Relationships among Open Innovation Processes, Entrepreneurial Orientation, and Organizational Performance of SMEs: The Moderating Role of Technological Turbulence

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Abstract. Open innovation processes have become important mechanisms that are integrated into organization's innovation strategies to improve performance among small and medium-sized enterprises (SMEs) under dynamic technological settings. This study explored the relationships among open innovation processes (outside-in, inside-out, and coupled), entrepreneurial orientation (EO), and organizational performances (innovation and financial) of SMEs and analyzed the moderating role of technological turbulence on these relationships. Drawing on the technology-based view, we proposed a conceptual framework that depicts how SMEs' EO facilitates open innovation processes, which consequently affect performance. The empirical results from a sample of 161 Taiwan-based SMEs reveal that EO serves as a precursor for open innovation processes, and practicing specific open innovation processes improve specific performance outcomes. Outside-in process is positively related to both performance outcomes. Inside-out process is linked to financial performance, and the coupled process is linked to innovation performance. Under high degree of technological turbulence, the positive relationship between EO to outside-in and inside-out processes and the relationship between outside-in process to both innovation and financial performance are strengthened. However, high technological turbulence does not facilitate the relationship between EO to the coupled process or the coupled process to both performance outcomes.

Keywords: open innovation, entrepreneurial orientation, organizational performance, technological turbulence, small and medium-sized enterprises.

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1 Introduction

Nowadays organizations are challenged by rapid technological changes, shortened innovation cycles, and escalation of research and development (R&D) costs. These have caused organizations, including small and medium-sized enterprises (SMEs), to gradually move toward the "open innovation" model by actively seeking linkages with external environment [1], [2], [3], [4]. This global trend of open innovation encourages that an organization should access both internal and external sources of R&D to improve their innovation competencies. Furthermore, an organization should also use internal and external commercialization paths to advance their technologies [1], [2].

Among others, Gassmann & Enkel [5] from a process perspective developed an open innovation theory. The theory asserts that there are three core processes of open innovation: outside-in, inside-out, and coupled process [3], [5]. The outside-in process is the search for and adoption of knowledge and technologies from outside an organization's boundaries. Inside-out process is the various ways in which internally developed innovations can be commercialized and entered into new markets. The coupled process links the integration and commercialization of knowledge and technologies through collaborating with other organizations in innovation networks, such as strategic alliances and joint ventures [3], [5].

Since then, studies on the relationship between open innovation processes and organizational performance have increased [6], [7], [8], [9]. Despite the growing interest, the majority of these studies had only separately investigated the effects of each open innovation process on performance. Likewise, there is a lack of empirical studies simultaneously examining all three processes in a single integrated research model [9], [10], [11]. This research gap is unfortunate because in practice, organizations usually utilize all or a mix of the three processes of open innovation to improve their innovation efforts and economic returns. Hence, a motive for this study is to fill this gap by simultaneously investigating the impact of all three processes on organizational performance.

Scholars have also asserted that practicing open innovation not only can be beneficial for large enterprises, but it's crucial for the success of SMEs as well [1], [2], [12], [13], [14], [15], [16]. SMEs are clearly different from their larger counterparts with the respect to how they can utilize open innovation. On one hand, innovative developments is often challenging for SMEs because SMEs usually suffer from the "liability of smallness" due to limited resources for R&D, undeveloped competencies, and unstructured innovation processes [13], [17]. Yet, on the other hand, SMEs often benefit from their entrepreneurship. *Entrepreneurial traits* such as the willingness to take risks, the stress on being innovative, the eagerness for learning, and the ability to adapt easily and rapidly to environmental changes are the key strengths of many SMEs [13], [18]. Collectively these entrepreneurial characteristics enable SMEs to become proficient in applying open innovation while concurrently compensate for their liability of smallness [13], [15].

In accordance, a growing number of SMEs have practiced open innovation processes during this past decade [13], [14], [16], [19], [20], [21]. This movement is crucial not only to the sustainability of individual organizations, but also to the economy of many countries, such as China [22], Brazil [23], Australia [19], Sweden [13], and Taiwan [18], [24], where SMEs are the powerhouse for driving economic growth. For example, Taiwan relies heavily on SMEs' innovation performance and entrepreneurship. In terms of innovation records, Taiwan ranked 6th in the Economist Intelligence Unit's Global Innovation Index of 2009-2013 and ranked 3rd in the world's most entrepreneurial country [25]. SMEs not only account for more than 97.63% of Taiwan's total enterprises, but also SMEs' total R&D expenditure in Taiwan has risen with a growth rate of 17.17% in 2008, 2.05% in 2009 and to 4.46% in 2010 [26]. Therefore, an integrated examination on how open innovation processes improve Taiwan-based SMEs' performance is not only important to Taiwan, but also can be beneficial to other countries where SMEs and innovation play a crucial role in facilitating economic growth.

In addition, open innovation studies have focused on several aspects of an organization that may influence its open innovation strategies and organizational performance [6], [10], [11], [18], [19], [27], [28]. For instance, the absorptive capacity of organizations has been frequently highlighted as a crucial characteristic that helps to achieve a sustainable competitive advantage [19], [28], [29]. However, the direct impact of entrepreneurial orientation on open innovation practice to organizational performance is less explored. In summary, the objective of this study is to have a closer look at Taiwan-based SMEs' entrepreneurial orientation and their impact on their open innovation practices and organizational performance.

Based on the research background and motives listed above, the contribution of this study is threefold: (1) it investigated the potential antecedent role of EO of SMEs in driving their implementation of open innovation processes; (2) it simultaneously examined the effect of each open innovation process on both innovation performance and financial performance; (3) it investigated the potential moderating role of technological turbulence on the previous two relationships.

2 Conceptual Background and Hypothesis Development

Reflecting on the contributions listed in the previous section, Figure 1 presents the conceptual framework and respective hypotheses. The framework indicates that SMEs' EO acts as a precursor towards the three core processes of open innovation, and practicing open innovation process improves a specific performance outcome. In addition, technological turbulence is included in the model to serve as a moderator to the previous two relationships. In summary, this framework guides the proposition of the hypotheses, which are presented below.

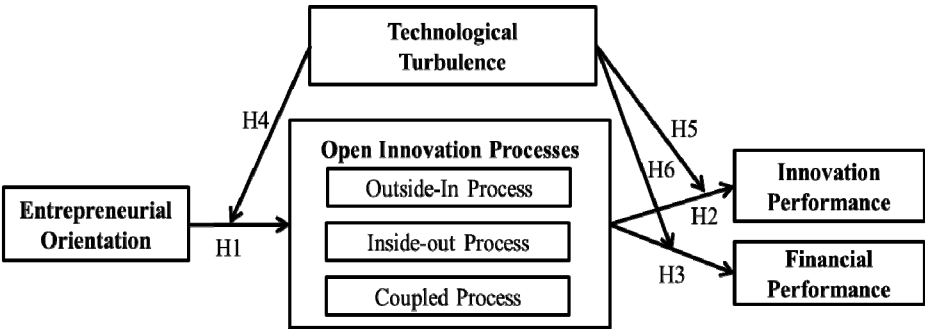

Fig. 1. Conceptual Framework

2.1 Technology-Based View

With the growing importance of technological knowledge, intellectual property and the integration of internal and external sources as a resource in economic and technological development, understanding the key perspectives on collaborative innovation and knowledge sharing are essential [10], [11], [30]. A significant theory in strategic management that has served as a theoretical foundation for studying collaborative efforts is the resource-based view (RBV) [31]. The key concept of the RBV is that organizations possess a set of resources or capabilities that differ among organizations, and these unique resources and capabilities can lead them to a sustainable competitive advantage [31]. Various perspectives related to RBV have arisen, and the most notable one is the technology-based view.

Technology-based view focuses on the technological competencies as a central part of an organization's resource base. Simply put, technology-based view considers an organization's technologies and resources as being a special kind of knowledge that assist in dealing with technological uncertainties [32], [33]. Thus, technology-based view is suggesting that collaboration innovation is a strategy for organizations to develop appropriate acquisition and exploitation strategies to externalize their technological competencies to deal with technological uncertainties. This perspective can be used to explain the impacts of EO to open innovation processes and open innovation processes on organizational performance which will be presented below.

2.2 Open Innovation and Its Core Processes

Traditionally, organizations had operated under a fundamentally *closed* innovation paradigm. All innovation processes must be tightly controlled within the organizations and not exposed externally, even if the R&D projects had already been discarded or put on hold [1], [34]. However, in an era where technological knowledge is diffused across organizations combined with the increasing importance of porous boundaries, organizations can no longer depend on their own R&D to

innovate. In accordance, Henry Chesbrough in his ground-breaking book, *Open Innovation: The New Imperative for Creating and Profiting from Technology*; suggested that a paradigm shift had occurred and coined the new paradigm as "*open innovation.*" He defined it as "*the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation, respectively*." In other words, the open innovation paradigm promotes active interactions with various stakeholders not only in the R&D process, but also in commercialization initiatives [1], [2].

Later, from a process perspective, Gassmann & Enkel [5] had provided an in-depth analysis on open innovation and identified three core processes: outside-in, inside-out, and coupled process. The *outside-in process* involves the usage of external sources of knowledge to enrich the knowledge base within an organization. It opens the innovation process to external knowledge exploration through the integration of suppliers and customers' knowledge and competencies [3], [4], [5]. In addition, organization can also integrate non-profit organizations like universities, government agencies, and other research institutions to integrate their different competencies to enrich its own innovation competencies. For instance, many large pharmaceutical firms, such as Eli Lilly, actively acquire a significant amount of their technologies from external partners to enhance their internal capabilities [8], [12].

The *inside-out process* involves externally commercializing and/or transferring of internally developed technologies in order to gain monetary and strategic benefits [3], [5], [35]. This process results in faster time-to-market for products and technologies, and it also makes them more valuable than when they are initially developed [1], [2]. For example, IBM not only benefitted from their internal innovations, but IBM also generated millions of dollars in licensed technologies annually [1], [2], [8], [36].

Organizations may also integrate both outside-in and inside-out processes to yield the *coupled process* by closely collaborating with other organizations through strategic alliances or joint collaborations [3], [5], [30]. In order to collaborate and cooperate successfully, a right balance of give and take is crucial. Cooperation is usually characterized by a profound form of interaction between organizations over a long period of time. This interaction tends to result in intensive exchanges of knowledge and initiates a process of mutual learning [5]. Furthermore, the coupled process allows the transfer of tacit knowledge among organizations which normally cannot be easily blueprinted or packaged through licensing or market transactions [5].

Although the idea of practicing the three core processes of open innovation is rather intriguing, nevertheless, through a comprehensive review of prior studies, we have identified that the majority of the studies had only explored the impacts of outside-in, inside-out, and coupled process individually. In addition, to date, the majority of prior research has focused on large enterprises and less on SMEs [13], [14], [15], [16] as shown in Table 1. As a result, we find that it is practical and theoretically relevant to focus on the topic of SMEs and simultaneously investigate how all three processes can influence performance in a single research model.

Table 1. Prior Studies on Open Innovation and Organizational Performance Based on Organization Size

Focus	Outside-In	Inside-out	Coupled
Large Enterprises	Chiang & Hung [24] Ebersberger et al. [37] Hung & Chiang [18] Inauen & Schenker-Wicki [10] Laursen & Salter [38] Lee et al. [17] Lin & Wu [39] Mazzola et al. [9] Spithoven et al. [28], [40] Tsai et al. [41] Un et al. [42]	Belderbos et al. [43] Inauen & Schenker-Wicki [11] Kutvonen [44] Lichtenthaler [45], [46], [47] Lichtenthaler & Ernst [35], [48] Mazzola et al. [9]	Belderbos et al. [43] Bogers [30] Faems et al. [49] Mazzola et al. [9] Lin et al. [50] Nieto & Santamaria, [51]
SMEs	Huang & Rice [19], [52] Kim & Park [20] Lasagni [21] Neyens et al. [53] Parida et al. [13] Suh & Kim [54] Zeng et al. [22]	Bianchi et al. [14]	Lee et al. [17] Neyens et al. [53] Suh & Kim [54]

2.3 Entrepreneurial Orientation (EO) and Open Innovation

Entrepreneurial orientation (EO) has been recognized as the key for innovative activities for many organizations especially SMEs [13], [18], [22], [54]. EO refers to an organization's strategic orientation that reflects specific aspects of an organization[55], [56]. These aspects of EO are demonstrated by the extent to which the top managers or chief executive officers (CEO) are inclined to take business-related risks (inclination to risk-taking), to favor change and novelty in order to obtain a competitive advantage (innovativeness), and to compete aggressively with other organizations (pro-activeness) [56], [57], [58].

More specifically, risk-taking is the willingness of an organization to take bold actions such as exploiting significant resources or utilizing business strategies where the outcome is highly uncertain. Innovativeness refers to the organization's willingness to engage in creative processes, to try new technological processes, and to improve existing or to create new products and/or experiment with new ideas and technologies. Pro-activeness refers to actively seeking new opportunities, such as taking advantage of first mover strategies in a competitive environment [56], [57], [59], [60]. Altogether, these three dimensions of EO facilitate organizations to be flexible to environmental changes and be responsive to external opportunities; hence, they may assist organizations in adopting open innovation [3], [4], [14].

Based on this logic, we argue that high EO can assist an organization in implementing open innovation processes. First, organizations with high EO will actively scan its task environment to look for adequate sources of knowledge, in turn allowing them to deepen the pool of technological opportunities available to them. Prior studies on open innovation have asserted that searching for external sources of knowledge can increase the chance for organizations to improve its internal

knowledge base [10], [24], [37], [38]. Second, an organization with high EO is more willing to take risks by adopting innovative strategies such as divesting and/or transferring of a given technology into new markets. Such processes accelerate commercialization of innovations which provide both monetary and strategic benefits [44], [45], [46]. Third, organizations with high EO are more inclined to initiate collaboration projects, where one organization provides the specialized knowledge and the other organization provides the needed infrastructure and resources for producing, marketing, and commercializing an innovative product or service [13], [18]. Overall, organizations possessing a high EO are more equipped to adopt open innovation processes to improve their innovation efforts than their counterparts with low EO. Prior studies have found a positive relationship between EO and innovative strategies [15], [18], [55], [58].

H1a: EO is positively related to the outside-in process of open innovation.
H1b: EO is positively related to the inside-out process of open innovation.
H1c: EO is positively related to the coupled process of open innovation.

2.4 Open Innovation and Innovation Outputs

The technology-based view has emphasized that with the growing importance of technological knowledge and intellectual capital, organizations should actively engage in collaborative innovation with the external environment [4], [30]. Scholars have also indicated that the reason organizations have adopted open innovation is because organizations believe that utilizing the paradigm is critical to growth in profits and improvement in their innovation efforts [1], [2], [3], [6], [7], [8], [61]. In other words, with the three open innovation processes (outside-in, inside-out, and coupled process), organizations can greatly improve their performance outcomes.

First of all, outside-in process refers to the integration of external knowledge, competencies, and resources gained from stakeholders outside the boundaries of an organization [3], [5]. Practicing the outside-in process can enrich an organization's internal knowledge base and in turn increase its overall innovativeness. The concept of absorptive capacity illustrates that new knowledge that is complementary to prior knowledge can enhance an organization's innovation capabilities [29], [62]. Through absorptive capacity, organizations can expand their knowledge base, improve their ability to assimilate, utilize new information, and enhance their innovation outputs [19], [28]. Previous studies have asserted that by accepting and utilizing external sources of R&D, organizations can improve their innovation efforts such as innovations' flexibility and value added to customers [10], [20], [28], [38], [52]. Moreover, Parida et al [13] suggested that by utilizing outside-in strategies, such as technology scouting of new technological developments and technology sourcing of complementary knowledge, organizations can keep up with new developments and innovations to improve their innovation performance [21], [27].

Besides impacting the innovation performance, the outside-in process affects an organization's financial performance as well. Many prior empirical studies have indicated that the integration of external parties' knowledge and expertise tend to be beneficial for organizations in terms of revenue, net-profit, and sales [9], [10], [18],

[43]. In summary, relying on external developed technologies or knowledge enables an organization to improve both its innovation and financial performance. For this reason, we suggest the following hypotheses:

H2a: The outside-in process of open innovation is positively related to innovation performance.

H3a: The outside-in process of open innovation is positively related to financial performance.

The inside-out process is increasingly considered as a strategic practice, in which an organization can profit from its own technological developments through various contracts such as out-licensing, spin-offs, and/or technology commercialization. Gassmann & Enkel [5] suggested that for organizations to successfully transfer its knowledge to the external environment, a *multiplicative capability* is required. The concept of multiplicative capability illustrates that for an organization to transfers their knowledge, a strategic selection of partners that are willing to multiply the application of the technology is essential. Basically, when an in-house technology does not match with the organization's business model, the organization should look for others with business models that are better suited [1], [2], [35]. By commercializing or transferring internal unused technological knowledge to the market, organizations are able to gain strategic opportunities, which result in a positive impact on both innovation and financial performance [11], [44], [46].

Although prior empirical studies on the inside-out process mostly focused on the results on financial performance, non-monetary benefits can be gained as well [35], [43], [47]. The most commonly acknowledge non-monetary benefit for inside-out process is accelerating the commercialization of an innovation and identifying the potential various applications of a given technology [1], [2], [35]. Based on this logic, we suggest the following:

H2b: The inside out process of open innovation is positively related to innovation performance.

H3b: The inside-out process of open innovation is positively related to financial performance.

Lastly, coupled process refers to co-creation with complementary organizations through strategic alliances and/or joint ventures. Organizations that practice the coupled process are heavily involved in inter-organizational relationships, where the critical factor for success is a cooperatively pattern of giving and taking of complementary resources [3], [4], [5]. According to Dyer & Singh [63], the concept of relational capacity illustrates that an organization can be differentiated from their competitors by the networks in which it is connected to. In other words, an organization's competitive advantage is its capability to build and maintain a strong innovative network with partners [63]. Working in R&D collaboration with complementary partners facilitates organizations to scan the external environment for potential new innovation opportunities and complementary technologies [12], [50].

Overall, practicing the coupled process enables organizations to jointly produce efficient performance outcomes measured by the variety of offered products and services, sales and revenue growth, and overall customer satisfaction [37]. Prior studies on inter-organizational collaboration asserted that forming both R&D and manufacturing alliances

are of crucial importance in achieving higher degree of novelty and quality in product innovation [50], [51]. In summary, by co-developing new products and services together, organizations can improve both performance outcomes since both parties can reduce costs and production time. Therefore, we hypothesize:

H2c: The coupled process of open innovation is positively related to innovation performance.

H3c: The coupled process of open innovation is positively related to financial performance.

2.5 Technological Turbulence's Moderating Effects

Contingency theory asserts that an organization's strategic orientation and innovation strategies will not be equally effective under unconventional environmental conditions [59], [60]. Accordingly, the external environment of an organization is a key intervening variable that affects how EO functions in terms of driving an organization's innovation practices. A particular environmental condition that is believed to pressure SMEs into practicing open innovation is technological turbulence [16], [64]. Technological turbulence refers to the extent which the industry that an organization is embedded in is impacted by rapid changes in technological conditions [65].

Within a setting of high technological turbulence, competitions among organizations can be characterized by extreme short innovation cycles [1], [2], [46]. New products and services can emerge very unpredictably and quickly. The constant change of technologies also yields greater risks such as technical obsolescence and high R&D cost [14]. To cope with these increased risks, organizations with a high EO tend to intensify their risk-reduction initiatives [18], [30], [56], [59]. For instance, by adopting outside-in process, organizations can shorten product development cycles through leveraging external sources of technologies and knowledge [19], [38], [52]. By adopting inside-out process, organizations can avoid the risk of technical obsolescence [35], [46]. In addition, by adopting coupled process such as long-term collaborative arrangements, organizations can constitute an effective risk-sharing mechanism [30]. Studies on open innovation have argued that under high levels of technological uncertainty, an organization's strategic orientation will facilitate the gathering and transferring of knowledge and technologies for superior responsiveness [46], [66], [67]. Based on the argument above, we propose the following:

H4a: Technology turbulence positively moderates the relation between EO and outside-in process of open innovation.

H4b: Technology turbulence positively moderates the relation between EO and inside-out process of open innovation.

H4c: Technology turbulence positively moderates the relation between EO and coupled process of open innovation.

Existing studies on open innovation have stressed that technological turbulence can moderate the effectiveness of open innovation processes on both innovation and monetary outcomes [16], [46], [68]. Technology-based view also suggested that with the emergence of a technological and knowledge-abundant economy, an organization needs to ensure that it captures value from its technological and knowledge resources

as a mean to improve performance and sustain competitive advantage [30], [32], [33]. In high technological turbulent environments, there are higher technical obsolescence and shorter innovation cycles, in which the benefits from practicing innovations may be undermined [10], [11], [46]. For example, the possibilities of achieving more profits from R&D investments are limited when technologies are constantly changing. Hence, technology-based view suggested that organizations need to concentrate on the exploitation of their technological resources to capture value from innovations if technologies are developing rapidly [30], [32], [33]. In other words, high technological turbulence facilitates the relationship between open innovation processes and both innovation outputs and economical returns. Lichtenthaler [46], [47] suggested that in environments characterized as high technological turbulence, it motivates organizations to utilize the inside-out process to create opportunities for superior financial returns by actively commercializing or licensing out unused technologies. In addition, high technological turbulence demands active acquisitions of external sources of R&D resources because organizations are not able to cover all technological developments independently [11], [44], [46], [68] . Base on the arguments above, we propose the following:

H5a: Technology turbulence positively moderates the relation between outside-in and innovation performance.

H5b: Technology turbulence positively moderates the relation between inside-out and innovation performance.

H5c: Technology turbulence positively moderates the relation between coupled and innovation performance.

H6a: Technology turbulence positively moderates the relation between outside-in and financial performance.

H6b: Technology turbulence positively moderates the relation between inside-out and financial performance.

H6c: Technology turbulence positively moderates the relation between coupled and financial performance.

3 Research Methodology

3.1 Data and Sample

The sampling frame for this study is SMEs in Taiwan. It is difficult to define SMEs since the definition not only varies across countries to countries, but also the definition changes over time [13], [22]. According to small and medium enterprises administration (SMEA), SMEs in Taiwan are mainly composed of two sectors, manufacturing and services [26]. The average number of employees is 200 or less, with a paid capital of New Taiwanese dollars (NT$) 80-100 million or less. The definition of SMEs in Taiwan is obviously different from other countries; therefore, we followed the U.S. Small Business Administration's definition and labeled the size of our sampled Taiwan-based SMEs as enterprises with fewer than 500 employees [69].

For data collection, we used a questionnaire survey on Executive Master of Business Administration (EMBA) students from several well-known universities across Taiwan. EMBA students represent an appropriate sample as SMEs for various reasons. First of all, many of these EMBA students are CEOs or top executives of SMEs. In addition, they are

people engaged in further enrichment of their knowledge and relational networks, and this fulfills the requirements for wanting to operate in an open environment where knowledge is abundant. These features make EMBA students suitable targets for studying the relationship between open innovation processes and organizational performance in SMEs. A total of 161 useable questionnaires were obtained. Out of the 161 respondents: 112 (69.5%) are from the manufacturing sector and 49 (30.4%) are from the services sector.

3.2 Variables and Measures

This study adopted survey measurement items from past studies based on relevant literature. Modifications were made to fit the context of the study. All scales were measured using a five-point Likert scale ranging from 1 (strongly disagree/low) to 5 (strongly agree/high) (see Appendix).

Open innovation is a broad concept that includes different dimensions; thus, based on Gassmann & Enkel [5]'s theory and Inauen & Schenker-Wicki [10], [11]'s descriptions, we operationalized open innovation as consisting of three dimensions (outside-in, inside-out, and coupled) and developed measurement scales for each process. *Outside-in process* measures the practices to which an organization integrates external initiatives into their innovation process. *Inside-out process* measures the practices to which an organization externally transfers or commercializes its internally developed resources. *Coupled process* captures an organization's interaction characteristics with their innovation partners.

To ensure adequate reliability and validity of our composed measurement scales, we conducted a pilot test with a convenience sample of 67 EMBA students. The data of the pilot test were then subjected to evaluation using Cronbach's alpha and factor analysis [70]. Cronbach's alpha assesses the reliability of the scales. Items that did not significantly contribute to the reliability were eliminated [70]; as a result, one item was removed from each process (see Appendix). The overall reliability coefficients for the dimensions were 0.873, 0.873, and 0.808 respectively. All coefficient scores were over the cutoff of 0.70 [70], [71]. To examine whether the scales of each open innovation processes could load on to three components respectively, we subjected the data to exploratory factor analysis (EFA) [70]. EFA found all items loaded onto their respective factors, which concurred with Gassmann & Enkel [5] and Inauen & Schenker-Wicki [10], [11]'s descriptions. These findings provided preliminary support for the adequacy of our scales for open innovation processes.

Following Covin & Slevin [56], we measured *entrepreneurial orientation* as a uni-dimensional construct and adapted items to measure an organization's tendency to risk-taking, innovativeness, and pro-activeness (Alpha=0.939).

Innovation performance was assessed as product innovation adapted from Prajogo and Ahmed [56]'s indicators representing the generation and creation of new ideas that were reflected in the end product or service (Alpha= 0.775).

For *financial performance*, we adapted Wiklund & Shepherd [58]'s scale to measure the sales, net profit, and revenue growth of the respondent's organizations in comparison to their competitors in the past three years (Alpha=0.813).

Technological turbulence was adapted using scales derived from Jaworski and Kohli [65]. Respondents were ask to rank the intensity of each based on the changes in their industry. The construct's reliability coefficient is 0.854.

4 Results

The descriptive statistics and correlations of variables are presented in Table 2. The mean and standard deviations showed enough variance in all variables, while correlation coefficients suggested functional inter-relationship between variables. In order to test our hypotheses, a two-step moderated hierarchical regression analysis was carried out using the approach described by Cohen et al. [72]. In the first step of the hierarchical regression, the dependent variables were being regressed on the independent variables to assess the main effects. In step two, we added the moderating variables and the interaction terms of moderator * independent variables respectively. In order to prevent multi-collinearity on the interaction terms, we took a mean-centered approach for all the independent variables before conducting regression analysis. In addition, we followed the suggestions in the literature and only considered one interaction term per model [72]. Regression analysis results are provided in Table 3-5.

Table 2. Descriptive Statistics and Correlation Matrix

Measures	1	2	3	4	5	6	7
1. Outside-in	1						
2. Inside-out	0.516**	1					
3. Coupled	0.248**	0.172*	1				
4. EO	0.678**	0.405**	0.281**	1			
5. Product Innovation	0.626**	0.306**	0.194*	0.671**	1		
6. Financial Performance	0.464**	0.516**	0.147	0.505**	0.451**	1	
7. TT	0.407**	0.411**	0.0.17	0.481**	0.470**	0.247**	1
Mean	3.94	3.39	3.77	3.96	4.01	3.59	3.68
S.D.	0.55	0.60	0.38	0.60	0.55	0.48	0.67
Cronbach's α	0.873	0.873	0.808	0.939	0.775	0.813	0.854
Factor loading	0.78-0.86	0.74-0.88	0.75-0.86	0.72-0.90	0.66-0.86	0.81-0.86	0.79-0.92

EO: Entrepreneurial Orientation; TT: Technological Turbulence
N = 161; ***p<0.001, **p<0.01, *p<0.05

Table 3. Regression Analysis for H1 and H4

Variable	*Outside-in Process*		*Inside-out Process*		*Coupled Process*	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
EO	*0.678***	0.557***	*0.455***	0.280***	*0.281***	0.317***
TT		0.208**		0.330***		-0.148
Moderators						
EO * TT		*0.247***		*0.193***		0.094
R^2	0.459	0.520	0.207	0.287	0.079	0.099
Adjusted R^2	0.456	0.511	0.205	0.273	0.073	0.081
F	135.050	56.735	41.552	21.061	13.629	5.719

EO: Entrepreneurial Orientation; TT: Technological Turbulence
N=161; ***p<0.001, **p<0.01, *p<0.05, +p<0.1

Table 4. Regression Analysis for H2 and H5

Variables	*Innovation Performance*			
	Model 7	Model 8	Model 9	Model 10
Outside-in Process	*0.623***	0.465***		
Inside-out Process	-0.046		0.127+	
Coupled Process	*0.112*+			0.172*
Technology Turbulence (TT)		0.302***	0.416***	0.467***
Moderators				
Outside-in * TT		*0.165***		
Inside-out * TT			*0.150***	
Coupled * TT				0.071
R^2	0.413	0.472	0.258	0.257
Adjusted R^2	0.402	0.462	0.244	0.243
F	36.838	46.727	18.237	18.134
	N=161; ***p<0.001, **p<0.01, *p<0.05, +p<0.1			

Table 5. Regression Analysis for H3 and H6

Variables	*Financial Performance*			
	Model 11	Model 12	Model 13	Model 14
Outside-in Process	*0.265***	0.400***		
Inside-out Process	*0.377***		0.502***	
Coupled Process	0.017			0.155*
Technology Turbulence (TT)		0.098	0.041	0.252***
Moderators				
Outside-in * TT		*0.176**		
Inside-out * TT			-0.102	
Coupled * TT				-0.020
R^2	0.320	0.229	0.70	0.085
Adjusted R^2	0.307	0.214	0.256	0.067
F	24.632	15.543	19.323	4.857
	N=161; ***p<0.001, **p<0.01, *p<0.05, +p<0.1			

Within all the basic models before inclusion of the interaction terms, we found significant direct effects of EO on all three processes of open innovation (as shown in model 1, 3 and 5). These findings provide support for hypothesis 1: EO is positively related the core processes of open innovation. With regard to the relationships between each open innovation process to organizational performance, only outside-in process is positively and significantly related to both performance variables. Inside-out process is positively related to financial performance, and coupled process is positively linked to innovation performance (see models 7 and 11). These findings provide partial support for both hypothesis 2 and 3.

As for the moderating effects, hypothesis 4 proposes that technological turbulence has a positive moderating effect on the relationships between the open innovation process and EO. Model 2 and 4 indicate that technological turbulence only moderates the relationship between outside-in process (Beta = 0.247, p<0.001) and

inside-out process (Beta = 0.193, p<0.01) to EO and thus providing partial support for hypothesis 4. Model 8 and 9 demonstrate that technological turbulence strengthens the relationship between outside-in process (Beta = 0.165, p<0.01) and inside-out process (Beta = 0.150, p<0.01) on innovation performance, while no such interaction effect can be observed for the coupled process; therefore, the data only partially support hypothesis 5. In support of hypothesis 6, the interaction term for outside-in process (0.176, p<0.05) is positive and significant, while the interaction terms for inside-out process and coupled process are not significant as shown in Models 12-14.

5 Discussion and Conclusions

Despite the recent emergence of research on open innovation [2], [3], [4], [7], [8], [61], analyses in the context of SMEs are still lacking. In addition, studies relating to the impact of an organization's entrepreneurial orientation (EO) to their open innovation practices have not yet been explored as well [55]. Furthermore, to the best of our knowledge, studies that simultaneously explore the impact of outside-in, inside-out, and coupled processes of open innovation on organizational performance in a single framework are also lacking. Therefore, this study acts as a pioneering effort to further the understanding regarding these issues by investigating the potential impact of SMEs' EO on outside-in, inside-out, and coupled process, and how these impacts in turn influence their organizational performance. We also examined the potential moderating role of technological turbulence in this context. Using data collected from 161 EMBA students from well-known universities across Taiwan, our empirical results have provided strong support for the importance of open innovation for SMEs in Taiwan.

Table 6 illustrates a summary of the empirical findings to the proposed hypotheses based on our conceptual framework (see Figure 1). There are a number of interesting findings from our empirical results. First, as seen in the descriptive statistics of the variables (Table 2), the mean score of outside-in process (3.94) exceeds both inside-out process (3.39) and coupled process (3.77), which suggests that Taiwan-based SMEs tend to engage more in outside-in process of open innovation. Additionally, our regression results indicated that under technological turbulent settings, SMEs focus more on outside-in process to improve both their innovation and financial performance than the other two processes. Second, previous studies have asserted that an organization's strategic orientation may serve as a precursor on the relationship between open innovation and organizational performance. Our empirical findings further contribute by confirming that EO may serve as a precursor for open innovation processes [18], [55].

Perhaps a more interesting finding is that under technological turbulent settings, possessing a high EO does not support SMEs in adopting the coupled processes. Despite the importance of collaborative innovation under technological turbulent conditions claimed by prior studies [30], [46], [68], strong EO does not intuitively facilitate the coupled process and in turn improve organizational performance. According to SMEA, when SMEs in Taiwan are faced with uncertainty in technological development, they prefer to tackle it alone and are reluctant to collaborate with others [26]. Thus, Taiwan-based SMEs only practice the coupled practice if the imperfections in technological turbulence are reduced.

In summary, the findings of this study confirm the insights of previous studies that the trend towards open innovation may be a global phenomenon since the implementation of open innovation is found not only in developed countries such as USA and Europe [2], [8], but also in developing countries such as Taiwan, China, and Brazil [13], [18], [19], [20], [21], [22], [54].

Table 6. Results of Hypotheses Testing

Hypotheses	Supported
H1a: EO is positively related to the outside-in process of open innovation.	Yes
H2b: EO is positively related to the inside-out process of open innovation.	Yes
H3c: EO is positively related to the coupled process of open innovation.	Yes
H2a: The outside-in process is positively related to innovation performance.	Yes
H2b: The inside-out process is positively related to innovation performance.	No
H2c: The coupled process is positively related to innovation performance.	Yes
H3a: The outside-in process is positively related to financial performance.	Yes
H3b: The inside-out process is positively related to financial performance.	No
H3c: The coupled process is positively related to financial performance.	No
H4a: TT positively moderates the relation between EO and outside-in process.	Yes
H4b: TT positively moderates the relation between EO and inside-out process.	Yes
H4c: TT positively moderates the relation between EO and coupled process.	No
H5a: TT positively moderates the relation between outside-in and innovation performance.	Yes
H5b: TT positively moderates the relation between inside-out and innovation performance.	Yes
H5c: TT positively moderates the relation between coupled and innovation performance.	No
H6a: TT positively moderates the relation between outside-in and financial performance.	Yes
H6b: TT positively moderates the relation between inside-out and financial performance.	No
H6c: TT positively moderates the relation between coupled and financial performance.	No

5.1 Theoretical and Managerial Implications

The contributions and implications of this study are relevant to the growing interest of both scholars and practitioners of open innovation and SMEs. First, our study contributes to existing open innovation literature by providing further insights on how each open innovation processes could improve both innovation performance and financial performance [2], [3], [4], [7], [8], [9]. It also contributes to SMEs' literature by augmenting to the body of knowledge on how SMEs' EO drives the adoption and implementation of open innovation processes [12], [13], [16], [18]. Our study also developed and validated new metrics for Gassmann & Enkel [5]'s theory of open innovation. These measurement scales may be useful to future researchers in gauging the extent of organizations' engagement in open innovation processes.

From the managerial perspective, our findings provide understandings for managers of SMEs in selecting the appropriate open innovation process to improve

performance outcomes under a specific environmental setting. More specifically, in high technological turbulent settings, SMEs should actively practice the outside-in process to overcome their liability of smallness.

5.2 Limitations and Future Research Directions

Despite the contributions and implications that are previously mentioned, this study has several limitations that may be considered and possibly addressed in future research. First of all, we have focused on a sample of SMEs from a single country, which limits the generalization of results. Moreover, the data we had used to empirically test our research model is a convenience sample of EMBA students. Considering the number of variables in the study, the sample size is not that large. A larger scale of survey with random sampling is suggested for future research. In addition, since innovation is a long process and sometimes outcomes are not seen instantaneously, future studies may adopt a longitudinal research design with larger data set from different industries and countries to examine the complex relationships among open innovation process, entrepreneurial orientation, technological turbulence, and organizational performance. Secondly, we have only considered the precursory role of EO and the moderating influence of technological turbulence. It is possible that others variables may moderate and even mediate the relationships between open innovation process and organizational performance. Therefore, incorporating other potential variables into our conceptual framework is also a very promising research field in the future. Thirdly, we have only further contributed to extant open innovation literature by simultaneously examining the impact of outside-in, inside-out, and coupled process of open innovation on both innovation and financial performance. Future research may want to discuss the combined or interacting effects of three processes of open innovation on organizational performance. In conclusion, addressing these limitations can further advance our understanding on the complex relationship between open innovation and organizational performance.

References

1. Chesbrough, H.: Open innovation: The new imperative for creating and profiting from technology. Harvard Business School Publishing Corporation, Boston (2003)
2. Chesbrough, H., Vanhaverbeke, W., West, J.: Open innovation: Researching a new paradigm. Oxford University Press, New York (2006)
3. Enkel, E., Gassmann, O., Chesbrough, H.: Open R&D and open innovation: exploring the phenomenon. R&D Management 39(4), 311–316 (2009)
4. Gassmann, O., Enkel, E., Chesbrough, H.: The future of open innovation. R&D Management 40(3), 213–221 (2010)
5. Gassmann, O., Enkel, E.: Towards a theory of open innovation: three core process archetypes. In: R&D Management Conference, Lisbon, Portugal (2004)
6. Dahlander, L., Gann, D.M.: How open is innovation? Research Policy 36(9), 699–709 (2010)
7. Huizingh, E.K.: Open innovation: state of the art and future perspectives. Technovation 31(1), 2–9 (2011)

8. Lichtenthaler, U.: Open innovation: Past research, current debates, and future directions. Academy of Management Perspectives 25(1), 75–93 (2011)
9. Mazzola, E., Bruccoleri, M., Perrone, G.: The Effect of Inbound, Outbound and Coupled Innovation on Performance. International Journal of Innovation Management 16(6) (2012)
10. Inauen, M., Schenker-Wicki, A.: The impact of outside-in open innovation on innovation performance. European Journal of Innovation Management 14, 496–520 (2011)
11. Inauen, M., Schenker-Wicki, A.: Fostering radical innovations with open innovation. European Journal of Innovation Management 15, 212–231 (2012)
12. Chesbrough, H., Crowther, A.K.: Beyond high tech: Early adopters of open innovation in other industries. R&D Management 36(3), 229–236 (2006)
13. Parida, V., Westerberg, M., Frishammar, J.: Inbound open innovation activities in high-tech SMEs: The impact on innovation performance. Journal of Small Business Management 50(2), 283–309 (2012)
14. Bianchi, M., Campodall'Orto, S., Frattini, F., Vercesi, P.: Enabling open innovation in small and medium-sized enterprises: how to find alternative applications for your technologies. R&D Management 40(4), 414–431 (2010)
15. Christensen, J.F., Olesen, M.H., Kjær, J.S.: The industrial dynamics of open innovation: Evidence from the transformation of consumer electronics. Research Policy 34(10), 1533–1549 (2005)
16. Van De Vrande, V., De Jong, J.P.J., Vanhaverbeke, W., De Rochemont, M.: Open innovation in SMEs: Trends, motives, and management challenges. Technovation 29(7), 423–437 (2009)
17. Lee, S., Park, G., Yoon, B., Park, J.: Open innovation in SMEs - An intermediated network model. Research Policy 39(2), 290–300 (2010)
18. Hung, K.P., Chiang, Y.H.: Open innovation proclivity, entrepreneurial orientation, and perceived firm performance. International Journal of Technology Management 52, 257–274 (2010)
19. Huang, F., Rice, J.: The role of absorptive capacity in facilitating "Open innovation" outcomes: A study of Australian SMEs in the manufacturing sector. International Journal of Innovation Management 13(2), 201–220 (2009)
20. Kim, H., Park, Y.: The effects of open innovation activity on performance of SMEs: The case of Korea. International Journal of Technology Management 52(3), 236–256 (2010)
21. Lasagni, A.: How can external relationships enhance innovation in SMEs? New evidence for Europe. Journal of Small Business Management 50(2), 310–339 (2012)
22. Zeng, S.X., Xie, X.M., Tam, C.M.: Relationship between cooperation networks and innovation performance of SMEs. Technovation 30(3), 181–194 (2010)
23. Kaminski, P.C., De Oliveira, A.C., Lopes, T.M.: Knowledge transfer in product development processes: A case study in small and medium enterprises (SMEs) of the metal-mechanic sector from Sao Paulo, Brazil. Technovation 28, 29–36 (2008)
24. Chiang, Y.H., Hung, K.P.: Exploring open search strategies and perceived innovation performance from the perspective of inter-organizational knowledge flow. R&D Management 40(3), 292–299 (2010)
25. Economist Intelligence Unit. A new ranking of the world's most innovative countries. An Economist Intelligence Unit Report Sponsored Cisco (2009)
26. Small and Medium Enterprise Administration Ministry of Economic Affairs. White paper on small and medium enterprises in Taiwan. White Paper (2012)
27. Keupp, M.M., Gassmann, O.: Determinants and archetype users of open innovation. R&D Management 39(4), 331–341 (2009)

28. Spithoven, A., Clarysse, B., Knockaert, M.: Building absorptive capacity to organise inbound open innovation in traditional industries. Technovation 31, 10–21 (2011)
29. Cohen, W.M., Levinthal, D.A.: Absorptive capacity: A new perspective on learning and innovation. Administrative Science Quarterly 35(1), 128–152 (1990)
30. Bogers, M.: The open innovation paradox: knowledge sharing and protection in R&D collaborations. European Journal of Innovation Management 14(1), 496–520 (2011)
31. Barney, J.: Firm resources and sustained competitive advantage. Journal of Management 17(1), 99–120 (1991)
32. Granstrand, O.: The economics and management of intellectual property: towards intellectual capitalism. Edward Elgar Publishing, Cheltenham (2000)
33. Granstrand, O.: Multi-technology management. In: Cantwell, J., Gambardella, A., Granstrand, O. (eds.) The Economics and Management of Technological Diversification, pp. 296–332. Routledge, London (2004)
34. March, J.G.: Exploration and exploitation organizational learning. Organization Science 2(1), 71–87 (1991)
35. Lichtenthaler, U., Ernst, H.: External technology commercialization in large firms: Results of a quantitative benchmarking study. R&D Management 37(5), 383–397 (2007)
36. Chesbrough, H., Schwartz, K.: Innovating business models with co-development partnerships. Research-Technology Management 50(1), 55–59 (2007)
37. Ebersberger, B., Bloch, C., Herstad, S.J., Van De Velde, E.: Open innovation practices and their effect on innovation performance. International Journal of Innovation and Technology Management (2010)
38. Laursen, K., Salter, A.: Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. Strategic Management Journal 27(2), 131–150 (2006)
39. Lin, B.W., Wu, C.H.: How does knowledge depth moderate the performance of internal and external knowledge sourcing strategies? Technovation 30(11), 582–589 (2010)
40. Spithoven, A., Frantzen, D., Clarysse, B.: Heterogeneous Firm-Level Effects of Knowledge Exchanges on Product Innovation: Differences between Dynamic and Lagging Product Innovators. Journal of Product Innovation Management 27, 362–381 (2010)
41. Tsai, K.H., Hsieh, M.H., Hultink, E.J.: External technology acquisition and product innovativeness: The moderating roles of R&D investment and configurational context. Journal of Engineering and Technology Management 28, 184–200 (2011)
42. Un, C.A., Cuervo-Cazurra, A., Asakawa, K.: R&D Collaborations and Product Innovation. Journal of Product Innovation Management 27, 673–689 (2010)
43. Belderbos, R., Faems, D., Leten, B., Van Looy, B.: Technological Activities and Their Impact on the Financial Performance of the Firm: Exploitation and Exploration within and between Firms. Journal of Product Innovation Management 27(6), 869–882 (2010)
44. Kutvonen, A.: Strategic application of outbound open innovation. European Journal of Innovation Management 14(4), 460–474 (2011)
45. Lichtenthaler, U.: External commercialization of knowledge: Review and research agenda. International Journal of Management Reviews 7(4), 231–255 (2006)
46. Lichtenthaler, U.: Outbound open innovation and its effect on firm performance: Examining environmental influences. R&D Management 39(4), 317–330 (2009)
47. Lichtenthaler, U.: Technology exploitation in the context of open innovation: Finding the right "job" for your technology. Technovation 30(7), 429–435 (2010)
48. Lichtenthaler, U., Ernst, H.: Opening up the innovation process: The role of technology aggressiveness. R&D Management 39(1), 38–54 (2009)

49. Faems, D., De Visser, M., Andries, P., Van Looy, B.: Technology Alliance Portfolios and Financial Performance: Value-Enhancing and Cost-Increasing Effects of Open Innovation. Journal of Product Innovation Management 27, 785–796 (2010)
50. Lin, C., Wu, Y.J., Chang, C., Wang, W., Lee, C.Y.: The alliance innovation performance of R&D alliances-the absorptive capacity perspective. Technovation 32(5), 282–292 (2012)
51. Nieto, M.J., Santamaria, L.: The importance of diverse collaborative networks for the novelty of product innovation. Technovation 26(6), 367–377 (2007)
52. Huang, F., Rice, J.: Openness in Product and Process Innovation. International Journal of Innovation Management 16(4) (2012)
53. Neyens, I., Faems, D., Sels, L.: The impact of continuous and discontinuous alliance trategies on startup innovation performance. International Journal of Technology Management 52(3/4), 392–410 (2010)
54. Suh, Y., Kim, M.S.: Effects of SME collaboration on R&D in the service sector in open innovation. Innovation: Management, Policy & Practice 14(3), 349–362 (2012)
55. Chaston, I., Scott, G.J.: Entrepreneurship and open innovation in an emerging economy. Management Decision 50(7), 1161–1177 (2012)
56. Covin, J.G., Slevin, D.P.: Strategic management of small firms in hostile and benign environments. Strategic Management Journal 10(1), 75–87 (1989)
57. Miller, D.: The correlates of entrepreneurship in three types of firms. Management Science 29(7), 770–791 (1983)
58. Wiklund, J., Shepherd, D.: Knowledge-based resources, entrepreneurial orientation, and the performance of small and medium-sized businesses. Strategic Management Journal 24(13), 1307–1314 (2003)
59. Lumpkin, G.T., Dess, G.G.: Clarifying the entrepreneurial orientation construct and linking it to performance. Academy of Management Review 21(1), 135–172 (1996)
60. Lumpkin, G.T., Dess, G.G.: Linking two dimensions of entrepreneurial orientation to firm performance: The moderating role of environment and industry life cycle. Journal of Business Venturing 16(5), 429–451 (2001)
61. Van De Vrande, V., Vanhaverbeke, W., Gassmann, O.: Broadening the scope of open innovation: past research, current state and future directions. International Journal of Technology Management 52(3/4), 221–235 (2010)
62. Zahra, S.A., George, G.: Absorptive capacity: A review, reconceptualization, and extension. Academy of Management Review 27(2), 185–203 (2002)
63. Dyer, J.H., Singh, H.: The relational view: Cooperative strategy and sources of inter-organizational competitive advantage. Academy of Management Review 23(4), 660–679 (1998)
64. Terziovski, M.: Innovation practice and its performance implications in small and medium enterprises (SMEs) in the manufacturing sector: A resource-based view. Strategic Management Journal 31(8), 892–902 (2010)
65. Jaworski, B.J., Kohli, A.K.: Market orientation: Antecedents and consequences. Journal of Marketing 57(3), 53–70 (1993)
66. Chiaroni, D., Chiesa, V., Frattini, F.: The Open Innovation Journey: how firms dynamically implement the emerging innovation management paradigm. Technovation (2009)
67. Chiaroni, D., Chiesa, V., Frattini, F.: Unravelling the process from Closed to Open Innovation: evidence from mature, asset-intensive industries. R&D Management 40(3), 222–245 (2010)

68. Schweitzer, F.M., Gassmann, O., Gaubinger, K.: Open innovation and its effectiveness to embrace turbulent environments. International Journal of Innovation Management 15(6), 1191–1207 (2011)
69. The U.S. Small Business Administration (2013), http://www.sba.gov
70. Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E., Tatham, R.L.: Multivariate data analysis: A global perspective, 7th edn. Prentice Hall, Upper Saddle River (2010)
71. Nunnally, J.C.: Psychometric theory, 3rd edn. Tata McGraw-Hill Education, New York (2010)
72. Cohen, J., Cohen, P., West, S.G., Aiken, L.S.: Applied Multiple Regression/Correlation Analysis for the Behavioral Science, 2nd edn. Lawrence Erlbaum, New Jersey (2003)

Appendix

Notes: (X), Items were removed from final analyses due to low item-to-total correlation

	Outside-in Process
OIOI-1	Your company sources external R&D initiatives from other organizations (e.g. ideas, knowledge, personnel, and technologies). (X)
OIOI-2	Your company integrates customers' R&D initiatives (e.g. ideas and knowledge).
OIOI-3	Your company integrates suppliers' R&D initiatives (e.g. ideas, knowledge, personnel, and technologies).
OIOI-4	Your company integrates non-profit organizations' R&D initiatives (universities, government agencies, and other institutions).
OIOI-5	Your company licenses-in external sources of R&D initiatives (e.g. patents, intellectual property, and technologies).
	Inside-out Process
IOOI-1	Your company commercializes internally developed R&D initiatives (e.g. knowledge and technologies). (X)
IOOI-2	Your company transfers internally developed R&D initiatives (e.g. knowledge, personnel, and technologies).
IOOI-3	Your company licenses-out internally developed R&D initiatives (e.g. patents, IP, and technologies).
IOOI-4	Your company sells internally developed R&D initiatives (e.g. patents, IP, and technologies).
IOOI-5	Your company starts up new ventures drawing on internally developed R&D initiatives.
	Coupled Process:
COI-1	Your company and R&D partners have a high degree of trust.
COI-2	Your company and R&D partners interact with each other on a regular basis.
COI-3	Your company exchange knowledge with R&D partners intensively.
COI-4	Your company and R&D partners have a process of mutual learning. (X)
COI-5	There is a right balance of give and take between your company and R&D partners.

Entrepreneurial Orientation:	
EO-1	Your company has a strong proclivity for high-risk projects with chances of very high return.
EO-2	Your company believes bold, wide-ranging acts are necessary to achieve the business objectives.
EO-3	When confronted with uncertainty, your company adopts an aggressive posture in order to exploit potential opportunities.
EO-4	In dealing with competitors, your company initiates actions which competitors then respond to.
EO-5	Your company is often the first to introduce new products/services, administrative techniques, or operating technologies, etc. (X)
EO-6	Your company typically adopts a very competitive "undo-the-competitors" posture.
EO-7	Your company has a strong emphasis on R&D, technological leadership, and innovations. (X)
EO-8	Your company has marketed many new products or services in the past three years.
EO-9	Changes in the product or service line in your company has been dramatic.
Product Innovation	
ProdI-1	Level of newness (novelty) of your new/improved products for the past three years.
ProdI-2	Development speed of your new/improved products for the past three years.
ProdI-3	Number of new/improved products introduced to the market for the past three years.
Financial Performance	
FinP-1	Compared the performance of your company with that of your competitors for the past three years in terms of growth in sales.
FinP-2	Compared the performance of your company with that of your competitors for the past three years in terms of growth in revenue.
FinP-3	Compared the performance of your company with that of your competitors for the past three years in terms of growth in net profits.
Technological Turbulence	
TT-1	Technology in our industry is changing rapidly.
TT-2	Technological changes in our industry are unpredictable.
TT-3	Technological breakthrough results in many new product ideas in our industry.