The Integrative Model of International Innovation Network and Performance

Gang FANG[1], Yves PIGNEUR [2]

[1,2]HEC School of Business, University of Lausanne, Lausanne 1015, Switzerland
gang.fang@unil.ch, yves.pigneur@unil.ch

Keywords: International innovation network; Network structure; Network relationship; Network position

Abstract

Research in social network has demonstrated that firms in changing environment will benefit from innovation network. However, the lack of consensus on what factors and how these factors impact the performance impedes the further research in this area. In this paper, the concept of international innovation network and its performance are clarified. Then, based on reviews of the social network and knowledge management literature, especially along with the results of previous empirical studies, we propose an integrative model in which the performance of focal firm within international innovation network is impacted by network structure (network range and density), network relationship (tie strength, duration, and norm distance), and network position (centrality). We also come up with some efforts that the firm can make in order to improve its performance. In the end, the future research following this study is discussed.

1 Introduction

Many researchers suggested that knowledge is the principal source of competitive advantage. Globalization and other rapid changes in markets and technologies increasingly require firms to acquire and generate new knowledge in order to remain competitive.

However, knowledge transfer is not easy across firm boundaries (Singh, 2005). Consensus has grown in the literatures that innovation network form an efficient mechanism to effectuate the potential for learning and innovation across firms (Uzzi, 1997; Gilsing and Nooteboom, 2005). Recently, the growing demand for knowledge has further initiated the creation of a new global innovation ecosystem that is called "International Innovation Network". International innovation networks helps companies solicit and harness external talent, expertise, and ideas worldwide; identify and capture global collaborative opportunities; and maximize profitability through new ventures.

According to the previous studies on innovation network, the network structure (Reagans et al., 2004; Walker et al., 1997), network relationship (Gilsing and Nooteboom, 2005; Reagans and McEvily, 2003), and network position (Tsai, 2001; Bell, 2005; Salman and Saives, 2005) are crucial factors which impact the performance of the innovation network. In order to build an advantageous innovation network which has appropriate network structure, and to mobilize and maintain the effective relationship with the partners in the network, the firms need proactive approaches and special capabilities which can ensure the success of knowledge transfer and innovation through this network. The antecedent of these efforts is to understand clearly about what the network structure, relationship and position are and how they influence the performance of the international innovation network. However, although prior studies have provided some foundation to understand these issues, our knowledge remains underdeveloped and unsystematic.

The purpose of this research in progress and this paper is to build an integrative model of international innovation network. Firstly, the concept of international innovation network and its performance are clarified. Then we identify the crucial factors which affect the performance of international innovation network. Finally, an integrative model of international innovation network and performance is developed. The contribution of this paper is that it enables the integration of different researches within social network area, and expands them into the international context. The paper is also unique in coming up with a network pattern from which focal firm can obtain benefits mostly when it participate an international innovation network.

2 Concept of International Innovation Network

In the era of globalization, international competition is increasingly viewed as taking place at the level of organizational networks rather than at the level of the individual organization. "One of the main reasons that firms participate in international innovation network is to learn knowledge and capabilities from their network partners" (Kale et al., 2000).

Social network theory was originally come up with to describe the relationships among the individuals. Some researchers used this theory to analyze and study the mechanism of knowledge transfer or knowledge diffusion among persons (e.g. Obstfeld, 2002; Reagans and McEvily, 2003; Singh, 2005). Recently, there also emerged some studies which were committed about the co-operational innovation between the organizations by using this theory (Uzzi, 1997; Bell, 2005; Gilsing and Nooteboom, 2005; Salman and Saives, 2005). Due to the increased amount and complexity of knowledge, no single firm can afford to innovate continually and to develop world-class competencies in all the different fields. Also, firms which want to do business in international market will suffer from the lack of

the knowledge of local market when they enter a new country. Firms therefore try to find cooperative partners globally to form international innovation networks, which benefits include: (1) provide more opportunities to access the latest technical breakthroughs and new insights to problems (Ahuja, 2000), (2) learn and internalize new technologies, know-how, and physical assets beyond firm and country boundaries, (3) share risk or uncertainty with their partners (Bleeke and Ernst, 1991).

Unfortunately, there is little consensus in the literatures on the definition of international innovation networks. As network originally means a complex, interconnected group or system, DeBresson and Amesse (1991) regarded innovation networks simply as innovating companies working together. Van Aken and Weggeman (2000) argued that innovation network is a system of autonomous and legally equal organizations connected by select and persistent business relations to deal with product or process innovation or both. Drawing on this argument, the international innovation network (IIN) is defined in this study as a system of autonomous and legally equal organizations connected globally by select, formal and persistent relations to share information, to transfer knowledge, or to innovate cooperatively. Actually, IIN is "a basic institutional arrangement to cope with systemic innovation" (Freeman, 1991). The configurations of IIN include joint ventures, licensing arrangement, management contracts, sub-contracting, research associations, and other formal forms of international cooperation on innovation.

Another important issue about IIN is what the performance of IIN is and how to measure it. The most important performance of IIN is amount of knowledge learned from partners, so some researchers in social network area used learning achieved (Kale et al., 2000), knowledge sharing each other (Tsai, 2002), or the receipt of useful knowledge (Levin and Cross, 2004) to measure the performance. In the meanwhile, more researchers measured the performance of innovation network by innovation output or innovation success. For example, Owen-Smith and Powell (2004) and Salman and Saives (2005) used the number of patent or license owned by focal firm, Ahuja (2000) used the number of successful patent applications, and Tsai (2001) used the number of new products introduced to test empirically the relationship between some properties of innovation network and its performance. Combined these two different measures, the performance of focal firm within IIN in this study comprises both of them: the amount of knowledge gained from partners and its innovation output. In our opinion, this definition of performance would reflect the goal of IIN more appropriately.

3 Mechanism of IIN

Most explanations of effective knowledge transfer and advantageous performance of innovation network in the area of social network focus on some main properties of it. In addition, knowledge management literatures also contribute ideas about the properties of knowledge and the mechanism of knowledge transfer between senders and recipients. Relevant empirical studies from these areas are briefly highlighted in the table 1, which summarized the constructs used in each research study classified by properties of network, level of analysis, and the main findings.

The table indicates that though the points of view of scholars have not reached consensus entirely, researchers tried to find how the properties of network impact the performance. Among these properties, we can identify and integrate three of them to which researchers paid main attention, i.e., network structure, network relationship, and network position. They impact substantially the extent to which the firms get knowledge from partners within IIN, or the success of innovations.

3.1 Network structure

In prior studies, many researchers confirmed that network structure influence the knowledge transfer and the performance of innovation among the network. For example, Gilsing and Nooteboom (2005) argued that exploration networks require density of ties to improve the competence for innovation and governance of relational risk. As they pointed out, the classical features of network structure are network size, stability, and density (number of direct ties in relation to total possible number of direct ties). In their research of evaluating the potential of a work group, Reagans et al. (2004) found "two social network variables – internal density and external range have a positive effect on a team's performance". It is also be true in the individual level that network structure would be positively associated with the ease of knowledge transfer among the innovation network (Reagans and McEvily, 2003).

We integrate these studies about effects of network structure on focal firm's performance by focusing on the importance of two main components of network structure – network range and density of ties.

Range

Network range refers to the extent to which network connections span institutional, organizational, or social boundaries (Reagans and McEvily, 2003). Thus, there are two main features of network range: size and diversity of members. Firstly, concerning the size of network, there are very few studies tested its effects on the performance of IIN. As Bianchi and Bellini (1991) argued, when the number of entrants is rapidly increasing, the transaction-cost advantages based on common language and reciprocal reliability fall down. However, enough number of members in network is the basis of communication and knowledge transfer. With the abundant partners, the focal firm can assess the value of relevant knowledge residing at different points in the network, can learn more from various organizations and exploit more resources that are made available through the network relationship, and eventually, can successfully promote the level of innovation and performance.

Secondly, network diversity is a core consideration for reasons of communication and innovations. The value of

Table 1 Summary of construct used in recent empirical researches on innovation network

Authors	Network Structure	Network Relationship	Network Position	Level of Analysis	Main Findings
Ahuja (2000)	Structural holes	Indirect ties, Direct ties		Interfirm	Direct and indirect ties both have a positive impact on innovation but the impact of indirect ties is moderated by direct ties. Increasing structural holes has a negative effect on innovation.
Bell (1999)			Centrality	Interfirm	Locating centrality in the managerial tie network enhances firm innovation, while centrality in the institution tie network does not.
Cummings (2004)	Structural diversity			Interfirm	The value of external knowledge sharing increase when work groups are more structurally diverse.
Cummings and Teng (2003)		Norm distance		Interfirm	Transfer success decreases as norm distance between source and recipient increases.
Gilsing and Nooteboom (2005)	Density of ties, Scope	Stability, Duration, Frequency of interaction, Control, Trust/openness	Centralization	Interfirm	The effect of density and strength of ties on knowledge transfer is moderated by the type of knowledge
Hansen (1999)		Tie weakness		Interunit	Weak ties help search for useful knowledge but impede the transfer of complex knowledge, which tends to require a strong tie.
Levin and Cross (2004)		Tie strength		Interindividual	The link between strong ties and receipt of useful knowledge was mediated by trust. Once trust is controlled, the structural benefit of weak ties emerged.
Manev and Stevenson (2001)		Cultural distance		Interindividual	Mangers establish and maintain strong expressive ties with peers who come from similar cultures.
Obstfeld (2002)	Structural holes			Interindividual	The small the number of structural holes, the greater innovation involvement.
Owen-Smith and Powell (2004)			Centrality	Interfirm	Centrality will positively effect innovation.
Powell et al. (1996)		Diversity of ties	Centrality	Interfirm	The greater the diversity of ties, the more centrally connected the firm becomes. The greater centrality, the more rapid firm's growth.
Reagans and McEvily (2003)	Network range	Tie strength, Social cohesion		Interindividual	It is easier to transfer all kinds of knowledge in a strong tie and more difficult to transfer all kinds of knowledge in a weak tie.
Reagans et al., 2004	External range	Internal density		Interunit	Both of Internal density and external range have positive effect on a team's performance
Salman and Saives (2005)			Centrality	Interfirm	By occupying a central position in a network, a firm is more likely to access useful knowledge.
Simonin (1999)		Cultural distance		Interfirm	Cultural distance is positively related to ambiguity, which is negatively related to knowledge transfer.
Singh (2005)		Indirect ties, Direct ties		Interindividual	The existence of a tie is found to be associated with a greater probability of knowledge flow.
Tsai (2001)			Centrality	Interunit	Units can produce more innovations and enjoy better performance if they occupy central network positions.
Uzzi (1996)		Embedded ties, Arm's-length ties		Interfirm	Organizations tied to network partners by embedded, as opposed to arm's-length, ties increase their probability of survival.
Uzzi and Lancaster (2003)		Embedded ties, Arm's-length ties		Interindividual	Arm's-length ties promote the transfer of public information, while embedded ties are suited for the transfer of private information.
Walker et al. (1997)	Structural holes			Interfirm	The more relationship a firm forms, the more likely its social capital will increase.

external knowledge sharing increases when network members are more structurally diverse. "A structurally diverse network is one in which members, by virtue of their different organizational affiliations, roles, or positions, can expose the partners within IIN to unique sources of knowledge" (Cummings, 2004). According to the innovation theory, end-

users, manufacturers, research organization, even competitors should be the sources of innovation, especially under the situation of turbulent market and rapid change technologies. In the meanwhile, in the context of globalization, the partners which have different experiences and heterogeneous characteristics will bring new and fresh ideas and the knowledge of the market they reside in. This will be particularly useful to firms that want to enter a new market abroad. In sum, "the greater range associated with diversity enhances the focal firm's capacity for learning and creative problem solving" (Reagans and McEvily, 2003; Reagans et al., 2004). Therefore, we can conclude that network range is positively related with the performance of focal firm within IIN.

Density

Network density refers to the number of direct ties established by focal firm in relation to total possible number of direct ties (Gilsing and Nooteboom, 2005). With affluent direct ties connected to the partners, the focal firm can establish stable relationship and cultivate mutual trust within partners. This stable relationship and mutual trust is very useful, according to the knowledge management theory, to share standard or routines, and to exchange know-how or tacit knowledge.

This argument is consistent with the latest researches on the structural holes theory (Ahuja, 2000). Structural holes are gaps in information flows between partners within network, or disconnections between a firm's partners. On the early stage of research on structural holes, the Burt (1992), who put forward this concept firstly, argued "that structural holes present opportunities for brokering information flows among the firms. A structural hole indicates that the people on either side of the hole have access to different flows of information". So, maximizing the structural holes spanned or minimizing redundancy between partners is an important aspect of constructing an efficient, information-rich network. However, some recent research indicated that dense networks of shared understanding are the basis of success knowledge transfer that leads to innovation (Obstfeld, 2002). Drawing on a longitudinal study of firms in the international chemicals industry, Ahuja (2000) found that in the interfirm collaboration network increasing structural holes has a negative effect on innovation, while "the impact of indirect ties on knowledge transfer is moderated by the number of a firm's direct ties". It is clear that direct ties among the partners provide more resource-sharing and information-spillover benefits than indirect ties do. In addition, dense ties between partners can foster the development of knowledge-sharing routines (Uzzi, 1991; Walker et al., 1997), and can also provide more possibilities to find new opportunities. Therefore, we can conclude that network density is positively related with the performance of focal firm within IIN.

3.2 Network relationship

There are three dimensions of network relationship which can be clarified according to the previous studies to specify its effects on knowledge transfer: tie strength, duration and norm distance. Tie strength means the frequency of interaction (Gilsing and Nooteboom, 2005), and the extent of confidence and reciprocity between partners (Granovetter, 1983); duration measures the stability of network relationship (Dhanaraj and Parkhe, 2006); whereas norm distance indicates the comparability between partners on work routines or value systems.

Tie strength

There is a long-term debate in the social network research about the different role of weak ties, or arm's-length ties and strong ties, or embedded ties in knowledge transfer. Compared with strong tie networks, the weak tie networks have members with whom there are few interactions over time, a lower emotional intensity, a lower level of confidence and little reciprocity (Granovetter, 1983). One stream of researches argued that weak ties are more efficient in knowledge transfer because the cost of setting up and maintaining ties increases with the strength of ties (Burt, 1992). In addition, strong ties can lead to reduced variety and tend to be poor sources of new ideas and ways of learning. The other stream, contrarily, contended that strong ties are more accessible and willing to be helpful (Krackhardt, 1992), and so strong ties lead to greater knowledge exchange (Levin and Cross, 2004).

Following this ambiguous condition, the subsequent researches adopted a contingent approach (Ahuja, 2000). That means, in the different environment weak ties and strong ties would act respectively as main channels for learning and knowledge transfer. For example, Uzzi and Lancaster (2003), Hansen (1999) and Gilsing and Nooteboom (2005) argue that weak ties promote the transfer of public information or simple knowledge from a wide range of actors, while strong ties are suited for the transfer of private information or complex knowledge. The reason of that is because weak ties require little investment in time or mutual obligation. "Weak ties enable actors to economically maintain many ties to other actors" (Uzzi and Lancaster, 2003). So, when time and other resources are limited, the importance of weak ties would emerge. Further more, Uzzi (1997) found empirically that network which integrate both weak and strong ties "optimize an organization's performance potential; network structures comprising only weak ties or strong ties decrease organizational performance potential"[1].

This view is furthered by Reagans and McEvily (2003). According their empirical research, they concluded that it is easier to transfer all kinds of knowledge in a strong tie and more difficult to transfer all kinds of knowledge in a weak tie. However, tacit knowledge (complex and noncodified) was more difficult to transfer than explicit knowledge (simple and codified), so strong ties are more efficient on transferring tacit knowledge while weak ties on explicit knowledge.

Although the empirical evidence about the tie strength is various, the consensus is that to establish and maintain the

[1] Actually, Uzzi (1997) used the term of arm's-length tie and embedded tie here. In our study, we consider that the meaning is same between arm's-length tie and weak tie, as well as embedded tie and strong tie. For more information, see Uzzi and Lancaster (2003).

strong ties with partners need more efforts and more cost than that for weak ties. If taking this cost for account, the conclusions of previous studies would be consistent: the strong tie does play more important role in transfer knowledge between partners, but it is not efficient to transfer codified knowledge when we consider the high cost to maintain it. However, on one hand, according to our definition of IIN, international innovation network is a kind of formal and persistent relations, so number of members within the IIN is not very large. On the other hand, trust is crucial for innovation and successful relationship (Levin and Cross, 2004), and strong ties are necessary for this to be achieved. Actually, the focal firm should be beneficial from formal partners within IIN through strong ties to get much codified and nocodified knowledge, while it should be beneficial from informal partners outside the IIN through weak ties, as Uzzi (1997) suggested, enlarging the width of search for information. Therefore, in this study, the conclusion is that tie strength is positively related with the performance of focal firm within IIN.

Duration

Duration refers to the stability of the network relationship. The long-term interaction between partners is conducive to foster the trust and common norm or routine within IIN, which, in turn, can enhance the transfer of knowledge, especially for tacit knowledge. Hence, the critical task for focal firm within IIN is to promote network stability (Kenis and Knoke, 2002). Conversely, instability would significantly impair innovation output of IIN (Lorenzoni and Lipparini, 1999). A recent research indicates that a stable network reinforces relationships among network members. Thereby, the higher level of network stability is helpful to focal firm's acquirement of knowledge and produces greater network innovation output (Dhanaraj and Parkhe, 2006). Consistent with these findings, therefore, we can draw the conclusion that duration is positively related with the performance of focal firm within IIN.

Norm distance

Norm distance refers to the extent to which partners within IIN share same organizational culture, value systems (Cummings and Teng, 2003), or common language.

It is acceptable widely that the distance and difference in organizational culture and norm between partners is an important barrier of effective interfirm knowledge transfer (Mowery et al., 1996), especially when knowledge transfers internationally. The reason is that facing the different societal value system of foreign partners, focal firm has to pay more attention or allocate more resources to communication, design common standard or work routines, and develop common managerial approaches. Lyles and Salk (1996) provided some empirical evidence in their study that the cultural conflicts and misunderstandings can impede knowledge transfer between international partners or "minimize flows of information and learning" (Lyles and Salk, 1996). Simonin (1999) put forward the mechanism between cultural distance and knowledge transfer, i.e., cultural distance would enhance the ambiguity of knowledge transferred, and it would in turn weaken the knowledge transfer between partners.

In contrary, common norm would improve the transfer of knowledge between partners. Manev and Stevenson (2001) found in their empirical study that when cultural distance is small, the strong ties between partners will be developed. As forementioned, this would eventually increase the success of knowledge transfer. Thus, focal firm desiring to learn from partners should overcome cultural differences and establish common norms with its partners. Because the common norms "not only provide predictability and understanding between the parties, but also ensure that a common approach will be adopted in the transfer process" (Cummings and Teng, 2003). Summarizing these findings, therefore, a conclusion we can draw is that norm distance is negatively related with the performance of focal firm within IIN.

3.3 Network position

Firms which possess different network positions would have different opportunities "to access new information and knowledge that is critical to developing new innovative ideas" (Tsai, 2001). Network Position refers to the pattern of relationships which describe the location relative to other members in the IIN. In the social network analysis, the firm's network position affects its ability to access external information and knowledge, to recognize and respond to new market opportunities, and to share the resource with the partners. Thus, network position of a firm could be considered as one of its intangible strategic resources (Salman and Saives, 2005). Furthermore, the innovation benefits are only achieved by those organizations that are centrally positioned in a network (Owen-Smith and Powell, 2004).

Centrality

A wide accepted method that attempts to describe and measure properties of firm location in a network is centrality. Centrality measures the involvement in the network (Bell, 2005), and describes "the extent to which the focal firm occupies a strategic position in the network by virtue of being involved in many significant ties" (Salman and Saives, 2005).

According to the previous studies, the more central the firm is in the innovation network, the more innovations it produces (Powell et al., 1996; Tsai, 2001). Actually, first of all, focal firm can obtain more information timely and understand the latest change of technology. "Centrality in a network facilitates common understandings and shared principles of cooperation between the partners, thus enhancing further exchange" (Powell et al., 1996). In the meanwhile, as Salman and Saives (2005) contended that a firm's centrality within a network is positively related to the likelihood of it gaining access to complementary knowledge. Moreover, centrality would also be helpful to compare information across sources and assess its veracity (Bell, 2005). Finally, firm occupying a central position in the IIN is less likely to miss vital information, as multiple information sources provide multiple channels to discover new information.

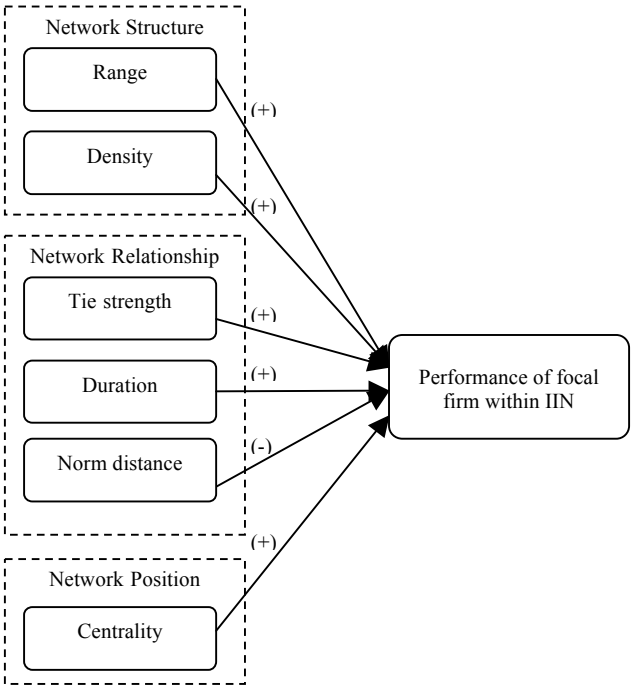

Figure 1 Integrative model of IIN

In addition, centrality shapes a firm's reputation (Powell et al., 1996), which enhances the firm's ability to access to resources of various partners. This, in return, would improve the especial opportunities for focal firm to learn tacit knowledge. Following the analysis mentioned above, therefore, the conclusion is that centrality is positively related with the performance of focal firm within IIN.

4 The Integrative Model

According to the discussion above, the integrative model in this study which describes the properties of international innovation network which impact the performance of focal firm and the mechanism how they do this is shown in Figure 1. As shown in Figure 1, network structure impacts the performance of focal firm within IIN by the factors of range and density of network; network relationship influences the performance through factors tie strength, duration, and norm distance; while network position affects the performance by the factor of centrality.

Under the context of international innovation network, therefore, in order to gain more useful knowledge from partners within network and improve its innovation output, the efforts focal firm can make include: (1) enlarge the range of cooperation globally, include direct or indirect connection; (2) increase the number of direct ties with partners; (3) enhance the frequency of interaction and reciprocity between partners; (4) improve the stability of network relationship; (5)establish common norms with its partners; or (6) occupy a central position in the network. According to these principles, the position of focal firm in network (a), described in Figure 2, is peripheral. It looks like that the center of network is firm 1, and most information would be exchanged through firm 1. In the network (b), though focal firm occupies a centre position, there are some structural holes between focal firm and its partners. The best pattern of network is (c), because focal firm has not only established affluent and close relationship with its partner, but located itself in the centre of network.

5 Conclusion and Future Research

The increased attention has been focus on the role and importance of innovation network on firm's innovation and competitive advantage in recent years. Although previous research has shown that the firm performance benefits of innovation network, further attention is needed to understand how the properties of network shape the performance of focal firm within IIN. This study find that the structure of network focal firm involved in, the relationship with partners, and the position focal firm occupy would influence the amount of

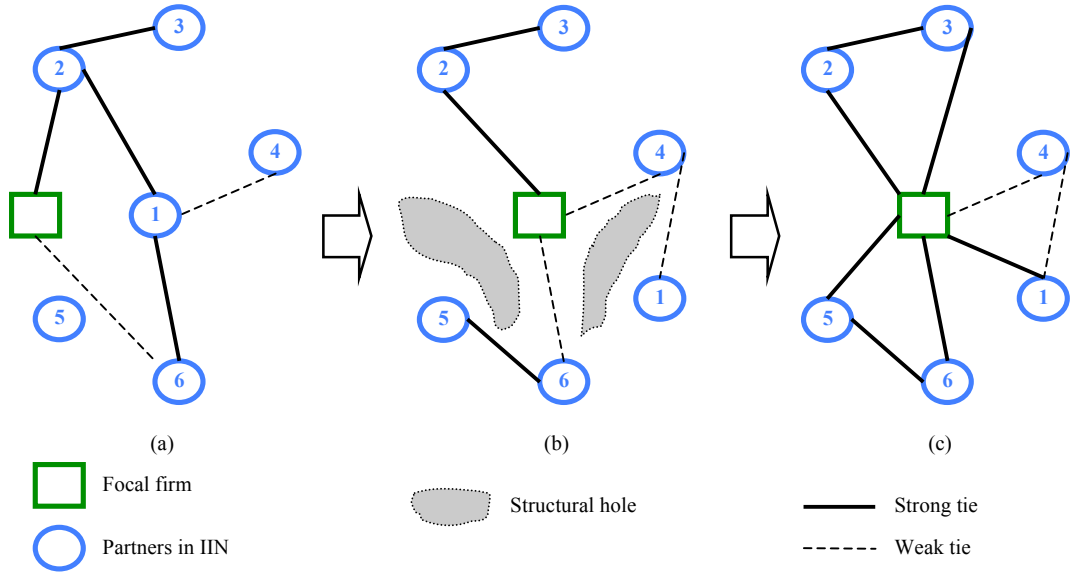

Figure 2 International Innovation Network

knowledge gained from partners and the level of innovation success. And an integrative model is come up with in this study. For one thing, this model has integrated the results of prior studies and identified six factors impacting the performance, which is useful for scholars in this area to further research; for another, this model provides some suggestion about efforts firms can make, which is helpful for practitioners in global market to improve benefits from networks.

Obviously, firms in the global market are not able to decide whether to have relationships or not and whether to care about them; the only choice for firms is how to cope with them effectively and efficiently (Ritter et al., 2002). To face environment changing rapidly, firms try to take some proactive approaches to establish collaborative relationships or innovation networks and, more important, to maintain and manage these relationships successfully. It needs some special capabilities. From the perspective of strategy management, the purpose of these capabilities is to build an appropriate network structure, to mobilize and maintain the effective relationships, and to occupy a good network position, eventually, to gain competitive advantage. One of our next researches is to understand what these capabilities are and the mechanism how these capabilities impact the level of knowledge transfer and innovation output within IIN. Furthermore, we will also try to find where these capabilities come from and how to foster them. These are all next task.

References

[1] Ahuja, G., 2000. "Collaboration networks, structural holes, and innovation: a longitudinal study". *Administrative Science Quarterly*, 45, pp. 425-455

[2] Bell, G. G., 2005. "Clusters, networks, and firm innovativeness". *Strategic Management Journal*, 26, pp. 287-295

[3] Bianchi, P., and Bellini, N., 1991. "Public policies for local networks of innovators". *Research Policy*, 20(5), pp. 487-497

[4] Bleeke, J., and Ernst, D., 1991. "The way to win in cross-border alliances". *Harvard Business Review*, 69(6), pp. 127-135

[5] Burt, R. S., 1992. "Structural holes: the social structure of competition". Cambridge, MA: Harvard University Press

[6] Cummings, J. N., 2004. "Work groups, structural diversity, and knowledge sharing in a global organization". *Management Science*, Vol. 50, No. 3, pp. 352-364

[7] Cummings, J. L., and Teng, B., 2003. "Transferring R&D knowledge: the key factors affecting knowledge transfer success". *Journal of Engineering and Technology Management*, 20, pp. 39-68

[8] DeBresson, C., and Amesse, F., 1991. "Networks of innovators: a review and introduction to the issue". *Research Policy*, 20, pp. 363-379

[9] Dhanaraj, C., and Parkhe, A., 2006. "Orchestrating innovation networks". *Academy of Management Review*, Vol. 31, No. 3, pp. 659-669

[10] Freeman, C., 1991. "Networks of innovators: a synthesis of research issues". *Research Policy*, 20, pp. 499-514

[11] Gilsing, V., and Nooteboom, B., 2005. "Density and strength of ties in innovation networks: an analysis of multimedia and biotechnology". *European Management Review*, 2, pp. 179-197

[12] Granovetter, M. S., 1983. "The strength of weak ties: a network theory revisited". *Sociological Theory*, 1, pp. 201-233

[13] Hansen, M. T., 1999. "The search-transfer problem: the role of weak ties in sharing knowledge across organization subunits". *Administrative Science Quarterly*, 44, pp. 82-111

[14] Kale, P., Singh, H., and Perlmutter, H., 2000. "Learning and protection of proprietary assets in strategic alliances: building relational capital". *Strategic Management Journal*, 21, pp. 217-237

[15] Kenis, P., and Knoke, D., 2002. "How organizational field networks shape interorganizational tie-formation rates". *Academy of Management Review*, 27, pp. 275-293

[16] Krackhardt, D., 1992. "The strength of strong ties: the importance of philos in organizations". N. Nohria, R. Eccles, eds. *Network and Organizations: Structure, Form and Action*. Harvard Business School Press, MA, pp. 216-239

[17] Levin, D. Z., and Cross, R., 2004. "The strength of weak ties you can trust: the mediating role of trust in effective knowledge transfer". *Management Science*, Vol. 50, No. 11, November, pp. 1477-1490

[18] Lorenzoni, G., and Lipparini, A., 1999. "The leveraging of interfirm relationships as a distinctive organizational capability: a longitudinal study". *Strategic Management Journal*, 20, pp. 317-338

[19] Lyles, M. A., and Salk, J. E., 1996. "Knowledge acquisition from foreign parents in international joint ventures: an empirical examination in the Hungarian context". *Journal of International Business Studies*, Vol. 27, No. 5, pp. 877-903

[20] Manev, I. M., and Stevenson, W. B., 2001. "Nationality, cultural distance, and expatriate status: effects on the managerial network in a multinational enterprise". *Journal of International Business Studies*, 32, 2, pp. 285-303

[21] Mowery, D. C., Oxley, J., E., and Silverman, B. S., 1996. "Strategic alliance and interfirm knowledge transfer". *Strategic Management Journal*, Winter Special Issue, 17, pp. 77-91

[22] Obstfeld, D., 2002. "Knowledge creation, social networks and innovation: an integrative study". *Academy of Management Proceedings 2002 TIM*

[23] Owen-Simth J., and Powell, W. W., 2004. "Knowledge network as channels and conduits: the effects of spillovers in the Boston biotechnology community". *Organization Science*, Vol. 15, No. 1, Jan-Feb, pp. 5-21

[24] Powell, W. W., Koput, K. W., and Simth-Doerr L., 1996. "Interorganizational collaboration and the locus of innovation: networks of learning in biotechnology". *Administrative Science Quarterly*, 41, pp. 116-145

[25] Reagans, R. and McEvily, B., 2003. "Network structure and knowledge transfer: the effects of cohesion and range". *Administrative Science Quarterly*, 48, pp. 240-267

[26] Reagans, R., Zucherman, E., and McEvily, B., 2004. "How to make the team: social networks vs. demography as criteria for designing effective teams". *Administrative Science Quarterly*, 49, pp. 101-133

[27] Ritter, T., Wilkinson, I. F., and Johnston, W. J., 2002. "Measuring network competence: some international evidence". *Journal of Business & Industrial Marketing*, Vol. 17, No. 2/3, pp. 119-138

[28] Salman, N. and Saives, A. L., 2005. "Indirect networks: an intangible resource for biotechnology innovation". *R&D Management*, 35, 2, pp. 203-215

[29] Simonin, B. L., 1999. "Ambiguity and the process of knowledge transfer in strategic alliance". *Strategic Management Journal*, 20, pp. 595-623

[30] Singh, J., 2005. "Collaborative networks as determinants of knowledge diffusion patterns". *Management Science*, Vol. 51, No. 5, May, pp. 756-770

[31] Tsai, W., 2001. "Knowledge transfer in intraorganizational networks: effects of network position and absorptive capacity on business unit innovation and performance". *Academy of Management Journal*, 44, pp. 996-1004

[32] Tsai, W., 2002. "Social structure of coopetition within a multiunit organization: coordination, competition, and intraorganizational knowledge sharing". *Organization Science*, Vol. 13, No. 2, pp. 179-190

[33] Uzzi, B., 1997. "Social structure and competition in interfirm networks: the paradox of embeddedness". *Administrative Science Quarterly*, 42, pp. 35-67

[34] Uzzi, B., and Lancaster, R., 2003. "Relational embeddedness and learning: the case of bank loan managers and their clients". *Management Science*, Vol. 49, No. 4, April, pp. 383-399

[35] Van Aken, J.E., and Weggeman, M.P., 2000. “Managing learning in informal innovation networks: overcoming the Daphne-dilemma”. *R&D Management*, 30 (2), pp. 139-149

[36] Walker, G, Kogut, B., and Shan, W., 1997. “Social capital, structural holes and the formation of an industry network”. *Organization Science,* Vol. 8, No. 2, March-April, pp. 109-125