

Chapter 39

The Research on Knowledge Spillover of Industry-University-Research Institute Collaboration Innovation Network

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Abstract Industry-University-Research institute collaboration innovation network is the important part of national innovation system, and knowledge spillover is key knowledge flowing mechanism of Industry-University-Research institute collaboration innovation network. This paper defines and generalizes knowledge spillover of Industry-University-Research institute collaboration innovation network, demonstrates the adjustment mechanism of knowledge spillover combined with 3 phases of run-in coordination, standard development and spiral rising, analyzes the relevant effect on innovation network, innovation main body, regional industrial cluster, innovation capability and economy increasing, at last promotes expectation of further research.

Keywords Adjustment mechanism · Collaboration · Knowledge spillover · Industry-university-research institute · Innovation network

39.1 Introduction

Science and technology evaluation system of Chinese universities and institutes always considers research production more important than technology conversion. Enterprises are affected by constraint of scale, currency flow, R&D staff and

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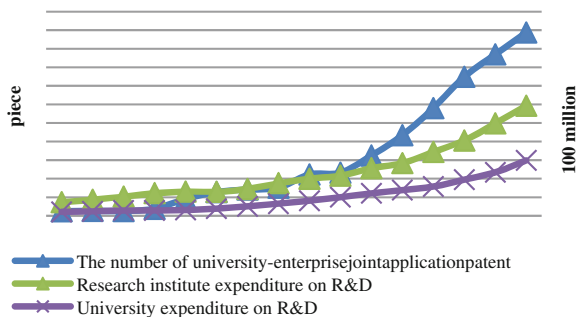
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innovation resource. Different kinds of intermediary organizations that provide service of information, consultation, visa, financing and risk investment are so few. Intellectual property rights protection, economy development level, innovation culture, innovation policy and collaboration profit distribution limit the innovation environment. Therefore, as the main source of technology innovation, national universities institutes and enterprises collaborate not smoothly, collaboration mode is single and collaboration mechanism is not regular. So, at the year of 1992, our country initiated “Industry-University-Research institute collaboration development program”. Especially, at the year of 2007, our country advanced officially: speeding up to establish the technology innovation system which takes enterprises as main body and market as guide, based on Industry-University-Research institute collaboration; leading and supporting key innovation elements to centralize to enterprise, so as to transfer technology innovation outputs to practical productive force. Various industry technology innovation strategy unions appeared, promoting the concordance of national universities, realizing that universities and institutes share the talents. Collaboration of institutes and enterprises becomes more and more frequent, and the collaboration mode changes from point to point to tridimensional network pattern (Liu et al. 2011). Date of last recent years, the number of Chinese university-enterprise joint application patent, the university and research institute expenditure on R&D, rise step by step (Fig. 39.1), describing that the collaboration become closer, and the innovation outputs increase.

Knowledge spillover is key mechanism of Industry-University-Research institute collaboration innovation network formation and development. Whereas, the organization mode and operation mechanism of Industry-University-Research institute collaboration innovation network provides convenient condition for knowledge spillover. Through the research of experts such as Drucker (1999), scholars of management science and economics come to a conclusion that knowledge spillover is as important as knowledge innovation. Knowledge spillover makes obvious contribution to speed up industrialization of technology production, promotes high-tech industry development and conventional industry upgrade, and improves innovation capability of network and its main body.

As Freeman (1991) firstly advanced “innovation network” (Freeman 1991), the worldwide research became more and more abundant in innovation network.

Fig. 39.1 The number of university-enterprise joint application patent and university and research institute expenditure on R&D



Etzkowitz and Leydesdorff (1999) advanced “Universities-Industry-Government” 3-helix innovation model, which set solid base of university—enterprise collaboration research. Zhu and Peng (2003) firstly advanced Industry-University-Research institute collaboration innovation network. Mowery (1998) indicates that the motivation for enterprise to participate in collaboration is to acquire knowledge spillover and reduce development cost. However, similar researches focus on: organization mode and operation mechanism of collaboration innovation network, evolution process, network ability and knowledge transfer and integration, etc. Ke (2010), Xu et al. (2011), Hui and Zhou (2010), and knowledge spillover of industrial cluster innovation network or technology innovation network (Gui 2008; Jiang 2003). But knowledge spillover mechanism of different kinds of innovation network is different. So, knowledge spillover of Industry-University-Research institute collaboration innovation network needs to be researched systematically.

39.2 Definition of Knowledge Spillover of Industry-University-Research Institute Collaboration Innovation Network

Based on knowledge chain of dynamic knowledge network, collaboration innovation network shows its value as to provide main body of innovation network the method of matching the uncertainty of technology and market, and the solution to complexity in innovation process, so as to lower down R&D cost and risk. The network contains knowledge innovation of main body through collaboration, but also knowledge transfer based on technology transaction, patent authorization and collaboration with share of technology, together with knowledge spillover based on knowledge sharing, enterprise derivation, talent flowing, personnel and technology communication.

Knowledge spillover of collaboration innovation network means as the discrepancy of knowledge stock and configuration of main bodies, innovation network forms a series of processes that knowledge spillover from the knowledge source, transferred in network, absorbed and innovated again by the knowledge recipient, through the official innovation network based on agreement, and unofficial innovation network based on incompact agreement or exceeding the agreement limitation. To be different with innovation network of industrial cluster network and regional innovation network, the relationship between main bodies of collaboration innovation network isn't the type of market competition, so it seldom appears to minimize the knowledge spillover of its own and maximize the learning from others as “Hitchhike” in management strategy. Based on the 3-helix innovation model with “Government-Enterprise-University” of Etzkowitz and Leydesdorff (1999), collaboration model of Santoro (Santoro et al. 2000), together with the above definition to deliver the conceptual model as Fig. 39.2.

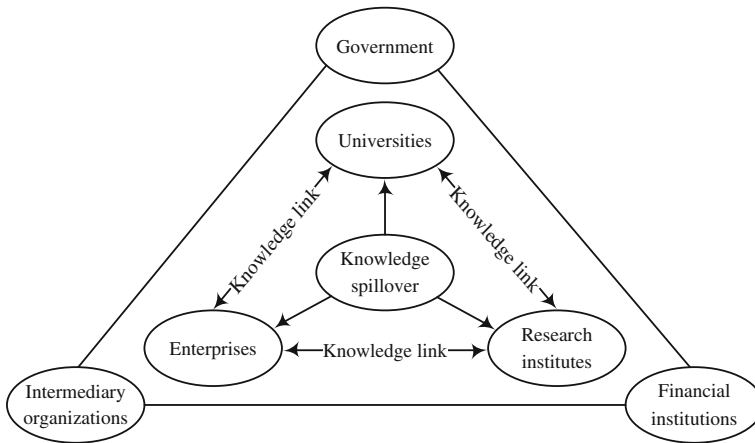


Fig. 39.2 The model of knowledge spillover of industry-university-research institute collaboration innovation network

Table 39.1 Different knowledge spillover of collaboration innovation network

Dimension	Type	Characteristic
Subjective willing	Voluntary	Voluntary and initiative, subject to the control of spillover source, adjustment with the relationship between each other
	Involuntary	Involuntary, in part or completely uncontrollable, the objective existence
Knowledge character	Dominant	Dominant or encoded knowledge
	Subdominant	Hidden or silent knowledge
Main body	Vertical	Spillover between different types of enterprises universities or institutes
	Level	Spillover between the same type of enterprises universities or institutes
Spillover carrier	Carrier of human	By the flow of talent, personnel exchanges and cooperation seminars
	Carrier of object	Through technical literature, patents for inventions and products
Spillover direction	University and institute to enterprise	Spillover of basic research, applied basic research and knowledge
	Enterprise to university and institute	Spillover of production technology, market information and management methods and experience
Spillover range	Network internal	Inside the network
	Network external	Beyond the network, the core nodes of the network act as “gatekeepers”

Based on different dimensions, we can come to a conclusion of the different types and characteristics of knowledge spillover of collaboration innovation network, as Table 39.1.

39.3 Adjustment Mechanism of Knowledge Spillover to Collaboration Innovation Network

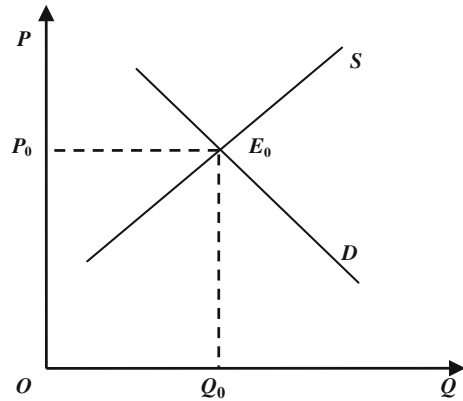
Collaboration innovation network is composed with highly autonomy members by means of loosen style to form a new innovation union, further step to form knowledge network with equal nodes, which belongs to loosely coupled system (Zhang et al. 2012). Its form and evolution mechanism is in accordance with complex scale-free network based on features of self-increasing and preferred connectivity (Feng et al. 2009). We can derive from social network and capital theory, through long-time official contact collaboration and unofficial communication of technology and staff, relationship capital of the network accumulates day by day, together with deeper and deeper reliance. Therefore, in the innovation network, two features of scale-free network and network relationship capital form evolution power of innovation network.

Ke indicates that collaboration innovation network evolution includes: run-in period, coordination period, specification period and development period, matching four kinds of knowledge transferring mode: spontaneous mode, competition mode, collaboration mode and the altruism mode (Ke 2010). Based on the research conclusion and the development law of innovation network, this paper divides innovation network evolution process into 3 sections: run-in coordination period, standard development period and spiral rising period. At the same time, based on improvement of knowledge spillover in regional innovation network by Gui (2008), it defines the innovation knowledge that enterprises (technology demand party) get through the methods of cooperative research, technology introduction, technology transaction based on agreement as direct demand, and defines the innovation knowledge that enterprises get through the unofficial methods of talent flowing, staff communication and technology seminar as indirect demand. Addition of the two demands above is defined as total demand of technology demand party. Accordingly, it defines the innovation knowledge that is provided by universities and research institutes (technology supply party), through by-self and cooperative innovation, as the total supply. Suppose that in the collaboration innovation network, each main body complies with intellectual property right protection principle based on ideal and serious protection system and environment.

39.3.1 Run-in Coordination Period

Collaboration innovation network initiates newly, each main body gets different understanding attitude and goal, lack of knowing understanding and trust between each other, and different in the aspect of organization background and culture. So, everyone is cautious to enter the innovation network to learn knowledge supply-provide information, communicate or collaborate with each other, and resolve contradictions. So inside the network, spillover from technology field to economic

Fig. 39.3 Knowledge supply-provide balance in innovation network of run-in coordination period



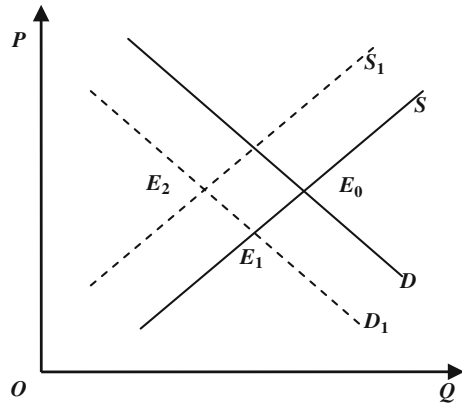
field is so little that even could be ignored. Technology demand party attains the innovation knowledge by means of collaborating with supply party on technology research, technology introduction, technology transaction based on agreement. As in Fig. 39.3, direct demand to innovation knowledge is the total demand, when it comes to the balance, total supply curve S will intersects with total demand curve D at point E_0 , Q_0 is the balance quantity of innovation knowledge, and P_0 is the balance price of innovation knowledge.

39.3.2 Standard Development Period

With the development of collaboration innovation network, each main body strengthens the relationship, deepens the trust, cooperates more and more standard, and collaboration goal is clearer. Then, it evolves to more solid combination in control, and network stability and main body embeddedness gets stronger, leading to more stable work mechanism and closer communication between staff and technology. Now, it forms favorable condition for knowledge spillover, on condition that universities and institutes protect the core technology or knowledge of their own, knowledge spillover happens and accumulates more and more. On condition that total demand is fixed, for the reason that knowledge spillover leads to indirect demand increases, direct demand decreases accordingly (Fig. 39.4).

As Fig. 39.4, demand curve D descends to D_1 , it leads rarity of network internal innovation knowledge gets down, balance point would then come down; price would come down, balance point transfers from E_0 to E_1 . As network evolves, demand party will increase knowledge stock through collaboration absorption and knowledge spillover, supply and demand party comes closer in the knowledge position, meanwhile difference of knowledge structure of two sides descends. In Fig. 39.4, supply curve S transfers to the left S_1 , on condition that demand is fixed, rarity of network internal innovation knowledge rises, price rises and balance point transfers from E_1 to E_2 .

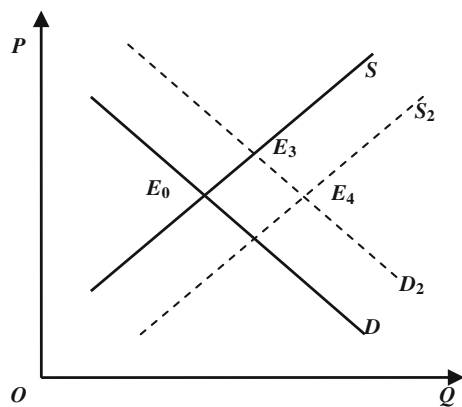
Fig. 39.4 Knowledge supply-provide balance in innovation network of specification development period



39.3.3 Spiral Rising Period

Collaboration innovation network asks for higher level, after specification development period, it comes to stable state. Outside the network, market competition, market demand, and technology innovations demand the network to suit to environment. Network faces new chance and pressure of adjustment. Now, as the majority of demand party, enterprises increase demand on technology and product upgrade more and more. As Fig. 39.5, demand curve transfers from D to D₂, leading to network internal innovation knowledge rarity rise, balance price rises, balance point transfers from E₀ to E₃. As the majority of knowledge and technology supply party, universities and institutes raise their knowledge position compared with the technology demand party by means of increment of product and technology innovation, so as to amplify the discrepancy in knowledge structure of two parties and supply of innovation knowledge increases. In Fig. 39.5, supply curve transfers from S to S₂, on condition that demand is fixed, rarity of network internal innovation knowledge descends, price descends and balance point transfers from E₃ to E₄.

Fig. 39.5 Knowledge supply-provide balance in innovation network of spiral rising period



39.4 Analysis on the Effects of Knowledge Spillover of Collaboration Innovation Network

Knowledge has the feature of noncompetitive and exclusive, so it has the effect of public property and external. However, knowledge spillover of collaboration innovation network does not only have the “distribution effect” in the common external character, at the same time it also has “production effect” and affects the innovation performance of whole network and collaboration main body. Through knowledge spillover, it forms the public knowledge pool, each main body interacts with network, spirally rises, adds knowledge stock etc. based on network public and their own knowledge. Therefore, knowledge spillover of collaboration innovation network affects the innovation network, cooperative main body and relevant region with corresponding economy effect.

39.4.1 For Innovation Network

The ultimate goal of collaboration is to achieve knowledge value creation; it mainly depends on the effective transaction of knowledge between each main body. At first, knowledge spillover is considered to be the supplementary of collaboration innovation network based on official agreement. It can speed up the internal knowledge flowing, increase the efficiency of knowledge transaction between main bodies, and increase the knowledge creation capability of network (Ke 2010). Secondly, knowledge spillover will form network public knowledge pool, which will make each main body create more efficiently on public technology platform, and innovate again through the absorbed knowledge by means of network interaction, further to increase public knowledge stock and promote creation ability and efficiency of network (Gui 2008). Thirdly, production technology, market information and management experience transfers from enterprises to institutes. Therefore, it can strengthen market demand guide, optimize the use of innovation resource, and promote network creation capability and capacity for sustainable development. Fourthly, knowledge spillover is in favor of network to form mechanism of collective learning and promote the collection of talents from all main bodies.

39.4.2 For Innovation Main Body

Enterprises can attain knowledge spillover effect through collaboration, and then reduce research cost, transaction cost and uncertainty, achieve research scale economic effect. What’s more, through knowledge spillover, enterprises could also attain all kinds of external knowledge such as public knowledge and innovation

knowledge of other enterprises, and promote knowledge learning and absorption ability and technology creation ability (Cyert and Goodman 1997) by means of all kinds of communication, research and seminar. For university and research institute, subjective and objective knowledge spillover will reduce the position distance between enterprises and them, and promote efficiency and width of knowledge transfer, speed up propagation of new thought, new concept, new information and new technology. What's more, knowledge spillover promotes institutes come across organizational boundaries, transfer and integrate knowledge timely and efficiently in space and time, and then it's more in favor of transferring subdominant knowledge to the internal network. At last, knowledge spillover can make universities and research institutes attain market information in time, understand real problems, then improve the use of new technology and make research activity conform economic closely (Diao et al. 2009).

39.4.3 For the Region

At first, the knowledge spillover of collaboration innovation network is the main power of regional industrial cluster effect. Fujita and Thisse (2002) indicate: cost external and technology external led by knowledge spillover together is the key reason of economic activity agglomeration. As existence of public knowledge pool, it leads to marginal productivity rate of network internal enterprises rises, then make network get more efficient. Secondly, it is an important factor of affecting regional innovation efficiency and capability. Wei et al. (2010) research that regional innovation ability is not only affected by R&D input, but also relies on regional innovation efficiency. Innovation efficiency relies on special factor, including: industrial cluster environment, combination quality, ability of absorbing knowledge spillover outside the region. Thirdly, knowledge spillover of collaboration innovation network promotes total factor productivity and high-tech industry, and then affects regional economy increase. Kose and Moomaw research knowledge spillover effect on Europe regional economy increase, through analysis on improvement of 57 regions from France, Italy and Spain, they indicate: R&D intension and R&D spillover both affect the region economy increase positively.

39.5 Discussion

This paper combines collaboration innovation network and knowledge spillover, promotes the definition of knowledge spillover of collaboration innovation network, and describes it based on subjective willing, knowledge type, main body, spillover carrier, spillover direction, spillover range. By means of micro-economics supply-demand analysis method, it analyzes three periods of knowledge spillover of collaboration innovation network which are run-in coordination period,

specification development period and spiral rising period, and indicates the adjustment mechanism of knowledge spillover on network internal knowledge. As known from analysis, knowledge spillover dynamically affects the balance of knowledge supply and demand in the network; through affecting direct knowledge demand, it can change the knowledge distance between two parties, and impel the innovation capability of collaboration innovation network and spiral evolution of the network. At last, it analyzes effects of knowledge spillover on network development, innovation capability and performance of main bodies, region industrial cluster and economy increase.

Collaboration innovation network's ultimate value is knowledge creation, flowing and value addition. Knowledge spillover is the important knowledge flow mechanism of collaboration innovation network, it has great significance to impel collaboration to cycle methodically, to promote market configuration of innovation resource, and to achieve the sustainable development of collaboration innovation. For the lack of research in this paper, follow-up research could be improved as followings: firstly, to analyze knowledge spillover of collaboration innovation network from micro mechanism and relevant influencing factors (e.g., collaboration benefit distribution and sharing mechanism); secondly, to carve up the main body of collaboration innovation network more appropriately, fully considering discrepancy of university, institute and enterprise on condition of type, scale, innovation resource and efficiency; thirdly, to discuss about relevant measure and estimation method, and impel the method of quantitative analysis; fourthly, to analyze its effects from all aspects, including both the positive and the negative.

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