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Relationship between User Innovation Activities and Market Performance: Moderated Mediating Effect of Absorptive Capacity and CEO's Shareholding on Innovation Performance

Eun Hwa Lee, Choo Yeon Kim and Jae Wook Yoo *

College of Business Administration, Konkuk University, Seoul 05029, Korea; tobejjan@konkuk.ac.kr (E.H.L.); chookim@konkuk.ac.kr (C.Y.K.)

* Correspondence: jwyoo@konkuk.ac.kr

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Abstract: Although user innovation has been regarded as an important source of firms' competitive advantage, the internal processes and mechanisms involved in the relationship between firms' user innovation activities and market performance are seldom studied. By applying moderated mediation analyses, we examine (1) whether firms' user innovation activities have a positive impact on market performance and (2) how and under what conditions user innovation activities can have a positive impact on a firm's market performance. The findings on a sample of Korean manufacturing firms indicate that user innovation activities significantly increase firms' innovation performance, which consequently leads to superior market performance (confirming the mediation effect of innovation performance). Additionally, we observe the positive mediation effect of innovation performance only in firms with higher levels of absorptive capacity (confirming the moderated mediation effect of absorptive capacity). Further analysis confirms that the positive interaction effects between user innovation activities and absorptive capacity on market performance through innovation performance were more pronounced for firms with higher Chief Executive Officer (CEO) shareholding levels (confirming the moderated mediation effect of CEO's shareholding). Our findings provide theoretical and practical implications on the successful implementation of user innovation strategies.

Keywords: user innovation; absorptive capacity; CEO's shareholding; innovation performance; market performance

1. Introduction

Korean firms previously grew using fast-follower strategies that imitated the innovation activities of first movers. However, the shortening of the product life cycle and diversification of consumer values due to rapid technological advancement limited growth and development through fast-follower strategies. Many firms began focusing on open innovation activities to strengthen competitiveness and improve performance [1,2]. In particular, many Korean firms focused on user innovation based on cooperative relations with consumers [3]. Innovation activities that incorporate user participation are beneficial to understanding the needs of consumers, developing new products and services, and improving performance by reducing the time and cost required for the innovation process [1,4–6]. However, prior studies that have analyzed the relationship between user innovation activities and firm performance have reported inconsistent findings. Some studies have suggested that user innovation activities have a positive impact on firm performance [6–9], while others present an insignificant [10] or negative impact [11–13]. These conflicting findings from prior studies could be explained by another factor that mediates the relationship between user innovation activities and market performance.

Therefore, the first goal of this study is to analyze the mediation effect of innovation performance between user innovation activities and market performance among Korean manufacturing firms.

In order for user innovation activities to succeed, firms require more than mere access to consumers [2,3,11–13]. Firm's absorptive capacity determines the extent to which externally acquired knowledge is converted into new products or services from which a firm can reap financial benefits [14–16]. As the knowledge and information provided by consumers have high levels of tacitness and stickiness, firms need absorptive capacity to effectively acquire and utilize this information and knowledge for innovation [11–15,17–20]. Absorptive capacity is the capacity required in the processes of receiving, converting, and utilizing externally acquired information into the organization to improve performance [14–16]. It is required to identify and secure a source of the necessary external information and enables firms to use this information by transferring it to the internal knowledge base. However, there is little research into the impact of a firm's absorptive capacity on improving performance by utilizing the knowledge and information acquired from consumers. Therefore, the second goal of this study is to analyze how absorptive capacity affects the relationship between user innovation activities and firms' performance.

A CEO's risk-taking tendency and short-to-long term characteristics in strategic choices, which may differ depending on their shareholding of the firm, can influence the firm's innovation strategy and the level of absorptive capacity [21,22]. The degree of absorptive capability, such as a firm's Research and Development (R&D) investment, can vary depending on its governance structure (ownership structure) [23–26]. Thus, the influence of user innovation activities on market performance may vary depending on the CEO's shareholding and the firm's level of absorptive capacity. However, previous studies have overlooked the role of CEO's shareholding, which can have a significant impact on the relationship between absorptive capacity and innovation performance. It is an interesting and important research question because Korean manufacturing firms are characterized by higher CEO shareholding levels compared to Western firms. Therefore, the third goal of this study is to comprehensively analyze the impact of the relationship between user innovation activities and internal mechanisms, which may vary depending on the level of absorptive capacity and the CEO's shareholdings, on the firm's innovation and market performance.

In this study, we address these gaps in the existing literature by applying open innovation, firms' absorptive capabilities, and governance structure perspectives from an integrated perspective.

We deal with three critical issues (1) whether, (2) how, and (3) under which conditions user innovation activities have a positive impact on the market performance of Korean manufacturing firms.

By extending our proposed mediation model, we examine how the effect of user innovation activities on market performance through innovation performance varies depending on the firm's absorptive capacity and level of CEO's shareholding in a unified moderated moderated mediation model.

This study provides practical insights for the effective use of corporate governance and firms' internal and external resources to improve innovation and market performance among Korean manufacturing firms in a rapidly changing business environment. In addition, this study contributes to academic development in the areas of innovation strategies and corporate governance by presenting and verifying a comprehensive and interdisciplinary research model of the key factors at the individual and corporate levels that affect a firm's strategies, innovation, and market performance.

2. Theoretical Background and Previous Research

2.1. Open Innovation and User Innovation Activities

Open innovation secures a source of innovation by extending the scope of a firm's activity and by combining internal and external knowledge. Therefore, it can increase the speed of development and the commercialization of ideas to improve performance in terms of quality enhancements and market share expansion [9,27,28]. Open innovation activities can be divided into two types:

“outside-in” and “inside-out”. Firms implement the inside-out type by providing its technology to other firms through sales or licensing, or by making the platform available to the public. On the other hand, firms implement the outside-in type innovation activities by obtaining an external source of innovation through cooperation with third parties in combination with their internal capacity [27,29]. Outside-in innovation activities provide opportunities for market development along with product and technological advancements [30].

The types of open innovation can also be divided into subcategories according to the position of the cooperation partner within the supply chain, such as suppliers, competitors, and consumers [7]. User innovation activities refer to cooperation with consumers, who are positioned in the last stage of the value chain. They suggest various new ways for users to address the problems they have experienced in using products or services. Such activities can have a positive impact on innovation performance, such as new product development, by increasing the likelihood of commercializing ideas [5,29]. Therefore, firms have recently changed their R&D and innovation strategies with a focus on user involvement [3,7,30,31].

Many studies have emphasized the role and importance of users as a source of information and knowledge for innovation [3,4,18,32–34]. This is because consumers, as final users of products and/or services, actively provide the knowledge and ideas necessary for innovation based on their increased level of education and ability to acquire information [3,5,8,18,32]. Unlike competitors or suppliers, they are not likely to take opportunistic actions, leading to the improvement of a firm’s market performance [4,35]. Hence, industry sectors such as information technology, medical care, sports goods, clothing, and toys are using user innovation activities [5,7,32]. However, prior studies have argued that the effect of user innovation activities on a firm’s performance may differ according to the innate nature of user ideas and knowledge as a public good, the gap between the consumer and firm’s interests, and differences in each firm’s capability to acquire and use the information and knowledge users provide [3,11,29,31].

2.2. Absorptive Capacity

Knowledge and information acquired from users through open innovation activities are broader and more diverse than those acquired from competitors or suppliers who have similar industry knowledge or information systems. Moreover, they present high stickiness and tacitness because this information has an unsystematic pattern that is difficult to record and exists only in the heads of users. Thus, it may be difficult to utilize interactive communication with consumers [2,18,29]. To accurately understand and use knowledge and information acquired through user innovation activities, it is important for the organization to establish and utilize its absorptive capacity [4,19]. In general, absorptive capacity refers to the capacity to accept external knowledge and information into an organization and to convert and utilize such knowledge in a manner suitable to the organization [14–16]. Hence, absorptive capacity for user innovation activities is an important element required to understand consumers and markets and to develop a wider range of knowledge needed for commercialization and distribution. [6,17,18,20]. From this perspective, absorptive capacity should be considered an essential factor for adapting to environment changes and gaining competitiveness [28,33].

Many research findings show that the level of absorptive capacity has a significant influence on a firm’s innovation activities and performance [16,34–38]. Studies on Western firms have suggested that absorptive capacity positively influences a firm’s innovation performance, including new product development [17,33,36]. In addition, some studies on Korean firms have suggested that absorptive capacity increases patent registrations and improves financial performance [2,24,34,37,38]. Other studies have reported that firms’ performance may decline when their absorptive capacity rises above a certain level in technical cooperation with a partner firm [39]. Thus, they argue that absorptive capacity has an inverted U-shaped relationship with innovation performance [28,38,40]. Some studies

have suggested no statistically significant relationship between a firm's absorptive capacity and performance [41].

2.3. CEO's Shareholding

Firms can disperse risks and facilitate capital supply through the separation of ownership and management. However, these factors can create an agency problem in which managers, as agents, place their self-interests ahead of the interests of shareholders. According to agency theory, in a firm with separate ownership and management, the manager is more likely to commit a moral hazard that prioritizes their job security or compensation over shareholders' interests. Therefore, firms should establish and utilize corporate governance mechanisms to address the agency problem and protect shareholders' wealth [26,42–44].

Corporate governance mechanisms include the board of directors, audit committee, general shareholders' meeting, and CEO's shareholding [26,44,45]. The "convergence of interest hypothesis" of agency theory argues that the interests of the CEO can be aligned with those of shareholders by increasing the CEO's shareholding. In general, CEOs as agents are under pressure to achieve high performance within their tenures, so it is easy to focus on improving short-term financial performance [45]. Therefore, the convergence of interest hypothesis argues that stock options should be provided as compensation to CEOs to increase their shareholding [21,26,42,46]. It is necessary to align the CEO's interests with those of shareholders to provide motivation for innovation activities, strengthen long-term competitiveness, and improve the firm's market value [42–44].

On the other hand, the "managerial entrenchment hypothesis" claims that under high shareholding, CEOs can strengthen their management rights and power within the firm, making it difficult to control and monitor their behaviors through corporate governance mechanisms. Therefore, the hypothesis warns that it may become difficult to control the tendency of CEOs to settle for reality and pursue self-interest [26,47]. In this regard, some studies have argued that as a CEO's shareholding increases, opportunistic decision-making, such as excessive dividend payments or internal transactions between affiliates, may occur [45]. The firm's value may decrease due to the increase in agency costs [26].

Considering the conflicting argument of these two hypotheses and the results of previous studies, we can assume that the CEO's shareholding, one of the characteristics of a firm's ownership structure, can have a significant impact on the firm's strategic decision making and performance. However, since the direction and degree of the impact may vary depending on the situation, verification based on empirical analysis is necessary.

3. Research Hypotheses

3.1. Relationship between User Innovation Activities and Market Performance

In a business environment with increased uncertainty, innovation activities that effectively utilize various types of internal and external knowledge and information are essential elements for the survival and growth of firms [9,34]. In particular, as active information exchange reinforces the "knowledge spillover" effect, firms focus on open innovation activities using external knowledge and information, rather than closed innovation activities based on the development and utilization of internal capacity [4,27].

The development of IT and improved levels of education among consumers are creating opportunities to encourage user innovation, a collaborative way to create value based on customer participation [3–5]. The firm can implement improvement activities for internal processes that help create a competitive advantage through interactive communication and feedback from users. Further, by establishing various networks with users, firms can quickly recognize and reflect market changes to enhance the value creation effect of products and services internally [5–29,35] while improving legitimacy and awareness of the innovation activities externally [3,31]. Hence, the firm's user innovation activities enable rapid market access and information acquisition. It improves market

performance through the objective evaluation of the ability to improve its capabilities and operational efficiency [7,8,35,48].

Therefore, many Korean firms have recently started to focus on user innovation activities that utilize the information and knowledge provided by final consumers as sources of innovation to improve competitiveness and market performance. This is because of the high level of IT infrastructure in the Korean market and users' ability to use the information provided by the infrastructure to build and apply the two-way communication system necessary in the cooperation process [3,5,35]. Two-way communication with customers enables Korean firms to quickly acquire useful information and knowledge from users and reflect and utilize it in its various operation methods such as manufacturing, marketing, services, and distribution, as well as new product development [31,34]. Hence, we establish the following hypothesis on the relationship between user innovation activities and a firm's market performance.

Hypothesis 1 (H1). *User innovation activities positively influence a firm's market performance.*

3.2. Relationship between User Innovation Activities and Innovation Performance

The increasing uncertainty of business environments and shortening product life cycles [6,9,27,49–51] further emphasize the importance of user innovation activities reflecting the consumer's desire as a product user in innovation processes (e.g., eliminating errors that may occur in the commercialization process and improving the speed of new product development). According to prior studies targeting Korean and non-Korean firms, user innovation activities have a positive effect on technology development and product innovation in general manufacturing and knowledge-based industries [4,7,28,31,38]. In particular, prior studies have reported that small- and medium-sized firms lacking internal resources strengthen open innovation activities in cooperation with various external stakeholders to acquire special capacity and create innovation performance [49].

The user involvement in innovation provides creative ideas for the development of new products and improves the quality of existing products and services [30,35,51]. It can help reduce the risks, time, and costs that may occur during the innovation process [3,4]. Moreover, unlike when cooperating with competitors or suppliers, users are less likely to pursue self-interested and opportunistic behaviors when cooperating with firms [4,29,49]. Thus, we establish the following hypothesis on the relationship between user innovation activities and the firm's innovation performance.

Hypothesis 2 (H2). *User innovation activities positively influence a firm's innovation performance.*

3.3. Mediating Effect of Innovation Performance

Innovation is an essential element of a firm's survival. Firms that fail to develop new products or technologies that provide sufficient value to the market in an environment with rapidly changing technology and user demands will fall behind their competitors and be forced to leave the market [9,51]. Thus, firms should be able to reinforce innovation that can provide higher added value to users to secure their market positions and obtain high profits [3,5]. Several empirical studies have shown that new technologies or products derived from firms' innovation performance can enhance their market competitiveness and increase their sales and market share [6,37,49,52]. Users can provide problem-solving ideas or methods for existing products, thereby helping the firm offer differentiated new products that do not exist in the current market. New products can create a large demand based on the high market orientation [49,53]. Accordingly, we set the following hypothesis on the relationship between innovation performance and market performance.

Hypothesis 3 (H3). *A firm's innovation performance positively influences a firm's market performance.*

In a business environment with shorter product life cycles and increased uncertainty, firms should improve user- and market-oriented innovation activities to increase their competitiveness. User innovation activities using ideas or information provided by the consumers of products and services offer useful knowledge and information [5,12]. Firms can use such knowledge and information to improve innovation performance, such as through new technology and product development [6,35,54]. In turn, firms' innovation performance can improve their market performance through increased consumer satisfaction and brand awareness [2,34,55]. Consequently, we establish the following hypothesis on the mediating effect of innovation performance on the relationship between user innovation activity and market performance.

Hypothesis 4 (H4). *The positive effect of user innovation activities on market performance is mediated by innovation performance.*

3.4. Moderated Mediating Effects of Absorptive Capacity

Absorptive capacity relates to the method of recognizing external information and the structure and path of collecting a network [17,28,36]. Thus, the influence of externally acquired information and knowledge on a firm's internal process and performance may vary depending on its absorptive capacity [2,17,38]. In particular, the ideas and information provided by consumers possess the characteristics of public goods and are easy to obtain in the market. On the other hand, transferring and utilizing them inside a firm may be difficult because of high tacitness and stickiness [4,5,29]. Therefore, no matter how well a firm obtains problem-solving methods or new product development ideas from users, the lack of ability to absorb and develop them in combination with internal knowledge will make it very difficult to commercialize users' ideas or knowledge as real products [16,36]. Since absorptive capacity can reduce costs and increase the possibility of commercializing ideas during the transfer of information and knowledge between other information subjects [31], it is very important to internalize and effectively utilize information obtained from users [14,38,56]. The firms with high absorptive capacity can effectively improve innovation performance (e.g., new product development) because they can actively internalize and utilize the knowledge and information acquired from users [14,18,34,57].

The higher the absorptive level, the less time and error that occurs in the course of users' knowledge transfer and interaction, and the greater the utility of knowledge and information acquired from users [4,19,34]. This will lead to the creation of innovative products that accurately reflect the needs of users, thereby providing higher added value compared to competitors and generating increased sales [5,9,17,31,58]. We can thus infer that the firm's absorptive capacity can help it acquire useful ideas and information required in constantly changing markets faster than competitors, strengthen R&D activities through efficient internal transfer, and improve innovation performance in areas such as new product development, possibly leading to an increase in their sales and market share. Therefore, we set the following hypothesis on the two-way interaction effect of absorptive capacity and user innovation activities on market performance, mediated by innovation performance.

Hypothesis 5 (H5). *The positive impact of user innovation activity on market performance through innovation performance will be strengthened as the firm's absorptive capacity increases.*

3.5. Moderated Mediating Effects of the Interaction between CEO's Shareholding and Absorptive Capacity

From a corporate governance perspective, CEO shareholding is an internal governance mechanism that can have a significant impact on firms' strategic decision making and performance. An increase in shareholding can incentivize the CEO to strengthen the firm's long-term innovation activities [23,25,26,45]. Further, by making strategic decisions with high discretion, it can strengthen CEOs' motivation to use absorptive capacity more actively, along with information on problem-solving methods and consumer preference changes gained by user innovation activities [21,46].

On the other hand, low or absent shareholding can make the CEO more inclined to avoid uncertainty than to increase profits through innovative activities, which may weaken the CEO's motivation to apply user innovation activities and absorptive capabilities effectively [26,42]. This may become a factor that weakens the firm's innovation performance and market performance [28]. Thus, we establish the following hypothesis on the conditional effect of the three-way interaction of user innovation activities, absorptive capacity, and CEO's shareholding on market performance through innovation performance as a mediator.

Hypothesis 6 (H6). *The moderated mediating effect of absorptive capacity (hypothesis 5) will strengthen as the CEO's shareholding increases.*

Figure 1 presents the research model of the relationships between the variables proposed in the hypotheses.

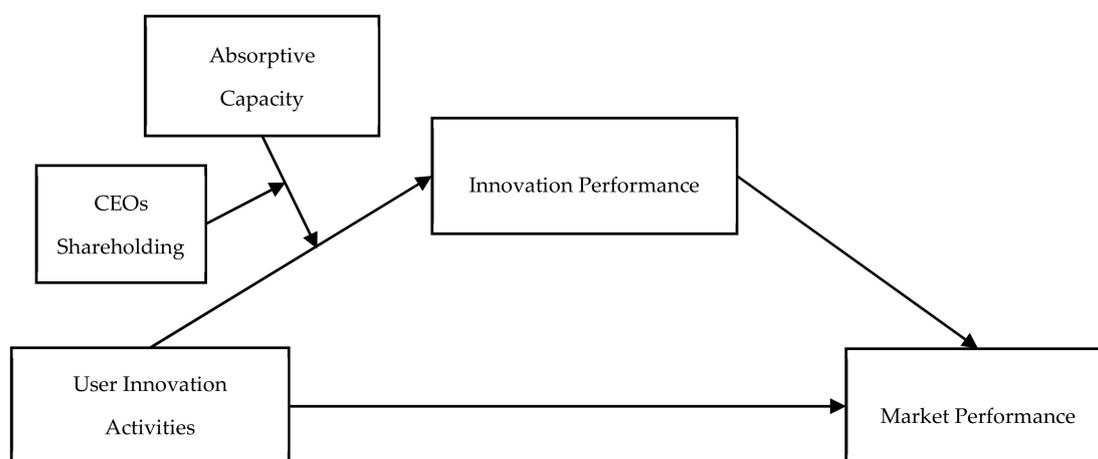


Figure 1. Research model.

4. Research Method

4.1. Sample Selection and Data Collection

The initial sample included manufacturing firms who responded to the innovation activity questionnaire in the 2014 Korea firm innovation survey [59]. We obtained the data on the innovation activities and performance of the sample firms from the survey responses. The Korean firm innovation survey, which investigates the innovation activities of firms in the manufacturing and services sectors according to the Oslo Manual presented by the Organisation for Economic Co-operation and Development (OECD) in 1998, was designated as a set of nationally approved statistics to ensure its objectivity and accuracy. The 2014 survey included investigative data of domestic firms that performed innovation activities between 2011 and 2013.

We selected the final sample for the empirical analysis considering the following factors. Only firms in the manufacturing sector were selected to control the potential variation caused by different industry characteristics. Among them, we selected 445 firms who responded to the questionnaire related to user innovation activities. Finally, after excluding firms that omitted R&D cost data, we had a final sample of 169 firms whose ownership structure and shareholding data for corporate governance were available obtain to the Data Analysis, Retrieval, and Transfer System (DART) of the Financial Supervisory Service of the Republic of Korea.

The final sample included manufacturing firms in a total of 10 industrial sectors when classified on the basis of 3 digit industrial classification code. Specifically, it includes the firms in the food sector (4.7%), fabricated products sector (8.3%), basic chemical and pharmaceutical sector (16%), non-metal manufacturing sector (5.9%), primary steel and metal processing sector (8.9%), semiconductor and

electronics sector (13.6%), computer, communications equipment, and peripherals sector (7.7%), motor and control devices sector (7.7%), general and special purpose machinery sector (13%), and automobile and ship manufacturing sector (14.2%). Since there was no significant difference in the firm size and performance between the included and excluded sample firms, we assumed that the potential problems with the generalizability of the research findings due to biased sampling are very low.

4.2. Measurement of Variables

4.2.1. Dependent Variables

Market performance, a dependent variable of the study, must be measured as the extent of the direct impact of innovation activities on changes in the market demand [2,5,16,36,48,60,61]. Consequently, we measured market performance in this study using firms' responses to three items in the 2014 Korean firm innovation survey (market share, product diversity, and product quality improvement), which were investigated to understand the impact of firm innovation activities on market performance. We conducted factor analysis to verify the reliability and validity of the responses. The Kaiser–Meyer–Olkin test result is 0.741 (effective when deriving 0.7 or higher), while the Cronbach's alpha value is 0.839 [62], signaling the high internal reliability of each questionnaire. As the response to each item was measured on a 4-point Likert scale from 0 (low impact) to 3 (high impact), we calculated the market performance variable as a continuous variable (minimum value of 0 to maximum value of 9) obtained by summing the answers for each question of market share, product diversity, and product quality improvement [35,56,63].

4.2.2. Independent Variables and Moderating Variable

Independent Variable

According to previous studies, the role of user innovation activities as a source of innovation and its impact on performance can vary depending on the extent of user participation [12,18,29,54]. Consequently, we measured user innovation activities as an independent variable as the extent and degree of user involvement in the firm's innovation process. Specifically, we assigned a value of "1" to those who answered "yes" to questionnaire items such as "the consumer was directly involved in innovation activities and the development processes", "consumers partially improved existing products developed by the firm," and "the firm further developed a product initially developed by consumers". Otherwise, we assigned a value of "0" for those who answered "no". We then calculated the total score by summing each user innovation activity (a continuous variable from 0 to 3 points) [6,18,34,54,64].

Moderating Variables

Absorptive capacity: R&D investment cost includes the cost for network construction and commercialization to capture the external knowledge required for innovation and transfers of information to the organization [14,57,58]. Moreover, since firms invest in R&D within the range in which it can utilize its absorptive capacity, we can measure the level of absorptive capacity affecting innovation performance by R&D investment cost [2,14,39,57]. In line with suggestions in prior studies, we measured absorptive capacity, a moderating variable, as the logarithmic value of the R&D investment cost per person (R&D investment cost/total number of people) [34,36].

CEO's shareholding: We measured CEO's shareholding by investigating the status of the ownership structure disclosed in the firms' annual reports. In particular, we measured the share held by the CEO rather than the top management team to analyze the impact of the CEO's incentives and motivation on strategic decision making [21,47,65].

4.2.3. Mediating Variable: Innovation Performance

We can measure innovation performance by evaluating whether a product developed by a firm through user innovation activities is new or has differentiated functions compared to the existing products offered by the firm or a competitor [4,6,12,34]. Since patent-related indicators are easy to measure as the primary outcome of innovation activities, they have been widely used as an innovation performance variable [4,5]. We followed the same approach as in prior studies and calculated the number of patent applications registered by the firm that incorporated users' ideas and knowledge into its innovation activities during the study period to measure innovation performance [38,66].

4.2.4. Control Variables

We added controls for the effects of firm size, firm history, and alliance experience. Innovation requires considerable cost and resources. Therefore, some studies have argued that larger firms with more spare resources are more likely to implement innovation activities [34]. In contrast, others argue that large firms tend to exhibit risk-averse tendencies as they have a stable market share, and thus may be passive in innovation activities. Therefore, we controlled the effect of firm size, measured by the log value of the total number of employees, in the analysis [2,34].

If a firm's history is long, accumulated experience and knowledge can increase the positive effects of cooperative relationships and activities with external parties. Meanwhile, inertia in the firm may slow its reaction to external environment changes or become a factor that makes the firm not prefer cooperative activities with external parties [18,19]. Hence, we calculated the firm history variable by subtracting a firm's establishment year from the survey year as a control variable in the analysis.

Firms experienced with innovation processes based on cooperative relationships with other firms or competitors may be more active in building and utilizing cooperative relationships with users [19,37]. Therefore, we coded alliance experience with knowledge or resource sharing through strategic cooperation with other organizations as a dummy variable (those who answered "yes" to the partnership experience were given "1", whereas those who answered "no" were given "0") [40].

4.3. Statistical Methods

We examined the hypotheses by implementing Baron and Kenny's mediated analysis and the indirect effect analysis using Bootstrap of the PROCESS macro 2.0 [67–69]. PROCESS macro 2.0 enables a comparison of not only the estimation of the regression coefficient and confidence interval of each path between variables in the multi-mediated model analysis, but also the difference between the significance test and effect size of both the direct and indirect effects [67]. We analyzed the moderating effect and the moderated mediating effect models through an interaction effect analysis based on a multiple regression analysis and a post-hoc analysis using the Johnson–Neyman technique [67,69,70].

5. Results

5.1. Descriptive Statistics and Correlations

Table 1 reports the descriptive statistics and correlations of all variables included in the analyses. The average value of CEO's shareholding, measured as the percentage of shares owned by the CEO, was 18.724%. This value is higher than that of Western firms, reflecting the characteristics of the Korean manufacturing industries, in which a larger number of firms are controlled by owner-managers. All correlation coefficients are below the threshold level of 0.6, suggesting that our estimations are not likely to be biased by multicollinearity problems.

Table 1. Descriptive statistics and correlation matrix (N = 169).

Variable	M	SD	1	2	3	4	5	6	7
1. MARKET_PERFOR	3.289	3.456	1						
2. ALLANCE EX	0.372	0.484	0.425 **	1					
3. FIRM AGE	30.816	17.915	-0.043	0.148	1				
4. FIRM SIZE (lg)	5.717	0.927	0.364 **	0.375 **	0.219 **	1			
5. USER_INNOVA	0.278	0.739	0.469 **	0.290 **	-0.075	0.198 **	1		
6. ABSOR_CAPA (R&D lg)	1.651	1.157	0.376 **	0.347 **	-0.173 *	0.061	0.042	1	
7. CEO_SHARE	18.724	16.060	0.041	0.027	-0.046	-0.021	0.109	0.035	1
8. INNO_PERFORM	4.67	8.986	0.320 **	0.320 **	-0.100	0.274 **	0.544 **	0.244 **	0.237 **

* $p < 0.05$; ** $p < 0.01$.

5.2. Findings

5.2.1. Mediation Analysis

Table 2 includes the results of the hierarchical multiple regression analysis conducted to examine the mediation effect, moderation effect, and moderated mediation effect presented in the hypotheses. The baseline model that includes the control variables (model 1) shows that alliance experiences ($b = 2.477, p < 0.001$) and firm size ($b = 0.996, p < 0.001$) are positively related to market performance. However, the effect of firm age on market performance was not significant ($b = -0.030, p > 0.05$). Model 2, 4, and 7 in Table 2 provide the results of the regression analysis performed to investigate the mediation effects of innovation performance on the relationship between user innovation activities and firms' market performance based on Baron and Kenny's method. The results in model 2 present a significant positive effect of user innovation activities on market performance ($b = 1.598, p < 0.001$), thereby supporting hypothesis 1. This finding implies that Korean manufacturing firms are seeking to improve market performance by reflecting the information and knowledge acquired from users in various functions such as manufacturing, distribution, marketing, and service.

In model 4, reported in Table 2, we found that user innovation activities have a significant positive effect on innovation performance ($b = 5.609, p < 0.001$). Furthermore, in the analysis of model 7, we found a significant positive effect of innovation performance on firms' market performance ($b = 0.081, p < 0.01$) after controlling the effect of user innovation activities on firms' market performance ($b = 1.144, p < 0.01$). Thus, hypotheses 2, 3, and 4 were all supported. These findings imply that the use of information and knowledge obtained from users can increase the opportunities for new product development. It also reduces the time and errors required in the process of innovation, thereby improving innovation performance.

Table 3 shows the results of the bootstrap significance test for total, indirect, and direct effects, respectively. According to the findings, the total effect ($b = 1.598, CI = 0.984\sim 2.212$), indirect effect ($b = 0.454, CI = 0.111\sim 1.109$), and direct effect ($b = 1.144, CI = 0.460\sim 1.828$) were all significantly positive, providing evidence that is consistent with the results of the regression analysis. Thus, the results of both hierarchical multiple regression and bootstrap analyses confirm that firms' innovation performance partially mediates the positive effect of user innovation activities on firms' market performance. Therefore, hypothesis 4 was supported.

5.2.2. Moderated Mediation and Moderated Moderated Mediation Analyses

Hypothesis 5 predicts that the mediation effects of innovation performance on the relationship between user innovation activities and market performance vary depending on the levels of firms' absorptive capacity. To confirm this hypothesis, a significant moderating effect should be found only in indirect paths, not direct paths [69,70], in a moderated mediation analysis [67,69]. Thus, we first examined the interaction effect between user innovation activities and absorptive capacity on market performance. As shown in model 3 of Table 2, the interaction effect on market performance was not

significant ($b = -0.353, p > 0.05$). Therefore, we could apply the moderated mediation model shown in Figure 1 to test hypothesis 5.

As reported in model 5 in Table 2, the interaction between user innovation activities and absorptive capacity has a significant positive impact on innovation performance ($b = 2.632, p < 0.001$).

In other words, it proves that the higher the absorptive capacity, the more information and knowledge obtained from users can be effectively utilized by firms to increase innovation performance [6,9,27]. Additionally, we applied the Johnson–Neyman (JN) technique [71] to investigate how the positive effect of user innovation activities on innovation performance varies depending on the level of absorptive capacity. The point of transition that determines the regions where the interaction effects are significant and not significant was 0.444. This result indicates that the effect of user innovation activities on innovation performance is significantly positive for firms that have a high level of absorptive capacity ($M \geq 0.444$), but not significant for firms that have a low level of absorptive capacity ($M < 0.444$).

Figure 2 is the JN plot that depicts the conditional effect of user innovation activities on innovation performance at values of the moderator, absorptive capacity.

Table 2. Hierarchical multiple regression for market performance and innovation performance.

Variables	Market Performance (Model 1–3)			Innovation Performance (Model 4–6)			Market Performance
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	B	B	B	B	B	B	B
<i>Control Variables</i>							
ALLIA_EX	2.477 (0.519) ***	1.839 (0.499) ***	0.845 (0.511)	2.719 (1.301) *	1.280 (1.352)	1.801 (1.107)	1.619 (0.496) **
FIRM AGE	−0.030 (0.013)	−0.020 (0.013)	−0.007 (0.012)	−0.061 (0.033)	−0.035 (0.032)	−0.017 (0.028)	−0.015 (0.012)
FIRM SIZE	0.996 (0.275) ***	0.829 (.258) **	0.960 (0.440) ***	1.487 (0.673) *	1.547 (0.645) *	0.994 (0.570)	0.709 (0.257) **
<i>Independent Variables</i>							
USER_INNO		1.598 (0.311) ***	2.320 (0.587) ***	5.609 (0.810) ***	5.664 (0.775) ***	6.589 (0.770) ***	1.144 (0.347) **
ABSOR_CAPA (R&D lg)			0.997 (0.202) ***		1.710 (0.520) **	1.419 (0.464) **	
CEO SHARE						0.050 (0.031)	
INNO_PERFOR							0.081 (0.029) **
<i>Interaction</i>							
USER*ABSOR			−0.353 (0.299)		2.632 (0.791) ***	2.053 (0.775) **	
USER*CEO						0.084 (0.043)	
ABSOR*CEO						0.097 (0.026) ***	
<i>Three-way interaction</i>							
USER *ABSOR*CEO						0.239 (0.047) ***	
F-Statistics	18.513 ***	22.626 ***	21.179 ***	22.294 ***	19.601 ***	21.766 ***	22.294 ***
R2	0.163	0.235	0.248	0.336	0.379	0.422	0.355
AdjustedR2	0.148	0.212	0.237	0.314	0.367	0.409	0.338

Note: the table provides parameter estimates; standard errors are in parentheses; estimated effects, * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 3. Bootstrap significance test for mediating effects.

	Effect (B)	Boot (se)	p	LLCI	ULCI
Total effect of User Innovation activities on Market Performance	1.598	0.311	0.000	0.984	2.212
Direct effect of User Innovation activities on Market Performance	1.144	0.347	0.001	0.460	1.828
Indirect effect of User Innovation activities on Market Performance through Innovation Performance	0.454	0.253		0.111	1.109

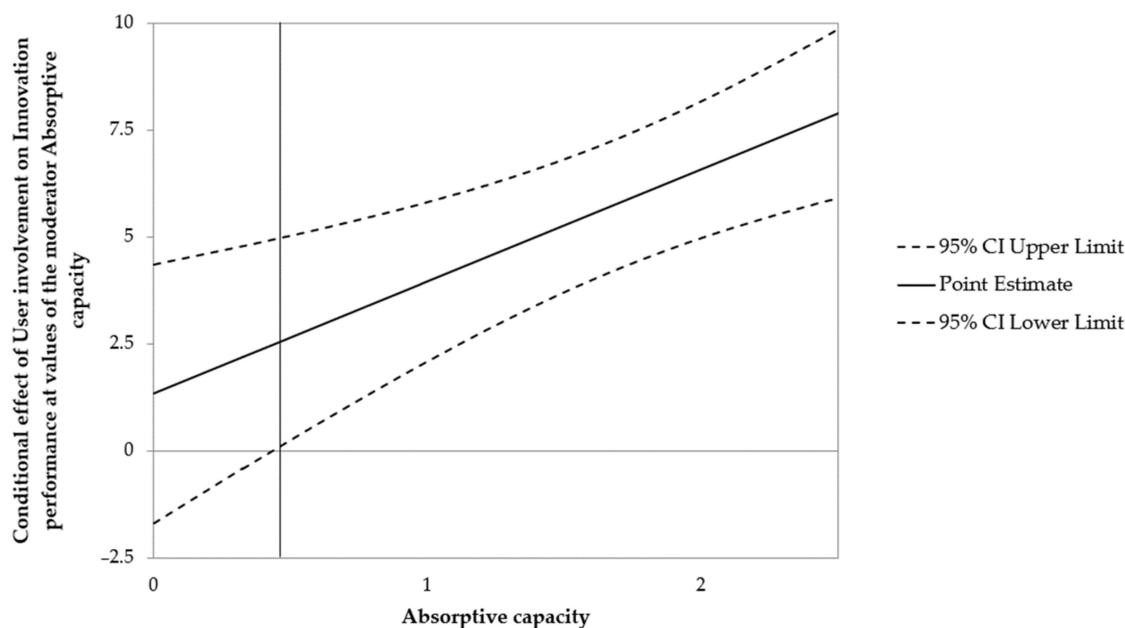


Figure 2. Conditional effect of user innovation activities on innovation performance at values of absorptive capacity.

For the next step, we conducted a bootstrap significance test for the moderated mediation effect (conditional indirect effect) that presents how the mediation effect (indirect effect) varies depending on the levels of absorptive capacity. As shown in Table 4, the mediation effects vary depending on the level of absorptive capacity. The mediation effect was significantly positive in firms with medium (1.651) ($b = 0.458$, $CI = 0.086\sim 1.077$), and high absorptive capacity (2.808) ($b = 0.705$, $CI = 0.155\sim 1.456$), but not significant in firms with low absorptive capacity (0.493) ($b = 0.212$, $CI = -0.055\sim 0.973$). Thus, the moderated mediation effect proposed in hypothesis 5 was supported. The results imply that firms with high absorptive capacity will more likely have a better understanding of the knowledge and information provided by users, thereby improving innovation performance [5,6,16].

Table 4. Bootstrap significance test for conditional indirect effect (user innovation activities, innovation performance, market performance).

	Moderated Mediated Index(β)		Boot SE	Boot LLCI	Boot ULCI
	0.213		0.136	0.024	0.582
	Moderator (Absorptive Capacity)	Conditional Indirect Effects(β)	Boot SE	Boot LLCI	Boot ULCI
Mediator (Innovation Performance)	0.493 (-1 SD)	0.212	0.260	-0.055	0.973
	1.651 (mean)	0.458	0.261	0.086	1.077
	2.808 (+1 SD)	0.705	0.344	0.155	1.456

Hypothesis 6 predicts that the interaction effects of user innovation activities and absorptive capacity on market performance through innovation performance vary depending on the levels

of CEO's shareholding (the percentage of shares owned by the CEO). We performed "moderated moderated mediation analysis" to test hypothesis 6 [67]. As reported in model 6 in Table 2, the three-way interaction has a significant and positive impact on innovation performance ($b = 0.239$, $p < 0.001$). Additionally, we examine how the interaction effect between user innovation activities and absorptive capacity on innovation performance depends on the different levels of CEO's shareholding by applying the Johnson–Neyman technique. The interaction effect between user innovation activities and absorptive capacity on innovation performance was significantly positive only for the firms with more than 16.758% of CEO shareholding. These findings suggest that, even among the firms that have high levels of both user innovation activities and absorptive capacity, firms with higher CEO's shareholding are likely to achieve better innovation performance than others. Figure 3 is the JN plot that shows the conditional effect of the interactions between user innovation activities and absorptive capacity on innovation performance at different values of CEO's shareholding.

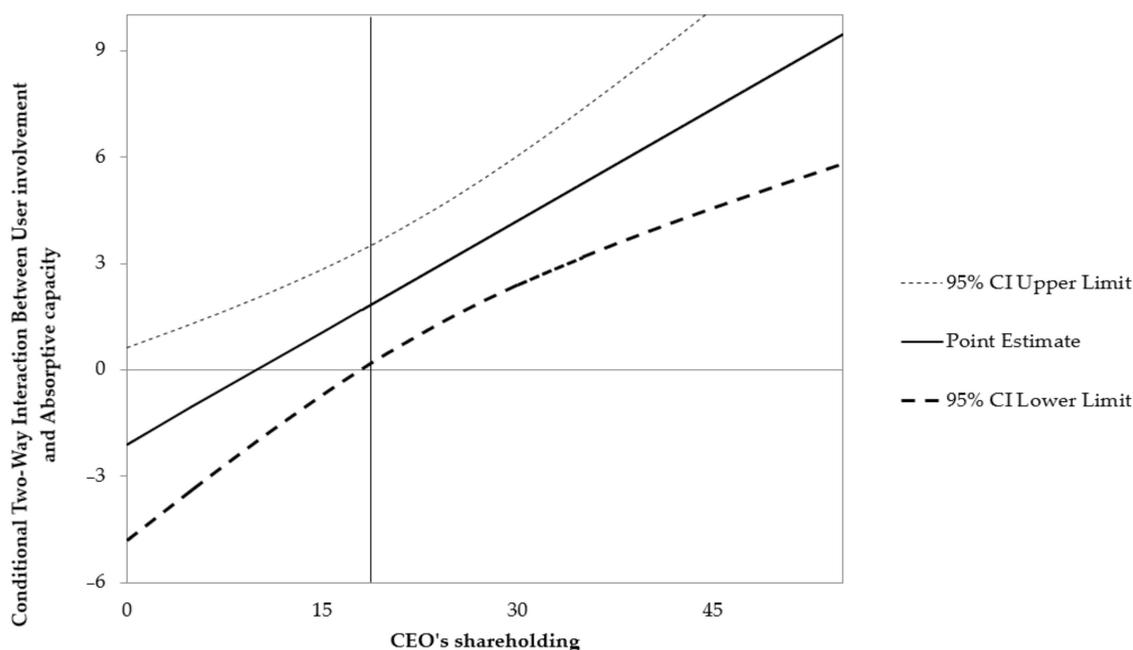


Figure 3. Conditional two-way interaction between user innovation activities and absorptive capacity as function of CEO's shareholding.

Lastly, we conducted a bootstrap significance test to examine how the mediating effect of innovation performance varies depending on the different levels of the two moderators, a firms' absorptive capacity and CEO's shareholding. As shown in Table 5, we found that the mediation effect of innovation performance was not significant in the firms with low absorptive capacity (0.493). In addition, we found that even among firms with high levels of absorptive capacity (2.808), significant mediating effects were only observed in firms with medium (18.725%) and high (34.785%) levels of CEO's shareholding. Therefore, we finally conclude that hypothesis 6 was supported. These results are consistent with the argument of previous studies. Researchers should consider corporate governance mechanisms when they examine the effects of open innovation and/or absorptive capacity on the performance of firms [28,58].

Table 5. Bootstrap significance test for effect of moderated moderated mediation (effect of moderated mediation of 3-way interaction).

	Moderated Mediated Index(β)			Boots Se	BootLLCI	BootULCI
	0.016			0.015	0.002	0.092
	Moderator (Absorptive Capacity)	Moderator (CEO's Shareholding)	Conditional Indirect Effects	Boots Se	BootLLCI	BootULCI
Mediator (Innovation Performance)	0.493	2.664	0.497	0.458	−0.032	1.929
	0.493	18.725	0.286	0.266	−0.012	0.981
	0.493	34.785	0.075	0.275	−0.219	0.674
	1.651	2.664	0.356	0.318	−0.005	1.186
	1.651	18.725	0.448	0.290	0.018	1.132
	1.651	34.785	0.539	0.352	0.079	1.552
	2.808	2.666	0.216	0.387	−0.117	1.297
	2.808	18.725	0.609	0.392	0.052	1.572
	2.808	34.785	1.003	0.670	0.217	3.449

6. Conclusions

Recent changes in the market environment, including diversified consumer needs, shortening product life cycles, and increasing uncertainty, have led firms to focus more on user innovation activities, which allow firms to rapidly acquire and apply market information and knowledge. However, prior studies on the impact of user innovation activities on corporate performance have reported mixed findings. In addition, only a very small number of studies have aimed to identify the effect of the process of user innovation activities on the market performance of firms. Therefore, in this study, we examined the impact of the user innovation activities of Korean manufacturing firms on market performance. In addition, we explored a mediating effect of innovation performance and the moderated mediation effect of absorptive capacity and the moderated mediating effect of CEO's shareholding on these relationships. According to the results of our hierarchical multiple regression analysis, user innovation activities have a significant positive impact not only on innovation performance measured by the number of product patent applications but also on market performance measured by market share. These findings demonstrate the efforts of Korean manufacturing firms to develop new products and strengthen market competitiveness by using information and knowledge provided by consumers [3,4,6,31].

The hierarchical multiple regression analysis, JN technique, and bootstrap significance testing show that the interaction effects of user innovation activities and absorptive capacity have differing effects on market performance and innovation performance. Specifically, the interaction effects of user innovation activities with absorptive capacity had a significant positive effect on innovation performance, but no significant impact on market performance. We presume that these results are related to the method we employed to measure absorptive capacity. As we explained in Section 4, we measured absorptive capacity by R&D investment per capita. However, prior studies have demonstrated that increasing investment in R&D may weaken the investments in other functional areas such as production, marketing, distribution, services, and human resource management [31,54]. In addition, if the firm's sole source of innovation is users, then the scope of the firm's activities for innovation may be limited, negatively affecting market performance [12,72].

This study provides the following academic implications. First of all, the three-way interaction effect of user innovation activities, absorptive capacity, and CEO's shareholding presents a positive effect on market performance through innovation performance as a mediator. This finding is consistent with the argument of the convergence of interest hypothesis in agency theory. A CEO's shareholding percentage could reinforce the effect of absorptive capacity on open innovation activities, helping the firm recognize market changes faster than its competitors and enhancing innovation performance, thereby significantly improving market performance. Thus, CEO's shareholding should be considered a particularly important approach to improve the performance of a firm's open innovation activities in Korea.

Our findings also contribute to the academic development of innovation strategy and corporate governance areas by presenting and verifying a comprehensive and integrated research model of the factors at the individual and corporate levels that can affect strategic choices and performance. Some prior studies have suggested that entrepreneurship or leadership of managers could affect open innovation or absorptive capacity of a firm [22,73–75]. However, there has been no research that has analyzed the effects of open innovation, absorptive capacity, and the corporate governance system in an integrated model. From this point of view, we believe this study adds new knowledge for open innovation by presenting empirical findings of significant three-way interaction effects among open innovation activities, absorptive capacity, and CEO's shareholding on innovation and market performance [28,58].

Researchers in the field of open innovation should conduct studies with a more comprehensive consideration of various factors inside and outside the firm. In particular, they should pay more attention to the firm's characteristics and resources that can affect innovation activities and the absorptive capacity to acquire, assimilate, and utilize external information.

Increasing uncertainties in the business environment due to the Fourth Industrial Revolution and COVID-19 make it difficult for firms to innovate activities and increase performance [76]. In this complex and rapid change of environment, this study provides valuable practical implications for Korean firms seeking to enhance their expertise and improve their performance by introducing a professional management system. Korean firms might be able to utilize the findings of this study to establish an open innovation system that effectively utilizes their limited internal and external resources and corporate governance mechanisms to improve their innovation and market performance [38]. In a rapidly changing and highly uncertain environment, Korean firms should intensify and utilize an internal system, namely absorptive capacity, to quickly acquire more information and knowledge from consumers and use it in developing new products. They might be able to strengthen the positive impact of absorptive capacity on the relationship between open innovation activities and performance by intensifying CEO's shareholding.

Despite its practical and academic contributions, this study has the following limitations.

First, we limited the research sample to firms in the manufacturing sector to control the impact of the distinct characteristics of the industrial sector on the results. Therefore, there is a limit to the generalizability of the research findings. Future research that includes more diverse industries, such as the service sector, will help overcome this limitation.

Second, absorptive capacity has been defined and used in various fields based on different theories. Thus, it can be measured by various proxies, such as level of human resources and knowledge usage. However, we measured absorptive capacity by R&D cost per capita from a financial perspective, which may have influenced the research findings. Further research to measure and analyze absorptive capacity from a more diverse perspective will help improve the objectivity and validity of the results of this study.

Finally, open innovation can be achieved not only through users but also through cooperation with suppliers, competitors, and other stakeholders [77,78]. Furthermore, the impact of external information and knowledge acquired from various stakeholders can be a factor that affects the firm's performance depending on the nature of the industry or the degree of change in the business environment. Therefore, future studies that compare and analyze firms that perform open innovation activities simultaneously based on cooperation with various stakeholders should provide more value by presenting the most appropriate open innovation strategy depending on a firm's characteristics.

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