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Determining Factors in Innovation of Small Firm Networks: A case of Cross Industry Groups in Japan

Nobuya Fukugawa

ABSTRACT. We examine the relationship between network characteristics and innovation under different phases of innovation. Based on micro data of cross industry groups, small firm networks for knowledge sharing and R&D cooperation, we show that close-knit networks, represented as dense communication and a high level of commitment among members, are correlated with initiating joint product development. Furthermore, the results show that establishing contact with external sources of knowledge such as public research institutes is important to achieve technical success in innovation. Lastly, engaging in cooperative activities in sales is correlated with commercial success in innovation.

1. Introduction

The relationship between innovation and networks is one of the most frequently discussed issues in relevant fields in economics, managerial science, and sociology. Theory suggests different benefit of different networks to innovation. Weak ties and non-redundant networks promote innovation through efficient transfer of codified knowledge while strong ties and close-knit networks promote cooperation through intense transfer of not-codified knowledge. Recent empirical studies attempt to integrate different views on network effect on innovation from the viewpoint of the contingency approach that assumes that different network characteristics are influential in innovation under different environments. Based on micro data of cross industry groups' (CIGs), small firm networks uniquely established in Japan for knowledge sharing and R&D cooperation, this study examines the relationship between network structure of CIGs and their innovative output under different phases of joint product development. Foreshadowing the results, CIGs with more homogeneity, more routines for knowledge sharing, and higher commitment to activities in CIGs are likely to engage in joint product development. Among CIGs that have engaged in innovative activities, CIGs exploiting external source of knowledge, such as public research institutes, are likely to achieve technical success in innovation, while network structures that enhance connectedness within the CIG are not influential any more. Furthermore, among CIGs with technical success in innovation, CIGs engaging in cooperative activities in sales are likely to achieve commercial success in innovation, while determinants in other phases of innovation show insignificant results. The results imply that network structure conducive to innovation significantly varies according to the phase of innovation.

The remainder of this paper is organized as follows. We present a brief description of CIGs in Section 2. The dataset and empirical method are introduced in Section 3. Based on the review of the previous literature, we present four sets of empirical relationships between network characteristics and innovative output of CIGs under different phases in joint innovation in Section 4 and show empirical results in Section 5. We summarize empirical implications and refer to the agendas for further research in Section 6.

2. Cross industry groups

A CIG is defined as a voluntary organization among small firms belonging to various sectors,

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Nobuya Fukugawa
Department of Economics
Nagasaki Perfectural University
123 Kawashimo, Sasebo Nagasaki, 858-8580, Japan
E-mail: nfukugawa@gmail.com

which aims at knowledge sharing and R&D cooperation (SMEA, 1981). Its origin can be traced back to the SME (small and medium-sized enterprises) policy implemented in the early 1970s. In 1971, an advisory board of prime minister suggested that small firms be linked to respond demand fluctuation in the post high growth era. Based on this suggestion, in 1972, the SME council, an advisory board of minister of international trade and industry fostered associations among small firms conducting intensive R&D. In 1981, the technology transfer center where managers of small innovative firms exchanged information was established throughout Japan and several laws promoting cross industry groups were enacted in 1980s. Local authorities that were seriously concerned about regional development after the oil crisis actively intermediated in the networking of small firms to revitalize regional economies through innovations of small local firms. As a result of intensive coordination by local authorities and their related institutions, the number of CIGs greatly increased in 1980s. Figure 1 indicates that the number of CIGs and participants nearly doubled during 1990s. By 2001 there were assumed to be 2992 CIGs with 132,846 participants. While small firms account for a large section of the participants, some of them are large firms. Since most of the CIGs were established to have small local firms linked together and develop regional economies, the administrators of CIGs tend to be local economic agents, such as local authorities and their affiliated institutions (19%), the chamber of commerce and industry (24%), and SMEs themselves (20%). Figure 2 shows the distribution of CIGs according to the year of establishment. Figure 2 indicates that approximately 90% of CIGs that existed in 2001 were established after 1980s. The upsurge in 1985 is influenced by the national project for entrepreneur development in cross industry groups. The upsurge in 1988 is influenced by the enactment of the 'Law for Temporary Measures to Develop a New Frontier by Knowledge Integration among SMEs in Different Industries.' This law aimed to promote innovative activities of small firms through CIGs.

About 78% of the CIGs are organized as voluntary groups, which makes it difficult to compile the official database. However, 15% of the CIGs have legal entity as cooperative business associations. The main reason of CIGs to form cooperative business associations is that legal entity enables them to receive subsidies from the local and central government that aim

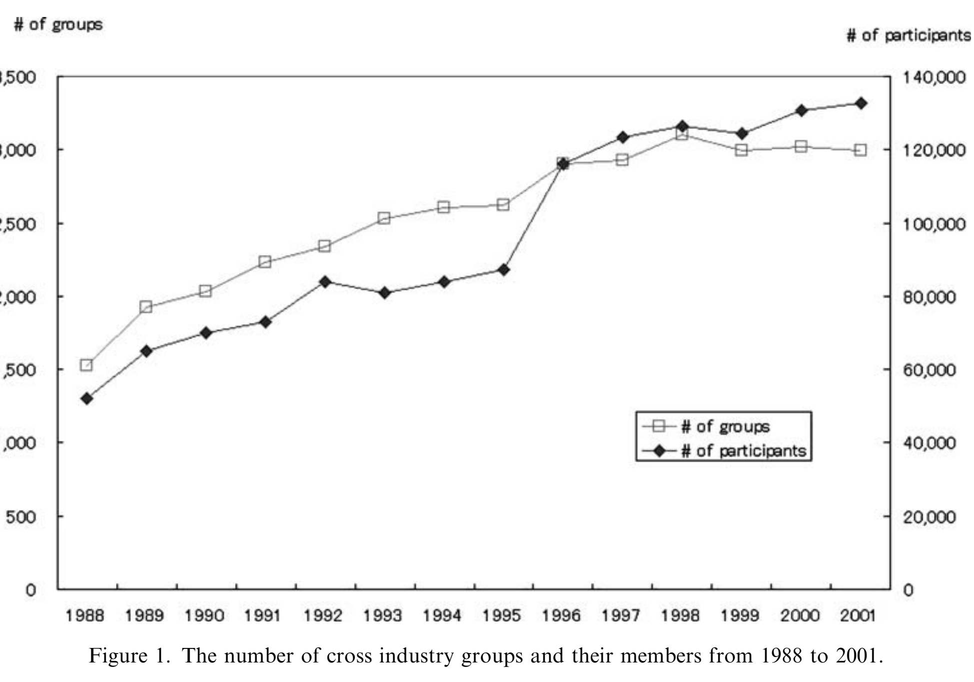

Figure 1. The number of cross industry groups and their members from 1988 to 2001.

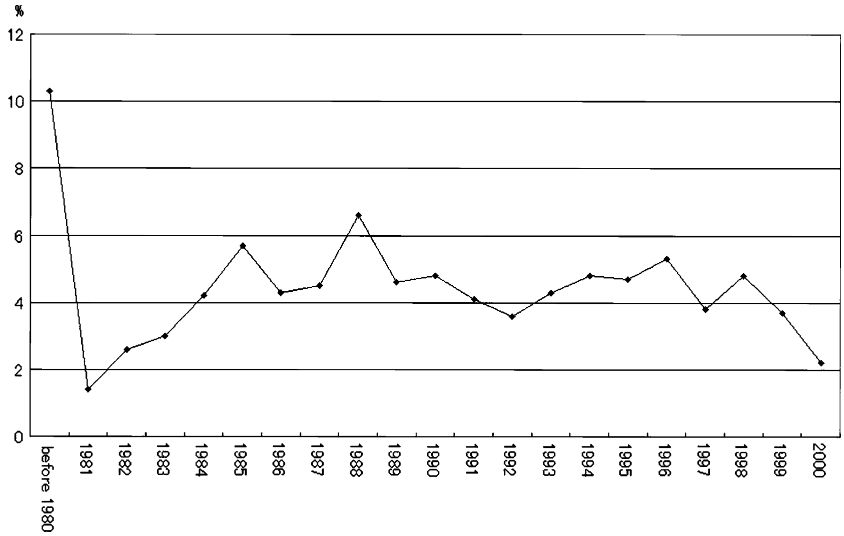

Figure 2. The distribution of cross industry groups by year of establishment.

to promote innovations through small firm networks. Actually, 38% of the CIGs organized as cooperative business associations aim to develop new products within the group while the ratio is 15% in the case of the CIGs organized as voluntary groups. Furthermore, among 387 CIGs that initiated joint product development, 63% of the CIGs organized as cooperative business associations receive public subsidies for their joint product development while the ratio is 29% in the case of the CIGs organized as voluntary groups. Lastly, firms in various sectors participate in CIGs. About 89% of the CIGs include manufactures as members, 78% of the CIGs include wholesalers and retailers as members, and 58% of the CIGs include firms in the service sector as members.

The CIGs initiate their activities through information exchange among participants, who are, in many cases, managers of small firms. Approximately half the groups are formed for this purpose. Most groups hold regular meetings several times in a year, thereby providing participants with opportunities to share information and discuss their managerial problems. After gaining familiarity with each other, some participants go further and exploit others' resources through transactions. Utilizing each other's resources helps participants to realize the competitive advantage of others and to identify potential R&D partners. Finally, when participants find others' resources to be attractive and complementary, and vice versa, they may initiate innovative activities such as joint product development. Approximately a quarter of the groups are established for the purpose of innovative activities, however, the ratio of groups who do enter into this stage falls to below 20%.

3. Data

We employ micro data of the Japan Small and Medium Enterprise Cooperation (JASMEC) 'Survey on Cross Industry Groups' in 2001.[1] The JASMEC sends an inquiry to the local authorities, the national federation of small business associations, and the chamber of commerce and industry, regarding the location of representatives of CIGs. In many cases, those organizations are themselves involved in establishing and coordinating CIGs, and frequently hold events such as business seminars and trade fairs, wherein they retain information on CIGs that participated in those events. Based on the list obtained, JASMEC sends a questionnaire to the representatives of CIGs. About 36% of the 2992 representatives respond. After omitting invalid responses, the sample used in this study consists of 1064 observations. Among these observations, we identify 387 CIGs that have conducted joint product development. We classify innovation-active CIGs into 201 CIGs that have achieved technical success in innovation and 186 CIGs that have not. We define technical success in innovation as the completion of product development. Furthermore, we classify technically successful CIGs into 82 CIGs that have achieved commercial success in innovation and 119 CIGs that have not. We define commercial success in innovation as yielding profits from the products. Figure 3 shows the nested structure of the sample representing three phases of joint product development.

We need to mention two caveats on the dataset. First, the dataset is not compiled at the product development project level but at the group level. Therefore, it is difficult from the dataset to identify whether the innovative outcome of the CIG is achieved by the CIG as a whole or by some members of the CIG. Since the data only provides information on network structure of the CIG as a whole, we examine the relationship between network characteristics of CIG as a whole and innovative output of CIGs. Second, the dataset is not compiled as a panel data but a cross-sectional data. Therefore, it is difficult to identify whether network characteristics affect innovative output or innovative output affects network characteristics. Actually, Powell et al. highlight the cycle of learning, implying that the relationship between network structure and innovation is not unidirectional but recursive (Powell et al., 1996, 1999, 2005). To deal with endogeneity without a panel data, we need to identify the instrumental variable that is correlated with network characteristics but is uncorrelated with the error term, i.e., unobservable determinants in innovative output, which is difficult in this dataset. Therefore, we predict correlations, instead of causality, between network characteristics of CIGs and innovative output. Then we conduct the test of difference in network characteristics between two groups according to three phases of innovation described in Figure 3. Specifically, we compare (1) CIGs with and without experience in joint product development, (2) CIGs with and without technical success in innovation, and (3) CIGs with and without commercial success in innovation. We pay attention to both flows of causality in interpretation of the results in Section 5.

4. The relationship between network structure and innovation under different environments

Sociologists have developed conceptual instruments to describe network characteristics such as bridge (Harary et al., 1965), weak ties (Granovetter, 1973), embeddedness (Granovetter, 1985), closure (Coleman, 1988), and structural

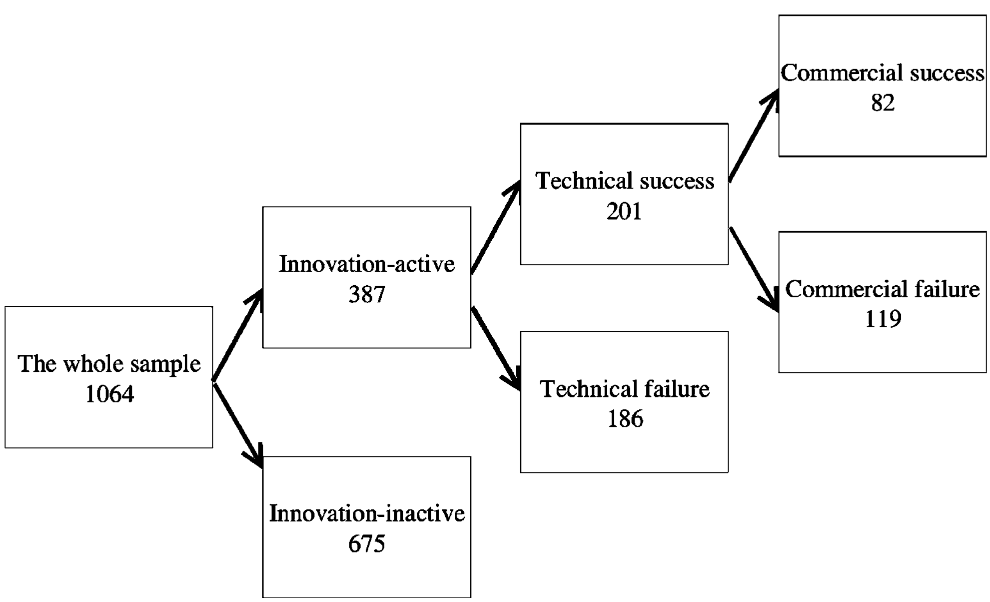

Figure 3. Configurations of the sample according to phases of innovation.

holes (Burt, 1992). Networks can be effective when an unique actor links other actors that otherwise would have been fragmented. Burt refers to such link, i.e., a bridge, as a structural hole and emphasizes that occupying a structural hole accrues competitive advantage to the actor (Burt, 1988, 1992). Kogut refers to this type of benefit as Burt rent (Kogut, 2000). Granovetter (1973) also focuses on a bridge but in a different way in that weak ties (virtually equivalent to a bridge in his assumption) tend to bring new and diverse knowledge to the actor. Arguments of Burt and Grannovetter imply that non-redundant networks or weak ties promote innovation because of the efficient transfer of diverse and new knowledge. Baum et al. (2000) indicate that non-redundant networks are likely to contribute innovations of dedicated biotech firms. Shane and Cable (2002) show that indirect ties are more important channels that convey private information of founding teams of new technology-based firms than direct ties in investment decision of venture capitals, while both ties become irrelevant in investment decision when public channel represented as reputation is available. In contrast, Coleman highlights that closed networks and redundant ties enhance social capital (Coleman, 1990). Kogut refers to this type of benefit of networks as Coleman rent (Kogut, 2000). Coleman's argument implies that tightly knit networks or strong ties promote innovation since they are advantageous in the transfer of tacit knowledge that plays a key role in innovation and requires a close communication within the network. Several empirical studies give support to this argument (Krachhardt, 1992; Ahuja, 2000; Godoe, 2000). However, excessively embedded ties may deter innovation since they tend to be exclusive and reduce the accessibility to new knowledge (Grabher, 1993; Portes and Sensenbrenner, 1993). Furthermore, balancing two types of network structure, such as between arm's-length and embedded ties (Uzzi, 1996, 1997) and between weak and strong ties (Ruef, 2002) is important for survival and innovation.

Several studies attempt to understand seemingly conflicting findings of previous studies in an integrated manner. From a theoretical perspective, March (1991) argues that strong ties are advantageous in the utilization of existing knowledge or exploitation, while weak ties are advantageous in the creation of new knowledge or exploration. Hansen (1999) also argues that contradictions in the existing network literature that weak ties promote innovation while cohesive networks are conducive to innovation as well, are recognized as compatible when the types of knowledge searched and transferred is considered. These arguments provide a basis for the contingency approach that assumes different impacts of network structure on innovation under different conditions. Rowley et al. (2000) show that strong ties and cohesive networks are complementary to performance in the exploitative environment such as in the steel industry, while weak ties are complementary to performance in the explorative environment such as in the semiconductor industry. Hite and Hesterly (2001) develop a network theory emphasizing that cohesive networks and strong ties are complementary to performance in the emergence period, while sparse networks and weak ties are complementary to performance in the early growth period of new firms. Elfring and Hulsink (2003) indicate that new technology-based firms need to employ different network strategies represented as strong and weak ties under different phases of growth and technological environment. Examining alliance strategies in the biotechnology industry, Rothaermal and Deeds (2004) show that although characteristics of affiances, i.e., exploitative or explorative, affect technical and commercial success in innovation, such correlation becomes insignificant as the biotech firm grows. We apply the contingency approach suggested by the previous literature to the relationship between network characteristics of CIGs and their innovative output under different phases of innovation. Specifically, we address four sets of empirical relationships under different phases of joint innovation.

(1) To represent heterogeneity, we use the number of industries into which members are classified. There are eleven industrial classifications available in the survey: mining, construction, manufacturing, wholesale, retail, finance and insurance, real estate, transport and communication, travel, utilities, and services. This

variable captures heterogeneity in terms of technical and commercial resources. While some empirical studies utilize distinctive indices regarding the heterogeneity of both technical and commercial resources (Sakakibara, 2001; Branstetter and Sakakibara, 2002), it is difficult to identify clear demarcations between these resources due to the lack of firm level information. When members belong to various industries, the network can be viewed as more heterogeneous in terms of commercial resources, since they are less likely to compete with each other in the same product market. We can also regard it as more heterogeneous in terms of technical resources, since they are more likely to offer different technical advantages. Thus, networks with greater heterogeneity are expected to provide members with greater incentives to share knowledge with others more willingly, since there is assumed to be less conflict of interest in the product market. Furthermore, members are expected to learn from others more effectively, since there are assumed to be better opportunities to mutually assimilate complementary technical knowledge. These organizational features will promote cooperative activities. Sakakibara (2001) indicates that government-affiliated Japanese research consortia with heterogeneous technical and commercial resources promote participants to conduct more R&D in order to assimilate and exploit external knowledge.[2] On the other hand, when firms attempt to establish knowledge linkages with other firms, they need to develop absorptive capacity required for the assimilation of external knowledge (Cohen and Levinthal, 1990). In a firm level analysis, absorptive capacity is represented by firms' internal knowledge resources such as R&D stock. In a network level analysis, it can be represented by a shared knowledge base among members. Measuring absorptive capacity by the degree of overlap of technical resources across firms, Mowery et al. (1998) propose the hypothesis that networks aiming at exploration, such as R&D alliances, require greater absorptive capacity than networks aiming at exploitation, such as production alliances, while their empirical findings do not support this argument. Furthermore, Sakakibara and Branstetter (2003) indicate that ATP-sponsored US research consortia with more technical proximity among participants contribute to increasing patent grants by consortium participants in the targeted area. In summary, heterogeneity has a dual impact on innovative activities in CIGs. On the one hand, heterogeneity helps to reduce the coordination cost stemming from conflicts of interest in the product market and fosters the knowledge sharing which precedes R&D cooperation. On the other hand, it also decreases the shared knowledge base among members that is required for assimilating external knowledge, thereby making mutual learning and innovation difficult. Thus, we predict both a positive and negative correlation between heterogeneity in CIGs and initiating joint innovation.

(2) To represent routinized communication within CIGs, we employ a binary dummy taking a value of one when CIGs organize subgroups to discuss specific managerial or technical problems, and zero otherwise. We also use the number of regular meetings in a year. To represent members' commitment to activities in CIGs, we employ the average rate of participation in regular meetings. Kogut (2000) argues that it is important to establish the principle of coordination in situations where firms need to promote knowledge sharing among others with a conflict of interest. Dyer and Nobeoka (2000) argue that a significant part of the competitive advantage that Toyota enjoys stems from its well-designed production network, which promotes knowledge sharing and organizational learning. The coordination principle employed by the Toyota production network involves three features: a routine for knowledge sharing; the participants' identity of being a network constituency; and safeguards to constrain opportunism. Specifically, voluntary learning teams in the Toyota production network provide participants with a routine for knowledge sharing, and dense communication encourages suppliers to recognize themselves as a part of the knowledge network of Toyota. Moreover, Toyota constrains opportunistic behaviors, such as free riding and the appropriation of valuable information, by economic sanctions such as suspension of transaction. Furthermore, Weaver and Dickson (1998) indicate that a decrease in perceived opportunistic behaviors of partners

contributes to improving the outcome quality of alliances among small firms. Kale et al. (2000) argue that establishing trust and relational assets contributes to solving the dilemma between sharing and appropriating knowledge among participants of alliances. By promoting mutual trust, network structures discussed above provide members with better opportunities to identify eligible R&D partners, Therefore, we predict a positive correlation between routines for communication and members' commitment to activities in CIGs, and initiating joint product development.

(3) To represent incentive mechanisms, we employ a binary dummy taking a value of one when the development costs are shared equally among project participants, and zero otherwise. We also use a binary dummy taking a value of one when the project leader bears a significant part of the costs, and zero otherwise. How members share costs implies how they share the outcomes. Examining the government affiliated research consortia in Japan, Branstetter and Sakakibara (2002) show that the organizational design of the consortia is a more significant determining factor of innovation outputs, compared with innovation inputs measured by the simple summation of R&D investment by individual participants. From the theoretical perspective, Holmstrom and Milgrom (1994) argue that reward, ownership, and discretion are important elements in the design of an organization, and these elements must be arranged in a complementary manner according to the economic environment. If the participants in joint product development are heterogeneous in their innovative capacity, it is incentive-efficient that a core firm among participants shares a significant part of the costs, and obtains a significant part of the innovative outcomes. In this case, the project leader should be strongly motivated to make a contribution to the success of the innovative activity. However, if the participants are homogeneous in their innovative capacity, it is incentive-efficient that participants bear the costs and outcomes equally so that the participants will match their contributions with each other. In this case, there are no strong incentives available to the participants to strive for the success of the innovation.[3] Examining R&D cooperation of small Japanese firms, Okamuro (2004) highlights that the consistent design of incentive mechanism between cost-sharing and output-sharing positively correlates with the success of innovation. The dataset, however, does not provide information on the variation of capabilities among participants and on the distribution of output in joint product development. Thus, it is difficult to predict whether strong or weak incentive in terms of cost-sharing encourages the success of innovation at the network level. Therefore, we predict a positive correlation both between setting strong incentive and technical success in innovation, and between setting weak incentive and technical success in innovation.

(4) To represent external sources of knowledge, we employ a binary dummy taking a value of one when CIGs engaging in product development establish contact with universities and public research institutes, and zero otherwise. The recent empirical studies indicate that small firm innovations receive significant spillover from university research (Link and Rees, 1990; Acs et al., 1994; Audretsch and Vivarelli, 1996; Piergiovanni et al., 1997). In addition, public research institutes, administrated by local authorities, provide small local firms with solutions to technical problems in product development, in addition to conducting their own research. The previous studies show that they play a key role in localized knowledge spillovers received by small firms (Beise and Stahl, 1999; Romjin and Albaladejo, 2002; Izushi, 2003). Therefore, we predict a positive correlation between CIGs' establishing contact with universities and public research institutes, and technical success in innovation.

5. Results

Table I indicates a significant and negative correlation between age of CIGs and innovation. This reflects that CIGs that exclusively aim information sharing among small firm managers tend to last longer than those aiming cooperative R&D. It is also reasonable that CIGs aiming joint innovation are likely to resolve when they find less to learn from others as a result of mutual learning. Nakamura et al. (1996) suggest

TABLE I
Difference in network structure between CIGs with and without experience in innovation

	Method	CIGs with experience in innovation	CIGs without experience in innovation	Significance
Log (year of establishment)	*t*-test	7.594	7.594	***
Log (the number of members)	*t*-test	2.46	3.14	***
Log (the number of industries in which members are classified)	*t*-test	1.01	1.17	***
The presence of subgroup to discuss managerial problems = 1, otherwise = 0	Chi-squared test	26.3%	20.2%	**
Log (the number of regular meetings in a year)	*t*-test	2.09	1.93	***
The average rate of participation in regular meetings	*t*-test	73.1%	63.2%	***

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

that international joint ventures resolve when intra-network resource becomes convergent, which implies an U-shaped relationship between age of international joint ventures and resource diversity. In contrast, Inkpen and Ross (2001) argue that the high cost of establishing alliances makes participants reluctant to resolve networks even after the completion of technical goal. The results show a significant and negative correlation between size of CIGs and innovation, which contradicts the finding of Baum et al. (2000) that larger networks lead more innovations of biotechnology Canadian startups. The results seem to reflect that CIGs that exclusively aim information sharing among small firm managers need to arrange more various members, which makes the CIG larger in size. There is a negative correlation between heterogeneity and joint product development. One interpretation is that CIGs consisted of homogeneous members have more knowledge in common about technical skills of other members, which is preferable for identifying appropriate R&D partners and initiating joint product development. The other interpretation is that in the process of joint product development, a member that is quite different from other participants, in terms of market or technology, may quit the project since the member finds it difficult to match contributions with others, or other participants find it difficult to cooperate with the member. Routinized communication, represented as subgroups and regular meetings, has a positive correlation with joint product development. An intense communication among members contributes to initiating joint development project since they encourage creation of trust and transfer of not-codified knowledge. We also can consider that intra-group communication becomes routinized and organized, rather than casual, when the CIG initiates joint product development. The degree of members' commitment to activities of CIGs has a positive correlation with joint product development. Members who are willing to exert effort in the CIG are likely to cooperate in R&D. It is also plausible that participating in joint innovation encourages members to commit activities in the CIG more dedicatedly.

As opposed to Table I, Table II shows that age and size of CIGs have a positive correlation with technical success in innovation. It is notable that Table II analyses the sample exclusively consisted of CIGs with experience in innovation, which are found to be younger and smaller from Table I. Therefore, Table II indicates that, among young and small CIGs, relatively older and larger CIGs tend to experience in technical success in innovation. Heterogeneity, routines, and commitment are not significantly correlated with technical success in innovation. Establishing access to external source of knowledge such as public research institutes is significantly and positively correlated with technical success in innovation, while the same does not hold true for universities. The difference in impacts between public research institutes and universities may reflect that public research institutes are legally responsible for providing solution to technical problems of small local firms, while university-based scientists are not necessarily motivated to interact with small local firms. Since the sample configuration is nested as shown in Figure 3, Table II indicate that, based on a strongly intertwined network, CIGs seeking solutions to technical problems in innovation can complete product development and introduce the product into the market through establishing contact with public research institutes. It should be borne in mind that the results do not imply that network characteristics dramatically change from the phase initiating innovation to the phase of technical success in innovation. Rather, CIGs retain additional network characteristics in the process of innovation. This implies that different network characteristics are influential in innovation under different environments, which is consistent with existing empirical findings based on the contingency approach. In other words, before engaging in innovative activities in a CIG, members should get to know well each other through intensely exploiting routinized and specified information sharing channels. Such organizational arrangements facilitate the transfer of tacit knowledge and the creation of mutual trust. Based on a close-knit network, members exploit external source of knowledge to complete joint product development. Organizational efforts to enhance internal connectedness are unnecessary in this phase. Lastly, although Table II seems to indicate the positive (negative) correlation between strong (weak) incentive setting and technical success in innovation, the results are statistically insignificant in both cases.

Table III shows that all of network characteristics discussed in Section 4, i.e., heterogeneity, commitment, routinized communication, external source of knowledge, and incentive mechanism are uncorrelated with commercial success in innovation. It is reasonable that public research institutes do not play a key role any more in CIGs' successful innovation since augmenting small firm manager's skill in marketing and sales is beyond their compass. Only influential factor is cooperative activities in sales. Organizational effort to establish virtual networks such as opening group's own website has no significant impact on commercial success

TABLE II

Difference in network structure between CIGs with and without technical success in innovation

	Method	CIGs with technical success	CIGs without technical success	Significance
Log (year of establishment)	*t*-test	7.595	7.596	***
Log (the number of members)	*t*-test	2.55	2.36	**
Log (the number of industries in which members are classified)	*t*-test	1.06	0.96	
The presence of subgroup to discuss managerial problems = 1, otherwise = 0	Chi-squared test	28.6%	23.8%	
Log (the number of regular meetings in a year)	*t*-test	2.08	2.10	
The average rate of participation in regular meetings	*t*-test	72.4%	73.8%	
Establishing contact with universities in joint product development = 1, otherwise = 0	Chi-squared test	14.9%	10.8%	
Establishing contact with public research institutes in joint product development = 1, otherwise = 0	Chi-squared test	14.9%	6.4%	***
Equally sharing the costs in joint product development = 1, otherwise = 0	Chi-squared test	25.8%	30.1%	
A core firm's sharing the costs in joint product development = 1, otherwise = 0	Chi-squared test	6.4%	3.7%	
Receiving public subsidies in joint product development = 1, otherwise = 0	Chi-squared test	37.8%	38.1%	

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE III
Difference in network structure between CIGs with and without commercial success in innovation

	Method	CIGs with commercial success	CIGs with commercial success	Significance
Log (year of establishment)	*t*-test	7.595	7.595	
Log (the number of members)	*t*-test	2.46	2.62	
Log (the number of industries in which members are classified)	*t*-test	0.99	1.11	
The presence of subgroup to discuss managerial problems = 1, otherwise = 0	Chi-squared test	23.6%	32.1%	
Log (the number of regular meetings in a year)	*t*-test	2.13	2.04	
The average rate of participation in regular meetings	*t*-test	73.4%	71.6%	
Establishing contact with universities in joint product development = 1, otherwise = 0	Chi-squared test	13.4%	15.9%	
Establishing contact with public research institutes in joint product development = 1, otherwise = 0	Chi-squared test	14.6%	15.1%	
Equally sharing the costs in joint product development = 1, otherwise = 0	Chi-squared test	26.8%	25.2%	
A core firm's sharing the costs in joint product development = 1, otherwise = 0	Chi-squared test	8.5%	5.0%	
Receiving public subsidies in joint product development = 1, otherwise = 0	Chi-squared test	36.5%	38.6%	
Arranging on-line shopping for group's products = 1, otherwise = 0	Chi-squared test	24.3%	15.9%	
Engaging in cooperative activities in sales = l, otherwise = 0	Chi-squared test	48.0%	22.5%	***

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

in innovation. The results seem to indicate that CIGs achieving both technical and commercial success in innovation employ distinct strategies according to the phase of innovation. To start with, members develop a close-knit structure within the group for sharing knowledge. Then they interact with external source of knowledge for exploration of new knowledge represented as a new product. Lastly, they establish a new inward-focused structure for exploitation of existing knowledge represented as sales channels.

Empirical results in Tables I, II, and III are summarized as Figure 4. Phase 1 represents small firm managers' joining CIGs. Phase 2 represents that members get to know well each other through attending regular meetings and subgroups for discussing specific managerial problems. The results show that developing close-knit linkages within the group promotes to initiate joint product development in the group. The results may show the adverse causality as previously stated. Phase 3 represents that members in the process of joint product development establish linkage to external source of knowledge. The link to external source of knowledge is depicted as a dashed line because members are considered to have little interaction with the external source of knowledge before they enter into Phase 3. To identify whether the tie between the CIG and the external source of knowledge is strong or weak, we need to arrange for a project level data. The results indicate that establishing contact with public research institutes contributes to the completion of joint product development, i.e., technical success in innovation. In this phase, organizational efforts to enhance connectedness within the CIG are not necessary any more. Phase 4 represents that members with technical success in innovation engage in cooperative activities. The link within the group is depicted in a bold line because members are connected not only through information sharing but also through business activities that are considered to require a more close relation. The results indicate that engaging in cooperative activities in sales contributes to yielding profits from the product, i.e., commercial success in innovation. In this phase, organizational efforts to enhance connectedness within the CIG and establishing contact with public knowledge are not necessary any more.

6. Conclusion

Although uniquely developed in Japan, a case of cross industry groups indicates general implications to theory and practices in other regions. By definition, CIGs aim to promote knowledge sharing and cooperation among small firm managers, and then go further to conduct joint innovation. The results suggest Coleman rent (Kogut, 2000) dominates CIGs in the phase of knowledge sharing and initiating joint innovation. However, among CIGs with joint product development, in order to achieve technical success in innovation, organizational efforts to enhance connectedness with in the CIG are unnecessary any more. Rather, establishing linkage with external source of knowledge has a significant impact on technical success in innovation. Although it is difficult to identify whether Burt rent (Kogut, 2000) dominates CIGs in the phase of aiming technical success of innovation, since Burt's argument is based on competition theory, instead of cooperation, it is likely that the actor eager to occupy a structural hole for a positive rent is unsuitable for joint innovation where small firms managers share experience and competitive advantage. The results show that, among CIGs with technical success in innovation, CIGs engaging in cooperative activities in sales are likely to achieve commercial success in innovation. It seems that Coleman rent is important in the phase of aiming commercial success of innovation since business activities such as collaboration in marketing and sales require a more close relation among participants than in the case of knowledge sharing. In summary, a case of CIGs in Japan implies networks aiming cooperation and innovation can be managed better if organizers understand and apply the contingency approach suggested by this study. For more detailed implications for theory and practice, the future research will

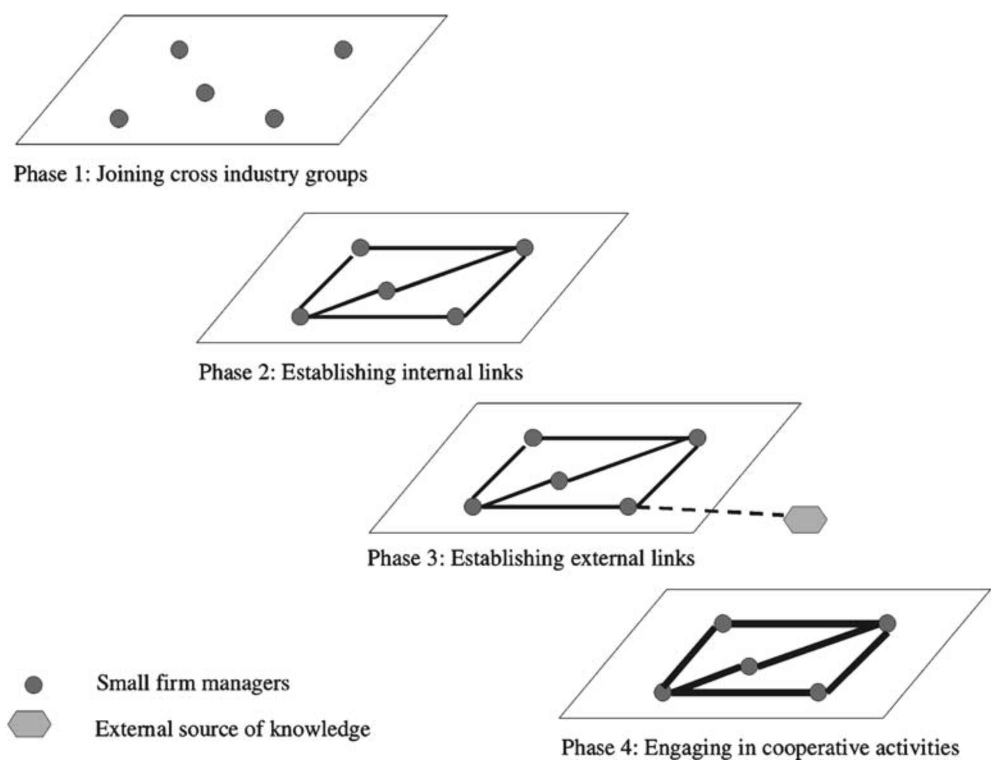

Figure 4. Summary of the results.

examine a project level data of CIGs that enables us to capture network structure more precisely.

Notes

[1] It is notable that this survey was not designed for this research, implying that we cannot test whether the sample is representative of the population due to a lack of a comprehensive dataset.

[2] Irwin and Klenow (1996) show that cost-sharing, instead of skill-sharing (Sakakibara,1997), dominates SEMATECH because of less technical and commercial heterogeneity, and that R&D expenditure decreases as a result of attempts at avoiding overlapping investment into similar themes.

[3] It is plausible that none of the participants in a project are motivated to take the initiative in product development when the theme has a poor chance of success.

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