.53216***	0.29858
	TESTP	- 1.24641***	0.31295
Statistics	McFadden Pseudo R-squared	0.62421	
	Chi squared	361.7060***	
	Akaike I.C.	0.48423	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Besides, it turned out that whether the technology commercialization projects succeeded can be affected by the duration of the projects operation. Looking into the estimation results in 〈Table 3〉, the variable MONTH, the monthly times of the project, has statistically significant and positive estimated coefficient at 1% significant level. Considering inputs

of human resources, however, we can see that just increasing input of technology developer(INPUT1) could not be helpful for the success of technology commercialization from the estimation results. Rather, the estimation results show that the technology management (MOT) staffs that are specialized in commercialization rather than technology development can be a key success factor for the technology commercialization projects.

In addition, the estimation results of model 1 convince us that the initiating phase of technology commercialization projects can also be another influential factor. Naturally, the earlier phase the technology commercialization projects are initiated at, the lower probability its success is. As a result, it is critical to catch the appropriate timing of commercialization in order to enhance the chance of the success of technology commercialization because which phase of the commercialization process firms plunge into can be crucial to increase success probability of the projects. The results of estimating the model 1 show that control factors considered in our analyses control the models appropriately which examine the effects of independent variables on the success probability of commercialization projects.

Now we are going through the results of examining the effects of characteristics of the market which technology commercialization project is targeting on the success of the project. Reviewing the estimation results of Model 2 in <Table 4>, the likelihood of technology commercialization projects to succeed is increasing as market size(MKSIZE) gets larger. However, other characteristics of the targeted market do not have significant relationship with success probability of the technology commercialization projects. That is, the estimation results show that the degree of market uncertainty(MKRISK), the strength of market competition

(MKCOMP), and the role of the governmental regulation in target markets(MKRG) are not important and significant factors for the success of the projects.

Besides, the institutional environments surrounding the technology commercialization activities of firms could be also considered as important factors determining the success of the projects. Thus we considered the strength of entrance regulation, the strength of domestic market protection regulation, the environmental regulation, and protection strength of the intellectual property rights in businesses related to the commercialization projects as these institutional environments. From the estimation results of Model 3 in <Table 4>, we can see that the entrance regulation(ENTRG), the domestic market protection regulation (MKPROT), and the protection strength of IPRs(IPRST) have no significant effects on the success of the commercialization projects. However, the governmental regulations which could be directly related to technological innovation activities in the industry such as environmental regulations (ENVRG) appeared to have negative relationship with the success of technology commercialization projects as it gets stronger. We can understand these results as follows; enhancing more strict environmental regulations to the technological fields planned to be commercialized can require longer times to technology commercialization by demanding additional technology developments to firms.

Finally, we examined how the governmental programs supporting sufficiently technology commercialization projects could influence the success of the commercialization projects. Before estimating the Model 4, we examined statistically whether there is significant difference in success rate of the commercialization between the projects supported by the governmental programs such as the purchase priority(BUY), the

investment and loan(INVLOAN), the idea commercialization supporting program(IDEA), and the technology assessment (TASSESS) which have only small fraction among the samples and other projects.

Testing results indicated no statistically meaningful inter-group differences in success rate of the commercialization of the projects except the investment and loan supporting program(INVLOAN). This mean the probit estimation results can be credible because the results are free of error from small cases among samples.

〈Table 4〉 Probit estimation results for the success of technology commercialization projects (2)

		Model 2		Model 3	
		Coeff.	Std. Error	Coeff.	Std. Error
Explanatory Variables	AGE	- 0.01562**	0.00736	- 0.01444**	0.00737
	CEO	0.29856	0.30005	0.26986	0.30024
	MOTSPE	- 0.01415	0.23105	- 0.00168	0.23237
	MONTH	0.01740**	0.00713	0.01632**	0.00722
	INPUT1	0.03433*	0.02103	0.04067*	0.02172
	INPUT2	0.08986**	0.04077	0.08374**	0.04113
	BASIC	- 3.66572***	0.34507	- 3.60157***	0.34285
	APPLY	- 2.55031***	0.31832	- 2.53658***	0.31532
	TESTP	- 1.22772***	0.33602	- 1.24197***	0.33053
	MKSIZE	0.31034**	0.12522	0.42246***	0.12522
	MKRISK	- 0.20418	0.11104	-	-
	MKCOMP	0.05100	0.13381	-	-
	MKRG	0.10369	0.11331	-	-
	ENTRG	-	-	0.21423	0.14923
	MKPROT	-	-	- 0.08973	0.14783
	ENVRG	-	-	- 0.24359*	0.13503
	IPRST	-	-	- 0.05255	0.12880
Statistics	McFadden Pseudo R-squared	0.65275		0.65337	
	Chi squared	378.2451***		378.6021***	
	Akaike I.C.	0.46684		0.47018	

* p<0.10, ** p<0.05, *** p<0.01

When we consider the public policy for supporting technology commercialization in private firms, the first category is the one that

intends to increase the demand of new products or services as outcomes of commercialization projects. This category of government supports includes the purchase priority program(BUY) and the new products or technology authentication program(AUTHEN) in this study. According to the estimation results of Model 4 in <Table 5>, the purchase priority program(BUY) has no significant influence on the success of technology commercialization projects given that the projects got sufficient support by the governmental program in the process of the commercialization projects. In contrast, the new products and technology authentication program(AUTHEN) by governments have significant and positive effects

<Table 5> Probit estimation results for the success of technology commercialization projects (3)

		Model 4		Model 5	
		Coeff.	Std. Error	Coeff.	Std. Error
Explanatory Variables	AGE	- 0.01563**	0.00799	- 0.01506*	0.00800
	CEO	0.33038	0.31780	0.33171	0.32139
	MOTSPE	0.16637	0.24910	0.20699	0.25386
	MONTH	0.01413*	0.00766	0.01549**	0.00767
	INPUT1	0.03530	0.02302	0.03583	0.02334
	INPUT2	0.10885**	0.04581	0.10331**	0.04764
	BASIC	- 3.70384***	0.31330	- 3.70565***	0.37358
	APPLY	- 2.85243***	0.35390	- 2.80377***	0.35058
	TESTP	- 1.35145***	0.35329	- 1.30638***	0.35401
	MKSIZE	0.52512***	0.12734	0.50005***	0.12932
	ENVRG	- 0.31460**	0.12588	- 0.28621**	0.12768
	BUY	0.72489	1.18424	-	-
	AUTHEN	1.82094***	0.44158	1.88138***	0.44883
	INVLOAN	-	-	0.95623	0.65127
	TASSUR	-	-	- 0.27595	0.45969
Statistics	McFadden Pseudo R-squared	0.69098		0.69501	
	Chi squared	400.3957***		402.7322***	
	Akaike I.C.	0.42172		0.42104	

* p<0.10, ** p<0.05, *** p<0.01

on the success of commercialization projects. This is partly because the new products and technology authentication from governments could provide customers with signals that the commercialized products or technologies are credible.

Besides, regarding the policy that governments support directly financial aids to the technology commercialization activities of firms, this study focused on the investment and loan supporting program(INVLOAN) and the technology assurance program(TASSUR) and examined the effects of these factors on the technology commercialization of the firms. As we can see from the estimation results of Model 5 in <Table 5>, it turned out that these factors have no significant effects on success of the commercialization projects of firms. However, in the case of the investment and loan support program(INVLOAN), there was significant difference in success rate of commercialization between two groups, one group of projects with supports of the investment and loan program by governments and the other group of projects without the same supports at the significant level of 5%. Thus there is chance to show significant positive relationship between the success of the commercialization projects and the investment and loan supporting program. Surprisingly, in the case of the governmental supports through the technology assurance program(TASSUR), the estimation results indicate a chance of negative effects of it on the success of commercialization projects.

Finally, we examined whether specialized governmental programs for fostering technology commercialization could positively influence the success of the commercialization projects of the benefited firms. The estimation results of Model 6 in <Table 6> show that the governmental programs supporting the idea commercialization(IDEA), the commercialization-linked technology development(COMLINK) and the technology

assessment(TASSESS) have no significant impact on the success of technology commercialization. However, the specialized program focusing on the products development in the commercialization process turned out to have significant positive effects on the success of the technology commercialization projects.

〈Table 6〉 Probit estimation results for the success of technology commercialization projects (4)

		Model 6	
		Coeff.	Std. Error
Explanatory Variables	AGE	- 0.01206	0.00826
	CEO	0.42848	0.32521
	MOTSPE	0.14770	0.26015
	MONTH	0.01353*	0.00797
	INPUT1	0.03349	0.02413
	INPUT2	0.10514**	0.04884
	BASIC	- 3.72910***	0.38913
	APPLY	- 2.93374***	0.37105
	TESTP	- 1.41001***	0.36735
	MKSIZE	0.50484***	0.13370
	ENVRG	- 0.32400**	0.13142
	AUTHEN	1.60055***	0.45262
	IDEA	0.52762	0.74948
	COMLINK	0.34987	0.32581
	PRODEV	0.49534*	0.26187
	TASSESS	-0.02098	0.41295
Statistics	McFadden Pseudo R-squared	0.70623	
	Chi squared	409.2392***	
	Akaike I.C.	0.42001	

* p<0.10, ** p<0.05, *** p<0.01

In a nutshell, our empirical research examining the effects of the governmental programs supporting the technology commercialization on the success of technology commercialization can be summarized as follows; the authentication program which could promote the demand on new products or technologies and the specialized program focusing on

developing products have positive impact on the success of technology commercialization projects of firms, but other governmental programs intending to support technology commercialization have no significant effects on the success probability of the commercialization projects.

V. Concluding Remarks

Recently, firms acquire technologies through various mechanisms in order to obtain competitive advantage under ever-changing environments as sources of technological knowledge have become widely dispersed. Technology commercialization process has to be proficiently conducted for the acquired technologies to be linked to economic value for firms, universities or public research institutes which have offered technologies to firms as principal entities of commercialization. In developed countries, creating economic value with technologies resulted from R&D requiring lots of resources commitment has been an important interests of both managers in private firms and policy makers for a long time. Recently, interests in the technology commercialization increase in both public and private sectors in Korea as well. Notwithstanding, even actual situations of technology commercialization activities are not enough surveyed even though recognition of importance of technology commercialization is gradually increased. Mostly, previous literatures on the technology commercialization activities in Korea focus on public sectors, but this research investigates particularly the technology commercialization activities within private firms, the major principals of technology commercialization, because most of technology commercialization activities are implemented by private established firms in

Korea.

To our knowledge, there are lacks of knowledge regarding factors determining the success of technology commercialization at the project level even though previous literatures reviewed in the paper provide multi-dimensional implications for success factors of technology commercialization. This study is expected to supplement prior knowledge as to how we can foster the technology commercialization in private sectors and what factors could determine the success of commercialization projects, based on the unique survey of private firms which their commercialization projects are closely linked to the governmental programs supporting technology commercialization. To do this, this study tried to shed lights on the success conditions of technology commercialization by focusing on contextual factors around firms rather than internal organizational factors. We can summarize the results as follows; first, the market size the technology commercialization projects targeted(MKSIZE) is an important factor positively related to the success of technology commercialization projects of firms. Second, the success of technology commercialization projects of firms is strongly and negatively affected by the factors directly conditioning the technological innovation activities of firms like the environmental regulations. However, other governmental regulations such as the entry regulation (ENTRG), the domestic market protection regulation(MKPROT), the domestic protection strength of the intellectual properties rights(IPRST) has no significant effects on the success of technology commercialization projects. Third, regarding the governmental efforts to support technology commercialization of firms, we could ascertain that some of programs intending to increase the demand or specialized in commercializing technology have significant impacts on the success of technology

commercialization projects of firms. Specifically, the governmental programs supporting the new products or technology authentication and the products development phase of commercialization process only have effectiveness on the technology commercialization within firms, but other various programs seem to be no significant effects on the success of the commercialization projects.

This study overcomes limitations of prior studies at firm level by empirically analyzing the success factors for technology commercialization at the project level within firms. Moreover, it is highly meaningful because it is first systemic research examining technology commercialization activities of firms in Korea using the unique survey. It is also expected to contribute to design governmental policies more effective for technology commercialization in private sectors.

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기업의 기술사업화 프로젝트 성공요인에 관한 실증연구

권영관* · 박종복**

기업의 기술사업화에 관한 다양한 이론적 모형과 실증연구들이 존재함에도 불구하고 기존의 연구들은 실제 기업의 기술사업화 프로젝트 수준에서 그 성공가능성에 영향을 미치는 요인들에 대한 시사점을 충분히 제공해 주지 못하고 있다. 본 연구는 기존의 연구를 보완하여 한국의 기업들을 대상으로 한 설문조사 자료를 기반으로 기업의 기술사업화 프로젝트의 성공에 영향을 미치는 요인들을 실증분석을 통해 탐색하였다. 기업의 기술사업화 촉진에 관한 정책적 시사점을 도출하기 위해 기업의 내부적 요인보다는 기업을 둘러싼 외부환경과 정책적 요인에 초점을 맞춰 연구를 수행하였다. 분석한 결과, 신제품 또는 신기술 인증과 같이 기술사업화 프로젝트가 목표로 하고 있는 신기술이나 신제품에 대한 수요 창출과 관련된 요인이나 사업화 프로세스 중 제품화 단계에 대한 정책적 지원이 기술사업화 프로젝트의 성공에 긍정적인 요인이 되는 것으로 밝혀졌다.

Keyword

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