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A Empirical Study on the Moderating Effect of Influencing Factors over R&D Output Commercialization in ICT Industry

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Abstract

Objectives: Up to now, many studies on commercialization of R&D output (Research and Development output) (technology) have been conducted. The present study tried to identify the influencing factors in ICT industry and analyzed the relationship of those factors. **Methods/Statistical Analysis**: To answer two research questions, this study was carried out with the researchers in the research institutes of ICT private firms, which take 75% of total R&D investment in Korea: first, "Is there a hierarchical structure among influencing factors over the success or failure in commercialization of R&D output?" and second, "Do internal and external factors of a company affect the success of commercialization of R&D output?". **Findings**: The results of this research demonstrated (i) that internal and external factors of a company play moderating role between business feasibility of R&D output and the success of commercialization and (ii) that external factors of a company have a greater moderating effect than internal factors of a company. **Improvements/Applications**: When the internal and external factors of a company were sub-divided, it was found that the ability to use technology, supporting system for commercialization, financial status but executives will and interest among the internal factors of a company and macro-economic situations and government's policy support but legal/institutional arrangement among the external factors of a company affect the success/failure of commercialization of R&D output.

Keywords: Commercialization, Influential Variables (Factors) of Technology Transfer and Commercialization, R&D Output, Technology Commercialization, Technology Transfer, Technology Valuation

1. Introduction

Technology gap leads to difference in economic standard. These days, technology gap causes income gap among countries. And inability to convert technology values into goods and services for national infrastructure and market can limit economic ripple effect. Accordingly, it is important to link researches in technology and goods and service to the activities of commercialization[1]. In 2014, total research and development (R&D) expenditure of Korea was 63.7 trillion KRW (the 6th in the world), increasing 7.5% from the previous year and it took 4.3% (the second in the world, following

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to Israel) of the nominal GDP of the nation. In addition, most of financial resources for R&D come from private sectors (75%) and most of R&D projects are ordered by the government (78%)[2]. In addition, many studies support that as consumer's needs have rapidly changed, R&D investment is used as one of corporate strategies to create differentiated competitiveness in a market, and has a significant effect on business performance[3–5]. According to Booz & Company Annual Report on 1,000 global companies, however, high level of R&D investment does not always lead to good business performance. Although Google, Apple, Samsung, and Toyota have lower rate of R&D investment than their competitors, they show good business performance whereas Nokia and Intel show low business performance despite of high R&D investment[6]. In this respect, the Korean government and private organizations have tried various promotion policies for technology commercialization to raise the success rate of commercialization of R&D output and established several organizations to support it[7–9]. However, patent transfer rate (that is an index for actual commercialization for R&D success rate) and research productivity (e.g. royalty) in Korea are quite lower than advanced countries. In general, R&D output is a comprehensive concept regarding output or outcome that an R&D project yields and this output is used to produce goods and services, sold in a market, or reduces cost[10]. Based on this broad concept, a number of studies have been carried out on transfer activation and commercialization of R&D output[11–14], but few researches have systematically analyzed the relationship among influencing factors over technology transfer and commercialization, being limited to the use of empirical data of private companies[15]. In this respect, the present study is aimed to conduct an empirical study on ICT private firms to find the effect of influencing factors over commercialization of R&D output upon success/failure of the commercialization, and to contribute insightful findings to maximizing commercialization of R&D output.

2. Theoretical Background and Literature Review

2.1 Definition of R&D Out and Commercialization

According to Article 2 (Paragraph 8) of Act on National R&D Project, Etc Performance Assessment and Management, R&D output is classified into primary outcome and secondary outcome: primary output includes science and technology output (e.g. patent and research paper based on R&D), and secondary output includes other tangible/intangible economic, social, and cultural output.

In their theoretical model for R&D output assessment, a study divided influencing factors over commercialization into research output and outcome from R&D output and defined research output as a product of knowledge such as patent, new product, and process, research paper, and knowledge, and defined research outcome as generating a specific economic value such as cost reduction or sales increase[16].

The other study divided R&D output into scientific and technological research output and research impact, and suggested research paper, patent, goods, prototype, and standard as scientific and technological research output, and divided research impact into scientific and technological impact, economic impact, social impact, and policy impact[17]. With this categorization, they set the scope of R&D output to embrace research output such as research paper and patent, which are acquired as result of performing R&D project, and R&D outcome such as economic outcome and social/cultural ripple effect impact that result from research output. A paper explained that R&D output comes from the process in which invented technology by R&D investment is shaped in a form of a right; a contract for technology transfer goes to effect with a company through negotiation; income is made from technology transfer[18]. In short, they defined it as a result from the process of transferring an invention or knowledge asset of university to a profit-seeking entity such as company and commercializing it.

In this research paper, R&D output is defined as research output that can be commercialized, including research paper, patent, prototype, which are generated through R&D activity, on the basis of precedent studies. In addition, Act on Technology Transfer and Commercialization Promotion (Para. 3 of Article 2) domestically defines 'commercialization' as developing, producing, or selling a product by using technology, or improving technology related to the foregoing process. The research defines 'technology commercialization' as a series of process of supplementing technological resources with various information and knowledge; producing salable goods; actually selling them in a market; and maximizing profit out of it[19]. The other study defined technology commercialization as a series of process of connecting developed technology to goods and making them marketable[20]. In[21] technology commercialization as creating a new product or/and new business using technology or knowledge, or a series of activity that innovates technology related to the foregoing process[21]. In[22] considered technology commercialization

as consisting of acquisition of idea connected to each stage of R&D, idea reinforcement with complementary asset, improving salable goods and selling in a market[22]. The term 'technology commercialization' can be switched with other synonyms such as popularization, practicability, industrialization, or corporatization according to researcher's preference or the characteristics of applied sector, but it is commonly interpreted as 'activity of value generation and the process through transferring, spreading and applying R&D output'.

As for technology commercialization, it is important to develop technology itself, but more important to utilize developed technology. Therefore, as open system has been introduced for technological development, technology acquisition, and commercialization, technology acquisition and commercialization are designed and practiced in a variety of ways[23]. Act on Technology Transfer and Commercialization Promotion (Article 2), In [24,25]classify the type of technology commercialization into transfer, granting a right of implementation, technology guidance, collaborative research, technology-based business incubation, joint venture or M&A, direct investment and the likeas shown in Table 1[24,25].

2.2 Studies on Influencing Factors over Commercialization of R&D Output (Technology)

Most of existing studies on commercialization of R&D output focus on technology transfer, buyer and seller of R&D output, and various external environment and influencing factors over the success of commercialization[25–31]. And Many studies examined the intrinsic value factors of R&D output such as technology, market, and business feasibility to see if they affect the success/failure of commercialization and asserted that the intrinsic values of R&D output are important for the success of commercialization[32–35].

According to the researches, it is known that resource capability of a company that commercialize R&D output such as manpower size, connectivity of technology, and R&D investment of a company, and government's R&D policy and support are getting more important[36–38].

In addition,[39] maintained that technology resources contribute only 1% to the determination of the values of technology commercialization and 10% is decided by a 'viable' business model of a company[39]. Therefore, 89% of technology business value depend on how it is implemented. In other words, the influencing factors over technology commercialization are closely related to not only technology itself but also to peripheral environment. Therefore, when the influencing factors on the success of technology commercialization are examined, it is desirable to look into both intrinsic values of technology, market, and business, and extrinsic factors such as external environment of a company as shown in Table 2.

However, most of existing research into technology transfer and commercialization have been conducted on the impact on commercialization of R&D output by factor or the extent to or path through which those factors

Table 1. Type of technology commercialization

Classification		Key Contents of Commercialization
Technology Transaction	Collaborative Research	A technology transferor conducts collaborative research for the purpose of technology transfer to a technology transferee
	Transfer	A technology transferor transfers ownership of technology to a technology transferee
Technology Licensing	Right of Implementation	A technology transferor permits right of implementation of technology to a technology transferee
	Technology Guidance	A technology transferor provides a technology transferee with education/training for application of technology, often coming with license.
Technology Joint Venture	Joint Venture	A technology transferor and a technology transferee establishes the third company and promote commercialization
	M&A	A technology transferee merges and/or acquires a technology transferor with necessary technology and managerial infrastructure so the former can promote commercialization
Technology Direct Investment	Spin-Off	An affiliated employee (a technology transferor, researcher, etc.) is transferred employee invention and sets up a new company or joins the new company
	Technology Holding Company	A technology transferor (public research institute, etc.) establishes a technology holding company, invests holding technology in a form of capital, and run a subsidiary company to commercialize technology

Table 2. Division of influencing factors over commercialization of R&D output (Technology)

Influencing Factors		Component
IntrinsicValue	Technology	Technology Difficulty
		Technology Completeness
		Technology Novelty (Relevance to Existing Technology)
		Technology Compatibility. (Ripple Effect)
	Market	Market Size
		Growth Potential
		Competitive Intensity
	Business	Easy to Commercialize
		Possibility of New Sales Generation
		Business Feasibility (Competitiveness)
ExtrinsicFactors	Inside Company (Internal Environment)	Technology Affinity(Technology Resource Capability)
		Available Resource (Financing Capability)
		Commercialization Support Process
		Communication and Participation
		CEO's Support and Will
	Outside Company (External Environment)	Macro-Economic Situations (Demand/Growth Rate)
		Government's Policy Support Program
		Legal/Institutional Support

have effect on the commercialization. Therefore, it can be said that the relationship among the influencing factors have not been systematically analyzed so far. Particularly, few studies have been carried out on how the internal and external factors of a company are related to the intrinsic value factors that closely affect the success/failure of commercialization of R&D output.

With this blind spot focused, this research set sales generation or cost reduction through new creation of goods and service as a yardstick for the success of commercialization of R&D output: accordingly, it sets as independent variable (i) the intrinsic values of R&D output and (ii) the extrinsic factors of a company that affect the success of R&D output commercialization. And then, an empirical study was conducted on ICT private firms to demonstrate the impact of those independent variables on the success of R&D output commercialization and the relationship among them.

3. Research Model and Hypothesis

3.1 Research Model

Based on feasibility assessment model, business feasibility, which was suggested as influencing factor over commercialization of R&D output in [5, 35, 40] was defined as intrinsic value to R&D output, including technology factors and market factors[5,35,40].

And the internal characteristics and external environment of a company were set as extrinsic factors. The internal characteristics of a company includes executives' will and interest, ability to use technology, commercialization support system, and financial status (investment) as influencing sub-factor while the external environment factors of a company consist of economic environment (region and growth rate), the extent of legal/institutional arrangement, and policy support program.

This study set the internal and external factors of a company influencing over commercialization of R&D output as moderating variable and examined the impact of business feasibility, which is the intrinsic value of R&D output on the success of commercialization as shown in Figure 1. And the success of R&D output commercialization, which is a dependent variable in this model, means a possibility that goods and service are developed from R&D output, sold in a market, and as a result generate sales or improve profitability.

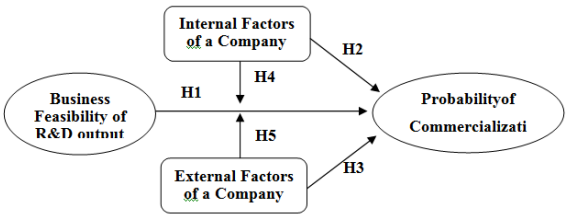

Figure 1. Research model for moderating effect of extrinsic factors on commercialization of R&D output.

3.2 Hypothesis

3.2.1 Business Feasibility of R&D Output

H1: Business feasibility of R&D output will have a positive effect (+) on success of commercialization of R&D output.

1. Ease of commercializing R&D output will have a positive effect (+) on success of commercialization of R&D output.
2. Possibility of generating new sales from R&D output will have a positive effect (+) on success of commercialization of R&D output.
3. Competitiveness of R&D output will have a positive effect (+) on success of commercialization of R&D output.

According to [5,27,41] it was suggested that new market generation or existing market expandability, competitiveness, low barrier to market, profitability and the like have effect on the success of R&D output commercialization[5,27,41]. In his empirical study on the relationship the assessment index of technology and the success of technology commercialization, proved that the commercial viability of technology has a positive effect on the success of commercialization of technology[42]. In addition[43] reported that the competitiveness of a technology-based product and R&D information expansion system influence the transferability of technology[43].

3.2.2 Company Internal/External Factors on R&D Output

H2: Internal factors of a company will have a positive effect (+) on success of commercialization of R&D output.

1. Executives' will and interest will have a positive effect (+) on the success of commercialization of R&D output.
2. Ability to use technology of a company will have a positive effect (+) on the success of commercialization of R&D output.
3. Technology commercialization support system of a company will have a positive effect (+) on the success of commercialization of R&D output.
4. Financial status of a company will have a positive effect (+) on the success of commercialization of R&D output.

In this study, executives' will for and interest in commercialization, ability to use technology of a company, technology commercialization support system of a company, financial status of a company were considered as influencing internal factors of a company over technology transfer and commercialization. According to [44] CEO's strong will for technology commercialization can lead to the success of commercialization[14,44]. And among company's capabilities, it is most important in the process of technology transfer and commercialization to understand technology acquired from outside and secure an ability to adjust and utilize it to a company[45–49]. In [13,28,31,43] demonstrated that an exclusive team for technology transfer (Technology Licensing Organization: TLO) and technology support system have a positive effect on technology transfer and commercialization[13,28,31,43].

H3: External (environment) factors of a company will have a positive effect (+) on success of commercialization of R&D output.

1. Macro(regional) economic situation (growth rate) will have a positive effect (+) on success of commercialization of R&D output.
2. Government's policy support program will have a positive effect (+) on success of commercialization of R&D output.
3. Legal/institutional arrangement will have a positive effect (+) on success of commercialization of R&D output.

In the precedent studies, it was found that the external economy of a company and policy/institutional environment is important factors to affect the commercialization of R&D output and the expansion of outcome. The characteristics of government's policy and institutional system, and the consistency of government's R&D investment[50-53] and the extent to which government implements the supporting programs for technology transfer and commercializationwere proved to have effect on R&D output commercialization[54-58]. In [38] demonstrated that the integration of world economy, finance and slowdown of growth, change of economic structure are the influencing factors over technology commercialization[38].

3.2.3 The Moderating Effect of Company's Internal/External Factors on Success of Technology Commercialization

The studies on the impact of (i) business feasibility, (ii) internal factors and (iii) external factors of a company on the success of commercialization can be categorized into 2 groups: one group sub-divides one of the three factors and examine how each sub-factor moderates the impact of business feasibility on the success of commercialization[5,55]

and the other examines how two of the three factors moderate the impact of business feasibility on the success of commercialization[14,25,27,38,59].

However, since the latter researches focused on the impact of influencing factors on the success of commercialization of R&D output, there have been few studies to examine the relationship among the influencing factors over the success of commercialization of R&D output.

Based on the precedent researches, the present study could set 3 hypotheses on the impact of the influencing factors (business feasibility, internal factors of a company, and external factors of a company) over the success of commercialization and the relationship among the factors.

H4: The effect on business feasibility of R&D output and success of commercialization will be affected by internal factors of a company.

H5: The effect on business feasibility of R&D output and success of commercialization will be affected by external (environment) factors of a company.

4. Research Method

4.1 Operational Definition of Variables

To analyze the impacts of the influencing factors over the success of commercialization and their relationship, this study sub-divided each of 3 independent variables into 3 or 4 observed variables and prepared the questions to measure each sub-variable. Those questions were selected from the precedent studies research and revised, and measured with 7-point Likert scale (1: least agree; ~ 7: most agree).

First, business feasibility is sub-divided into 3 variables (ease of commercializing R&D output, new sales generation, and business competitiveness). Second, the internal factors of a company consist of 4 sub-variables (executives' will and interest in commercialization, ability to use technology of a company, support system of a company, and financial status of a company). Third, the external (environment) factors of a company is divided into 3 sub-variables (macro-economic situations of a nation (region) including growth rate, government's support policy and program (e.g. financial support), and legal/institutional arrangement). Table 3 summarizes the influencing variables over the success of commercialization of R&D output and the operational definition of the variables.

4.2 Data Collection and Sampling

To collect data necessary to test the research model, this study carried out a survey with questionnaires on the researchers who are currently conducting an R&D project in one of domestic private companies in ICT industry. And considering the fact that the survey was conducted on R&D projects in operation, this study distributed

Table 3. Influencing factors over the success of commercialization of R&D output and operational definition

Classification	Key Influencing Factors		Measuring Variables
Independent Variable	Business Feasibility	Easy to Commercialize	Seven-point scale (1: Least Agree ~ 7: Most Agree)
		Possibility of Generating New Sales	
		Business Competitiveness	
Moderating Variable	Internal Factors of a Company	Executives' Will and Interest	
		Ability to Use Technology	
		Supporting System for Commercialization	
		Financial Status	
	External (Environment) Factor of a Company	Macro-Economic Situations	
		Government's Support Policy and Program	
		Legal/Institutional Arrangement	
Dependent Variable	Success of Commercialization		

questionnaires evenly among the researchers in order to cover the entire scope of R&D projects and avoid bias to certain projects.

Online survey method was adopted for a total of 500 researchers and 208 responded as shown in Table 4, which records about 50% response rate.

5. Results

The purpose of this study is to firstly find out the effect of (i) business feasibility of R&D output, (ii) the internal factors of a company, and (iii) the external (environment) factors of a company upon the success of commercialization of R&D output, and secondly to examine the moderating effect of the internal and external factors of a company on the success of commercialization of R&D output. To achieve the purpose, hierarchical multiple regression analysis and moderated regression analysis including interactive terms were conducted according to the procedure that[59]. Data were processed and analyzed by SPSS Statistics 22 program. The validity of the research model was verified and the verified measurement model was used to test the hypotheses with hierarchical multiple regression analysis and moderated regression analysis.

The final number of the questionnaires approved for analysis is 205 after excluding 3 due to outliers.

5.1 Reliability and Validity Analysis

Factor analysis was used to test the convergent validity and discriminant validity of measuring instruments (construct models).Exploratory factor analysis showed that all the variables but executives' will and interest (EIF1) converged in 3 factors as shown in Table 5. And the factor loading of each variable was greater than 0.7, which verifies the convergent validity of constructs.

Correlation matrix of the factor analysis demonstrated that those constructs are properly discriminated as shown in Table 6.

As shown in Table 7 reliability analysis shows $p=0.000<0.05$, Cronbach's $\alpha > 0.7$, which confirms that the measures are reliable. However, Cronbach's α increase when executives' will and interest (EIF1) is deleted from the internal factors of a company. Therefore, executives' will and interest (EIF1) was deleted.

5.2 Hypothesis Test

5.2.1 *Effect of Business Feasibility of R&D Output and Internal/External Factors of a Company on the Success of Commercialization*

Multiple regression analysis was conducted to know the effect of business feasibility of R&D output on the success of commercialization, using SPSS program. Because

Table 4. The demographic characteristics of the samples

Classification		Frequency (Number of Person)	Percentage (%)
Age	20s	25	13.0%
	30s	73	35.1%
	40s	95	45.7%
	50s	13	6.3%
Gender	Male	162	78.8%
	Female	44	21.2%
Service Year	Less Than 5 Years	79	38.9%
	6~10 Years	40	19.2%
	11~15 Years	26	12.5%
	16~20 Years	22	10.6%
	More Than 21 Years	39	18.8%

Table 5. The results of exploratory factor analysis (rotated component matrix)

Classification	Component		
	1	2	3
BF 1	.449	**.701**	.017
BF 2	.215	**.876**	-.014
BF 3	.050	**.866**	.096
EIF1	.139	.393	.370
EIF2	**.814**	.118	.187
EIF3	**.828**	.230	.151
EIF4	**.821**	.194	.146
EEF1	.141	.100	**.741**
EEF2	.078	.086	**.877**
EEF3	.180	-.061	**.800**

Table 6. The results of exploratory factor analysis (correlation matrix)

Classification	BF1	BF2	BF3	EIF1	EIF2	EIF3	EIF4	EEF1	EEF2	EEF3
BF1	**1.000**	.682	.518	.157	.413	.506	.433	.199	.147	.084
BF2	.682	**1.000**	.643	.299	.280	.361	.334	.107	.095	.015
BF3	.518	.643	**1.000**	.308	.209	.262	.259	.151	.148	.048
EIF1	.157	.299	.308	**1.000**	.227	.282	.282	.170	.253	.259
EIF2	.413	.280	.209	.227	**1.000**	.601	.582	.295	.219	.258
EIF3	.506	.361	.262	.282	.601	**1.000**	.654	.220	.241	.250
EIF4	.433	.334	.259	.282	.582	.654	**1.000**	.226	.217	.239
EEF1	.199	.107	.151	.170	.295	.220	.226	**1.000**	.573	.404
EEF2	.147	.095	.148	.253	.219	.241	.217	.573	**1.000**	.613
EEF3	.084	.015	.048	.259	.258	.250	.239	.404	.613	**1.000**

Table 7. The results of reliability analysis

Classification	Component (pattern matrix)			Cronbach's α if items are deleted	Cronbach's α
	1	2	3		
BF 1	.311	-.025	**.695**	.783	**0.826**
BF 2	.059	-.054	**.887**	.681	
BF 3	-.127	.082	**.897**	.810	
EIF2	**.838**	.055	-.041	.790	**0.821**
EIF3	**.845**	.006	.066	.721	
EIF4	**.851**	-.003	.023	.741	
EEF1	-.003	**.775**	.089	.751	**0.772**
EEF2	-.061	**.904**	.055	.573	
EEF3	.110	**.789**	-.140	.726	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy					.782
Bartlett's Identity Matrix Test				Approximate Chi-square	738.770
				df	36
				Level of Significance	.000

Durbin-Watson ratio is approximate to 2, it was confirmed that there is no auto-correlation between error terms. And because it turned out that tolerance is approximate to 1 and VIF (Variance Inflation Factor) is below 10, it is less likely the variables have multicollinearity between them.

The relationship between business feasibility of R&D output and internal/external factors of a company was analyzed in sub-factor level and the result showed that all of them but legal/institutional arrangement (EEF3) of the external factors of a company met level of confidence ($p<0.05$) as shown in Table 8. In addition, because all of their standardized coefficient (β) were positive, which means they have a positive effect (+) on the success of commercialization.

Table 8. The results of regression analysis on business feasibility of R&D output and internal/factors of a company

Classification	Non-standardized Coefficient		Standardized Coefficient (β)	t	Level of Significance	Collinearity Statistic		Durbin-Watson
	B	S.D.				Tolerance	VIF	
BF1	.393	.064	.420	6.093	.000	.524	1.909	2.037
BF2	.171	.077	.172	2.227	.027	.420	2.382	
BF3	.223	.066	.222	3.372	.001	.574	1.741	
EIF1	.154	.055	.151	2.786	.006	.903	1.108	1.698
EIF2	.315	.071	.302	4.443	.000	.576	1.736	
EIF3	.169	.063	.198	2.693	.008	.492	2.031	
EIF4	.180	.058	.224	3.094	.002	.509	1.966	
EEF1	.357	.067	.384	5.346	.000	.667	1.499	1.773
EEF2	.151	.070	.178	2.142	.033	.498	2.008	
EEF3	.085	.076	.083	1.119	.265	.620	1.612	

※ Dependent variable: success of commercialization

5.2.2 Moderating Effect of Internal/External Factors of a Company

An interactive term was made for each variable and hierarchical regression analysis (SPSS program) was conducted on them to confirm the moderating effect of internal/external factors of a company on the relationship in which business feasibility of R&D output has effect on the success of commercialization.

As for the moderating effect of internal factors of a company in Table 9, hierarchical regression analysis showed that Durbin-Watson ratio is equal to 1.851 (approximate to 2), which confirms that there is no auto-correlation between error terms. And because it turned out that tolerance is approximate to 1 and VIF is below 10, it is less likely the variables have multicollinearity between them. Model 1 analyzed only the effect of the sub-variables of the business feasibility of R&D output upon the success of commercialization. And the results showed that the explanatory power of Model 1is R2=0.322 and verified that the model is fit (F=96.351, p=0.000) and the business feasibility of R&D output has a positive effect (+) on the success of commercialization. In model 2, where the internal factors of a company are added to Model 1, it turned out that R2 is equal to 0.567, which is 0.245 higher than Model 1, and also Model 2 was proved to be fit (F=36.08, p=0.000). Interactive terms were formed with independent variables multiplied by moderating variables and added to Model 3. As a result, it turned out that R2 is 0.567, which is 0.01 higher than Model 2, and Model 3 is also fit (F=-43.587, p=0.000). Therefore, it was confirmed that the internal factors of a company have a positive moderating effect on the relationship between the business feasibility of R&D output and success of commercialization.

As for the moderating effect of external factors of a company, hierarchical regression analysis showed that Durbin-Watson ratio is equal to 1.951 (approximate to 2), which confirms that there is no auto-correlation between error terms. And because it turned out that tolerance is approximate to 1 and VIF is below 10 (VIF<2), it is less likely the variables have multicollinearity between them. Model 1 showed the same results as in the case of the moderating effect of internal factors of a company. In Model 2, where the external factors of a company were added to Model 1, it turned out that R2 is 0.501, which is 0.179 higher than Model 1 and Model 2 is fit (F=36.08, p=0.000). Interactive terms were formed with independent variables multiplied by moderating variables and added to Model 3. As a result, it turned out that R2 is 0.523, which is 0.22 higher than Model 2, and Model 3 is also fit (F=-43.587, p=0.000). Therefore, it was confirmed that the external factors of a company have a positive moderating effect on the relationship between the business feasibility of R&D output and success of commercialization.

Furthermore, because standardized coefficient (β) of the interactive term for internal factors of a company

Table 9. Model summary

Variables	Model	R	R square	Adjusted R square	Standard error of estimate	Statistic Change				Durbin-Watson
						R-Square Change	F Change	df1	Level of Significance	
Internal Factors of a Company	1	.567[a]	.322	.319	1.020	.322	96.351	1	.000	1.851
	2	.753[b]	.567	.563	.816	.245	36.08	1	.000	
	3	.755[c]	.570	.564	.816	.003	-43.587	1	.000	
External Factors of a Company	1	.567[a]	.322	.319	1.020	.322	96.351	1	203	1.951
	2	.708[b]	.501	.496	.877	.179	72.353	1	202	
	3	.723[c]	.523	.516	.859	.022	9.402	1	201	

Table 10. Coefficients (business feasibility, internal/external factors of a company, success of commercialization)

Variables	Model	Non-standardized Coefficient		Standardized Coefficient (β)	t	Level of Significance	Collinearity Statistic	
		B	S.D.				Tolerance	VIF
Company Internal Factors	1 (Constant)	4.517	.071		63.432	.000		
	Business Feasibility	.701	.071	.567	9.816	.000	1.000	1.000
	(Constant)	4.517	.057		79.216	.000		
	2 Business Feasibility	.701	.057	.567	12.258	.000	1.000	1.000
	Internal Factors	.612	.057	.495	10.705	.000	1.000	1.000
	(Constant)	4.517	.057		79.273	.000		
	Business Feasibility	.717	.059	.580	12.187	.000	.944	1.060
	Internal Factors	.605	.057	.490	10.526	.000	.988	1.012
	3 Interactive Term (Business Feasibility* Company Internal)	.066	.058	.054	1.136	.075	.933	1.072
Company External Factors	1 (Constant)	4.517	.071		63.432	.000		
	Business Feasibility	.701	.071	.567	9.816	.000	1.000	1.000
	(Constant)	4.517	.061		73.742	.000		
	2 Business Feasibility	.701	.061	.567	11.411	.000	1.000	1.000
	External Factors	.522	.061	.423	8.506	.000	1.000	1.000
	(Constant)	4.517	.060		75.260	.000		
	Business Feasibility	.689	.060	.558	11.431	.000	.996	1.004
	External Factors	.507	.060	.411	8.407	.000	.994	1.006
	3 Interactive Term (Business Feasibility* Company External)	.176	.057	.150	3.066	.002	.990	1.010

a. predictor: (constant), business feasibility
b. predictor: (constant), business feasibility, internal factors of a company
c. predictor: (constant), business feasibility, internal factors of a company, company internal interaction
d. dependent variable: success of commercialization

(business feasibility*internal factors of a company) turned out 0.054, which is lower than the standardized coefficient (β)=0.150 of the interactive term for external factors of a company (business feasibility*external factors of a company), it was confirmed that the moderating effect of external factors of a company is relatively higher than that of internal factors of a company as shown Table 10.

5.2.3 The Results of Hypothesis Test

The results of this study demonstrated that the independent variables ((i) business feasibility of R&D output, (ii) the internal factors of a company, and (iii) the external factors of a company have a positive effect (+) on the dependent variable (the success of commercialization of R&D output). In sub-variable level, however, executives' will and interest (EIF1) of the internal factors of a company (EIF) had factor loading (eigenvalue) lower than 0.5 in exploratory factor analysis and when EIF1 was deleted from EIF, Cronbach's α increased. Therefore, hypothesis for EIF1 was rejected. In addition, when regression analysis was conducted with the success of commercialization (CSF) as dependent variable, legal/institutional arrangement (EEF3) of the external factors of a company (EEF) turned out p=0.265, which failed to meet level of significance ($p<0.05$). As a result, hypothesis for EEF3 was rejected.

It was demonstrated that both internal and external factors of a company have a positive moderating effect on the relationship in which business feasibility of R&D output (independent variable) has effect on the success of commercialization (dependent variable). In addition, it was confirmed that the moderating effect of external factors of a company is relatively higher than that of internal factors of a company on the relationship in which business feasibility of R&D output has a positive effect on the success of commercialization as shown Table 11.

6. Conclusion and Limitations

Many studies have so far been conducted to find the influencing factors over the success of commercialization of R&D output (technology), but mainly focused on their direct effect.

That is, especially because many of those studies tried to know the direct impact of such sub-factors as R&D investment, company internal competence, and company management capability, which are the extrinsic factors of R&D output, on the success/failure of commercialization of R&D output, without duly considering the intrinsic values of R&D output factors, they brought forth contradicting results to each other.

Therefore, there has been little explanation of the effect of variables acting between the intrinsic values and extrinsic factors of R&D output (technology) on the success of commercialization of R&D output.

Furthermore, few studies divided the influencing factors of R&D output into intrinsic and extrinsic values and examined and compared the separate effect of them on the success of commercialization.

In this respect, the present study analyzed the relationship between intrinsic values and the internal and external environment factors of a company while having effect on the success of commercialization of R&D output. This attempt was attributed to the need to clearly define the characteristics of variables that many researches have been lacking in studying the influencing factors over the commercialization of R&D output. In this study, the researcher wanted to examine the characteristics of sub-factors: (i) business feasibility as the intrinsic value of R&D output; (ii) executives' will and interest, ability to use technology, commercialization support system, financial status of a company as internal factor of a company under the extrinsic factors of R&D output; (iii) macro-economic situations, government's policy support, legal/institutional arrangement as external factor of a company under the extrinsic factors of R&D output. The results of analysis showed that both internal and external factors of a company moderate the effect of business feasibility of R&D output on the success of commercialization. And the external factors of a company have a greater moderating effect than internal factors of a company on the relationship in which business feasibility of R&D output has a positive effect on the success of commercialization. By sub-variable, ability to use technology, supporting system for commercialization, and financial status of a company, which are internal factors, had significant moderating effect, but executives' will and interest was rejected due to low reliability. On the other hand, macro-economic situations and government's policy support, which are external factors, had significant moderating effect, but legal/institutional arrangement was not significant.

This study has a practical implication: business feasibility of R&D output, internal and external factors of a company should be considered all together to improve the commercialization of R&D output. It means that R&D

Table 11. The results of hypothesis test

Influencing Sub-Factors			hypothesis	Classification
Business Feasibility	H1		**Business feasibility of R&D output will have a positive effect (+) on success of commercialization of R&D output.**	Accepted
	Easy to Commercialize	BF1	Ease of commercializing R&D output will have a positive effect (+) on success of commercialization of R&D output.	Accepted
	Possibility of Generating New Sales	BF2	Possibility of generating new sales from R&D output will have a positive effect (+) on success of commercialization of R&D output.	Accepted
	Business Competitiveness	BF3	Competitiveness of R&D output will have a positive effect (+) on success of commercialization of R&D output.	Accepted
Company Internal Factors	H2		**Internal factors of a company will have a positive effect (+) on success of commercialization of R&D output.**	Accepted
	Executives' Will and Interest	EIF1	Macro(regional) economic situation (growth rate) will have a positive effect (+) on success of commercialization of R&D output.	Rejected
	Ability to Use Technology	EIF2	Legal/institutional arrangement will have a positive effect (+) on success of commercialization of R&D output.	Accepted
	Supporting System for Commercialization	EIF3	Government's policy support program will have a positive effect (+) on success of commercialization of R&D output.	Accepted
	Financial Status	EIF4	Macro(regional) economic situation (growth rate) will have a positive effect (+) on success of commercialization of R&D output.	Accepted
Company External Factors	H3		**External (environment) factors of a company will have a positive effect (+) on success of commercialization of R&D output.**	Accepted
	Macro-Economic Situations	EEF1	Macro(regional) economic situation (growth rate) will have a positive effect (+) on success of commercialization of R&D output.	Accepted
	Government's Support Policy and Program	EEF2	Government's policy support program will have a positive effect (+) on success of commercialization of R&D output.	Accepted
	Legal/Institutional Arrangement	EEF3	Legal/institutional arrangement will have a positive effect (+) on success of commercialization of R&D output.	Rejected
Moderating Effect	H4 (Internal Factors of a Company)		**The effect on business feasibility of R&D output and success of commercialization will be affected by internal factors of a company.**	Accepted
	H5 (External Factors of a Company)		**The effect on business feasibility of R&D output and success of commercialization will be affected by external (environment) factors of a company.**	Accepted

output requires ability to use technology, supporting system for commercialization, and investment. And when related industry environment such as macro-economic situation and government's policy support program has properly settled, the success of commercialization of R&D output can improve.

This study has limitations. Sampling is biased to large ICT companies so that it can't represent ICT population and to the internal employees of ICT company so that their responses could lead to statistical distortion without correcting.

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