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**The Partners of Open Innovation Based-On Innovation Risks: An Empirical
Study from Manufacturing Enterprises in Taiwan**

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Abstract

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Abstract

With the more intense competition many companies have already changed innovative strategies to break boundaries and cooperated with their customers, partners or even competitors outside the organization. The concept "open innovation", from closed to open, is to introduce more elements and energy for innovation from outside and to share the unused idle resource with others.

However, not all firms have the motive or ability for open innovation. Prior research stated that the enterprise may proceed to innovation based on the expectations of its performance, including sharing risk, extending skill, competences and creativity. What the key factors may affect the firm's behavior of open innovation? This research is to explore the factors influencing firms open innovation.

In this study, the analysis based on the survey data of Taiwan questionnaire revised from the fourth edition of European Community Innovation Survey (CIS4). The study conducted in Taiwan manufacturing industry innovation activities. This study aims to investigate the correlation between their perceived of risk and cooperation status during the open innovation activities. What is the impact of the type of innovation? Further, we would like to understand the differences in different types of firm's behaviors for open innovation.

Keywords: Open innovation; Innovation risk; Collaborators

I. Introduction

Open innovation has been proposed as an important model for the management of innovation (Chesbrough, 2003; Gassmann, 2006). It has received increasingly attention in scholar research, but so far it has mainly been focused on the number and typologies of partners (Laursen and Salter, 2004; Laursen and Salter, 2006; Pisano and Verganti, 2008; Keupp and Gassmann, 2009) with complementary sources (Rigby and Zook, 2002; Teece, 2007). Few studies have demonstrated that open innovation also been analyzed on risk of innovation. Moreover, all of these few studies focus on the relationship between risk and the influence of open innovation by co-operation (Cassiman and Veugelers, 2006; Gassmann and Enkel, 2004).

In this paper, we intend to enrich this stream, by introducing the new perspective that considers two variables representing the relationship between risk and openness, which still are not deeply investigated: the types of risks and the types of partners of the innovation activities open from external contributions.

Our investigation will take place in Taiwan where, although the scarcity of empirical evidence about open innovation. For Taiwan scholars and practitioners, to investigate whether, how and with what results the firms and other organizations will work together become a significant issue nowadays. The purpose of this paper is to confirm, with an extensive study, that different types of partners can be found in practice in term of risk variety; hence a survey on a sample of manufacturing of Taiwan companies was conducted.

The remainder of the paper is structured as follows. Section 2 discusses the connection between innovation risk variety and open innovation, as well as on the relationship between innovation types and open innovation. And then developing some propositions are on the relationship between the risk and nature of innovation and open innovation collaborators in manufacturing companies. Section 3 describes our data, while Section 4 analyses the risk and connection externally towards open innovation, and finally, Section 5 concludes and discusses the limitations and implications of our work.

II. Literature Review

A. The Risk of innovation and Open Innovation

An awareness of risk has been dealt as the heart of commercial activity (Essinger and Rosen, 1991). Manuel(2007) define a risk is “a measure of the anticipated difference between expectations and reality, that exists because the future is unknown; no amount of precautions can ensure that a ship sent to a distant land returns at all, let alone returns laden with gold”.

Innovation is risky in the sense that innovative actions aimed at the future always confront uncertainty, and the prior research suggests that the existence of complementarities between in-house R&D and external know-how in the innovation activities are important (Teece, 1986) because of the complex of innovation activity. At the same time, recent researches on this issue glean the insights regarding boundaries of organizations and how to control elements of the innovation process, attention to the commercial process and output of innovation, and experimenting with “open business models for innovation” as a risk management tool (Chesbrough,2006).

The main reasons that push firms towards open innovation preference are based on the needs of costs and risk reducing during innovation activitye and the needs of extending skills, competences and creativity (Huang, Chung & Lin, 2009).On the other hand, innovation impacts on growth, but the lack of technological opportunities (technology obstacles), the lack of innovation and technical personnel (resource limitations) and the lack of market opportunities (market obstacles) perceived by the companies also influence the company’s decision to select the partners for its innovation strategy (Cassiman and Veugelers, 2006). Gassmann and Enkel (2004)

state that research-driven companies aim at reducing the R&D's fixed costs and sharing risk with external organizations. Further, they described that the benefits of co-operation are seen in an improvement in the competitive position and in minimizing the risk, but not in reducing developing time. The extent to which they should engage in cooperating with external organizations is likely to be contingent on the influence with the lacks. Given the considerations, we anticipate that making innovation and progressing with outsider applied by the type of the risk.

B. The Innovation Type and Open Innovation

It's difficult to assess who defined the dichotomy between incremental and radical innovation, but prior research has highlighted the different types of innovation may influence the company engaging in innovation by distinct approaches.

Based on different logics, companies may develop different strategies to spur the incremental or radical innovation activities. The statement of innovation type that radical innovations consist on important changes on products, and incremental innovations consist on smaller modifications had been proven.

Lichtenthaler (2008) finds that the degree of openness seems to rise with the degree of emphasis on radical innovation, especially concerning the degree of external technology commercialization. Two reasons are, that the first is the opportunity to commercialize knowledge applied in the internal organization, reveals to be residual; and the other is, the possibility to facilitate the acceptance on the market, and the creation of a standard. Further, it also been found that firms which emphasize radical innovation are obviously not able to develop all knowledge internally, and they usually have to strongly rely on complementary external sources and thus they use technology acquisition and/or collaborate with external organizations (Perrons, Richards, Platts, 2005; Teece, 2007). As a result, we propose that the decision-making on cooperating with outsider is more commonly applied by the type of innovation.

III. Methods

A. Sample

To analyze the risk of innovation with regards to open innovation, we use a survey data of Taiwan questionnaire revised from the fourth edition of European Community Innovation Survey (CIS4). The study conducted in Taiwan manufacturing industry innovation activities. Data collection was done over 3-year period from 2004 to 2006. A total of 761 valid respondents are in the manufacturing industry from overall firms in Taiwan. Table 1 shows how these respondents are distributed across turnover, size classes. In this study, as we observed, the mainly size classes of these companies have less than 500 employees, called SMEs.

Table 1

Distribution of respondents across turnover for 2006 and size classes in 2006

Class	TURN06		EMP06	
	freq.	%	freq.	%
1	33	4.3	6	.8
2	17	2.2	85	11.2
3	65	8.5	66	8.7
4	104	13.7	259	34
5	103	13.5	156	20.5
6	439	57.7	189	24.8
total	761	100.0	761	100.0

*The classes of TURN06 are: 1: < 5 million NT dollars; 2: 5 million NT dollars; 3: 10 million NT dollars; 4: 40 million NT dollars; 5: 100 million NT dollars; 6: >500 million NT dollars

** The classes of EMP06 are: 1: < 5 people; 2: 5~29 people; 3: 30~49 people; 4: 50~199 people; 5: 200~499 people; 6: >500 people.

B. Variables

The survey proceeded with questions on the type of innovation, the type of innovation risk and the nature of firm's innovation collaborators. More specifically, two innovation types, and three innovation risks and seven innovation collaborators were distinguished, which are defined in Table 2. The variables we measures are revised from Oslo Manual and Cassiman and Veugelers' research in 2006. Table 3 shows how these respondents are distributed across the nature of innovation, the type of innovation collaborators and the innovation risk.

Table 2

Surveyed variable and definition

Variable	Definition	Code
<i>Type of innovation</i>		
NEWMKT	Your enterprise introduced a new or significantly improved good or service onto your market before your competitors (it may have already been available in other markets)	0 = no; 1 = yes
NEWFRM	Your enterprise introduced a new or significantly improved good or service that was already available from your competitors in your market	0 = no; 1 = yes
<i>Type of collaborator</i>		
Co1	Suppliers of equipment, materials, components, or software	0 = no; 1 = yes
Co2	Clients or customers	0 = no; 1 = yes

Co3	Competitors or other enterprises in your sector	0 = no;1 = yes
Co4	Consultants, commercial labs, or private R&D institute	0 = no;1 = yes
Co5	R&D units or Labs from other distinct technical companies	0 = no;1 = yes
Co6	Universities or other higher education institutions	0 = no;1 = yes
Co7	Government or public research institute	0 = no;1 = yes

Type of innovation risk

RoT	The lack of technological opportunity	0 = no;1 = yes
RoP	The lack of innovation and technical personnel	0 = no;1 = yes
RoM	The lack of market opportunity	0 = no;1 = yes

firm-specific factors

TURN06	What was your enterprise's total turnover for 2006?
EMP06	What was your enterprise's total number of employees in 2006

Resources: revised from the fourth edition of European Community Innovation Survey (CIS4)

In this study, the most companies engage in innovation commonly by incremental approach to introduce a new or significantly improved good or service that was already available from their competitors in their market (74%). Less than half of 761 companies introduce a new or significantly improved good or service onto their market before their competitors (48.4%). These companies engage in innovation mainly by closed innovation more than open innovation, especially they would not collaborate with the organization from distinct technical area (86.5%). They prefer to collaborate with the direct members in the supply chain, include suppliers of equipment, materials, components, or software (34.2%) and clients or customers (35.2%). The number of companies less than 80% engaged in innovation would not get into the lack of technological opportunity (72%), but, the more than 50% get in the problem about the lack of innovation and technical personnel (57.7%) and market opportunities (50.9%).

As the result, the companies observed are generally small, but they do the effort on seek and seize the technological opportunity although they don't have the enough complementary resources to make profit from innovation. According with this result, we analyze when the company get into the barriers, what types of organization they will prefer to collaborate with.

Table 3

Distribution of respondents measured by the type of innovation, the type of collaborator and the risk

Variable	0	1
<i>Nature of innovation</i>		
NEWMKT	393(51.6%)	368(48.4%)
NEWFRM	198(26%)	563(74%)
<i>Type of collaborator</i>		
Co1	501(65.8%)	260(34.2%)
Co2	493(64.8%)	268(35.2%)
Co3	648(85.2%)	113(14.8%)
Co4	625(82.1%)	136(17.9%)
Co5	658(86.5%)	103(13.5%)
Co6	628(82.5%)	133(17.5)
Co7	639(84%)	122(16%)
<i>Type of innovation risk</i>		
RoT	548(72%)	213(28%)
RoP	322(42.3%)	439(57.7%)
RoM	374(49.1%)	387(50.9%)

C. Research Methodology

Agrawal, Imilienski and Swami (1993) presented association analysis, which is also called the association rule. The original purpose of association analysis was to find relationships between products in a point-of-sales interchange database. The following section briefly introduces the basic concept of building association rules. Let $I = \{i_1, i_2, \dots, i_m\}$, I be the set of all items. T is the items set in each exchange record. T is the subset of I ($T \subseteq I$). $D = \{T_1, T_2, \dots, T_m\}$; D is the T set of all exchange records in the database, but the exchange record in T is irrelative to the purchase amount of the items. The association rule is denoted by $A \rightarrow B$ and uses support and confidence to measure the association rules. Support indicates the proportion of the frequency of exchange records containing items A and B in D to the frequency of all the exchange records in D , as shown in (1). Confidence represents the proportion of exchange records containing item B given the condition of exchange records containing item A in D , as shown in (2).

$$s = \frac{\text{frequency}(A \cup B)}{\text{frequency}(D)}, (0 < s \leq 1) \quad (1)$$

$$c(A \rightarrow B) = \frac{s(A \cup B)}{s(A)}, (0 < c \leq 1) \quad (2)$$

Using a huge amount of customer purchasing data, association analysis can

identify the associations between purchased items to provide answers to questions such as “What is the most popular item found in a multi-item order?” and “What items are more likely to be purchased together than any other two items?” For instance, $A \rightarrow B$ (support=20%, confidence=75%) indicates that a purchase of both A and B accounts for 20% of all exchange records, and 75% of the customers who bought item A will buy item B at the same time.

We modify the items into the analysis by using the innovation risks and collaborators as exchanges in traditional association analysis. The innovation risks are treated as items purchased in one exchange at first, and then the collaborators are put in the next exchange. Using this approach, association analysis reveals the association rules between innovation risks and collaborators for the open innovation. Since a collaborator reveals a specific category, these results also illustrate the association between various collaborators’ positions. Thus, managers can employ these association rules to make decision to bridge the relationships between different partners based on the innovation risks in order to minimizing the uncertainty.

IV. Results

This study employs Clementine software to perform association analysis. Figure 1 displays the associations among these variables, which include NEWMT, NEWFM, RoT, RoP, RoM, Co1, Co2, Co3, Co4, Co5, Co6, Co7. In Fig. 1, the bold solid line indicates that different variables have high association (links > 100), the thin solid line indicates middle association (30 < links < 100) and the dotted line indicates low association (links < 30).

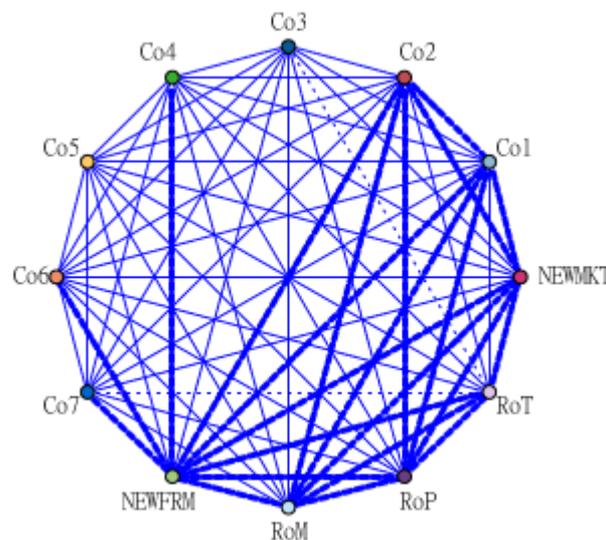


Fig. 1 The association among the studied variables

Table 3 shows the number of links between these variables. The strongest relationship is the innovation which is new to the market and the firm (368), and next

is when companies engaged in innovation always get into the barriers of market opportunities and innovation and technical personnel at the same time (331). The companies collaborate with suppliers of equipment, materials, components, or software (146) and clients or customers (135) when they involve in the innovation which is new to the market. Besides, They do more efforts on engaging in new-to-firm innovation with partners more than in new-to-market, include suppliers of equipment, materials, components, or software (208), clients or customers (201), universities or other higher education institutions (109), consultants, commercial labs, or private R&D institute(105), and government or public research institute(102).

In the other hand, the companies collaborate with suppliers of equipment, materials, components, or software (150/131) and clients or customers (153/131) when they get into lack of innovation and technical personnel and market opportunities. the companies do not often collaborate with partners when they get into lack of technological opportunity, especially with government or public research institute (29), competitors or other enterprises in your sector (29), R&D units or Labs from other distinct technical companies (31), universities or other higher education institutions (37), and, consultants, commercial labs, or private R&D institute (38), and then they do not often collaborate with R&D units or Labs from other distinct technical companies (48) when they get into lack of market opportunities.

In the results of this study, the companies always get into trouble in seeking the market opportunities (292) and managing innovation and technical personnel (323) when they engage in the new-to-firm innovation. Engaging on innovation new to the market, the companies always get into lack of innovation and technical personnel (219).

Table 3

The number of links between these variables

Links	Variable 1	Variable 2	Links	Variable 1	Variable 2	Links	Variable 1	Variable 2
368	NEWMKT	NEWFRM	93	NEWFRM	Co3	61	Co2	Co6
331	RoP	RoM	93	Co1	Co4	60	RoM	Co6
323	NEWFRM	RoP	89	Co2	Co4	58	RoM	Co7
292	NEWFRM	RoM	84	NEWFRM	Co5	58	Co4	Co5
219	NEWMKT	RoP	83	Co2	Co3	57	Co4	Co6
208	NEWFRM	Co1	83	RoP	Co4	57	Co3	Co4
201	NEWFRM	Co2	81	NEWMKT	Co6	57	Co6	Co7
192	NEWMKT	RoM	80	NEWMKT	Co7	54	RoP	Co3
161	NEWFRM	RoT	79	RoT	Co2	54	RoM	Co3

153	RoP	Co2	78	RoT	Co1	52	Co2	Co7
150	RoP	Co1	77	Co1	Co7	50	RoP	Co5
146	NEWMKT	Co1	76	NEWMKT	Co4	50	Co5	Co6
135	NEWMKT	Co2	72	RoP	Co6	48	RoM	Co5
134	Co1	Co2	72	RoM	Co4	47	Co3	Co5
131	RoM	Co1	72	Co1	Co6	46	Co5	Co7
131	RoM	Co2	72	Co1	Co3	39	Co3	Co6
118	RoT	RoP	72	Co1	Co5	38	RoT	Co4
113	NEWMKT	RoT	68	RoP	Co7	37	Co3	Co7
109	NEWFRM	Co6	67	NEWMKT	Co3	37	RoT	Co6
105	NEWFRM	Co4	66	Co2	Co5	31	RoT	Co5
105	RoT	RoM	63	Co4	Co7	29	RoT	Co3
102	NEWFRM	Co7	62	NEWMKT	Co5	29	RoT	Co7

The results in Table 4 shows that the relationship between antecedent variables and consequent variables. In the study, the percentage is 36.674% when the company often collaborates with suppliers of equipment, materials, components, or software because of engaging in innovation new to the market. The percentage is 37.089% or 36.62% when the company collaborates with clients or customers, or suppliers of equipment, materials, components, or software because of get into trouble in seeking the technological opportunity. The most important partners are the supply organizations and demand organizations, because the percentage is more than 30% when the companies get into trouble with lack of innovation and technical personnel and seeking market opportunities, they will collaborate with supply and demand sides.

The percentage is less than 20% when the company collaborates with competitors and the organization from distinct industries owing to any conditions. The average percentage of collaborating with university in the condition of involving in innovation (20.686%) is higher than getting into innovation risk (16.425%).

Table 4

The relationship between antecedent variables and consequent variables

Consequent	Antecedent	Support %	Confidence %	Consequent	Antecedent	Support %	Confidence %
Co1	NEWMKT	0.035	39.674	Co7	NEWFRM	0.054	18.117
Co2	RoT	0.02	37.089	Co4	RoT	0.02	17.84
Co1	NEWFRM	0.054	36.945	Co6	RoT	0.02	17.371
Co2	NEWMKT	0.035	36.685	Co5	NEWMKT	0.035	16.848
Co1	RoT	0.02	36.62	Co3	NEWFRM	0.054	16.519

Co2	NEWFRM	0.054	35.702	Co6	RoP	0.042	16.401
Co2	RoP	0.042	34.852	Co6	RoM	0.037	15.504
Co1	RoP	0.042	34.169	Co7	RoP	0.042	15.49
Co1	RoM	0.037	33.85	Co7	RoM	0.037	14.987
Co2	RoM	0.037	33.85	Co5	NEWFRM	0.054	14.92
Co6	NEWMKT	0.035	22.011	Co5	RoT	0.02	14.554
Co7	NEWMKT	0.035	21.739	Co3	RoM	0.037	13.953
Co4	NEWMKT	0.035	20.652	Co3	RoT	0.02	13.615
Co6	NEWFRM	0.054	19.361	Co7	RoT	0.02	13.615
Co4	RoP	0.042	18.907	Co5	RoM	0.037	12.403
Co4	NEWFRM	0.054	18.65	Co3	RoP	0.042	12.301
Co4	RoM	0.037	18.605	Co5	RoP	0.042	11.39
Co3	NEWMKT	0.035	18.207				

V. Conclusion

The study is based on the companies collaborate with outsiders in order to sharing risk. In other words, when the companies found themselves confronted by innovation risk, they will seek external organizations to minimize the uncertainty in the process of innovation.

Prior researches show that large companies involved in discovering, developing and commercializing internally has been labeled as the closed innovation model (Chesbrough, 2003), and the small- and medium-sized enterprises (SMEs) prefer to collaborate with external organizations (van de Vrande, de Jong, Vanhaverbeke, and de Rochemont, 2009). In this study, we found that the manufacturing companies engaging in innovation process would not collaborate with outsiders either in Taiwan, although they are SMEs.

The recent researches focus on the risk management and innovation increasingly. They describe how and why the companies engage in many open innovation practices, and the reason is they collaborate with external organizations should improve their abilities and share risk to minimizing uncertainty (Cassiman and Veugelers, 2006; Gassmann and Enkel, 2004; Huang et al., 2009). The study we investigated advances through finding the relationship between the innovation risk and the external collaborators by using association analysis.

In the results of this study, we find the manufacturing companies in Taiwan would like to collaborate with supply and demand sides in the innovation process, include innovation new to the firm and market, more than other outsiders. This result

confirms the importance of user innovation (von Hippel, 2005) for many SMEs: reducing the understanding bias of open innovation in SMEs who focus on science-driven innovations (van de Vrande, de Jong, Vanhaverbeke, and de Rochemont, 2009).

The issue of risk management and innovation is more important recently, and the major purpose of this research is to discover who the key outsider is when the companies getting into innovation risk. The finding of this study is the important external organizations for the companies reducing innovation risk are from the supply and demand side. In other words, the companies more often share risk with the rule on supply chain than “real outsiders”. Collaborating with universities and public institutions may raise the risk in the innovation, because these organizations don’t have the same pressures during the process of innovation as in the real competitive market. In other words, the companies prefer collaborate with universities and public institutions more than share risk, especially with universities in order to absorbing new ideas or knowledge for innovation new to the firm or market rather than sharing risk.

The current study is an exploration of the open innovation practices that companies cooperate with distinct outsiders on account of different innovation risks. Consequently, it has several limitations as we identified following. First, the data we used in this study is not longitudinal information. Therefore we could infer indirectly that the companies look for external organizations following the innovation risks in time based on the logics from prior studies. The existing research address that the companies use open approaches for innovation to avoid risk and minimizing the uncertainties. It means that the companies would seek cooperation opportunities externally when they get into trouble with innovation (Cassiman and Veugelers, 2006; Chesbrough, 2006; Huang et al., 2009). Finally, the performance of collaborating with outsiders in the innovation process may have the other limitation. We surveyed only if respondents reported that they had adopted the corresponding practices in the obstacle conditions, although we could not argue that the companies avoid risks by cooperating with partners for a certainty. Given these considerations, we make the assumption that the companies would do efforts to find partners from outside when they are confronting difficulties in innovation process, or they anticipate that the risks exist in the innovation actually.

In the future, the dynamics of open innovation is another research area that should be further developed. Our finding explored that the relationship with the companies and different partners is based on the risk type, which neglected the risks in different stages of innovation, including discovering, developing, and commercialization.

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