

Sun Wei¹

DYNAMIC ANALYSIS OF CLUSTER-BASED TECHNOLOGICAL INNOVATION

The article provides the definition of cluster-based technological innovation (CBTI). Industrial cluster is a rational form of industrial organization and an effective way of spatial competition. It can achieve scale economy at the industrial level and also has very strong technological innovation capabilities and advantages. CBTI is an innovative paradigm based on the capacity in technological innovation management, that is the demand for developing and deepening of international division, it is encouraged by pressure from technological innovation, that is the result of stratification and competition, and that is the requirements for forming core competence.

Keywords: industrial cluster; technological innovation; dynamic mechanism; core competence

JEL: L16, O32, R12.

Сунь Вей

ДИНАМІЧНИЙ АНАЛІЗ ТЕХНОЛОГІЧНОЇ ІННОВАЦІЇ НА ОСНОВІ КЛАСТЕРУ

У статті дано визначення технологічної інновації на основі кластеру. Індустріальний кластер — це раціональна форма організації промислового виробництва та ефективний засіб просторової конкуренції. Ефект масштабу в індустріальному кластері досягається завдяки здатності до технологічної інновації. Технологічна інновація на основі кластеру — це інноваційна парадигма на основі управління технологічними інноваціями, що є необхідним для розвитку та поглиблення міжнародного поділу праці. З одного боку, технологічна інновація — це результат стратифікації праці та конкуренції, з іншого — це передумова формування ключових компетенцій.

Ключові слова: індустріальний кластер; технологічна інновація; динамічний механізм; ключова компетенція.

Літ. 10.

Сунь Вэй

ДИНАМИЧЕСКИЙ АНАЛИЗ ТЕХНОЛОГИЧЕСКОЙ ИННОВАЦИИ НА ОСНОВЕ КЛАСТЕРА

В статье дано определение технологической инновации на основе кластера. Индустриальный кластер — это рациональная форма организации промышленного производства и эффективное средство пространственной конкуренции. Эффект масштаба в индустриальном кластере достигается благодаря способности к технологической инновации. Технологическая инновация на основе кластера — это инновационная парадигма, основанная на управлении технологическими инновациями, что является необходимым для развития и углубления международного разделения труда. С одной стороны, технологическая инновация — это результат стратификации труда и конкуренции, с другой — это требование для формирования ключевых компетенций.

Ключевые слова: индустриальный кластер, технологическая инновация, динамический механизм, ключевая компетенция.

¹ Doctor of Management Science, Professor, School of Economics & Management, Harbin Engineering University, China.

Introduction. During the industrialization process, the evolution of industrial organization basically follows the path of vertical integration, concentration and specialization, conglomeration and diversification. Between pure market organization and bureaucratic organization, there are many different kinds of hybrid organizations, the existence of which is endogenously determined by the organization itself from the perspective of the efficiency or viability. Industrial cluster, developed in industrialization and scientific-technological progress, is such a hybrid organization. It is a vertical division, horizontal competition and flexible specialization network, which is formed by space adjacent, independent and correlative companies around value-added chain. In the process of industrial structure supererogation, industrial cluster is a rational form of industrial organization. It can not only integrate scale economy of large enterprises with competitive vitality of small and medium-sized enterprises (SMEs), but also avoid x-inefficiency at large enterprises. Exploiting the advantages of large enterprises and SMEs in technological innovation is conducive to the formation and strengthening of regional innovation system. Industrial cluster has the following characteristics: external economics [1], generalized reciprocity [2], flexible specialization [3], competitiveness [4] etc.

The relationship between industrial cluster and technological innovation. High-tech innovation has increased the proportion of advanced and complex technologies, and has also expanded the applications of every technology horizontally. The faster the technological progress is, the quicker the vertical extension and the technological level transdifferentiation are. It's very hard to attempt to hold advantage in all fields and to master all the new technologies. In the process of complicating and upgrading a technology, only through reducing business scope and integrating the forces, enterprises ensure the advantages in the major business fields. SMEs in industrial cluster supplying components or service for large enterprises, become specialized production, sales and services enterprises, or research technology in some fields through matching with large enterprises, or develop high-tech products to which large enterprises don't attach importance to make up with its omissions. SMEs play an indispensable role in the high-tech field, and it is hard for large enterprises to take place of it. High-tech technology has the characteristics of extraordinarily complication and high level intellectual density, and the application of it has improved interdependence among the technologies of all the industry. Enterprises at different technological levels and industries will unite together and interact as the technological source and technical application object, work together and form the reproduction system that adapt to technology comprehensive development.

Industrial cluster is the spatial concentrated distribution of enterprises within the same industry, a higher degree related enterprises and supporting institutions in other industries (horizontal industrial cluster); and/or is the set formed by the existence of upstream and downstream relationship between independent and different industrial sectors (vertical industrial cluster) [5]. Industrial cluster is an effective way of spatial competition that can achieve scale economy at the industrial level, and that has very strong technological innovation capabilities and advantages. Combining industrial cluster with technological innovation, a cluster-based technological innovation is formed. It can effectively overcome the deficiencies of single enterprise in resources and capacities, give full play to advantages of an industrial cluster, and enhance the

effect of technological innovation. So-called CBTI is the "industrial cluster plus technological innovation", i.e. enterprises or institutions in the same industry or related ones consciously gather together in space, and form a new model of technological innovation based on deep specialized division and hierarchical competition. This is a new innovative paradigm based on the capacity in technological innovation management.

Dynamic mechanism of cluster-based technological innovation.

1. Demand for developing and deepening of international division. In the current trends of economic globalization and integration, international division is predominated by horizontal division and is deepened day by day. Now enterprises in developed countries conduct horizontal division and collaboration in industries, enterprises as well as on the production line, to play their own advantages of technology, and use others' advantages from specialization of product to component and then to technological process. The areas and scopes of division have become much wider, as each production process has been extended to several or dozen countries. The more developed the international division is, the wider interdependence and cooperation among enterprises from different countries are. The more it refined the division, the more requirements of the related enterprises to maintain the technological leading exist. The development of specification makes decentralized production of components focus, makes the use of special technology possible, and makes an opportunity and space for SMEs to improve its specialized technical level objectively and expand enterprise scale in connotation.

The development of SMEs characterized by deep specialized division, has laid foundations for large enterprises to focus on developing key technologies [6]; while large enterprises promote the improvement of management level and technical level of SMEs by giving collaborated enterprises support of technology, fund and business. Large enterprises can't survive without products and sales provided by SMEs, and should pay special attention to the function of specification and coordination played by SMEs in the economy. Establishing interdependent industrial cluster between large enterprises and SMEs, and forming industrial structure that takes large enterprises as the core and specified SMEs as the foundation, that are conducive to promoting the division and collaboration, scale economy and technological innovation among enterprises in different sizes. Industrial cluster is an organization formed basing on the division and collaboration. CBTI can make sure that every enterprise in cluster keeps technological advantages in procedure and technological process, so that it can keep pace with the diversity of market demand, realize the pluralism of technology, product and channel, and survive and develop in a rapidly changing market environment.

2. Pressure from technological innovation. It has been the time for enterprises to compete in high-tech. With the increasingly rapid spread of technological innovations, enterprises have to continue innovating and exploring new areas, while making full use of and improving existing core technologies. Fierce changes in the external environment put forward 3 basic requirements for enterprise R&D: shortening its time continuously, lowering its cost, dispersing its risk. CBTI can solve these problems effectively.

1) CBTI is beneficial to shorten the time of product innovation. The completion of a new complex high-tech product involves more and more science and technology

fields, and gets through more and more production processes. From design, trial and preparation of related equipment and so on, it is difficult to complete it separately for any enterprise in a short time. An enterprise can't have technological advantages in each technical field involving major technological innovation activities at the same time. And fierce competition in the development of new technology and new product don't allow it to take such a long time to cultivate technical force, which is involved in the activities of technological innovation and also at its relatively weak fields. So it is necessary to cooperate with other enterprises which have special technological advantages. In the form of industrial cluster, there are large numbers of enterprises joining. It is good to shorten the developing time to make each enterprise play a unique competitive advantage in what they do best.

2) CBTI is beneficial to lower the cost of R&D. It is hard to burden daily increasing development costs only by a sole enterprise, so it should be shared by organizations. In the developing activities of a high-tech project, a variety of high-tech becomes mutual integration and intersection. High-tech product is developing towards a comprehensive direction. It is difficult to have enough technological innovation resources to develop every high-tech product for a sole enterprise. When product technology increasingly diversifies today, no enterprise is able to monopoly a technology for a long time. Enterprises hope to master the initiative on their own, which is becoming increasingly difficult. It needs the same industry and even cross-industry collaboration to obtain complementary technology. Using advantages of enterprise complementary technologies in industrial cluster to develop new product technology, that can make complementarity and integration of the same industry and even cross-industry enterprise in core technology, achieve greater technical synergies, and lower the cost of R&D in each enterprise.

3) CBTI is beneficial to disperse the risk of R&D. For any enterprise, the R&D of a new product and technology is subject to its own capacity, incomplete information, consumer behavior etc. As technology becomes more complex, the costs of development are getting higher and higher. Because of these factors, it is the R&D of the new product and new technology that requires a lot inputs, has very high risk level, and it begins to transfer from technical self-sufficiency to technical cooperation among enterprises. Expanding the density and speed of information transmission through the form of industrial cluster, one can avoid waste of innovative resources caused by blind R&D and lower the risk of technological innovation.

3. Result of stratification and competition. Leading enterprises and auxiliary enterprises in an industrial cluster compete at different levels within the same industrial cluster [7]. Competition among leading enterprises is mainly at the product layer, while competition among SMEs is mainly at the component layer. On one hand, this clearly defines the competition space among enterprises in an industrial cluster to avoid excessive competition. On the other hand, it can pass the high-level competitive pressures from leading enterprises to auxiliary ones, this can promote auxiliary enterprises to improve labor productivity and technology level on high standards continuously, and generate a dynamic mechanism which can make the association and coexistence of high-level and low-level competition. Performance of enterprises at different levels depends on the competitiveness of other type's supporting enterprises at a market. So leading enterprises and auxiliary enterprises choose each other. The

enterprises are doing continuous technological innovation in this interaction environment in the whole industrial cluster [8]. CBTI has advantages that a large enterprise or SMEs can't have. Given the characteristics, the advantages and disadvantages of large enterprises and SMEs, and market competition, SMEs should be devoted to continuous (gradual) innovation, especially the process and the related technological innovation, while large enterprises should be devoted to make product innovation (discontinuous innovation or radical innovation) and process innovation (continuous or gradual innovation) to complement each other.

4. Requirement of forming core competence. With the advancement of technology and increasing technological content in products, manufacture and processing of products become increasingly advanced and complex. Completing a new complex product gets through more and more production processes. From the development and the completion of a product and so on, it has been the increasing scale strategic project. It is difficult to complete it separately for any enterprise in a short time. With the scientific-technological development, new industries and areas are emerging and relatively stable technical environment in the past has become turbulent, volatile and unpredictable [9]. There are two characteristics in the development of technology during this period: continuously shortening product life cycles, and increasing input costs. So enterprises should focus on certain fields, improve their core competition, and not seek to "become almighty".

Enterprises tend to transfer activities which are incompatible with their own competitive advantages and technology capacities to others, and concentrate on core activities. So they can focus on the parts of value-added chain and make employees get specific skills and capabilities. Enterprises in an industrial cluster have their own special resources and core competences. With mutual cooperation and promotion, they can have complementary effects and strengthen their core competences further. In an industrial cluster, members can do organizational learning, and get each other's core expertise by learning-by-doing to compensate their own weaknesses [10]. Formation of industrial cluster can deepen specialization and division. Stacking of comparative advantages of parts production, assembling various sectors of parts and the whole, provides opportunities for flexible combination of production factors between different enterprises, e.g. capital, technology and human resources, promotes technological innovation, and reduces the final cost most significantly. The core competence is inner innovation resources of enterprises, and continuous competitive advantage is the external appearance of them at a market. Transfer of core competence to continuous competitive advantage is the product of market evaluation of the materialized result of core competence. It shows the continuing value of the final product or service for consumers.

Conclusion. There are internal links between gradual development of an industrial organization and technological progress. Industrial cluster is a rational form of industrial organization. It can achieve scale economy at the industrial level and also has very strong technological innovation capabilities and advantages. CBTI is the combination of industrial cluster and technological innovation. It can effectively overcome the deficiencies of a single enterprise in resources and capacities, give full play to advantages of an industrial cluster, and enhance the effect of technological innovation. CBTI is a new innovative paradigm based on the capacity of technologi-

cal innovation management, that is the demand for developing and deepening of international division, encouraged by pressure from technological innovation, that is the result of stratification and competition, and is the requirement of forming core competence.

References:

1. *Krugman, P.* (1994). Complex Landscapes in Economic Geography, *American Economic Review*, 84, 412-416.
2. *Powell, W.* (1987). Hybrid Organizational Arrangements: New Form or Transitional Arrangements, *California Management Review* 30, 67-87.
3. *Kaiser, R. and Liecke, M.* (2007). The Munich Feature Film Cluster: The Degree of Global Integration and Explanations for its Relative Success, *Industry & Innovation* 14, 385-399.
4. *Ketels, C. and Memedovic, O.* (2008). From Clusters to Cluster-based Economic Development, *International Journal of Technological Learning, Innovation and Development* 1, 375-392.
5. *Zeller, C.* (2001). Clustering Biotech: A Recipe for Success? Spatial Patterns of Growth of Biotechnology in Munich, Rhineland and Hamburg, *Small Business Economics* 17, 123-141.
6. *Huallachain, B. and Lee, D.* (2011). Technological Specialization and Variety in Urban Invention, *Regional Studies* 45, 67-88.
7. *Campbell, D. and Hulme, R.* (2001). The Winner-takes-all Economy, *McKinsey Quarterly* 1, 82-93.
8. *Mooney, A.* (2007). Core Competence, Distinctive Competence, and Competitive Advantage: What Is the Difference? *Journal of Education for Business* 83, 110-115.
9. *Forsman, H.* (2009). Improving Innovation Capabilities of Small Enterprises: Cluster Strategy As a Tool, *International Journal of Innovation Management* 13, 221-243.
10. *Ozkanli, O. and Akdeve, E.* (2009). Cluster and Innovation Policy for Regional Development: the Case of Turkey, *International Journal of Management and Network Economics* 1, 211-231.

Стаття надійшла до редакції 20.04.2011.