

Research Article

Research on Collective Learning Mechanism and Influencing Factors of Industrial Cluster Innovation Network

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Abstract: This study attempts to contribute to the cluster innovation literature by adding the collective learning perspective and propose an analytical framework on collective learning of cluster. Industrial cluster is viewed as a prevalent mode for technology innovation in knowledge-based economy. Collective learning outlines how local innovation network and spatial proximity between actors influence the sharing and creation of skills and knowledge in cluster. Firstly, this study discusses the structure and character of innovation network within industrial cluster. Secondly, it analyzes the collective learning mechanism of industrial cluster, which is involves in three dimensions: horizontal learning, vertical learning and multi-angle learning. Then, it focuses on some influencing factors of collective learning within innovation network. Finally, this study analyzes the role of global-local linkages in the dynamic capability of cluster innovation network.

Keywords: Collective learning, industrial cluster, innovation network, learning mechanism

INTRODUCTION

Industrial clusters are geographic concentrations of interconnected enterprises and institutions in a particular field (Porter, 1998). Industrial cluster have received renewed attention in recent years because clusters are today recognized as an important instrument for promoting knowledge creation and innovation. The ‘clusterisation’ of firms tends to trigger processes that create not only general dynamism and flexibility but also learning and innovation” (Doloreux and Parto, 2005). Firms based in local or regional agglomerations benefit from locating in clusters as they outperform those located outside these clusters in terms of innovation outcomes (McCann and Folta, 2008; Bell *et al.*, 2009). Innovation process is a learning process in nature. Although, the correlative researches have presented diverse explanations on cluster innovation process, an increasing number of studies have identified collective learning as one of the key drivers of innovative activity in clusters.

Collective learning outlines how local innovation network and spatial proximity between actors influence the sharing and creation of skills and knowledge in cluster innovation network. Collective learning is an interactive process of accumulating knowledge from different local resources (Owen-Smith and Powell, 2004). The process is underlined by geographical, socio-economic, organizational and cultural proximity between actors, which encourages mutual understanding and trust-building among cluster actors (Anja *et al.*, 2008). This study attempts to contribute to

this research gap by adding the collective learning perspective to the cluster innovation literature.

INDUSTRIAL CLUSTER AS AN INNOVATION NETWORK FOR COLLECTIVE LEARNING

Cluster as an innovation network: As for inter-organizational innovation networks, a large body literature on local and regional innovation systems has been studying geographically concentrated clusters. The academic interest in clusters innovation networks has given rise to a vast stream of works in recent years. Alfred Marshall introduced the concept of industrial atmosphere and described the district as a place where mysteries of the trade become no mysteries; but are as it were in the air and children learn many of them, unconsciously (Marshall, 1920). The notion, such as “Buzz” (Storper and Venables, 2004), “Local broadcasting” (Owen-Smith and Powell, 2002), is used to emphasize the local cluster network’s significance for innovation and knowledge transfer.

Organizational learning is a cumulative process, which involves knowledge acquisition, sharing, dissemination and application (Dimovski and Penger, 2004). Cluster milieu facilitates knowledge sharing and, thus, interactive learning and innovation. In cluster milieu, inter-firm relationship is closer and the space distance is relatively smaller. The local culture leads to more “common language” between the clustering firms, which reduce the culture distance. Moreover, the organizational distance is decreased owing to business communication based on subcontract or cooperation production relationships. Clusters might greatly foster

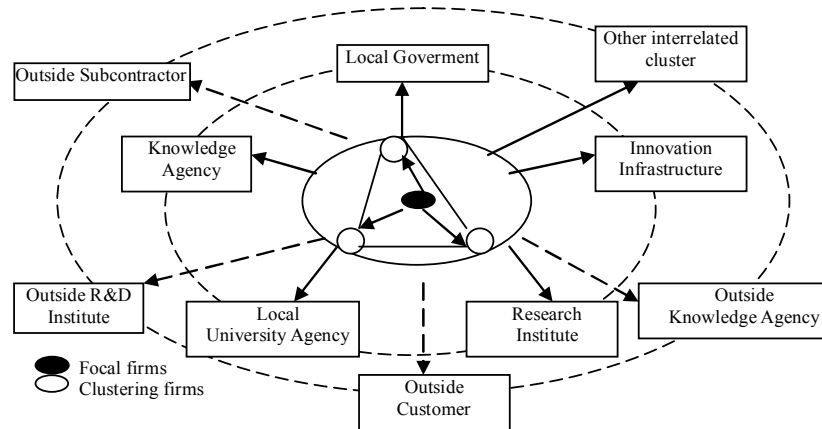


Fig. 1: The structure and elements of cluster innovation network

collective learning any time it involves a large share of tacit knowledge. Physical proximity among firms is considered to facilitate the emergence of interaction and the formation of interpersonal and firm networks leading to the genesis of complex collective learning mechanisms (Melachroinos and Spence, 2001; Storper and Venables, 2004).

The structure of cluster innovation network: The current research on innovation emphasizes the role of network in innovation process and performance. Industrial cluster is a type of network organization, which is different with market or bureaucracy organization. Clusters are characterized as networks of production of strongly interdependent firms (including specialized suppliers), knowledge producing agents (universities, research institutes, engineering companies), bridging institutions (brokers, consultants) and customers, linked to each other in a value-adding production chain (OECD, 1999).

As Fig. 1 shows that cluster innovation network is consisted of focal firms cluster firms (especially, SMEs) based on specialization division. The clustering firms are as the core part of cluster innovation network. The interconnected institutes (including local universities, research institutes, knowledge agency and etc.) are as assistant part of cluster innovation network. The outside knowledge resource (including outside R&D institutes, subcontractors, customers and etc.) is as for supplementary part of cluster innovation network. In cluster innovation, focal firms have a great influence on the learning process and innovation process of the cluster. Focal firms have a strong motivation to invest in R&D, which are able to develop and introduce radical innovation and incremental innovation. Owing to their outstanding advantage of technical resources and capacity, they improve and create new knowledge and excellence technology. Focal firms use external knowledge to a greater extent than other firms operating in the cluster, by leveraging on their intellectual and social capital, they can act as “technological gatekeepers” for the whole district, thus enhancing the

absorption of new information into the cluster and facilitating its internal dissemination (Alessandro *et al.*, 2007).

COLLECTIVE LEARNING MECHANISM WITHIN CLUSTER INNOVATION NETWORK

The collective learning maybe involves in three dimensions: horizontal learning, vertical learning and multi-angle learning.

Horizontal learning: Clustering firms located in the same link of value chain mostly belong to the same industry and provide similar production and service. In horizontal dimension, the relation of the firms is competition. The competition relations focus on the common raw material, labor force and production market. And the cooperation focuses on the creation of common market, the establishment and maintenance of common brand and so on. The learning process is involved in comparing, observing and imitating each other. Similar produce condition and “common language” benefit to the communication and knowledge transfer. Geographical proximity offers the firms the chance to observe and evaluate the innovation activities of others expediently and freely, which reduce the cognitive distance and enhance the absorptive capability of clustering firms.

Vertical learning: Vertical learning refers to the learning process of the firms located in different links of value chain. Forward interaction is involved in the learning between the provider and the consumer. Backward interaction is involved in the learning between the producer and the supplier. Because for complementary resources, the input-output relation is formed between these firms. The specialization division and the exchange of materiel and cooperation boost the creation of new knowledge.

The development process of new production is close related to the interaction with the users (Malmberg and Power, 2005). By keeping a close

contact with users, clustering firms can acquire market information timely. Especially, the rigorous users usually ask for the higher quality and higher reliability production, which contribute to the designing and improvement of production. The backward learning helps firms to acquire the complementary technology to upgrade their design and R&D capability. In industrial cluster, owing to long-term cooperation and high trust, the clients and the suppliers are able to communicate each other widely and freely, which benefit to the exchange of open information and the solve of common problem.

Multi-angle learning: Multi-angle learning refers to the interactive learning between firms with local government, university, public research institution and Intermediary organization. These institutions provide local firms with all kinds of services and infrastructure, which promote the cooperation, knowledge-sharing, information feedback. Especially as for the knowledge and technology infrastructure, university and public research institution not only create new idea, knowledge and technology but also perform the role in education, training and technology achievement transfer. On one hand, clustering firms can acquire the knowledge and high skilled worker through the institutions. On the other hand, clustering firms is better to focus on the cooperative innovation and technology development with the institutions.

INFLUENCING FACTORS OF CLUSTER COLLECTIVE LEARNING

Inter-firms trustiness degree: The influencing factors of knowledge transfer are mostly related to the motivation and dependability of knowledge holder and receiver (Szulanski, 2000). The more openness of the two parties in alliance is, the more knowledge both of cooperators will acquire (Kale *et al.*, 2000). So, in industrial cluster, the trust to each other is essential of knowledge transfer in localized learning process. As for knowledge holder, the worry of unfair revenue will reduce the dynamics to transfer knowledge. As for knowledge receiver, the dependability of knowledge holder will lead to the positive activities. When

knowledge headstream is undependable, the knowledge transfer becomes difficult.

Structure dimension: As Fig. 2 shows that we can analyze and explain the innovation advantage of cluster based on society capital theory. Society capital theory outlines and explains why industrial cluster benefit and accelerate innovation activity through two dimensions: structure dimension and relational dimension. Position, size, density and other variables in structure dimension have an important influence on clustering firms' learning ability. Likewise, Trust, norms, identity and other variables in relational dimension can enhance the clustering firms' learning ability. Clustering firms' learning ability includes knowledge acquirement ability, absorptive ability, integration ability and innovation ability. The advance and upgrade of above ability is relative to the innovation.

The structural dimension refers to the network structure's overall pattern of connections between actors (Nahapiet and Ghoshal, 1998), which can be measured by three indicators, the network centrality, the network size and the network openness. Positioning within a network is important because it can confer differential access to information (Burt, 1992). The firms located in the network center play a role in connecting network members, which are more likely to receive their support and more information resource (Sorenson, 2003). The location in cluster network has an important influence on learning capacity of clustering firms. The firms located in the "structure hole" has the advantage of knowledge acquisition, knowledge absorption and knowledge innovation. The larger cluster network size is, the more possibilities the cluster is able to acquire a wider range of knowledge sources and integration and absorb more knowledge. Within cluster innovation network, network centrality, network size and network openness is positive correlate with the organizational learning process.

Relational dimension: The relational dimension refers to the nature of the personal relationship that develops between specific people as manifested in "strong" versus "weak" ties (Powell *et al.*, 2005;

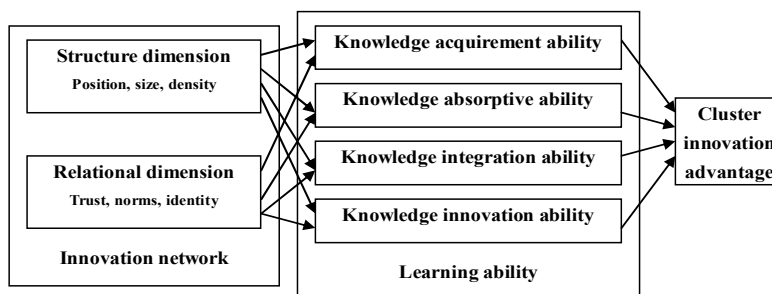


Fig. 2: The influencing factors of cluster collective learning

Whittington *et al.*, 2009). In cluster network, relationship dimension refers to the relationship based on long interactive process between individuals, which includes trust, norms, sanctions, obligations, expectations, identity and so on. Uzzi (1997) pointed out that the relationship network link has three features: trust, high-quality information exchange and joint problem-solving, which help with tacit knowledge transfer and organizational learning. Dyer and Kentaro (2000) think that the trust between the partners and relational capital can establish a unique path to knowledge sharing, which facilitate the organization-specific information communion and learning. Kale *et al.* (2000) affirms that relational capital is able to reduce the partner's opportunistic behavior and prevent the overflow of critical expertise, which help alliance companies' interactive learning.

Absorptive capability: The efficiency and performance of learning depend on the absorptive capability of enterprise. The primary influencing factors of absorptive capability is prior knowledge (basic skill and learning experience) and organizational management factors (such as: knowledge communion and sharing mechanism in organization) (Frans *et al.*, 2003). Except for prior knowledge, Jan *et al.* (2008) claimed that the investment in R&D, internal and external network linkages also have an important influence on absorptive capability of firms. The decrease of cognitive distance is able to advance the efficiency and performance of localized learning.

Compared to the firms outside the cluster, inter-firm relationship inside industrial cluster is closer and their space distance is relatively smaller. The business culture based on regional culture and local context leads to more "common language" between the clustering firms, which reduce the culture distance. Moreover, the organizational distance is decreased owing to business communication based on subcontract or cooperation production relationships. So, the absorptive capability of clustering firms is enhanced with the decrease of space distance, culture distance and organizational distance.

The role of focal firms: Lorenzoni and Baden-fuller (1995) define focal firms as strategic centre with superior co-ordination skills and the ability to steer change. Focal firms are companies that occupy strategically central positions because of the greater number and intensity of relationships that they have with both customers and suppliers (Lazerson and Lorenzoni, 1999). Focal firms are firms in a cluster that have-because of their size, market position, knowledge and entrepreneurial skills-the ability and incentive to make investments with positive externalities for other companies in the cluster (Nijdam and De Langen, 2003).

In the collective learning process, focal firms play an important role. Owing to their outstanding advantage

of technical resources and capacity, they improve and create new knowledge and excellence technology. They play a lead role in the cluster innovation network, generating new knowledge and technologies, attracting researchers, investments and research facilities, enhancing others firms R&D activities, stimulating demand for new knowledge and creating and capturing externalities. Their investments encourage innovation, enable internationalization of other firms in the cluster and improve the quality of the labor pool. In these ways, focal firms contribute to the competitiveness of other firms in the cluster and, as a consequence, the cluster as a whole.

Focal firms use external knowledge to a greater extent than other firms operating in the cluster, by leveraging on their intellectual and social capital, they can act as "technological gatekeepers" for the whole district, thus enhancing the absorption of new information into the cluster and facilitating its internal dissemination (Malipiero *et al.*, 2005).

GLOBAL-LOCAL INTERACTIVE LEARNING AND THE UPGRADE OF LOCAL INNOVATION NETWORK

The lock-in of localized innovation network: The performance of enterprise innovation is related to not only the local linkages within cluster but also the external linkages (Martha *et al.*, 2010). Too much proximity leads to a lack of openness and flexibility with negative impacts on learning and innovation. That too weak a cognitive distance may appear as a handicap when there is not a sufficient amount of variety introduced into the networks of innovative firms. In that case, clusters may thus come to be locked in an under-competitiveness syndrome as a result of an excess of conformism (Boschma, 2005). Levitt and March (1996) have described this as the 'competency trap'. It may be difficult to unlearn habits or routines that have been successful in the past, but which have become redundant over time.

Innovation Lock-in is resulted from firm's excessive reliance on the local knowledge networks and innovation resources. Learning and knowledge spillovers mechanism based on trust and informal nature of networks ties enable it easy and free that acquiring knowledge and technology by observing, comparing and imitating in local networks. However, knowledge flows through external linkage are not automatic and participation is not free. So, most clustering enterprises might select an "inward looking" innovation strategy. As a "rational economic man", firm would rather become the "free-rider" for innovative products than make independent innovation in cluster circumstance (Hubert, 1999). When clustering firms become too much inward looking, their learning ability may be weakened to such an extent that they lose their innovative capacity and are unable to respond to new developments.

Specially, when the technology development trajectory and global economic conditions change, the excessive inward-looking may become a main obstacle for clusters to enhance learning and innovation capacity.

Global pipelines and the acquiring of new knowledge: While a large number of studies have emphasized the importance of local innovation network, there is growing awareness that being connected to extra-local knowledge networks is a key to upgrade the innovation capability of clusters (Mark and Tallman, 2010). The openness of cluster relations and active search for large external markets is therefore the key in understanding the rise of successful clusters. Open networks can also offer updated insights about the components of a renovated competitiveness of local innovation systems. That attempts to consciously open network relations for the influx of external information, as well as maintaining a certain amount of distrust with respect to traditional solutions, is important to avoid lock-in.

Bathelt *et al.* (2004) uses the concept of “global pipelines” to refer to the channel used in global linkages. The more developed the pipelines that ‘pump’ information and news about markets and technologies into the local milieu are the more dynamic the buzz from which local actors benefit. Because of their potential to intensify local interaction, global pipelines strengthen the internal selection and translation processes in the local milieu.

Reaping the benefits of both the local innovation network and globalized network: Localized collective learning and globalized learning play different roles in the innovation and knowledge creation of industrial clusters. Localized learning can provide clustering enterprises with a free and efficient knowledge sharing platform, even localized learning might make up the lack of R&D within clusters. Globalized learning supplies local cluster with a large number of new innovative knowledge and technology. Especially for high-tech industry, cutting-edge knowledge is changing, improved products and process is evolving and upgrading. Which make it possible that clustering firms compare different technological options and choose the more suitable path in diverse circumstance? The aim of building global knowledge linkage for clustering firms is not only to exchange goods and services, but also access to external knowledge resources so as to upgrade local innovation resources.

Both localized collective learning and globalized learning offer particular, albeit different, advantages for the innovation and knowledge creation. So, it is better that reaping the benefits of localized learning and globalized learning at the same time. In other words, global linkages and local linkages should be all established and developed so as to upgrade the dynamic capability of industrial cluster.

CONCLUSION

This study discusses the collective learning mechanism and analyzes influencing factors of collective learning within cluster innovation network. It discusses and seeks the path to upgrade the innovation capability of cluster network. This study makes several conclusions as followed:

- Localized learning process is based on specialization division and local milieu, which greatly fosters innovation any time it involves a large share of knowledge, especially for tacit knowledge.
- The collective learning involves in three dimensions: vertical learning, horizontal learning and multi-angle learning.
- Some factors have an important influence on collective learning, which involved in inter-firms trustness degree, structure dimension, relational dimension, absorptive capability and leader firm’s role.
- Performance of clustering enterprise innovation is related to not only the local linkages within cluster but also the external linkages. Global and local linkages offer particular, albeit different, advantages for the innovation and knowledge creation within industrial clusters.

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