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Synergy effects of innovation on firm performance☆

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ABSTRACT

The synergy effects of product, process, marketing, and organizational innovation are examined with consideration of the innovativeness levels and industrial categories. This study also investigates the effect of a firm's strategic orientations, exploration and exploitation, on innovation activities. Results indicate that exploration and exploitation orientations have positive impacts on product innovation and process innovation respectively. Process innovation encourages both radical and incremental product innovation. In case of the moderating effect of marketing and organizational innovation, there are some differences between high-tech and low-tech industry. For high-tech firms, the relationship between a new product and firm performance is increased with the introduction of marketing innovation. In the case of low-tech firms, process innovation has direct and positive impacts on a firm's performance with organizational innovation. The findings show that the synergy effects of innovation exist and can be changed depending on the innovativeness levels and industrial categories.

1. Introduction

With the fast pace of technological change, the role of innovation on a firm's survival has received a great deal of scholarly attention (Rubera & Kirca, 2012; Rust, Ambler, Carpenter, Kumar, & Srivastava, 2004; Srinivasan, Pauwels, Silva-Risso, & Hanssens, 2009; Tellis, Prabhu, & Chandy, 2009) and managerial attention (Cheah, Lang, Snowden, & Watts, 2014). However, there are warnings for firms not to rely solely on new products for survival due to possible market failure (Chiesa & Frattini, 2011; Simpson, Siguaw, & Enz, 2006) and/or imitation by competitors (Naranjo-Valencia, Jiménez-Jiménez, & Sanz-Valle, 2011). Therefore, much of the research has expanded its scope to include different types of innovation such as process, organizational, and marketing innovation and examined when their interrelationship is effective in increasing firm performance. For example, Camisón and Villar-López (2014) reveal that the adoption of organizational innovation improves the firm's technical capabilities to develop new products and processes that lead to their superior performance. Similarly, Piening and Salge (2015) show that organizational capabilities that manage a wide range of innovation-related activities enable a firm to increase the likelihood of process innovation activity and its profit margins. In addition, the implementation of marketing innovation is proven to be effective in increasing firm performance (e.g., Gupta, Malhotra, Czinkota, & Foroudi, 2016).

Given that the underlying assumption of the synergy effects is "more is better" (Piening & Salge, 2015), understanding antecedents and consequences of the synergy effects can be the key for increasing innovation capabilities, which are "the ability to continuously transform knowledge and ideas into new products, processes and systems for the benefit of the firm and its stakeholders" (Lawson & Samson, 2001). Capabilities, complex bundles of skills and collective knowledge (Day, 1994), enable firms to effectively perform value-creating tasks in an ever-changing environment (Eisenhardt & Martin, 2000; Krasnikov & Jayachandran, 2008; Teece, Pisano, & Shuen, 1997; Yoo & Frankwick, 2012).

This study investigates the synergy effects among four different types of innovation activities–product, process, marketing, and organizational innovation–on firm performance.

To start, we investigate the role of a firm's strategic orientations–exploration and exploitation–as an antecedent of product and process innovation activities. Understanding both strategic orientations is important because they decide a firm's philosophy on innovation activities and innovation-based performance (Benner & Tushman, 2003; Moon, 2006; Song, Kim, & Kang, 2016; Yalcinkaya, Calantone, & Griffith, 2007). We then examine the synergy effects: the effect of process innovation on product innovation, which should provide more resources for NPD through an increase in production efficiency (Dehning, Richardson, & Zmud, 2007); the moderating effect of marketing innovation between product innovation and firm performance by assisting product commercialization activities

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(Aarikka-Stenroos & Sandberg, 2012; Chiesa & Frattini, 2011; Sood & Tellis, 2009); and the moderating effect of organizational innovation between process innovation and firm performance by encouraging internally oriented activities to obtain higher profit margins (Schmidt & Rammer, 2007). In this investigation, the influences of the innovativeness levels of product innovation: radical and incremental and industry categories: high-tech and low-tech on the synergy effects are compared.

Given that radical and incremental innovation vary in several aspects such as technological newness to the firm and the market (McNally, Cavusgil, & Calantone, 2010; O'Connor, 1998; O'Connor & Rice, 2013; Slater, Mohr, & Sengupta, 2014), financial returns (Sorescu & Spanjol, 2008), and sources for innovation (Brem & Voigt, 2009), comparing the innovativeness levels in terms of the synergy effects is worthy of research. In this study, *radical product innovation* refers to "totally new products that involve considerable change in basic technologies and methods; revolutionary ideas that can create new market," and *incremental product innovation* refers to "continuations of existing products, methods, or practices; generally minor improvements made with existing methods and technology" (Mohr, Sengupta, & Slater, 2009, 25p). Additionally, the industrial differences need to be considered in that the roles of innovation in firm performance (Rubera & Kirca, 2012) and the innovation patterns (Santamaría, Nieto, & Barge-Gil, 2009) vary between high-tech and low-tech firms. Thus, along with the innovativeness levels of product innovation, industrial differences in the synergy effects among different types of innovation activities are compared in this study.

The remainder of the paper is structured as follows. First, we provide the theoretical background and hypotheses development. Second, we introduce the methods and present the analysis results. Third, we discuss the findings leading to our conclusions and implications. Finally, limitations and future research directions are provided.

2. Theoretical background and hypotheses development

2.1. The antecedents of product and process innovation activities: Exploration and exploitation orientation

As the first step in investigating a firm's innovation activities, we examine strategic orientations, which mirror a firm's philosophy of how to conduct business through a deeply rooted set of values and beliefs that guide the firm's attempt to obtain superior performance (Gatignon & Xuereb, 1997; Zhou, Yim, & Tse, 2005). This study considers the role of *exploration orientation* and *exploitation orientation* on innovation activities. In accordance with March (1991), exploration orientation is related to "the experimentation with new alternatives that have returns that are uncertain, distant, and often negative," whereas exploitation orientation involves "the refinement and extension of existing competences, technologies, and paradigms." This study investigates exploration and exploitation orientation as an antecedent to product and process innovation activities.

2.1.1. The effect of exploration orientation on product and process innovation activities

The pursuit of exploration orientation encourages a firm to invest its limited resources in new knowledge and capabilities in activities whose payoffs are uncertain but persist in the long-term (Uotila, Maula, Keil, & Zahra, 2009). Firms with such an orientation aim to enter new product market domains and meet future market demand (He & Wong, 2004). Similarly, to develop radical product innovation, a firm should employ new technologies to create a new market, and its possible risks and returns are higher than those that are obtained from incremental product innovation (Mohr et al., 2009). Introducing radical product innovation influences the market in the forms of market expansion, cannibalization, and destabilization (Aboulnasr, Narasimhan, Blair, & Chandy, 2008). Accordingly, seeking exploration orientation will increase the possibility of developing a radical product; in contrast, it will decrease the chance of developing an incremental product that assures relatively safe results in the short-term.

Moreover, the exploration orientation expands a firm's search scope (March, 1991), and it thus brings new knowledge elements into the organization (Wu & Shanley, 2009). As the new knowledge from the expansion increases, the possibility of developing technological innovation also increases (Katila & Ahuja, 2002). Piening and Salge (2015) prove that the exposure to a unique and wide range of innovation related knowledge increases the effectiveness of process innovation activity. Therefore, the adherence of exploration orientation will cause firms to make changes in technologies that are related to process innovation activity such as production methods and logistics.

H1. A firm's exploration orientation will have (a) positive impacts on radical product innovation activity and (b) negative impacts on incremental product innovation activity.

H2. A firm's exploration orientation will have positive impacts on process innovation activity.

2.1.2. The effect of exploitation orientation on product and process innovation activities

Exploitation orientation, which focuses on measurable efficiency and variance reduction (Benner & Tushman, 2003), brings direct and immediate consequences to firms (March, 1991). Although the returns from radical product innovation are greater than those that are obtained from incremental product innovation (Srinivasan et al., 2009), such radical product innovation involves considerable changes in basic technologies and methods employed in mainstream industry (Mohr et al., 2009). However, incremental product innovation rarely deviates from the current product-market experience because there are only minor changes in technology (Atuahene-Gima, 2005). Thus, when a firm pursues exploitation orientation, the possibility of developing a radical product that involves higher risk and market uncertainty will decrease; in contrast, the chance of developing an incremental product that assures relatively safe results in the near term will increase.

In addition, to achieve greater efficiency and reliability, a firm with exploitation orientation invests resources into refining and extending existing knowledge, skills, and processes (Soosay & Hyland, 2008). Similarly, the underlying objective of process innovation is to acquire efficiency in the way in which a firm conducts its operations through repetition (Un & Asakawa, 2015). Therefore, as a firm becomes more exploitation-oriented, it will be more likely to introduce process innovation.

H3. A firm's exploitation orientation will have (a) negative impacts on radical product innovation activity and (b) positive impacts on incremental product innovation activity.

H4. A firm's exploitation orientation will have positive impacts on process innovation activity.

2.2. The effects of process innovation activity on product innovation activity

Utterback and Abernathy (1975)'s dynamic model, has long been utilized as a classical model to explain the evolution of product and process innovation. They argue that there are three evolutionary stages: the performance maximizing stage (product-oriented), the sales maximizing stage (process-oriented), and the cost minimizing stage (both product and process innovation become incremental with a decrease in the frequency). Although the model has contributed to establishing the interrelationship of product and process innovation, it is limited in that a chronological sequence of innovation 'product then process' is only considered and any simultaneous occurrence of radical and incremental product innovation at each stage is neglected (Durand, 1992; Martínez-Ros & Labeaga, 2009).

Our model shows a clear distinction from the traditional model in the sense that we investigate an inverse sequence 'process then product' which means that process innovation affects product innovation by encouraging both radical and incremental product innovation at the same time. In our model, the benefits of earlier process innovation such as productivity gains (Un & Asakawa, 2015) and cost and time savings (He & Wong, 2004) are considered to increase the amount of resources that are available to later product innovation. Process innovation will increase a firm's competitive advantages in resources for subsequent product innovation, given that resources include all of the tangible and intangible assets (Barney, 1991).

To develop incremental products, that are direct improvements and modifications of existing products, a good resource fit (e.g., the high quality of a relationship with internal team members (Obal, Kannan-Narasimhan, & Ko, 2016) is important because it results in "more efficient, error-free, and often more highly leveraged new product development" (de Brentani, 2001). Moreover, because of the uncertain nature of radical product innovation, resource acquisition becomes more important (O'Connor & Rice, 2013). Firms with more resources are thus in a better position to support radical innovation, which requires increasingly complex and sizable resources, and innovation costs (Cohen & Klepper, 1996; Kyriakopoulos, Hughes, & Hughes, 2015; Song & Thieme, 2009). Therefore,

H5. Process innovation activity will have (a) positive impacts on radical product innovation activity and (b) positive impacts on incremental product innovation activity.

2.3. The effect of product and process innovation activities on firm performance

2.3.1. The effect of product innovation activity on firm performance

Product innovation is considered to be a key contributor to a firm's financial and market performance, although there are conflicting results with regard to how product innovativeness levels affect firm performance (Calantone, Chan, & Cui, 2006; McNally et al., 2010; Rijsdijk, Langerak, & Jan, 2011; Rubera & Kirca, 2012; Sorescu & Spanjol, 2008). This study expects both radical and incremental product innovation to enhance firm performance.

Radical product innovation offers greater customer benefits on the basis of a technology which is entirely different from the one that is employed by existing products (Chandy & Tellis, 1998; McNally et al., 2010; Slater et al., 2014). Aboulnasr et al. (2008) describe radical innovation as "home runs" with a high potential to be lucrative. Highly innovative products obtain product advantage, which refers to the extent to which a new product is considered to be unique and differentiated from competitors' products, and it contributes to increasing firm performance (Kim, Shin, & Min, 2016; Li & Calantone, 1998; McNally et al., 2010).

Additionally, incremental product innovation can have a positive effect on firm performance because the familiarity in innovation projects allows a firm to avoid market failure (McNally et al., 2010; Song & Thieme, 2009). Developing incremental products has a higher degree of fit with a firm's resources and experience and thus new investments in physical and human capital aren't necessary in projects (de Brentani, 2001; Song & Thieme, 2009). These characteristics enable a firm to shorten speed to market and this time reduction leads to an increase in new product profitability (Chen, Damanpour, & Reilly, 2010; Langerak & Hultink, 2006). Hence:

H6. (a) Radical product innovation activity and (b) incremental product innovation activity will have positive impacts on a firm's performance.

2.3.2. The effect of process innovation activity on firm performance

In general, the benefits of process innovation are organized as productivity gains, improvements in product quality, and cost and time savings (Benner & Tushman, 2003; He & Wong, 2004; Martínez-Ros & Labeaga, 2009; Un & Asakawa, 2015). Many recent studies show that the benefits of process innovation are positively related to diverse financial indicators such as sales growth (He & Wong, 2004) and profit margins (Piening & Salge, 2015). For example, cost reduction in production and supply chain technologies from process innovation enables a firm to retain a higher profit margin and it passes price reduction on to consumers, which eventually leads to higher market sales and market shares (Dehning et al., 2007). Manufacturing capabilities (e.g., productivity and speed of delivery) contribute to increasing a firm's market performance by satisfying their customers and improving its customer relations (Li, 2005). Therefore,

H7. Process innovation activity will have positive impacts on a firm's performance.

2.4. The synergy effects of innovation activities on performance

2.4.1. The synergy effects of product and marketing innovation activities

Marketing innovation can be described as a firm's ability to approach the market, effectively use the channels of communication, and deliver product and service to capture potential or existing customers (Gupta et al., 2016). It has a strong relationship with product commercialization activities (Aarikka-Stenroos & Sandberg, 2012; Chiesa & Frattini, 2011; Sood & Tellis, 2009). This study considers marketing innovation will moderate the effect of radical and/or incremental product innovation on firm performance by facilitating the commercialization action.

Although radical products provide greater customer benefits with a substantially different core technology relative to existing products (Tellis et al., 2009), they can result in significant uncertainties for both firms and customers with the potential to hinder the product's success (Danneels & Kleinschmidtb, 2001; McNally et al., 2010). Marketing innovation should reduce the uncertainties, which are related to technology and market (O'Connor & Rice, 2013) by allowing a firm to develop new relationships with potential customers and to understand their behavior and learning requirements through a lead user analysis (Moreau, Lehmann, & Markman, 2001; Song & Thieme, 2009). Marketing resources, such as reputational resources (e.g., a firm's corporate image and name in its market) and relational resources (close ties with customers and channel partners), and marketing actions through advertisings effectively enhance the financial payoffs of radical innovation (Kyriakopoulos et al., 2015; Srinivasan et al., 2009). The complementary relationship between firms' innovation activities and their marketing capabilities is proven to be effective in enhancing customer-related performance (Ngo & O'Cass, 2012).

Further, the benefit of marketing innovation can be seen in incremental product innovation. The relatively lower returns from incremental products, which result from potentially perceived marginal consumer benefits (Hoonsopon & Ruenrom, 2012; Tellis et al., 2009) and failure in acquiring competitive position from the possibility of being imitated and lack of price advantage (Sorescu & Spanjol, 2008), can be reversed with marketing innovation. Marketing innovation can increase the competitiveness of incremental products through its ability to make customers perceive a new product as being novel (Brown, 1991). Naidoo (2010), for example, finds manufacturing firms obtain competitive advantages such as product differentiation and cost leadership in the market through marketing innovation activity. Therefore,

H8. Marketing innovation activity will moderate the relationship (a) between radical product innovation activity and a firm's performance and (b) between incremental product innovation activity and a firm's performance.

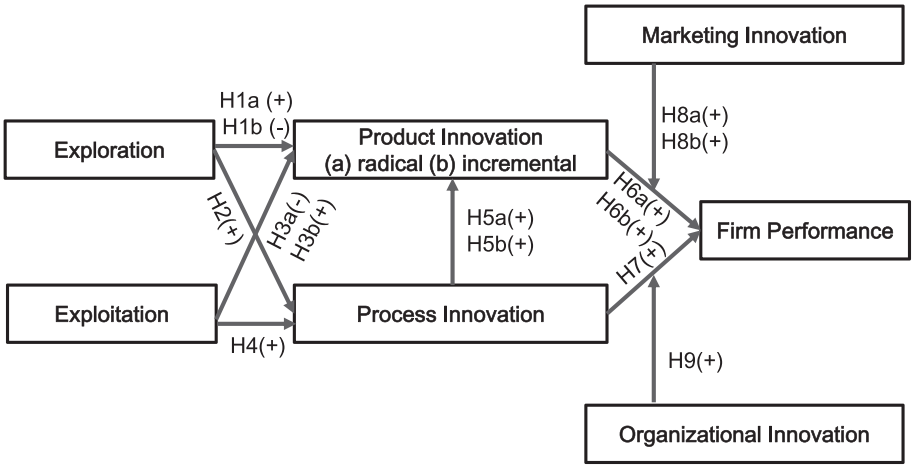

Fig. 1. Conceptual model.

2.4.2. The synergy effects of process and organizational innovation activities

The adoption of an organizational innovation that provides rare, valuable, inimitable, and non-substitutable working practice allows a firm to implement technical innovation capabilities for product and process innovation (Camisón & Villar-López, 2014). In particular, process innovation activity can obtain higher profit margins from innovation activities when it is accompanied by organizational changes (Schmidt & Rammer, 2007; Un & Asakawa, 2015). Thus,

H9. Organizational innovation activity will moderate the relationship between process innovation activity and a firm's performance.

Fig. 1 displays the conceptual model developed for this study.

3. Methodology

3.1. Data

A sample of 856 firms was drawn from the Korean Innovation Survey (KIS) 2014, which is the translated version of the Community Innovation Survey (CIS) based on the Oslo Manual (OECD, 2005). The CIS is subject to extensive pre- and pilot-testing in various countries and enterprises, thus increasing its interpretability, reliability, and validity (Laursen & Salter, 2006). Moreover, in this survey, the subject approach, which is largely based on the self-evaluation of the respondents, is employed, and it is advantageous to collect comprehensive data at the decision-making level of the firm, including all of its innovation outputs and activities (Mairesse & Mohnen, 2010).

3.2. Measurement

3.2.1. A firm's strategic orientations–exploration and exploitation

Following He and Wong (2004), exploration and exploitation orientation were measured as “objectives for undertaking innovation during the three years from 2011 to 2013”. On a dichotomous scale, the respondents were asked to answer why they implemented innovation activities for last three years. As a result of factor analysis, the items of objectives were largely divided into two distinct dimensions: to enter new product-market domains and to improve existing product-market efficiency. Depending on the definition of past research (Atuahene-Gima, 2005; March, 1991), the two constructs were categorized as exploration and exploitation orientation.

3.2.2. Types of innovation activities-product, process, marketing, and organizational innovation (see APPENDIX for the definition)

- *Product innovation activity–radical and incremental product innovation*

To measure radical and incremental product innovation, the survey asked the respondents to indicate the innovativeness levels of product innovation. On a binary scale, the respondents were asked to answer which domain their product innovation belongs to: new or significantly improved, new to your market or only new to your firm, and a first in your country or a world first. As a result of factor analysis, three items (new to your market, a first in your country and a world first) and two items (significantly improved and only new to your firm) were separately combined. In accordance with the definition in the Oslo Manual (OECD, 2005) and the related literature (Beers & Zand, 2014; Kostopoulos, Papalexandris, Papachroni, & Ioannou, 2011; Mohr et al., 2009; O'Connor, 1998), the former construct was employed as radical product innovation and the latter one was used as incremental product innovation in this study.

- *Process innovation activity*

This variable was measured by the question that asked whether a firm introduced new or significantly improved process innovation during the three years in a form of a binary variable. Based on the Oslo manual (OECD, 2005), these domains of activities were included: manufacturing methods, delivery methods, and supporting activities.

- *Marketing innovation activity*

This construct was accessed by means of significant changes in product design, product placement, product promotion, and pricing which are referred to as the elements of 4P mix. The elements of marketing mix are described as a representative set of marketing program (Yoo, Donthu, & Lee, 2000) and commercialization activities to launch a new product (Chiesa & Frattini, 2011).

- *Organizational innovation activity*

To measure *organizational innovation*, activities on three dimensions were included: business practice, workplace innovation, and external relationship. The measurement provided a wide range of information on both intra-organizational dimension which is related to specific departments and inter-organizational dimension which is related to structures or procedures beyond a firm's boundaries (Armbruster, Bikfalvi, Kinkel, & Lay, 2008).

- *Firm performance*

This study assumed that there were lagged effects of innovation activities on the outcomes and the total effects were reflected in the turnover in the previous year during the three years that were denoted by the data. The respondents were asked to estimate the percentage of total turnover in the previous year, 2013, which was caused by product innovation activities.

4. Analysis and results

Because most of the measures were composed of multiple items, their reliability and the respective underlying dimensions were tested through principal component analysis (PCA). All of the items were loaded above 0.5 on the appropriate constructs. Items of each construct on the same dimension were combined into one construct by item parceling, giving the greater reliability and more definitive rotational results (Bandalos, 2002). This study employed path analysis, which is a subset of structural equation modeling that involves only single indicators (i.e., observed variables) to provide each variable that consists of dichotomous items with ordinal scales. The use of path analysis was appropriate for this study because it allows simultaneous testing between more than one independent and dependent variables no matter how their forms are continuous or discreet, offering multi-measures to assess the reliability, e.g., CFI and RMSEA (Kostopoulos et al., 2011; Singh & Wilkes, 1996).

As evidence of internal consistency, the average variance extracted (AVE) and the construct reliability (CR) were measured, and all of the values exceeded the recommended thresholds (AVE ≥ 0.5, Fornell & Larcker, 1981; CR ≥ 0.7, Nunally, 1978). These values are listed with the descriptive statistics and correlation between the constructs in Table 1. Table 2 indicates the hypothesized path models showed an excellent fit with the data with a non-significant chi-square statistic and an acceptable level of fit ($CFI, TLI > 0.95; RMSEA < 0.06$, Hu & Bentler, 1999).

To test for moderation, the data was categorized into two groups: innovation group (marketing innovation (MI) and organizational innovation (OI) group) and non-innovation group (non-marking innovation (Non-MI) and non-organizational innovation group (Non-OI)). MI and OI groups consisted of firms which conducted either marketing or organizational innovation activity at least once during the reference period from 2011 to 2013. Then, through a multi-group analysis, the significant difference of path coefficients (from radical and/or incremental product innovation activity to firm performance; from process innovation activity to firm performance) was estimated.

Potential industry effects were assessed by dividing the sample into high-tech and low-tech industry based on the OECD (2011) classification (High-tech $n = 522$; Low-tech $n = 323$, the data of 11 firms were omitted in this analysis for their obscure industry category). To determine whether there was a potential problem of common source bias given the data collection method, we used different respondents from the sub-sample and ran the same analysis to check whether there are any significant differences in the results (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Because the samples were classified in terms of the industries to which they belong, we selected a sub-sample from high-tech firms and low-tech firms, respectively, and found that the results of the respondents indeed showed the same pattern from those of the full sample. The path estimates in Table 3 indicate that a firm's innovation activity and its effect on the innovation-based performance were differently shown in high-tech and low-tech industries.

The high-tech industry results show that Hypothesis 1a is strongly supported with exploration orientation is positively related to radical product innovation activity ($\beta = .143, p < .01$). Hypothesis 1b suggesting that such orientation is positively related to incremental product innovation activity is not supported ($\beta = .070, n.s$). In addition, the findings fail to confirm Hypothesis 2 with regard to a positive relationship between exploration orientation and process innovation activity ($\beta = .001, n.s$). Similarly, two different paths from exploitation orientation to radical and incremental product innovation activity fail to corroborate Hypothesis 3a and Hypothesis 3b, respectively ($\beta = -.022, n.s; \beta = .033, n.s$). The results provide support for Hypothesis 4, as exploitation orientation is significantly related to process innovation activity ($\beta = .292, p < .001$). The path coefficients of process innovation activity on the two different product innovation activities, radical and incremental product innovation activity ($\beta = .221, p < .001; \beta = .081, p < .10$), thus confirming Hypothesis 5a and Hypothesis 5b. Hypothesis 6a and Hypothesis 6b posit that both radical and incremental product innovation activity is positively related to firm performance. The results show that both path coefficients are proven to be positive and significant ($\beta = .152, p < .001; \beta = 197, p < .001$). Hypothesis 7, which states that process innovation is positively related to firm performance, is not supported ($\beta = .038, n.s; \beta = .054, n.s$). The results of the multi-group analysis show that marketing innovation activity is

Table 2
Overall model fit of path analysis.

	High-tech industry (n = 522)		Low-tech industry (n = 323)	
	Radial product innovation	Incremental product innovation	Radial product innovation	Incremental product innovation
Chi-square	1.367	1.475	1.410	1.105
Degree of freedom	2	2	2	2
p-Value	0.505	0.478	0.494	0.576
RMSEA[a]	0.000	0.000	0.000	0.000
CFI[b]	1	1	1	1
TLI[c]	1.008	1.008	1.021	1.039

Notes: [a]RMSEA: Root mean square error of approximation; [b]CFI: Comparative fit index; [c]TLI: Tucker-Lewis index.

Table 1
Correlations and descriptive statistics (n = 845).

	Variable	1	2	3	4	5	6	7	8
1	Exploration orientation	1							
2	Exploitation orientation	0.461**	1						
3	Radical product innovation	0.145**	0.152**	1					
4	Incremental product innovation	0.120**	0.078*	− 0.111**	1				
5	Process innovation	0.134**	0.301**	0.247**	0.05	1			
6	Marketing innovation	0.277**	0.396**	0.214**	0.086*	0.295**	1		
7	Organizational innovation	0.220**	0.483**	0.211**	0.080*	0.417**	0.507**	1	
8	Performance[a]	− 0.01	0.02	0.178**	0.182**	0.105**	0.02***	0.02	1
	M	2.07	2.33	0.73	1.63	0.49	0.89	0.87	24.62
	SD	1.08	5.65	0.99	0.32	0.71	1.89	1.28	672.3
	CR[b]	0.92	0.97	0.94	0.86	0.94	0.97	0.95	
	AVE[c]	0.79	0.86	0.86	0.83	0.84	0.89	0.86	

Notes: [a]Performance was measured by a single item, the percentage of total turnover in the previous year, 2013, caused by product innovation activities; [b]CR: composite reliability; [c]AVE: average variance extracted.

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 3
Results of path analysis.

	Hypothesized path	Full	High-tech	Low-tech
H_{1a}	Exploration orientation → radical product innovation activity	0.097**	0.143**	0.026
H_{1b}	Exploration orientation → incremental product innovation activity	0.106***	0.070	0.178**
H_2	Exploration orientation → process innovation activity	− 0.006	0.001	− 0.002
H_{3a}	Exploitation orientation → radical product innovation activity	0.097	− 0.022	0.153**
H_{3b}	Exploitation orientation → incremental product innovation activity	0.019	0.033	− 0.028
H_4	Exploitation orientation → process innovation activity	0.303***	0.292***	0.320***
H_{5a}	Process innovation activity → radical product innovation activity	0.222***	0.221***	0.231***
H_{5b}	Process innovation activity → incremental product innovation activity	0.033	0.081****	− 0.027
H_{6a}	Radical product innovation activity → firm performance	0.162***	0.152***	0.182**
H_{6b}	Incremental product innovation activity → firm performance	0.177***	0.197***	0.133**
H_7	Process innovation activity → firm performance	0.065****(R)[a]	0.038(R)	0.113* (R)
		0.095**(I)[b]	0.054(I)	0.163** (I)
H_{8a}	Radical product innovation activity * marketing innovation activity → firm performance	0.213***	0.225**	0.201**
H_{8b}	Incremental product innovation activity * marketing innovation activity → firm performance	0.101****	0.313***	0.029
H_9	Process innovation activity * organizational innovation activity → firm performance	0.171***(R)	0.12**** (R)	0.253**(R)
		0.202***(I)	0.124*(I)	0.311*** (I)

Notes: (R): radical product innovation activity is included in the model; (I): incremental product innovation activity is included in the model.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.
**** < 0.10.

effective to increase the positive relationship both the path from radical product innovation activity to firm performance($\beta = .225, p < .01$), and the path from incremental product innovation activity to firm performance ($\beta = .313, p < .001$). Hence, Hypothesis 8a and Hypothesis 8b are supported. Hypothesis 9 which suggests the moderating effect of organizational innovation activity between process innovation activity and firm performance is also supported in the occurrences of radical and incremental product innovation activity ($\beta = .12, p < .10; \beta = .124$, $p < .05$).

The results of the hypothesized model for low-tech industry show differences. The results do not offer support for Hypothesis 1a and Hypothesis 2 ($\beta = .026, n.s; \beta = -.002, n.s$). Contrary to the assumption in Hypothesis 1b and Hypothesis 3a, exploration orientation is positively related to incremental product innovation activity and exploitation orientation is positively related to radical product innovation activity ($\beta = .178, p < .01; \beta = .153, p < .01$). Hypothesis 3b, the path from exploitation orientation to incremental product innovation, is not significant ($\beta = -.028, n.s$). Hypothesis 4, which maintains that exploitation orientation is positively related to process innovation activity, is corroborated and the coefficient is reported as being greater than the one that is shown in high-tech industry ($\beta = .320, p < .001$). The positive relationship between process innovation activity and product innovation activity that is expected in Hypothesis 5a and Hypothesis 5b is only supported when the product innovativeness level belongs to a radical dimension ($\beta = .231, p < .001; \beta = -.027$, $n.s$). Hypothesis 6a and Hypothesis 6b, which predict a positive relationship between both radical and incremental product innovation activity and firm performance are proven to be significant and positive ($\beta = .182, p < .01; \beta = .133$, $p < .01$). Process innovation activity is positively related to firm performance when radical and incremental product innovation activity are respectively included in the model ($\beta = .113, p < .05; \beta = .163$, $p < .01$).

The results of multi-group analysis show that the moderating effect of marketing innovation activity only supports radical product innovation activity. Accordingly, Hypothesis 8a is supported but Hypothesis 8b is rejected ($\beta = .201, p < .01; \beta = .029$, $n.s$). The moderating effect of organizational innovation activity is strongly supported regardless of the innovativeness level of product innovation activity which is accompanied by process innovation activity ($\beta = .253, p < .01; \beta = .311, p < .001$).

5. Discussion, conclusion, and implications

Although innovation has been considered to be a key to surpass competitors in the market, a considerable body of research still emphasizes specific types of innovation activities, such as product or organizational innovation. The current study seeks to expand the range of innovation research by including four types of innovation activities: product, process, marketing, and organizational innovation. This study differs from earlier innovation studies in that the influences of innovativeness levels and industry categories on innovation activities are considered.

Our first finding indicates that the subsequent innovation types and the innovativeness levels depend on which strategic orientation is pursued by a firm. According to the results, exploration orientation, which focuses on new knowledge, skills, and processes, helps the firm to introduce both radical and incremental product innovation. In contrast, exploitation orientation, which aims to increase efficiency and the utilization of existing resources, increases the likelihood of process innovation. The findings suggest that managers should pay attention to achieving a balance between the two strategic orientations. The balanced view is based on the “ambidexterity” concept (Tushman & O'Reilly, 1996), which indicates that firms that are capable of implementing both exploration and exploitation orientation obtain higher performance than firms that focus only on a single type of orientation. Specifically, a balance between explorative and exploitative innovation strategies has a positive influence on sales growth rate, with the inverse found for imbalances (He & Wong, 2004).

Additionally, the research proves the effect of process innovation activity in increasing the levels of radical product innovation and firm performance. In the past studies, process innovation as a step removed innovation from customers and firm performance (Martínez-Ros & Labeaga, 2009; Un & Asakawa, 2015). However, this study proves such innovation has significant impacts on radical product innovation in both high-tech and low-tech industry and firm performance. Given that radical innovation has greater impacts on market position and a new business (Rubera & Kirca, 2012) which leads to greater firm performance, changes in production, logistics, and other works that are related to process innovation should accompany the new product development.

More importantly, the present work offers evidence of the synergy effects between technological and non-technological innovation according to the innovativeness levels of product innovation and industry

categories. The moderating effect of marketing innovation in the relationship between product innovation and firm performance is greater in high-tech industry because it increases the positive impacts of both radical and incremental product innovation on firm performance; in low-tech industry, such moderating effect is shown only in incremental product innovation.

The results can be explained by the characteristics of high-tech industry. Due to the fast-changing customer demands and shorter life cycle of new products, participating in product innovation activity ensures that a high-tech firm will survive with higher market and financial position (Mizik & Jacobson, 2003; Rubera & Kirca, 2012; Sääksjärvi & Samiee, 2011). In contrast, in the low-tech context, marketing innovation is not reported to be significant in increasing the positive impact of incremental product innovation activity on firm performance. The findings show that marketing innovation does not serve as a panacea for all manufacturing companies. Therefore, it is necessary for marketing managers to consider the innovativeness dimension their new product belongs to and the characteristics of the relevant industry in deciding the introduction of marketing innovation as a means of commercializing the product.

Furthermore, the moderating effect of organizational innovation in the relationship between process innovation and firm performance is more evident in low-tech industry than high-tech industry in that process innovation has direct and positive impacts on firm performance when it is accompanied by organizational innovation. It shows that firms that are open to organizational changes obtain productivity growth (Mol & Birkinshaw, 2009) and the full benefits of technological innovation (Doran, 2012). These findings encourage managers to cultivate the cooperation between administrative and production employees, and knowledge sharing with regard to changes in each function.

In short, this paper shows that focusing on a single type of innovation activity hinders the potential advantages resulting from the synergy effects of diverse innovation activities.

To increase innovation capabilities, firms should be equipped with a multifaceted approach toward different types of innovation activities.

6. Limitations and future research

The prior research insists that the advantage of intellectual capital on firm performance has a lagged effect; thus, a single year of data does not provide a comprehensive relationship between the intellectual capital and performance (Aboody & Lev, 2000). Although the survey that is employed in this study asked respondents to measure a firm's innovation activities over three years, the answers are cross-sectional in nature. To compensate for this weakness, future research may collect data from firms that have participated in the KIS survey over the years, match the identification code that has been assigned to each participant, and create panel data, which can provide a more detailed study of the different effects from innovation activities.

Moreover, although product innovation activity is divided into radical and incremental depending on its innovativeness level, process innovation activity is not categorized in this study. Given that process innovation activity could be categorized as either direct (including the activities that are related to the manufacturing process) or indirect (including the activities that support the manufacturing process through logistics and deliveries), future research could consider these interactions: 1) radical product innovation and direct process innovation, 2) radical product innovation and indirect process innovation, 3) incremental product innovation and direct process innovation, and 4) incremental product innovation and indirect process innovation.

Furthermore, future research could measure a firm's innovation activities by using objective data such as patent and marketing expenses. The assessment of innovation activities by both subjective measurement and objective measurement may increase the reliability of the results. Lastly, given that the Korean Innovation Survey (KIS) is based on the EU's Community Innovation Survey (CIS), which is employed in many European countries, the results among different countries could be compared for future study.

Appendix A

The classification of innovation activities: product, process, marketing, and organizational innovation.

In accordance with the Oslo Manual (OECD, 2005), innovation activities can fall into four different groups: product, process, marketing, and organizational innovation. The Oslo Manual defines these as:

- *Product innovation* is the introduction of a good or service that is new or significantly improved regarding its characteristics or intended uses. There are several typologies that are related to innovativeness levels, such as radical and incremental.
- *Process innovation* is the implementation of a new or significantly improved mode of production, delivery method, or administrative process.
- *Marketing innovation* is a new or significant change in nonfunctional characteristics such as product design or packaging, place, promotion, and pricing. For example, changing a product design is related to altering its appearance, not its function or user.
- *Organizational innovation* is the implementation of a new organizational method in a firm's business practices, workplace organization, or external relationships. Specifically, organizational innovation is primarily concerned with improving work structures such as employing flexible work arrangements and collaboration with partners.

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