Asian Journal of Innovation and Policy (2015) 4.3: 328--359
DOI: http//dx.doi.org/10.7545/ajip.2015.4.3.328

Performance Effect of the Fits between Industrial Environment, Innovation Capacity and Innovation: Focusing on Innovation-Intensive Korean Firms

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Abstract To explain the performance gap between firms in the same industry, this study focuses on innovation. It provides a new framework using the dynamic-capability view based on empirical analysis of domestic businesses. The findings of this study are as follows: First, when the uncertainty and competition intensity in the business environment and the level of innovation have "fit", it means that when the former goes up, so does the latter. In this regard, when the innovation capability of a firm is high, being "fit" means that the level of innovation is also high. When there was fitting innovation on industrial environment and innovation capacity, companies were able to achieve relatively high performance. Also, it was confirmed that instead of innovation for innovation capacity, innovation for industrial environment led to relatively higher performances of firms.

Keywords Innovation, industrial environment, innovation capacity, fit

I. Introduction

What determines the performance gap among businesses? The currently available literature can be divided into two streams: one focuses on external environmental factors such as market structures, and the other focuses on the firm's internal resources and capabilities. Previous literature has provided various important implications, but there is still no clear explanation about inter-firm performance gap within the same industry (Nelson, 1991; Zott, 2003). To answer this question, this study focuses on the firm's capabilities and its "fit" with the industrial environment. According to the dynamic-capabilities view, which was evolved from the resource-based view, the

Submitted, October 10, 2015; 1st Revised, December 10; Accepted, December 10.

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strategic choices made by the firm in responding to environmental changes in the industry as well as its abilities to dynamically reallocate resources are crucial factors in the firms' performance.

Schumpeter (1934) famously argued that economic development is mainly driven by an innovative process called "creative destruction." Since then, there has been much research on how innovation occurs in firms, and how it is related to their performance, survival and growth. In the process of developing and commercializing new products, services, and processes (Thompson, 1965), innovation may create new business opportunities and markets, and remarkably improve performance (Kim, 1997). Moreover, innovation is indispensable to creating and maintaining a competitive advantage (Wolfe, 1994; Eisenhardt and Brown, 1999). These studies point to the significance of examining the innovation capability of firms.

Based on the dynamic-capability view, this study examines the effect of "fit" between technological innovation capability and industrial environment on firm performance. To do this, we analyzed data from a survey of domestic manufacturers by industrial groups. The result shows that firms with a high degree of fit between its industrial environment and innovation, and between its innovation capability and innovation have better financial and non-financial performance than its counterparts. Moreover, the fit between innovation and the industrial environment was shown to have a greater effect on improving firm performance than the fit between innovation and innovation capability. This study offers a comprehensive empirical analysis that includes external changes in industrial environment and dynamic distribution of internal resources, and thus is particularly notable in that it provides an effective measure of establishing and implementing strategies for innovation.

Section 2 proposes hypotheses based on the analysis of the theoretical background and review of previous studies. Section 3 explains the research methodology. Section 4 provides and discusses the results of the analysis. Section 5 explains the results and discusses their implications.

II. Literature Review and Hypotheses

1. Relationship between Industrial Environment and Innovation

The performance of firms is not solely determined by a single factor, but is conditioned by interactions between various factors including the surrounding environment, internal resources, and business strategy (Wren, 1987). This implies that proper response to environmental change is an indispensable factor in business management. In fact, there are studies showing that strategies supporting existent competitive advantages may no longer be valid when disruptive technology emerges (Tushman and Anderson, 1986; Henderson and Clark, 1990; Leonard-Barton, 1992; Afuah, 2000; D'Aveni, 2000). Teece et al. (1997) criticized the resource-based view as static and propounded the dynamic perspective as an alternative, arguing that firms need to modify and change their core capability continually. Other studies support this view, showing how dynamic capabilities play an important role in determining firms' performance in several sectors (Henderson and Cockburn, 1994; Iansiti and Clark, 1994; Kale, 1999; Zollo, 1998).

The uncertainty in the environment surrounding firms always changes over time. Uncertainty, in this context, refers to the extent to which external environmental elements change dynamically, as they can be very complicated and unpredictable. The two metrics by which environmental uncertainty is measured are complexity and dynamics (Lawrence and Lorsch, 1967; Duncan, 1972; Hunt and Osborn, 1974; Yasai, 1986). If complexity is high, the environment is difficult to predict or control. The level of complexity becomes higher when the capacity of the industrial environment is exceeded, there is a high variety of production technologies, or there are diverse distribution channels (Child, 1972). Dynamics is a concept that explains the changes in the external environment. Environmental dynamics differ according to consumer desire, the competitors' strategy, and the launch of new products (Burns and Stalker, 1961; Myers and Marquis, 1969).

Earlier research implies that firms change their strategies with the increase in environmental uncertainty, which could lead to different patterns in choosing their innovation strategy. According to Poter (1980), firms seek to maintain their competitive advantage by differentiating their products and services when environmental uncertainty is high. Gupta and Govindarajan (1984) agreed with Poter's (1980) argument and proved that when uncertainty is high, differentiating from competing brands through marketing could be an effective strategy. Raubitschek (1988) also argued that when the environment is dynamic and prediction is difficult, firms tend to pursue product differentiation. When environmental uncertainty is high, firms tend to change their innovation strategy by providing differentiated products or services. As such, this study draws the following hypothesis:

- Hypothesis 1: Industrial environment is related to innovation.
- Hypothesis 1-1: Uncertainty of industrial environment is positively related to innovation.

Competition intensity within the market is also a major factor in firms' strategic decision-making (Zahra and Nielsen, 2002; Li et al., 2012). When competition intensity is high, firms tend to seek innovation by investing in R&D to maintain their competitive advantage (Porter, 1980). Meanwhile, Cash and Konsynski (1985), Iacovou et al. (1995) claimed that when competition intensity is high, firms tend to improve efficiency in their overall supply chain to improve operational efficiency and customer satisfaction. In management perspective, this kind of effort increases attention and investment on 'innovation of the business process'. Inter-firm competition leads to competition between the value chain and the supply chain. A cooperative relationship between business processes and information systems is considered to be crucial. Thus, to manage those elements, process capability and human capital were considered as very crucial to improvement of firm performance.

As such, when the competition intensity increases, firms seek cost-saving measures and improved efficiency, and firms will prefer new types of innovation to conventional ones. Thus, the relationship between competition intensity and innovation could be hypothesized as follows:

- Hypothesis 1-2: Competition intensity is positively related to innovation.

2. Relation between Innovation Capability and Innovation

A firm's capability refers to specific resources that help firms to maintain a competitive advantage, or know-how and knowledge in how to efficiently utilize those resources (Diericks and Cool, 1989; Stalk, Evans and Schulman, 1992; Grant, 1991). To maintain a competitive advantage, firms need to make an effort to adjust to changes in the external environment and need to have internal competence (Andrews, 1971; Chandler, 1962; Hofer and Schendel, 1978). Innovation capability refers to the internal ability to successfully implement or apply new ideas, products and processes (Burns and Stalker, 1961). With a high innovation capability, firms can integrate new innovations into their activity and achieve sustainable success (Burgelman et al., 2004).

When a firm has a high technological innovation capability, it is more likely to launch successful new products and adopt more efficient manufacturing processes (Bowen, Clark and Holloway, 1994; Day and Wensley, 1988; Gatingnon and Xuereb, 1997). Similarly, a high technology commercialization capability attracts skilled human resource by providing market feedback in the process of idea development, market analysis, and market testing (Clark and Fujimoto, 1991; Song and Parry, 1997; Yoon and

Lilien, 1985; Yam et al., 2004). In addition, it will also have major impacts on marketing innovation and human innovation, as it is a capability to make new product successful.

Based on this argument, the paper hypothesizes the relationship between innovation capability and innovation as follows:

- Hypothesis 2: Innovation capability is related to innovation.
- Hypothesis 2-1: Technological innovation capability is positively related to innovation
- Hypothesis 2-2: Technology commercialization capability is positively related to innovation.

3. Firm Performance and Fit between Industrial Environment or Innovation Capability and Innovation

According to the contingency theory, there is no one ideal organization type that is always efficient. Since the most efficient organization type differs depending on the level of uncertainty, there is only the most appropriate organization and organizational management systems for specific circumstances (Lawrence and Lorsch, 1967). Scott (1981) describes contingency theory in the following manner, "The best way to organize depends on the nature of the environment to which the organization must relate." Therefore, firm performance depends on the correspondence among various factors, namely, fit. When fit is improved due to consistency among the elements of business, firm performance also improves (Dess and Beard, 1984; Hambrick, 1983; Scott, 1987).

Meanwhile, fit can be divided into three categories: 'fit between external environment and strategy', 'fit between internal environment and strategy', and 'integrated fit between external environment and internal environment’ (Venkatraman and Camillus, 1984). Miller & Friesen (1983) proved that the fit between external environment and strategy plays an important role in enhancing short-term financial performance. Studies done on contingency theories commonly conclude that firms with high performance have higher fit between environmental characteristics and strategy than other competitors (Hambric, 1983; Miller, 1988, 1991; Venkatraman and Prescott, 1990). In this aspect, industrial environment and innovation have a dynamic correlation, and it would be reasonable to predict that fit between these two variables will be positively correlated with business performance. Thus, the third hypothesis of this study is as follows:

- Hypothesis 3-1: The fit between industrial environment and innovation will have a positive relation with firm performance,
- Hypothesis 3-1-1: The fit between industrial environment and innovation will be positively correlated with financial performance,
- Hypothesis 3-1-2: The fit between industrial environment and innovation will be positively correlated with non-financial performance.

To improve performance, firms tend to seek strategies that fit their innovation capability. Gatingnon and Xuereb (1997) showed that firms with high technology capability have a higher chance of developing new products, and that firms with technology manpower have a higher chance of pursuing new processes. Thus, we can conclude that high technology capability and manpower contribute to a better firm performance. Booz et al. (1982), in their empirical analysis, showed that technology commercialization capability had a significant impact on new product development and eventually had a positive impact on firm performance. Yam et al. (2004) analyzed market information through the lens of marketing capability, and argued that a firm can improve its performance by increasing its marketing capability by enhancing competitiveness of market information collection, product development, or production. In sum, innovation capability affects the direction of strategic decision-making, and when businesses adopt a "fit strategy" on innovation capability, it is predicted that there is positive effect on firm performance. Based on this, the following hypothesis was deduced:

- Hypothesis 3-2: The fit between innovation capability and innovation will be positively related to firm performance.
- Hypothesis 3-2-1: The fit between innovation capability and innovation will be positively related to financial performance.
- Hypothesis 3-2-1: The fit between innovation capability and innovation will be positively related to non-financial performance.

The question remains as to which "fit" is more significant when it comes to firm performance: the fit between industrial environment and innovation, or the fit between innovation capability and innovation? On one hand, some scholars argue that the technological environment is more significant when it comes to determining a business' innovation (Love and Roper, 2003; Dodgson and Rothwell, 1994; Freeman and Soete, 1999; Tidd et al., 2009). On the other hand, some argue (Renko et al., 2009) that internal capabilities, including technology capability, market orientation, and entrepreneurial orientation, are more important. Yet others (Daniel and Pervaiz, 2006) emphasize the internal elements of business management, including management leadership, human resource management, knowledge management and creative management. Synthesizing the above scholarship, this study suggests that innovation is the result of change in the technological environment, internal capabilities of the firm, and business management practices. Existing research, however, does not provide a clear picture of how the significance of external and internal environments changes in certain conditions. Regarding this question, YuiJin Song (1998) argued that the environment is the most important factor by showing that they had a bigger effect on innovation than internal factors, according to the survey results of 'Korean Technology Innovation Survey on Manufacturing Industry' conducted in 1996. To be more specific, environmental elements were the most significant factors for new production innovation, process innovation and product improvement. Empirical analysis supports the view that the market environment was the most significant element.

Taking into account the aforementioned studies, the following is our hypothesis regarding the relative importance of the fit between industrial environment and innovation, and between innovation capability and innovation on business performance.

- Hypothesis 3-3: The fit between industrial environment and innovation, and the fit between innovation capability and innovation will be related to firm performance.
- Hypothesis 3-3-1: The fit between industrial environment and innovation will have a stronger positive relationship with firm performance than the fit between innovation capability and innovation.

Figure 1 is the research model that displays the above hypothesis in diagram.

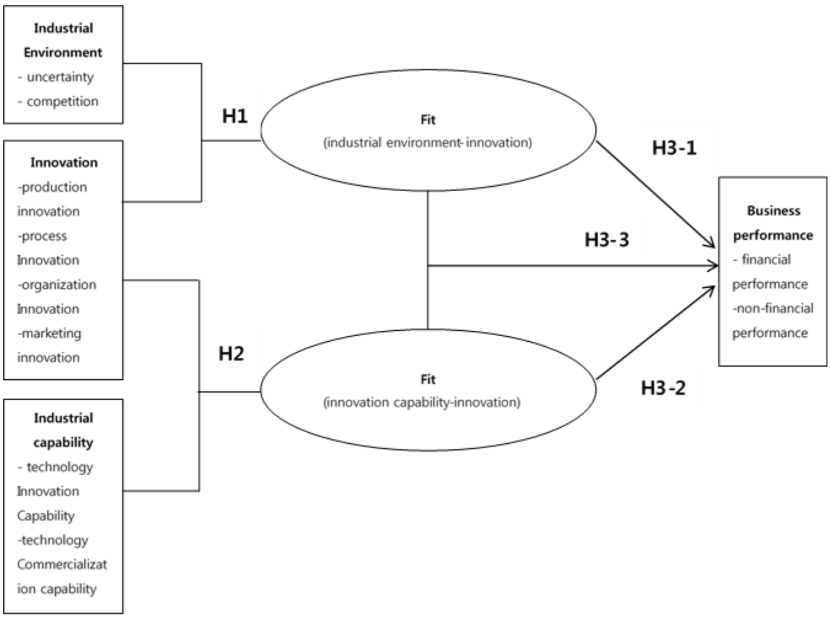

Figure 1 Research model

III. Research Methodology

1. Data Collection and Analysis

To examine our hypothesis, a survey was conducted on domestic firms. Firms in high-tech and medium high-tech industries were selected, as both industries place a heavy emphasis on R&D. This allowed us to analyze changes in industrial environment, the fit between innovation capability and innovation, and the gap in business performance. A total of 10 industries from two groups were selected for the survey.

The survey was carried out by a reputable market research firm mainly through e-mail and fax, although telephone surveys and interviews were also conducted depending on the respondents' availability. The survey was conducted between May 1 and May 30, 2015; some 3,000 businesses were asked to complete the survey, and a total of 223 surveys were returned. This exception of nine surveys with missing values or flaws, 214 surveys were analyzed. In order to ensure reliability and validity, executives in strategy or planning department who were fully aware of decision-making process of innovation were chosen as respondents. This study used SPSS 18.0 to analyze basic data and statistics to verify the hypothesis.

Table 1 Data industries

High-tech industry	Medium high-tech industry
(1) Aircraft and spacecraft (2) Pharmaceuticals (3) Office, accounting and computing machinery (4) Radio, TV and communications equipment (5) Medical, precision and optical instruments	(1) Electrical machinery and apparatus, n.e.c. (2) Motor vehicles, trailers and semi-trailers (3) Chemicals excluding pharmaceuticals (4) Railroad equipment and transport equipment, n.e.c. (5) Machinery and equipment, n.e.c.

2. Operational Definition and Measurement of Variables

In this study, the concept and estimation of variables were evaluated by using the scale of Likert 5. To compare and analyze change over time, respondents were asked to fill out the measurements twice, once for the year 2010 and once for the year 2015. The years of 2010 and 2015 were selected because we wanted to choose a time frame that was sufficiently long to measure change, yet not so long ago as to negatively affect recollection by the respondents.

2.1 Industrial Environment

The industrial environment of this study measures recognized environment. The level of competition, along with uncertainty (dynamics, complexity) were selected as factors within the industrial environmental. Questions that measure the dynamics and complexity of the environment were composed of 10 items derived from previous research by Miller & Friesen (1983), Child (1972), and Dess and Beard (1984). Items that measure competition intensity were composed of five questions based on the items used in Zahra and Nielsen’s 2002 study. The operational definition and measurement of each variable are shown in Table 2.

Table 2 Operational definition and measurement of industrial environment

Industrial Environment	Sub-factor	Operational definition	Measurement
Uncertainty	Dynamics	Level of complexity surrounding external environment of business	- Frequency of launching new product - Trend cycle of customer's taste - Degree of retail network - Degree of shortened product lifespan - Degree of demand
	Complexity		- Technology diversification applicable for new product development - Complexity of sales route and retail network - Diversification of production line within industry - Diversification of customer and market - Diversification of related business
Competition intensity	-	Various competition intensities surrounding business	- Competition intensity regarding brand differentiation - Competition intensity between companies within same industry - Competition intensity of sales and sales promotion - Degree of launching product's variety - Development speed of production technology

2.2 Innovation Capability

To classify and measure innovation capability, this study categorizes it into technology innovation capability and technology commercialization capability, and measures the sub-factors under each category according to the Oslo Manual by the OECD (2005). For measurement, we use items from Yam et al. (2004) and Yap and Souder (1994), which are based on the premise of "Technology Innovation Evaluation Index for SMEs" which reflects the Oslo Manual. After adjustments, 18 items for technology innovation capability and 20 items for technology commercialization capability were used in our survey. The operational definition and measurement item of each variable are arranged in Table 3.

Table 3 Operational definition and measurement of innovation capability

Classification of innovation capability	Sub-factor	Operational definition	Measurement
Technology innovation capability (Performing organizational capability that develops, introduces and adopts new products, services, ideas, and technology in the production process)	R&D capability	Systematic organizational capability to obtain and utilize science and technology in the organizational level	-Management of R&D special team -Clarity of R&D goals -R&D personnel's devotion to learning new technology -R&D investment rate -Procurement of R&D equipment and tool
	Technology accumulation capability	Organizational capability to effectively hold or accumulate technical resources	-Acquisition of key technology -Uniqueness of holding technology -Difficulty of holding technology -Acquisition of various technologies -Combination of self-developed technology and adopted technology -Experience in developing key technology -Securing right of holding technology
	Technology innovation system	Management system to effectively carry out technological innovation or network between organizations	-Technology development plan -Analysis system of market information -Network with external institution -Availability of internal and external resources -Scientific and reasonable research project -Systematic management of the results of technological developments

Technology commercialization capability (Performing organizational capability that develops, produces and sells products and services by using new technology)	Commercialization capability	Commercializing organizational capability to integrate technology with products and processes in order to successfully launch new products	-Standardization of the product development process -Excellence in product design system -Acquisition of key technology in the production process -Materialization of help technology into product -Technological analysis of product function -Systematic management of technology standardization -Cooperation with external institutions related to technology commercialization
	Production capability	Transitional organizational capability that places and operates production facilities so that a product that satisfies customers' needs could be launched, based on technology that is developed, introduced and adopted.	-Excellence of production management system -Efficient management of production facility -Automation of production facility -Management of production process -Management of measurement and test tool -Inspection and quality control -Facilitation of procuring raw material and components
	Marketing capability	Organizational capability that plans or implements products, services in retail and sales to satisfy the needs of customers.	-Implementation of systematic marketing strategy -Analysis of product's life cycle -Understanding competitors' products -Establishing a customer-oriented system -Securing marketing channels -Excellency in marketing manpower

2.3 Fit

This study uses the 'interactive approach' proposed by Van and Drazin (1985) on measuring situational variables including industrial environment, innovation capability and "fit" of innovation. To measure the fit between situational variables and structural variables, ANOVA (Analysis of Variance), regression analysis, and deviation score method were proposed. Meanwhile, Venkatraman (1989) proposed the concept of "goodness of fit" which is a similar concept to "interactive fit" as the related variables exist in harmony. ANOVA, deviation score method, and residual analysis were proposed for measurement methods. Therefore, this study uses ANOVA as proposed by Venkatraman (1989) to measure the fit between industrial environment and innovation, and the fit between innovation capability and innovation. After the measurement, this study classifies the respondents into a group with fit and a group without fit, in 2010 and 2015, respectively.

2.4 Innovation Type

In accordance with innovation object, innovation type is divided into four types including product innovation, process innovation, organization innovation, and marketing innovation. The Korean Innovation Survey (KIS) from the Science and Technology Policy Institute (STEPI), which is based on the Oslo Manual, was adjusted in order to be used as this study's operational definition and measurement. KIS investigates the innovation activities of enterprises in Korea and presents statistical tables and data. This study uses a total of 39 measurement items on innovation type. Table 4 below shows the operational definitions and measurements.

Table 4 Operational definition and measurement of innovation type

Innovation type	Operational definition	Measurement
Product innovation	In the case when contribution was made to sales after launching a completely new product/service or improved product/service)	-Launching a completely new product -Launching a highly improved product -Launching a product for the first time in the market -Launching a product for the first time from the business -New products' sales contribution -Being the main player in new product development -Cooperative relationship in new product development -Effectiveness of new product development -Protection method and availability of product innovation -Duration of developing new product -Average life cycle of calculated knowledge after development of new product

Process innovation	In the case when improvement of production·retail structure, reduction of delivery cost and quality improvement were made after adopting a completely new or improved method in the production process or delivery system, including retail.	-Implementation of a completely new or highly improved production process -Implementation of a completely new or highly improved logistics -Implementation of a completely new or highly improved support system -Implementation of a new process for the first time in the market -Implementation of a new process for the first time in the business -Being the main player in new process development -Cooperative relationship in new process development -Effects of developing new process -Cost saving effects of new process -Protection method and availability of process innovation -Duration of developing new processes -Life cycle of calculated knowledge after new process development
Organization innovation	In the case when new organizational management methods, including new business process, knowledge management, strengthened business flexibility and improved relation with external organization were made.	-Implementation of changed project delivery system -Implementation of changed knowledge management -Implementation of changed management including business flexibility and integration between departments -Implementation of a new relationship with external organization -Cost saving effects of organization innovation -Being the main player in organization innovation -Cooperative relationship in developing organization innovation -Effects of adopting organization innovation
Marketing innovation	In the case when huge changes in sales and marketing were made, such as new product design or packaging, product promotion, product display or product price.	-Change in product design and packaging -Implementation of a new advertising medium or marketing strategy including launching new brands -Implementation of new product strategies including product display and new sales channels -Implementation of new pricing method including price reduction and price differentiation -Sales contribution of adopting marketing innovations -Being the main player of marketing innovation -Cooperative relationship of developing marketing innovation -Effects of developing marketing innovation

2.5 Business Performance

In this study, business performance was divided into financial and non-financial performance. Govindarajan and Fisher (1990) and Gupta and Govindarajan (1984) argued that subjective performance indicators are preferable to objective performance indicators in terms of controlling industrial effect to measure business performance and in terms of comparing with competitors to measure competitive advantage. In this study, business performance in terms of competitive advantage was measured by using subjective performance indicators. Here, the term competitive advantage refers to the degree of predominance compared with major competitors or the industrial average. This study measures business performance as compared with major competitors and the industrial average.

Based on the items on Govindarajan and Fisher (1990) and Gupta and Govindarajan (1984), six items, including measuring market share, and sales and profit, were adopted for financial performance. Based on the items used in Dalton et al. (1980), six more items, including measuring product quality, customer satisfaction, and job satisfaction were adopted, adding up to a total of 12 items. Specific measurement items are shown below in Table 5.

Table 5 Operational definition and measurement of business performance

	Sub-factor	Operational definition	Measurement
Business performance	Financial performance	Comprehensive performance of financial and non-financial results considering various elements including environment, capability, and strategy	-Market share compared with major competitors -Market share compared with industrial average -Accomplished sales amount compared with major competitors -Accomplished sales amount compared with industrial average -Accomplished profit compared with major competitors -Accomplished profit compared with industrial average
	Non-financial performance		-Product quality compared with major competitors -Product quality compared with industrial average -Customer satisfaction compared with major competitors -Customer satisfaction compared with industrial average -Job satisfaction compared with major competitors -Job satisfaction compared with industrial average

IV. Results and Discussion

1. Preliminary Analysis

1.1 Composition of Data

To examine the general characteristics of the sample, frequency analysis was used on surveyed businesses. The result of frequency analysis is as below in Table 6.

Table 6 General characteristics of surveyed firms

Construct	Items	Number	%
Industry	Aircraft and spacecraft	10	4.7
	Pharmaceuticals	20	9.3
	Office, accounting and computing machinery	20	9.3
	Radio, TV and communications equipment	34	15.9
	Medical, precision and optical instruments	16	7.5
	Electrical machinery and apparatus, n.e.c.	21	9.8
	Motor vehicles, trailers and semi-trailers	33	15.4
	Chemicals excluding pharmaceuticals	19	8.9
	Railroad and transport equipment, n.e.c.	7	3.3
	Machinery and equipment, n.e.c.	34	15.9
Employee	Under 50	36	16.8
	Under 50~100	63	29.4
	Under 100~500	85	39.7
	Under 500~1,000	12	5.6
	Over 1,000	18	8.4
Sales scale (per year)	5 ~ 10 hundred million won	22	10.3
	10 ~ 50 hundred million won	23	10.7
	50 ~100 hundred million won	19	8.9
	100 ~ 500 hundred million won	78	36.4
	over 500 hundred million won	64	30.0
	No response	8	3.7
Founding year	Before 1979	53	24.8
	1980 ~ 1989	45	21.0
	1990 ~ 1999	65	30.4
	2000 ~ 2009	45	21.0
	After 2010	6	2.8
Position (subject of questionnaire)	Department head	197	92.0
	Senior executive	16	7.5
	Top executive	1	0.5
Target market	Domestic market	146	68.2
	Global market	68	31.8
Total		214	100

1.2 Factor Analysis

To verify the validity, this study carried out factor analysis. To extract the organizing factor, all measurement variables used principle component analysis and adopted varimax. This study followed the standard format used in social science of using eigen value greater than 1.0 and factor loading greater than 0.4 to analyze the data. The results from this analysis show that the “high R&D investment to sales within the industry” item, within the “R&D capability“ category was the only item below 0.4 of factor loading out of all innovation capability, and thus it was erased from the items.

1.3 Reliability Analysis

The reliability of this study was examined by using Cronbach's alpha. Nunnally (1978) has indicated that when Cronbach's alpha falls above 0.7, it is to be an acceptable reliability coefficient. After conducting a reliability analysis on measurement variables in the groups, the result shows that all Cronbach's alpha coefficients were above 0.7, which supports this study’s reliability. In other words, all the concepts were measured accurately and coherently from the survey respondents.

Table 7 Result of reliability analysis

Constructs		Number of items	Cronbach α	
			2010 년	2015 년
Industrial environment	Dynamics	5	.870	.884
	Complexity	5	.843	.877
	Competition intensity	5	.900	.899
Innovation capability	R&D capability	4	.882	.884
	Technology accumulation capability	7	.928	.919
	Technology innovation system	6	.934	.923
	Commercialization capability	7	.913	.918
	Production capability	7	.905	.905
	Marketing capability	6	.913	.900
Innovation	Production innovation	5	.907	.908
	Process innovation	5	.890	.878
	Organization innovation	4	.907	.878
	Marketing innovation	4	.893	.902
Performance	Financial performance	6	.918	.908
	Non-financial performance	6	.890	.889

1.4 Correlation Analysis

The correlation analysis provides results for both 2010 and 2015. The analysis of correlation among variables shows that all the variables commonly had positive (+) correlations in both 2010 and 2015, and the relative number of correlation coefficient was used to supplement hypothesis verification.[1]

2. Verification of Research Hypotheses

2.1 Verification of Hypothesis 1

The correlation coefficient among sub-factors in industrial environment and innovation is 0.2-0.4, which shows a low positive (+) correlation. To be more specific, uncertainty, competition intensity and changing trend in innovation were examined through t-test from 2010 to 2015.

Table 8 The t-test result on change of industrial environment and innovation

Constructs	Mean		t	p
	2010	2015		
Uncertainty Competition intensity	2.9808 3.2729	3.3383 3.8075	5.072 6.619	.000** .000**
Industrial environment	3.0782	3.4972	6.056	.000**
Product innovation Process innovation Organization innovation Marketing innovation	2.8598 2.6897 2.8411 2.6776	3.3037 3.1411 3.3727 3.1460	5.156 5.672 6.544 5.691	.000** .000** .000** .000**
Firm's innovation	2.7671	3.2409	6.815	.000**

*p< .05, **p< .01

T-test results show that the average value of uncertainty and competition intensity increased in 2015 compared to that of 2010. In other words, 2015 was more uncertain and competitive than 2010. As the average value of uncertainty and competition intensity in the industrial environment increased, businesses generally perceived the industrial environment more uncertain and competitive. Average value of product innovation, process innovation, organization innovation and marketing innovation also increased in 20015

[1] Detailed result of correlation analysis is attached as reference.

compared to 2010. In other words, the level of innovation rose in 2015 compared to 2010. As the average value of business innovation, comprised of four types of innovation, increased, in can be concluded that businesses are carrying out higher levels of innovation in 2015 than in 2010.

Table 9 T-test result on high and low industry group on innovation

Constructs		Mean		t	p
		Low industry	High industry		
2010	Product innovation	2.7100	3.4402	4.712	.000**
	Process innovation	2.7650	3.2276	3.046	.003**
	Organization innovation	2.9188	3.4770	3.966	.000**
	Marketing innovation	2.5500	3.2830	4.817	.000**
2015	Product innovation	2.9222	3.4972	4.476	.000**
	Process innovation	2.8472	3.2901	3.562	.000**
	Organization innovation	3.1076	3.5070	3.408	.001**
	Marketing innovation	2.7396	3.3521	4.886	.000**

*p< .05, **p< .01

To confirm the gap in levels of innovation between the businesses that considered industrial environment as uncertain and competitive, and the ones that did not, this study divided businesses into two groups. Using the t-test on the industrial environment index, the businesses that scored three (out of five) or above were classified into one group and the businesses that scored below three into another. The result shows that businesses that considered uncertainty and competition as high showed high levels of innovation in both 2010 and 2015 compared to the businesses that did not consider uncertainty and competition as high. Lastly, to understand the correlation between changes in industrial environment and changes in innovation, regression analysis were used to measure variable volumes in 2010 and 2015.

Regression analysis shows that uncertainty and competition intensity are positively (+) correlated with product innovation, process innovation, organization innovation, and marketing innovation. The comprehensive result reveals that uncertainty and competition intensity of the industrial environment increased from 2010 to 2015; thereby also raising the level of innovation. Also, businesses that were highly aware of uncertainty and competition intensity of the industrial environment performed high level of innovation. Industrial environment and innovation were in positive (+) correlation. Thus, the hypothesis 1-1 and 1-2 of this study were supported to be true.

Table 10 Regression analysis between in industrial environment and innovation

Dependent variable	Independent variable	ß	S.E.	t	P
Product innovation	Uncertainty Competition intensity	.374 .388	.077 .075	5.868 6.125	.000** .000**
	R^2=.136, R^2 as amended=.131, F=33.234 R^2=.150, R^2 as amended=.146, F=37.521				
Process innovation	Uncertainty Competition intensity	.368 .418	.081 .071	5.765 6.704	.000** .000**
	R^2=.140, R^2 as amended=.136, F=34.428 R^2=.175, R^2 as amended=.171, F=44.949				
Organization innovation	Uncertainty Competition intensity	.338 .391	.073 .067	5.235 6.184	.000** .000**
	R^2=.114, R^2 as amended=.110, F=27.410 R^2=.153, R^2 as amended=.149, F=38.242				
Marketing innovation	Uncertainty Competition intensity	.401 .375	.069 .065	6.375 5.886	.000** .000**
	R^2=.161, R^2 as amended=.157, F=40.635 R^2=.140, R^2 as amended=.136, F=34.640				

*p< .05, **p< .01

2.2 Verification of Hypothesis 2

Correlation analysis shows that the correlation coefficient of sub-factors was 0.4-0.6, which shows a relatively strong positive (+) correlation. To be more specific, technology innovation capability, technology commercialization capability and change in innovation from 2010 to 2015 were examined by t-test. The results show that the average value of technology innovation capability and technology commercialization capability were higher in 2015 than that of 2010. In other words, both technology innovation capability and technology commercialization capability increased from 2010 to 2015. The average value of innovation capability comprised of technology innovation capability and technology commercialization capability increased, and therefore, comprehensive innovation capability also increased. As mentioned previously, the average value of product innovation, process innovation, organization innovation, and marketing innovation increased in 2015 compared to 2010; thus, the level of innovation also increased.

Table 11 T-test result on change in innovation capability and innovation

Constructs	Mean		t	p
	2010	2015		
Technology innovation capability	3.1315	3.5173	4.904	.000**
Technology commercialization capability	3.1414	3.5476	6.086	.000**
Innovation capability	3.1365	3.5325	5.707	.000**
Product innovation	2.8598	3.3037	5.156	.000**
Process innovation	2.6897	3.1411	5.672	.000**
Organization innovation	2.8411	3.3727	6.544	.000**
Marketing innovation	2.6776	3.1460	5.691	.000**
Firm's innovation	2.7671	3.2409	6.815	.000**

*p< .05, **p< .01

Based on the innovation capability index on a scale of 1 to 5, this study divided the group into two to confirm the innovation gap between businesses with high innovation level and businesses with low innovation level. One group was for businesses rated three and above, and the other group was for businesses rated below three on a scale of 1 to 5. By using the t-test, we can understand the relationship between innovation capability and innovation.

Table 12 T-test result of high and low innovation capability

Constructs		Mean		t	p
		Low innovation capability	High innovation capability		
2010	Product innovation	2.4273	3.5306	8.016	.000**
	Process innovation	2.4409	3.3224	6.439	.000**
	Organization innovation	2.6136	3.5691	7.676	.000**
	Marketing innovation	2.3920	3.3412	6.770	.000**
2015	Product innovation	2.4755	3.5764	8.724	.000**
	Process innovation	2.5321	3.3416	6.293	.000**
	Organization innovation	2.7406	3.5807	7.094	.000**
	Marketing innovation	2.3915	3.3944	7.877	.000**

*p< .05, **p< .01

Analysis results reveal that businesses with high innovation capability had high levels of innovation both in 2010 and 2015 than its counterparts. This can be interpreted causally, as businesses with high innovation capability pursuing a relatively high level of innovation. To understand the correlation between change in innovation capability and change in innovation, regression analysis on variable volume was carried out in 2010 and 2015.

Table 13 Regression analysis between innovation capability and innovation

Dependent variable	Independent variable	ß	S.E.	t	P
Product innovation	Technology innovation capability Technology commercialization capability	.728 .611	.052 .070	15.445 11.246	.000** .000**
	R^2=.529, R^2 as amended=.527, F=238.555 R^2=.374, R^2 as amended=.371, F=126.465				
Process innovation	Technology innovation capability Technology commercialization capability	.795 .562	.043 .071	19.091 9.905	.000** .000**
	R^2=.632, R^2 as amended=.631, F=364.460 R^2=.316, R^2 as amended=.313, F=98.105				
Organization innovation	Technology innovation capability Technology commercialization capability	.666 .671	.074 .061	12.999 13.165	.000** .000**
	R^2=.444, R^2 as amended=.441, F=168.963 R^2=.450, R^2 as amended=.447, F=173.309				
Marketing innovation	Technology innovation capability Technology commercialization capability	.559 .628	.079 .062	9.804 11.764	.000** .000**
	R^2=.312, R^2 as amended=.309, F=96.124 R^2=.395, R^2 as amended=.392, F=138.395				

*p< .05, **p< .01

Regression analysis confirms that technology innovation capability and technology commercialization capability are positively (+) correlated with product innovation, process innovation, organization innovation, and marketing innovation. Comprehensive analysis shows that technology innovation capability and technology commercialization capability of innovation capability were higher in 2015 than that of 2010; thus, the level of innovation also increased. Businesses with high innovation capability performed a higher level of innovation than its counterparts. Thus, hypothesis 2-1 and 2-2 of this study were supported.

2.3 Verification of Hypothesis 3

As mentioned above, uncertainty and competition intensity of industrial environment, as well as innovation capability were higher in 2015 than that of 2010. The level of innovation also increased, as confirmed by hypothesis 1 and 2. When uncertainty and competition intensity of the industrial environment increase, the level of innovation increases. And when innovation capability increases, the level of innovation also increases. In other words, when uncertainty and competition intensity go up, being “fit” means the level of innovation also goes up. In this regard, when innovation capability is high, being “fit” means that the level of innovation is also high.

Instead of directly adopting the concept of fit, this study redefined the concept of fit as having two aspects – the fit between industrial environment and innovation, and the fit between innovation capability and innovation. This is supported by supported hypothesis 1 and 2. The significance of this fit on business performance is supported by hypothesis 3. The state of a business can be categorized into four types, according to the fit between industrial environment and innovation, the fit between innovation capability and innovation, and the level of innovation. First, when the uncertainty and competition intensity of industrial environment are high, and the level of innovation is also high, the two can be said to "fit". As such, when uncertainty and competition intensity of industrial environment are low, and the level of innovation is low the two are fit. On the other hand, when the uncertainty or competition intensity of industrial environment are low, but the innovation level is high, or when uncertainty and competition of industrial environment are high but level of innovation is low, these are not considered as fit situations.

Based on the industrial environment index and the innovation index, this study divides its samples into total of four groups (2*2), with groups that are either above or below three on a scale of 1 to 5, and with groups that fulfill or not fulfill the fit. As shown below in Table 14, businesses that belong to the 1st (A) and 3rd (C) quadrants fulfilled the fit but businesses in the 2nd (B) and 4th (D) quadrants did not. This method also applies to the fit between innovation capability and innovation. To examine the gap in the average values of the different groups, one way ANOVA was conducted. The result of this analysis is shown in Table 15, in which the groups were titled Group A, B, C, and D for convenience. The analysis shows equal variance, so we use results of Scheffe.

Table 14 Four types of groups according to the fit

<table>
<tr><td rowspan="3">Innovation level

⑤
④
③
②
①</td><td>Incongruity (B)
-Industrial environment (low) & innovation level (high)
-Innovation capability (low) & innovation level (high)</td><td>Fit (A)
-Industrial environment (high) & innovation level (high)
-Innovation capability (high) & innovation level (high)</td></tr>
<tr><td>Fit (C)
-Industrial environment (low) & innovation level (low)
-Innovation capability (low) & innovation level (low)</td><td>Incongruity (D)
-Industrial environment (high) & innovation level (low)
-Innovation capability (high) & innovation level (low)</td></tr>
<tr><td colspan="2">Industrial environment/innovation capability level
①---------②---------③---------④---------⑤</td></tr>
</table>

Analysis shows that A has the biggest average value followed by B, C, and D, except for in one case. Group A, which fulfilled the fit with high innovation level had the highest business performance, followed by Group B, which did not fulfill the fit but had a high innovation level, followed by Group C, which fulfilled the fit but with a low innovation level. Lastly, Group D did not fulfill the fit with low level of innovation, and had the lowest business performance.

Table 15 ANOVA analysis on fit assessment and firm performance

Business Performance	Group	Mean	F / P
2010 Financial performance	A (fit of industrial environment-innovation)	**3.6048**	19.959 /.000**
	B (fit of industrial environment-innovation)	3.1296	
	C (fit of industrial environment-innovation)	**2.8683**	
	D (fit of industrial environment-innovation)	2.7704	
	A (fit of innovation capability-innovation)	3.5718	28.788 /.000**
	B (fit of innovation capability-innovation)	3.1340	
	C (fit of innovation capability-innovation)	2.8333	
	D (fit of innovation capability-innovation)	2.6426	
2010 Non-financial performance	A (fit of industrial environment-innovation)	**3.6551**	26.611 /.000**
	B (fit of industrial environment-innovation)	3.6019	
	C (fit of industrial environment-innovation)	**2.8899**	
	D (fit of industrial environment-innovation)	2.8683	
	A (fit of innovation capability-innovation)	3.6156	33.840 /.000**
	B (fit of innovation capability-innovation)	3.2292	
	C (fit of innovation capability-innovation)	2.7470	
	D (fit of innovation capability-innovation)	2.7468	
2015 Financial performance	A (fit of industrial environment-innovation)	**3.6765**	24.135 /.000**
	B (fit of industrial environment-innovation)	3.5782	
	C (fit of industrial environment-innovation)	**3.0882**	
	D (fit of industrial environment-innovation)	2.7815	
	A (fit of innovation capability-innovation)	3.6301	34.100 /.000**
	B (fit of innovation capability-innovation)	3.0792	
	C (fit of innovation capability-innovation)	2.9048	
	D (fit of innovation capability-innovation)	2.5720	
2015 Non-financial performance	A (fit of industrial environment-innovation)	**3.9412**	33.147 /.000**
	B (fit of industrial environment-innovation)	3.7404	
	C (fit of industrial environment-innovation)	2.9741	
	D (fit of industrial environment-innovation)	2.9359	
	A (fit of innovation capability-innovation)	3.8076	42.012 /.000**
	B (fit of innovation capability-innovation)	3.0476	
	C (fit of innovation capability-innovation)	**3.1375**	
	D (fit of innovation capability-innovation)	2.7917	

*p< .05, **p< .01

In other words, when the level of innovation is the same, businesses that fulfill the fit could have high performance. This result is equally represented in the fit between industrial environment and innovation, and the fit between innovation capability and innovation. However, the fit between innovation capability and innovation on non-financial performance in 2015 was an exception, with the average value in the descending order of A-C-B-D. Instead of Group B that had high innovation but fulfilling the fit, Group C with low innovation but fulfilling the fit had a higher non-financial performance. Even this exceptional case shows the importance of the fit.

Thus, hypothesis 3-1 and 3-2 were both supported. In addition, to analyze the relative importance of the fit between industrial environment and innovation, and the fit between innovation capability and innovation in hypothesis 3-3, the largest average value of business performance in the group was marked in bold in Table 15. As it is indicated, Group A's average value was the largest in the fit between industrial environment and innovation. Namely, this study confirms that Group A's fit between industrial environment and innovation was more significant in affecting business performance than Group A's fit between innovation capability and innovation. This satisfies the fit between industrial environment and innovation, and if the level of innovation is high then this could lead to a high business performance. Although when the level of innovation is low, Group C's fit between industrial environment and innovation had more significance on business performance, except for Group C's fit between innovation capability and innovation. Thus, even when the level of innovation is low, if the fit between industrial environment and innovation is fulfilled, it will also lead to relatively high business performance. Namely, the fit between the industrial environment and the level of innovation is considered more significant for business performance regardless of the time frame. Thus, hypothesis 3-3-1 was supported as well as hypothesis 3-3.

V. Conclusion

The result of empirical analysis of this study is as follows. First, uncertainty and competition intensity of industrial environment was higher in 2015 than that of 2010, and as such the level of innovation also increased. According to the group analysis, businesses that highly recognized uncertainty and competition intensity had higher levels of innovation in all fields including production innovation, process innovation, organization innovation, and marketing innovation. Industrial environment and innovation are positively correlated. When uncertainty and competition intensity of industrial environment increases, the level of innovation also increases.

Second, both technological innovation capability and technology commercialization capability were higher in 2015 than that of 2010, signaling that innovation capability also increased. In addition, the innovation level of businesses also increased. Group analysis shows that the group with high innovation capability has higher levels of innovation in all fields including product innovation, process innovation, organization innovation, and marketing innovation than its counterparts. Innovation capability and innovation have a positive correlation, in which when innovation capability increases, the level of innovation also increases.

Third, this study confirms that when uncertainty and competition intensity of the business environment go up, being 'fit' means that the level of innovation also goes up. In this regard, when innovation capability of the firm is high, being 'fit' means that the level of innovation is also high. When the level of innovation is the same, businesses that satisfy the fit between industrial environment and innovation, and the fit between innovation capability and innovation had relatively higher performance than ones that did not satisfy the fit, both in financial and non-financial performances. In other words, regardless of the level of innovation, if the fit for industrial environment and the fit for innovation capability are fulfilled, it could lead to relatively high firm performance. Also, the analysis of relative influence of the fit between industrial environment and innovation, and the fit between innovation capability and innovation shows that the fit between industrial environment and innovation had more effect on firm performance than the fit between innovation capability and innovation.

It is certain that the findings of this study provide crucial implications in innovation strategy. However, there are some limitations in this study. First, the concept and measurement of fit are limited. In future studies, more sophisticated and effective concept and measurement of fit should be formulated by developing a more systematic and meticulous module of fit. Second, this study focused on ten R&D intensive industries. Thus, the limitation of this study is that its results cannot be generally applied to all industries. Third, the data for this study are based on respondents' subjective views gathered from the survey. Existing research (Shortell and Zajac, 1990) reveal that data collected by the person in charge of functional department is reliable and valid; however, further analysis based on more qualitative data will enhance the reliability on industrial environment, innovation capability, innovation, and firm performance.

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Reference chart − result of correlation analysis

Correlation matrix in 2010

Constructs	Inter-construct correlations														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dynamics	1.00														
Complexity	.645**	1.00													
Competition intensity	.568**	.719**	1.00												
R&D capability	.234**	.281**	.408**	1.00											
Technology accumulation capability	.160*	.248**	.252**	.679**	1.00										
Technology innovation system	.262**	.335**	.333**	.736**	.750**	1.00									
Commercialization capability	.262**	.307**	.272**	.680**	.751**	.817**	1.00								
Production capability	.253**	.278**	.337**	.585**	.606**	.668**	.697**	1.00							
Marketing capability	.241**	.281**	.283**	.565**	.643**	.726**	.741**	.701**	1.00						
Production innovation	.330**	.394**	.312**	.548**	.566**	.677**	.640**	.524**	.571**	1.00					
Process innovation	.486**	.435**	.327**	.401**	.403**	.466**	.480**	.454**	.438**	.604**	1.00				
Organization innovation	.320**	.354**	.302**	.477**	.474**	.606**	.590**	.573**	.568**	.588**	.627**	1.00			
Marketing innovation	.489**	.478**	.367**	.502**	.484**	.636**	.555**	.477**	.542**	.678**	.729**	.678**	1.00		
Financial performance	.173*	.153*	.171*	.396**	.481**	.486**	.543**	.548**	.548**	.468**	.447**	.519**	.416**	1.00	
Non-financial performance	.190**	.239**	.252**	.440**	.595**	.629**	.642**	.626**	.608**	.549**	.458**	.555**	.543**	.747**	1.00

$*p < .05$, $**p < .01$

Correlation matrix in 2015

Constructs	Inter-construct correlations														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dynamics	1.00														
Complexity	.668**	1.00													
Competition intensity	.625**	.751**	1.00												
R&D capability	.138*	.220**	.249**	1.00											
Technology accumulation capability	.186*	.226**	.207**	.712**	1.00										
Technology innovation system	.171*	.295**	.303**	.743**	.758**	1.00									
Commercialization capability	.154*	.285**	.267**	.667**	.763**	.806**	1.00								
Production capability	.171*	.317**	.354**	.524**	.600**	.653**	.708**	1.00							
Marketing capability	.142*	.260**	.272**	.532**	.654**	.758**	.721**	.657**	1.00						
Production innovation	.255**	.395**	.337**	.531**	.604**	.645**	.684**	.536**	.630**	1.00					
Process innovation	.248**	.345**	.271**	.407**	.438**	.523**	.544**	.561**	.458**	.551**	1.00				
Organization innovation	.214**	.340**	.334**	.436**	.522**	.615**	.630**	.605**	.571**	.542**	.661**	1.00			
Marketing innovation	.335**	.457**	.372**	.490**	.525**	.632**	.542**	.496**	.637**	.669**	.545**	.597**	1.00		
Financial performance	.179*	.189**	.117*	.489**	.583**	.579**	.633**	.539**	.619**	.606**	.500**	.569**	.520**	1.00	
Non-financial performance	.135*	.248**	.239**	.457**	.588**	.618**	.651**	.629**	.655**	.618**	.503**	.591**	.566**	.750**	1.00

*p< .05, **p< .01