The Study on the Relationship between the Openness Strategies and Innovation Performance: The Role of Intellectual Capital

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Abstract--**The study intends to clarify the relationship between open innovation and innovation performance through the examination of the mediation role of intellectual capital. Total valid 948 samples of service firms are compiled from The Second Taiwan Innovation Survey (TTIS) from year of 2004 to 2006. Based on research hypotheses are being developed from reviewing literature, the conceptual model using Hierarchical Multiple Regression (HMR) Structural and Equation Modeling (SEM) has been employed to examine hypothesis and model fits. The results show that the impact of openness strategies on innovation performance becomes indirect through the partial mediator of intellectual capital. This study has both theoretical and practical implications. All the hypotheses are supported. The model is able to assess what factors will affect the firm's collaboration and innovation in terms of intellectual capitals. Results show that intellectual capital is crucial to the development of the relationship between open innovation and innovation performance.**

I. INTRODUCTION

A. Research Background and Motivation

The current economic change has driven firms to develop more competitive advantage through innovation. Innovations are deliberate interventions designed to initiate and establish future developments means of technology, economics, and social practices. As for services industry, service is a necessary process not only enables services have a more stable customer base, also lock the competitors to improve their marketing strategies. Chesbrough [1] characterizes this new paradigm of open innovation as a way for firms to collaborate with external innovation sources and to develop new products or services. Innovation activities impacts on the degree of international growth, which in turn positively influences innovation performance. Forbes and Wield [2] argue that with innovative catching up, they argue that firms that innovate at the advanced level are those that are able to develop a distinctive capability having a 'proprietary' capability.

This study can infer that firms whose competitive advantage is driven by intellectual capital, including organization capital, social capital and human capital. The intellectual capital literature emphasizes that knowledge may be a more important source of competitive advantage than physical assets [3]. How in operations intellectual capital can capitalize on the benefits of open innovation is main issue in the open innovation era.

This paper explores the role of intellectual capital in the relationship between the openness of firms' external search strategies and their innovative performance. We discuss open innovation influence performance, and how practices matters for innovation while drawing attention to the notion of complementarities among intellectual capital. Moreover, we discuss various possible mediators of the intellectual capital.

The sample of the study are based on the Taiwan service firms in questionnaires survey that carried out from 2004-2006 by The Third Taiwan Innovation Survey (TTIS). National Science Council employed second large-scale innovation surveys , which includes enterprise size, the amount of turnover, the firm's major markets, the firm's major customers, the degree of innovation, sources of innovation, explore innovation impact and so on. We constructed a dataset including 948 service firms. While there are many factors that can affect innovation in the service innovation, there is little correlation study by this information discuss the correlation of the types of innovation and the degree of openness. Therefore, this study allows us understand more in-depth changes in Taiwan's industry and its value.

We empirically the relationship between the breadth and depth of external search and innovative performance examine, exploring how differences in search strategies among firms influence their ability to achieve different levels of novelty in their innovative activities. The main objectives in the study is how enterprise the role of intellectual capital in the relationship between openness strategies and innovation performance have open search strategies—those who search widely and deeply.

To be concluded, firms often invest considerable amounts of time, money and other resources in the search for new innovative opportunities. In a rapidly changing business environment, simply owning resources does not guarantee sustained competitive advantages of firms. Limited empirical works have explained how open strategies predict a firm's innovations. We argue that the level of intellectual capital of a firm serves as the basis for the open innovation that the results in firm competitiveness. On the contrary, the degree of openness is essential on performance of Intellectual capital. According to the research objectives, we will focus on the following question. What are the business strategies will influence the firm 's ability to achieve different innovative behavior? And What are the effective indicators in the success of open innovation model application in Taiwan service industries?

II. LITERATURE REVIEW

Porter [4] highlighted the importance of innovation on

competitive advantage in a given market. These companies are supported to explore innovation by realizing new products, new services, new technologies, new processes or just new ways of doing something. The concept of Innovation activities are shifted away from the manufacture products, toward the provision of a whole aimed at delivering a specific function. Therefore, the main motive for innovations was to increase efficiency and to offer a better service. In short, innovation ways has been considered as a positive performance toward firm to realization and improve business performance.

A. Service Innovation

The development of services is a major source of productivity growth, as it provides critical inputs for other activities and facilitates the development of new business models.

When all firms facing rapid technological change, either establishing alliances or cooperative agreements, a single firm rarely commands the full range of expertise that is required to create timely and cost-effective product innovation. Thus, Service innovation (SI) is the primary goal for knowledge-intensive service industries. To provide excellent services for customers, the firm generally enhances their service innovative abilities via knowledge innovation, which relies on empirical knowledge exchange and communication. In doing so, a firm should concentrate on the improvement of service quality and charge appropriate fair price in order to satisfy their customers who would ultimately help the firm to retain its customers [5]. Thus, completed knowledge value-added services can be offered to customers, and increase customer satisfaction and enterprise competitiveness.

In terms of service economy perspective, it is understood that innovative processes do not form, transmit or produce the same effects as those generated in a manufacturing environment, which are relate directly to products or productive processes. Marketing opportunities are also identified as an argument for using services to sell more products [6]. Innovation is one of the key ways by which companies adapt to and manage their environments [7], and innovation strategies are closely associated with organizational performance [8, 9,10]. Companies in any industry can make the critical shift from product- to service-centric thinking, from closed to open innovation where co-creating with customers enables sustainable business models that drive continuous value creation for customers.

As Coombs and Miles[11] point out, there are three main perspectives to define and measure innovation in services: assimilation, demarcation and synthesis. In line with this position, which maintains that services are neither totally different from manufacturing nor share the same characteristics.

1. Assimilation: the principal idea is that service innovation is essentially similar to Innovation in manufacturing, and, as a consequence, we can apply all the methods and procedures developed for this latter sector.
2. Demarcation: this perspective, on the other hand, holds that innovation in services is very different, in that it follows dynamics and shows features that demand new instruments and theories.
3. Synthesis: this position, that has to be elaborated further, suggests that service innovation reveals aspects neglected in the widely distributed innovation process in the economy.

In sum, service innovation is obtained more attention due to its potential value for creating competitive advantage and improving organizational performance. Service innovations have the potential to change the global value chains and modify the rules of the game in other industries.

B. Open Innovation

We explore how open innovation affects firms' abilities to generate, include new technologies, product improvements, or new product designs. The goal of innovation is to take an idea from concept to realization and improve business performance. For example, an innovation can be a new product, a new process, or a new way of doing business. The main ingredients of successful, innovation are a fresh perspective, a diverse source of ideas, and an open environment. It can come from anywhere or anyone inside or outside an organization. All organizations connect with their external environments to source capital and labour, search for ideas, collaborate on innovation, purchase inputs and sell goods or services [12].

Various theories of firm behavior explain the shift from closed to open innovation models. The opening up a firm's R&D system is beneficial for the innovative performance relying heavily on external technology sourcing to increase search, coordinating and monitoring costs and could hamper the building of path-dependent knowledge stocks within the firm. Therefore, an inverted U-shaped relationship exists between the share of external R&D activities and a firm 's innovative performance.

Huang and Rice [13] found that the significant relationship between absorptive capacity and innovation performance. They believe that firm's absorptive capacity plays an essential role in strengthening the firm's capability to innovate especially when it performs some modes of openness such as networking and technology buy-in. The literature on innovation collaboration suggests that firms participate in international markets to learn and obtain new knowledge, eg, technology or/and market know-how [14]. More specifically, in order to get the other firms' capabilities, gain access to new markets, and get support, to take advantage of their existing capabilities in [15,16].

Open innovation as a paradigm shift from creating and hoarding innovations internally to accessing and integrating external knowledge. Firms have a degree of choice in how "open" they wish their innovative search processes to be. The study developing a proxy variable for "openness" of a firm's

innovation search strategy. It also enables to explore the relationship between indicators of performance and different strategies for innovating. These indicator is new and the variable attempts to reflect the "openness" of a firm to the external knowledge environment.

C. Openness Strategies and Innovation Performance

Innovation collaboration, sourcing and embodied knowledge is the development of commercialization through relationships with specific partner organizations, and involves mutual exchanges of knowledge. Consequences for empirical research on innovation activities in the service sector are manifold, and new forms of indicators are needed. Laursen and Salter [17] introduce the notions of breadth and depth for their analysis of the search strategies of firms. Breadth refers to the variety of partners or activities and depth captures the intensity of the activity.

1) Breadth

The concept refers to external search breadth, which is defined as the number of external sources or search channels that firms rely upon in their innovative activities. Breadth describes the heterogeneity of the sources feeding into the firm's product development and commercialization process such as the purchase of external R&D, technological for innovation and other preparations for the innovation process and the co-development of product innovations or process innovations by outside actors. As a starting point, each of the 16 sources are coded as a binary variable, 0 being no use and 1 being use of the given knowledge source.

2) Depth

The concept refers to external search depth and it is defined in terms of extent to which firms draw deeply from the different external source search channels. Accordingly, the variable is named DEPTH and is constructed using the same 16 sources of knowledge as those used in constructing BREADTH. In this case each of the 16 sources are coded with 1 when the firm in question reports that it uses the source to a high degree and 0 in the case of no, low, or medium use of the given source. Innovation depth describes how intensive the outside contribution is by focus on high level of involvement. Involvement of outside actors is high if product innovations or process innovations are exclusively developed by outside factors.

3) Depth-Collaboration

Firms choose to cooperate on their innovation activities and in many cases close interaction may be a necessity to facilitate the transfer of knowledge. Among these are gaining access to proprietary technology, access to skills, know-how and other tacit knowledge, cost and risk sharing, and specialization. In general, collaboration is the "deepest" dimension of inter-organizational interaction. Collaboration depending on the degree of intensity and success in the interaction, result in processes of mutual learning and adaptation, but contains the risk of each partner gaining less through inflows of knowledge than what is communicated outwards. Calculating a measure (DEPTH_ COLLAB) has formal innovation collaboration links with different external sources. The survey lists eight different external partners, including: (1) suppliers, (2) clients or customers, (3) competitors, (4) consultants, (5) commercial laboratories/R&D enterprises, (6) universities or other higher education institutes, (7) government research organizations, or (8) private research institutes. As in the case of BREADTH and DEPTH, the eight dummies are subsequently added up so that each firm gets a score of 0 when no partners are used, while the firm gets a value of 8 when the firm is collaborating with all potential collaboration partners.

Exploring both the depth and scope of an external search strategy can provide a mechanism for assessing the openness of a firm's search activities, i.e. the degree to which the firm seeks to draw in new knowledge and to reuse existing knowledge from external sources. It suggests that different strategies for search can yield different innovative performance outcomes. Both the degree of scope and depth of search processes can play an important role in shaping success in product innovation [17]. Based on the literature review, we develop the following:

Hypothesis 1: Open innovation strategies breadth, depth, depth –collaboration has a positive correlation for innovation performance.

D. The role of Intellectual Capital on Open Innovation

Studies of intellectual capital as determinants to business performance and competitiveness are plenty [18], but studies on the relationship between intellectual capital and innovation remain relatively meager [19, 13].

The intellectual capital emphasizes that knowledge may be a more important source of competitive advantage than that of physical assets It is widely accepted that an organization's capability to innovate is closely tied to its intellectual capital, or its ability to utilize knowledge resources. In the light of the key role of intellectual capital on firms' innovation capability, the influence of three of their dimensions, organizational capital, social capital and human capital, on firms' product innovation, are discussed as follows:

First, Human capital at an individual level refers to knowledge and capabilities of employees who belong to the firm. Human capital is related to national factors affect the need for employee commitment, motivation, and skill. Where the work requires knowledge and skills that are unique to the firm and also generates significant value, substantial investment in developing and retaining human capital is likely.

Second, is organizational capital a proper management of organizational capital may lead to preserving the knowledge generated within the firm through formal processes of knowledge integration, making this knowledge accessible and usable by any member [20]. Organizational capital and innovation by means of knowledge integration at the

organizational level, a firm recognizes what is learned and decides how to use it. This compels people to consider the skills learned from their activities, facilitates combining new and different technological skills with existing ones, thereby broadening the technological skill set [21].

Third is Social capital. Social capital appears as a result of collaboration and interaction among those people who share their ideas [22]. Based on the literature review, we develop the following:

Hypothesis 2: Open innovation strategies breadth, depth, depth -cooperation has a positive correlation intellectual capital.

Strategies used to reduce development costs, lessen the inherent risks of product introduction, and access technology or know-how that is otherwise unavailable internally have led firms to establish alliances and cooperative agreements. Across different industries, firms are increasingly reliant on external collaboration in securing competitive advantage and enhancing their innovative capabilities [23]. Therefore, we posit the following:

Hypothesis 3: Intellectual capital is positively correlated with innovation performance.

Intellectual Capital is a key element in an organization's future earning potential. . Intellectual capital with human capital, innovation capital, process capital, and structural capital, and other different elements, to be through the various elements of the tie in order to create business value and improve performance [3,24,25],Theoretical and empirical studies show that it is the unique combination of the different elements of Intellectual Capital and tangible investments that determines an enterprise's competitive advantage. Therefore, we posit the following:

Hypothesis 4: Intellectual capital as a mediator between open innovation and innovation performance

III. RESEARCH METHODOLOGY

The data used for the study derive from the survey of Taiwan service firm conducted by National Science Council's project, namely, "Taiwan Technology Innovation Survey "(TTIS) from 2004 to 2006. The questionnaire of TTIS is based on the specifications of the European Innovation Survey (Community of Innovation Survey CIS).

TTIS survey employed the telephone survey and face-to-face interviews. The firm has more than 6 employees and innovation activities in the period (2004-2006). Since the paper focuses on service industries innovation, the sample for this study includes 4089 public-listed service. Of these, 948 valued questionnaires were returned, while a response rate is 24 percent.

The questionnaire asks firms to show what innovative activities has been employed by firms, for example, the introduction of market goods and services is either new or significantly improved with respect to fundamental characteristics. The innovations should be based on the results of new technological developments, or new combinations of existing technology or utilization of other knowledge.

According Laursen and Salter [17] two new variables reflect openness in terms of external search strategies of firms. The first variable is termed BREADTH and is constructed as a combination of the 10 sources of knowledge or information for innovation of this paper. As a starting point, each of the 10 sources are coded as a binary variable, 0 being no use and 1 being use of the given knowledge source. In other words, it is assumed that firms that use higher numbers of sources are more 'open', with respect to search breadth, than firms that are not. Subsequently, the 10 sources are simply added up so that each firm gets a 0 when no knowledge sources are used, while the firm gets the value of 9 when all knowledge sources are used.

A. Independent variables

The independent variables were: depth, breadth, and collaboration. From the TTIS information to find the matching indicator items, each item add up to be higher the score, the higher the degree of openness, the lower the degree of openness of the lower scores. Three variables reflect openness in terms of external search strategies of firms, determinants of innovative performance. As determinants of innovative performance, we introduce two new variables reflecting openness in terms of external search strategies of firms. The first new variable is termed BREADTH and is constructed as a combination of the 10 sources of knowledge or information for innovation listed. External search depth is defined as the extent to which firms draw intensively from different search channels or sources of innovative ideas. Accordingly, the second variable is named DEPTH and is constructed using the same 10 sources of knowledge as those used in constructing BREADTH. The third , calculating a DEPTH_ COLLAB measure by looking at whether or not the firm in question has formal innovation collaboration links with different external sources. This variable is based on a subsequent question on the Innovation survey.

B. Dependent variable

To measure a firm's innovative performance, the study exploring the degree of the diversity of innovation development in firms by innovation performance types have been developed in firms. Any attempt to assess innovative activity and performance must begin with the definition of suitable metrics. Performance include various forms of product and service innovations: new product development, improvement of existing products or services, responding to customers quickly through differing products or services, and diversifying products or services under environmental changes.

First, we use a variable aimed at indicating the ability of the firm to produce radical innovations. This variable is measured as the fraction of the firm's turnover relating to

products new to the world market. In addition, we add two variables as proxies for incremental innovation. Including a variable expressing the fraction of the firm's turnover pertaining to products new to the firm, and another variable expressing the fraction of the firm's turnover pertaining to products significantly improved.

C. Innovation mediating variable

Mediation exists when the influence of an independent variable (open innovation) on a dependent variable (innovation performance) is transmitted through a mediator (intellectual capital) .Actual partial mediation exists when open innovation exerts both direct and indirect effects on innovation performance.

We use intellectual capital at reflecting various types of meditation effect by firms. Intellectual capital including three items: First, social capital, implies that greater knowledge is embedded in relationships among individuals. It is expected to be positively associated with knowledge enhancement capability. Second, human capital (i.e., employee's skills, experience, and knowledge), contributes to the growth of organizational knowledge. Third, organizational capital (i.e., systems, technologies, philosophies, and processes) knowledge embedded in structures, systems, routines, etc. Thus, organizational capital is positively associated with knowledge enhancement capability of the firm.

D. Control variables

Research suggests that specific factors that influence the innovative performance of a firm, which need to be controlled for this study the size of firms means the number of firm employees and firm's revenue means total cash flow. Both are included the logarithmic form.

IV. RESULTS

A. Descriptive statistics

In the chapter, the procedure of data collection and the sample description will be represented firstly; and then hypotheses and analysis will be examined respectively-in the section.

Table 1 shows the means, standard deviations. The sample for this study includes 4089 public-listed service firms. Of these, 948 usable questionnaires were returned, for a response rate of 24 %. Of the follower respondent (N=948), the firm size is controlled by the study based on the census DGBAS (Directorate General of Budget, Accounting and Statistics, Executive Yuan, R.O.C) Industry Standard Classification of employees, that is, number 1 represents less than 5 employees; number 2 represents 5 ~ 29 employees; number 3 represents 30 to 49 employees; number 4 represents 50 to 199 employees; number 5 represents 200 - 499 employees; 6 represents 500 or more employees. Employees of firm size was more than 500 people large companies (SD=0.693).Breadth mean was 5.4 (SD=4.665), depth mean was 2.37 (SD=3.149), depth-collaboration mean was 4.49 (SD=3.25). Organization capital mean was 2.42(SD=2.334), human capital mean was 2.84(SD=1.108).Innovation performance mean was 19.94(SD=9.397).

1) Pearson correlations

Table 2 shows the means, standard deviations, and bivariate Pearson correlations among breadth, depth, depth-Collaboration, social capital, human capital, organization capital. The significant positive correlations variables were all over 0.625($p<.01$), showing that all of the sub-dimensions of openness degree correlated positively with the intellectual capital. In addition, the correlations for all of the sub-dimensions of openness degree and innovation performance are also positive and were all over 0.8($p<.01$).

TABLE 1 DESCRIPTIVE STATISTICS

	N	Min	Max	Mean	SD
Firm-size	948	4	6	5.42	0.693
Breadth	948	0	10	5.4	4.665
Depth	948	0	8	2.37	3.149
Depth-Collaboration	948	0	9	4.49	3.25
Organization Capital	948	7	6	2.42	2.334
Human Capital	948	2	4	2.84	1.108
Innovation Performance	948	6	36	19.94	9.397

TABLE 2 DESCRIPTIVE STATISTICS AND BIVARIATE PEARSON CORRELATIONS

	Mean	SD	1	2	3	4	5	6	7
Firm-size	5.42	0.693	-						
Breadth	5.4	4.665	.895**	-					
Depth	2.37	3.149	.628**	.739**	-				
Depth-Collaboration	4.49	3.25	.864**	.918**	.884**	-			
OC	2.42	2.334	.774**	.871**	.939**	.981**	-		
HC	2.84	1.108	.938**	.948**	.748**	.930**	.871**	-	
Innovation Performance	19.94	9.397	.8**	.886**	.924**	.972**	.976**	.894**	-

N = 948. Correlations are significant at 0.001 level.

B. Hierarchical regression

By table 3 model, the study hypothesis was tested using a series of hierarchical regression models. Hierarchical models were used because along with providing an estimate of the total variance explained by the model.

To test for mediation, one should estimate the three following regression equations: first, regressing the mediator on the independent variable; second, regressing the dependent variable on the independent variable; and third, regressing the dependent variable on both the independent variable and on the mediator. Separate coefficients for each equation should be estimated and tested [26].

First of all, we included firm size (number of employees) as control variables (β = .8, p < .001). Next step, by the Model 2, openness strategies has significant positive influence on intellectual capital (β = .141, p <.01; β =.172, p <.01, β =0.702, p <.01), the overall model has been significant.

Into the model 3, the three traits of openness strategies were entered, both breadth (β = .13, p < .001), depth (β = .308, p < .001) and depth-collaboration (β = .62, p < .001) became significant predictors.

Into the model 4, organization capital and human capital were added to the equation, both organization capital (β = .809, p < .001) and human capital (β = .204, p < .001) are emerged as significant predictors

With the final models, empirical study shows that breadth (β = .073, p < .001), depth (β = .271, p < .001), depth-collaboration (β = .462, p < .001), and the organization capital (β = .146, p < .001) and human capital (β = .139, p < .001) are significant predictors.

From Table 4.3 Model, after adding mediation variables, β of independent variables (breadth depth, depth-collaboration) were dropped. (Breadth is from β = 0.13 to β = 0.13；depth is from β = 0.308 to β = 0.271；Breadth is from β = 0.62 to β = 0.462). But still has a significant impact, which indicated that the indirect effect of intellectual capital was statistically significant (p < .001). Results showed that the intellectual capital in openness strategies impact on innovation performance in a partial mediating effect.

C. Measurement model

A confirmatory factor analysis using Amos 19.0 was conducted to test the measurement model. This study adopted test was conducted to examine the extent to which our variables were influenced by common method variance. CFA is a more sophisticated test of the hypotheses that a single factor can account for all of the variance in their data. Multiple-factor CFA analysis results show (χ2=1851.43, df=64, χ2/df=28.93, GFI=.802, AGFI=.675, CFI=.931, RMSEA=.172, TLI=.902).

Six model-fit measures were used to assess the model's overall appropriateness of fit: the ratio of chi-square to degrees of- freedom, goodness of fit index (GFI), root mean-square residual(RMR), normed fit index (NFI), comparative fit index (CFI), and root mean square error of approximation (RMSEA). These indicators were formed from original measure items for each of the latent constructs on the basis of the items' psychometric properties and substantive content. This procedure maximizes the degree to which the indicators of each construct share variance.

Table 4 presents descriptive statistics and bivariate Pearson correlations for the construct scales. Reliability of our construct scales was estimated through composite reliability. The composite reliability can be calculated as follows: (the square of the summation of the factor loadings)/{(the square of the summation of the factor loadings) + (the summation of item measurement error)}.

The composite reliabilities for the five constructs scales suggested acceptable reliability of the scales for further analysis (Breadth: 0.959, Depth: 0.968, Depth -Collaboration: 0.975, Intellectual Capital: 0.925, performance: 0.975). Convergent validity was evaluated by examining the factor loadings of indicators and their squared multiple correlations (Table 4.4).Following Hair et al.'s [27] recommendation, factor loadings greater than 0.50 are considered to be very significant. All factor loadings reported in Table 4.4 are greater than 0.50. Therefore, all constructs in the measurement model were judged as having adequate convergent validity. Discriminant validity was assessed by examining whether the confidence interval around the correlation between any two latent constructs includes one [28]. No confidence interval around the correlation in the measurement model included one, which indicated discriminant validity of the model. A significant difference in chi-square values between these models was observed. This implied that the unconstrained model is a better fit for the data – supporting the existence of discriminant validity.

TABLE 3 RESULTS OF HIERARCHICAL REGRESSION ANALYSIS

Variable	Intellectual capital		Innovation performance		
	Model 1	Model 2	Model 3	Model 4	Model 5
Log of number of employees (Firm size)	0.8***	0.564	0.476***	-0.037***	0.184***
Breadth		0.088	0.198***		0.064***
Depth		0.159*	0.221***		0.046***
Depth-Collaboration		0.35*	0.305***		0.057***
Organization Capital				0.809***	0.07***
Human Capital				0.224***	0.153***
ΔR^2		0.198	0.289***	0.321***	0.051***
F	1683.88***	2826	3106***	7718***	8057***
df	1,946	3,943	3,943	2,944	2,941

p < 0. 05 *, p < 0.01**,p< 0.001***

TABLE 4 FACTOR LOADINGS AND SQUARED MULTIPLE CORRELATIONS OF REMAINING ITEMS FOR ALL CONSTRUCTS

Construct	Observation variable	Factor loadings	SMC	C.R.	AVE
Breadth	A4	0.90	0.8		
	A8	1	1	0.959	0.885
	A9	0.92	0.85		
Depth	B1	0.97	0.95		
	B2	0.89	0.79	0.968	0.911
	B10	1	1		
Depth-Collaboration	C5	0.93	0.86		
	C7	0.96	0.92	0.975	0.929
	C8	1	1		
Intellectual capital	HC	0.99	0.99		
	OC1	0.9	0.82	0.925	0.805
	OC2	0.79	0.63		
Innovation Performance	IP1	0.98	0.96		
	IP3	0.93	0.86	0.975	0.929
	IP5	0.98	0.98		

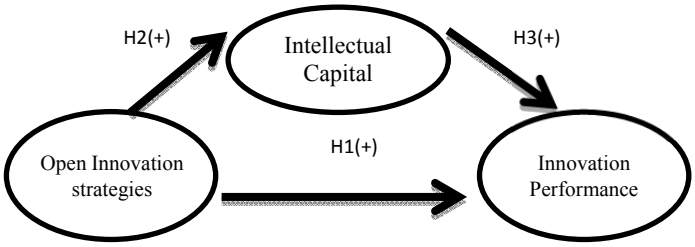
TABLE 5 MODEL PATHS AND MODERATION ESTIMATES

Path	standardized estimates	C.R.	p-Value
H1: Open Innovation →Innovation Performance	β =0.808	38.133	***
H2: Open Innovation →Intellectual Capital	β =1.032	63.599	***
H3: Intellectual Capital →Innovation Performance	β = 0.17	10.512	***

(χ2=3130.53; df =64, χ2/df=48.915, p<0.01, GFI = 0.576, CFI = 0.917, IFI = 0.917, NFI =0.906, RMSEA = 0.225). *p-value<0.05

D. Hypotheses test

The hypothetical structural model displayed in Table 5 fits the data (χ2=3130.53; df =64, χ2/df=48.915, p<0.01, GFI = 0.741, AGFI=0576, NFI=0.916, CFI = 0.917, TLI=0.883, IFI = 0.917, RFI =0.88, RMSEA = 0.225). In general, Figure 1 shows the relationship amongst variables.



Notes: *** p < 0.001; t-values for standardized path coefficients are provided in parentheses.

Figure 1. Hypothetical structural model with cognitive trust

Hypotheses1 investigate the path from open innovation strategies to innovation performance. The analysis suggested that intellectual capital (β= 0.808, t-value =38.133, p < 0.001) showed a strong, positive association with intellectual capital. Hypothesis 1 was supported.

Hypotheses 2 examine the path from open innovation strategies to intellectual capital. The analysis suggested that organizational intellectual capital (β=1.032, t-value =63.599, p < 0.001) showed a strong, positive association with intellectual capital. Hypothesis 2 was supported.

The structural model helped to examine the predictive power of open innovation on the intellectual capital. As seen in Table 4.1 and Figure 4.1, Hypotheses 3 investigate the standardized path from intellectual capital to innovation performance is significant. The analysis suggested that intellectual capital (β = 0.17, t-value = 10.512, p < 0.001). The empirical result supports Hypotheses 3.

E. Discussion

First, Hypotheses 1 was supported and significant. Results showed that the path from breadth of open innovation is associated to intellectual capital. The result emphasizes the importance of key concepts is external search breadth. Similarly, Katila and Ahuja [29] has justified that external search breadth and depth how widely the firm explores new knowledge, influences innovative performance. Results showed that the path from depth-collaboration of open innovation is associated to intellectual capital. It reflects the importance of deep use of key sources to the internal innovation process. Organizations often have to learn how to gain knowledge from an external source.

Second, Hypotheses 2 was significant. Results showed that the path from open innovation strategies is associated to intellectual capital.

The results presented the argument that intellectual capital mediates the effects of open search strategies on innovation performance. As H2 was significant, this highlighted the importance of intellectual capital, which has a direct effect on innovation performance.

Third, the analysis suggested intellectual capital leads to association with innovation performance. Hypotheses 3 was significant and supported. The effect of intellectual capital on innovation performance is well accepted. Organizational capital also affects organization's valuable relationships not only with its customers, but also with suppliers and other

stakeholders. Firm's openness to its external environment can improve its ability to innovate.

Finally, the intellectual capital is mediated the relationship between open innovation strategies and innovation performance. This study suggests that future intellectual capital research can benefit from similarly incorporating innovation—and perhaps efficiency—as partial mediator the effects of innovation capabilities on firm performance.

V. CONCLUSIONS AND IMPLICATIONS

This study has opened up a line of inquiry by examining the role of intellectual capital in open innovation. In doing so, we sought to extend conceptual understanding of openness search processes. Modern innovation processes require firms to master highly specific knowledge in terms of users, technologies, and markets. To deepen our understanding about how firms draw knowledge from external sources, the study examined whether the role of intellectual capital mediate the relationship between openness degree and innovation performance or not. Therefore, this paper imply that firms are required to established a solid intellectual capital in order to link firms' openness stagy with their performance.

Further researches are needed to examine the relationship between intellectual capital and firms' performance. For example, previous studies [17] showed a curvilinear relationship between external search depth and Innovative performance. While there are decreasing returns in innovation for increased openness in terms of external search depth, there are negative returns for sources only. In a word, how exactly this co-developmental process leads to a firm's performance needs to be studied in the future.

Indeed, as searching widely and deeply across a variety of search channels can provide ideas and resources to gain and exploit innovative opportunities. Future research is encouraged to follow this line of inquiry to bring more insights into how organizations should enhance their performance with well strategies and practices. An open mode of innovation can improve search capabilities to locate new sources from intellectual capitals. These capabilities may be further enhanced by a more mindful application of search strategies.

We recognize there is no research without research limitations. Firstly, firm database used for the survey has its limitation. This is because the firm managers in Taiwan have a tradition of emphasizing "relationship" (positive connections) in business operations. Thus, the selection bias may be a limitation for this study.

Second, firm size in service industry has its specific characteristic. Targeted companies for this study are majorly larger & medium firms in Taiwan. The smaller Taiwanese companies were excluded due to their short life span and the difficulty in collecting their performance data. Thus, readers should be cautious about generalizing the study's findings to small companies.

Third, potential common method variance may result from the use of self-report data. Finally, due to our focus on a parsimonious model, some potentially important factors may have been excluded in our investigation, as is common in social science models. A number of factors, including the organization structure, and the market environment, might moderate the relationships in the model.

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