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# The Systematical Analysis about the Effect of Knowledge Spillover on Technological Innovation Capability

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***Abstract*—**The paper studies implications between knowledge spillovers and technological innovation capability in the following three aspects: firstly, the paper debates on the effect of knowledge spillover on some perspectives of technological innovation ability; secondly, it discusses how different roles of knowledge spillover affect the technological innovation capability; finally, the paper creates the model of the factors of knowledge spillovers influencing to technological innovation capability. It concludes that knowledge spillovers affect all the main aspects of technological innovation ultimately to impact of technological innovation capabilities.

***Keywords*—**Knowledge Spillover, Technological Innovation Capability, Innovation Cluster, Innovation Network Factors.

## I. Introduction

WITH the coming of knowledge economy, knowledge and knowledge spillovers play an important role in technological progress and innovation, especially since the 21st century, more and more enterprises recognize that the knowledge is deeply relied on the successful operation of the technological innovation activities. Effective and successful knowledge creation and knowledge overflow always accompanied with technological innovation capabilities. Therefore, technological innovation has gradually shifted from the traditional ways to the ways of based knowledge creation and overflow [1], [2]. Based on the angle of the knowledge spillovers, scholars have focused on the technological innovation capability in the following aspects: First, it is from a macro point of knowledge and technological innovation [3]-[5]. The second is from the refinement of knowledge to research the relationship between knowledge spillovers and technological innovation outputs then at last with the economic development [6]. The third is from empirical research angle to study the dual roles of knowledge overflow to technological innovation capability [7]-[10]. The existing literatures on the relationship between them achieved fruitful results. However, it lacks of the implication relationship between each other, fails to segment all aspects of knowledge spillovers and technological innovation, only from the scope of the enterprise and lacking the variable economic agents in society.

So based on the study of the implications between knowledge spillover and technological innovation capability; the essay studies the model of the knowledge spillover factors which affect the technological innovation capability. According to the model, the essay got a system analysis about how the aspects of knowledge spillovers affect the different angles of technological innovation capability and the intrinsic link between.

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## II. The Implications between Knowledge Spillovers and Technological Innovation Capability

The definition for knowledge spillovers was from Marshall [6] who defined from the view of different input and output of both creators and imitators. Romer [11], [12] defined from the technological knowledge's characters which are non-competitiveness and partly exclusiveness, which essentially cause knowledge spillovers. Griliches [13] defined from imitator perspective, Kokko [14] defined from the perspective of the relationship of foreign enterprises and local enterprises; thereby he got three ways of overflow from local enterprises, mainly through trade channels, the human capital flows and the exemplary role of competition. It is believe that the knowledge spillover refers to the difference between the private costs and social costs, private benefits and social benefits for producing and using knowledge, and which cause the knowledge's non-competitiveness and non-exclusiveness.

The earliest research on technological innovation started by the Austrian economist Joseph Schumpeter, he studied from the point of production. And then other scholars studied from different angles on the connotation of technological innovation. Lynn firstly defined technological innovation from the process of innovation timing [15]; Freeman (1982) defined from using of new products, new processes, new systems and new services in commercial operation of technological innovation [16]. The above definitions of technological innovation all surround the production process. So it is believe that successful technological innovation should be in the center of production and the ultimate achievement of innovations is also for promoting the new products, then increasing corporate profits throughout the commercialization process.

From the definitions above, we can get the relationship between each other. Knowledge spillovers affect the entire processes and all aspects of technological innovation. Knowledge spillovers act on the technological innovation's initial phase through personnel exchanges, liquidity and espionage among enterprises. So these knowledge spillovers

from other enterprises strength the activities of inventing new patents for one enterprise, then increase the theoretical possibility to improve the production because of the technological improvement. Knowledge spillovers in this phase of the research and development increase next phase of technological innovation capability by taking full advantage of its knowledge in the production. So in the production process, the patents through knowledge spillover mentioned above are applied in production and technological innovation capability, which is called “learning by doing”. When the products are sold, knowledge spillovers from technological innovation have not ended. The enterprises compare with other companies about profits and prepare for the next round of production and during this phase the technological innovation capability become higher because the new liquidity or espionage movement through enterprises.

In summary, knowledge spillovers through technological innovation processes to ultimately affect the ability of technological innovation, and improve the level of productivity, quantity and quality of the products. So the more active and rich information and personnel exchange, the more innovation activities happen. The occurrence of knowledge spillovers increase the stock of knowledge, and then improve the technological innovation capability. So, technological innovation capability cannot be separated from knowledge spillovers, which is the achievement of the implementation of the knowledge as well as knowledge spillovers.

## III. The Effect of Knowledge Spillover on Some Perspectives of Technological Innovation Ability

Knowledge spillovers are the source of technological innovation, especially for high-tech industries. Some scholars even believe that the level of knowledge spillovers contributed more than R&D capital factors on innovation output. Technological progress has the self-reinforcing mechanism because of the knowledge spillover, which can produce a positive feedback effect of knowledge spillovers and then will accelerate technology innovation. Hence, knowledge spillovers affect the technological innovation through the following aspects:

### *A. The Effect of Knowledge Spillover on Spatial Cluster of Technology Innovation*

Comparing with explicit knowledge, tacit knowledge is more difficult to be codified, only through direct interaction and communication. The characteristics of tacit knowledge determine the cluster of technology innovation enterprises, which let enterprises have a better environment for more knowledge and innovation resources. The cluster is conducive to achieve complementarities among all enterprises in this cluster area and it is enable to let enterprises easily explore the right paths of innovation, then let enterprises get business benefits from knowledge spillovers. So Lammarino and McCann (2006) [17] believe that the innovative activities is generally influenced by the geography, so there is the relationship between space and production cost at different stages in the product cycle. Moreover, the cluster also can reduce risk and the cost of innovation and, because the university is a source of knowledge spillovers, the center of cluster is always beside the universities.

Therefore, from the region as a whole, the government should protect the technological innovation of the enterprises, which saves the cost of regional innovation, strengths the regional technological innovation capacity, especially for the high-tech industries and emerging industries, which play a prominent role in the new economy. In these industries, knowledge and innovation activities show more significant cluster trend

### *B. The Uneven Affect of Knowledge Spillover on Technological Innovation Capability in Different Economic Agents*

The impacts of Knowledge Spillovers to technological innovation capability vary from different economic agents. Most of the researches got that knowledge spillover influence the small and medium-sized enterprises (SMEs) in some extent because the SMEs is relatively flexible and the demand for new knowledge and new technology is big, so it is essential for these enterprises to access and use of new high knowledge spillover. Castells and Hall (1994) [18] had suggested that the geographical proximity of SMEs is a necessary criterion for the development of mutual trust relations based on a shared experience of interaction with decision-making agents in different corporations. It means that because the funding of SMEs is limited and they lack of staffs, so they are relatively strong sense of crisis that creates more changeable for internal staff in SMEs and more trust for each other. For the large enterprises, because of the abundant of staffs, large funds, complicated institutions and relationships, their innovation is lag and less efficiency in production

Knowledge spillovers also play an important role in the emerging industry because of its high content of knowledge and technology, and this knowledge is difficult to encode so the distances affect the ability to use these knowledge spillovers for emerging industry. The knowledge spillovers can promote continuously the industrialization of high-tech, and be easy to get economies of scope. On other hand, backward technology enterprise can get more knowledge spillovers than the advanced technology enterprise. Knowledge spillovers always flows from the knowledge abundant enterprise to the inadequate knowledge enterprises, so for the backward enterprises with strong absorbing capacity can use knowledge spillover to enhance the technological innovation capability. But this knowledge liquidity is limited by the human resource and equipment levels for inadequate knowledge enterprises

### *C. The Effect of Knowledge Spillovers on the Network of Technology Innovation Environment*

Technological innovation needs to have an open environment. Through the exchange of knowledge between the employees of various organizations, spillover influences the formation of the network. External information exchange and coordination of the organization's innovation is very important, which can effectively overcome the capacity limitations of

individual organization when engaging in complex technological innovation and reducing market uncertainty in the innovation activities. Technological innovation network is the sum of the activities of the various innovative agents, including the external network (other enterprises, universities, research institutions, government, intermediaries and financial institutions); the internal network (the mobility of various departments, economies of scope and the organization of whole R&D chain) and all economic agents which in the whole process of development, cooperation, and production of the new product

Knowledge spillovers play an important role in the innovation network. On one hand, the main agents of the network produce the knowledge spillover through the knowledge exchanging, knowledge creation, knowledge integration, and then, which improve the technological innovation capability. Knowledge spillovers, clusters and innovation networks influence each other because the knowledge spillovers, in the beginning, promote the cluster of enterprises, and then the cluster promotes the formation of innovation network environment. The network is not only good at the knowledge transferring, but also promoting the production of new knowledge. The cooperation of the members of the network, as well as the favorable conditions for cooperation network environment play an important role in promoting for knowledge creation, knowledge diffusion, knowledge achievement. Thus, knowledge and knowledge spillover from the cooperation and communication heavily affect the networks, and this network affects the organization of technological innovation capability.

On the other hand, the agents in technological innovation network connect with each other through knowledge exchanging, self-knowledge imitating, knowledge diffusion of knowledge spillover, which let network form have their own structural features, and such structural features affect the development of the technological innovation capability. In the process of Network development, the contacting of the main economic agents is becoming more and more closely, the abundance of knowledge spillovers among main economic agents is becoming more and more and at last, when the knowledge stock reaches a certain level, innovation become stability. In the network environment, all organizations cooperate to form a knowledge field, and the more important the role in technological innovation network is, the better performance for such organization to absorb knowledge spillover to generate more innovations. So, the more abundant knowledge in the innovation network, the more important status for the organizations in the innovation network, and then the stronger absorptive capacity of knowledge and the technological innovation capability.

## IV. The effect of Knowledge Spillovers' Main Agents on Technological Innovation Capability

Based on the different interaction and communication between the main agents, knowledge interacts among the various types of organizations and knowledge overflow is generated through different ways and means which all impact on technological innovation capability. Knowledge spillovers among them reduce the cost of innovation; accelerate the pace of technological innovation, so the knowledge can be shared among these agents. Knowledge spillover mechanism can be divided into at least the following four categories:

### *A. The Effect of Staffs' Mobility on Technological Innovation Capability*

Economic globalization has accelerated the flow of information; reduced the cost of logistics, but still under a lot of restrictions in the geography. The stickiness for mobility of staffs determine the interpersonal exchanges in the region is still an important way to transmit information, in other words, face-to-face communication plays an important role for tacit knowledge dissemination. Talented person flow in the region, and interact with the surrounding groups, which, on one hand, promotes the creation of new knowledge, and on the other hand, which accelerates the spread of knowledge between the different groups.

Knowledge spillovers generated by the movement of persons, which let the organizations learn from each other and mutual progress, then they complement and promote each other. These knowledge spillovers from staffs' mobility increase the stock knowledge in organizations and the entire region and enable organizations to promote the new technology and the production of new products, finally achieve the goal of improving the efficiency and the technological innovation capability [19].

### *B. The Effect of Multi-Agents Cooperation on Technological Innovation Capability*

Universities and institutions are the source of knowledge spillovers and the Government contributes a lot to knowledge spillovers as a provider of public knowledge and R&D investment. So the multi-agents cooperation has a superposition role on Knowledge spillovers, which increases the ability of technology of innovation. In addition, the multi-agents cooperation also includes financial institutions and intermediary service organizations. They are together to form the entire network, in which all agents merge and promote each other. The more extensive enterprises and agencies contact with each other, the more abundant resource of knowledge hidden in the network, and enterprises can absorb more knowledge spillover, and promote the organization of technological innovation capability.

### *C. The Effect of Entrepreneurs' Activities on the Technological Innovation Capability*

When entrepreneurs begin their business, they get a lot of tacit knowledge in the clustering area according to their special living environment such as the historical roots and cultural implication. With their talent, they can discovery and use this tacit knowledge successfully and others cannot see or think that such tacit knowledge has no value and they apply these knowledge spillover to the new production. Knowledge spillovers for entrepreneurs can be manifested by the rate of

new enterprises and the rate of self-employment rate [20].

Entrepreneurs absorb and utilize as much as possible knowledge spillovers through interaction and communication with different groups in their entrepreneurial process. It expands the set of entrepreneurs' selects that help the entrepreneurs to identify and take advantage of opportunities. Entrepreneurs can transfer the knowledge spillover successfully to the productivity and improve the technological innovation capability. So entrepreneurial activities let the learning opportunities from outside enterprises grow and speed up technology transfer and diffusion rate. Meanwhile, entrepreneurs can be further involved by other industries by expanding their business using other resources and knowledge spillovers and thus the form of the cluster.

### *D.The Effect of FDI and International Trade on the Technological Innovation Capability*

The knowledge spillover from International trade and foreign direct investment (FDI) significantly influence the backward countries through imitating foreign importing equipments or getting the knowledge spillovers from FDI. Coeand Helpman (1995) [21] investigated the role of international trade in the R&D for all countries and found every country benefits from the research and development activities through the knowledge spillovers from their own research and development and from its trading partners.

But there are some shortcomings about the knowledge spillovers from international trade and FDI on promoting technological innovation ability, such as the foreign firms would control the local market and crowd out domestic firms, because there is the technology gap between the own country and host country so the gap determines if the host country is hard to absorb the knowledge spillovers from the foreign counties.

### *E. The Effect of Cultural Systems on Technological Innovation*

In the region, knowledge spillovers and technology innovation are also influenced by the cultural, institutional, geographic and other factors. Innovation has a strong social effect. Granovetter (1991, 1992) [22], [23] has highlighted the role which social as well as purely instrumental business links may play in fostering localized growth. This social relationship is changing all the time within the changing in the technological innovation cluster, some cluster are from small to large, which represents the splendid future for the sunrise industry, such as IT high-tech Silicon Valley in the United States industries. Some represent the weakening sunset industry, such as Germany's Ruhr industrial area.

The geographical and historical reasons also have an important impact on the technological innovation capability. In some areas, there have the advantage in history and geography reasons, so they will have a good business environment and innovative knowledge spillovers. Such a good atmosphere for innovation will promote the development of innovative clusters, thus contribute to the development of the regional economy. Geographical proximity allows businesses to get the economy of scale, enterprises to access information resources and reduce costs.

## V. The Model of the Factors of Knowledge Spillovers Influencing on Technological Innovation Capability

According to above, the source of technological innovation is knowledge spillovers. In the case of knowledge spillovers, technological progresses have a self-reinforcing mechanism and knowledge spillovers can accelerate the positive feedback effects of technological innovation in gathering place. Knowledge spillovers affect the technological innovation capability through the intervention to some affects of technology innovation, which is shown in Fig. 1.

The knowledge spillover from movement of staffs, entrepreneurial activities, international trade and FDI, as well as the cooperation of all multi-agents affect the technology innovation through some intermediate variables and eventually also have a positive feedback effect for knowledge spillover Itself, in other words, with the increasing of knowledge spillovers, there is the same reaction to affect the movement of staffs and others. The generation of technological innovation also has a feedback effect to knowledge spillovers.

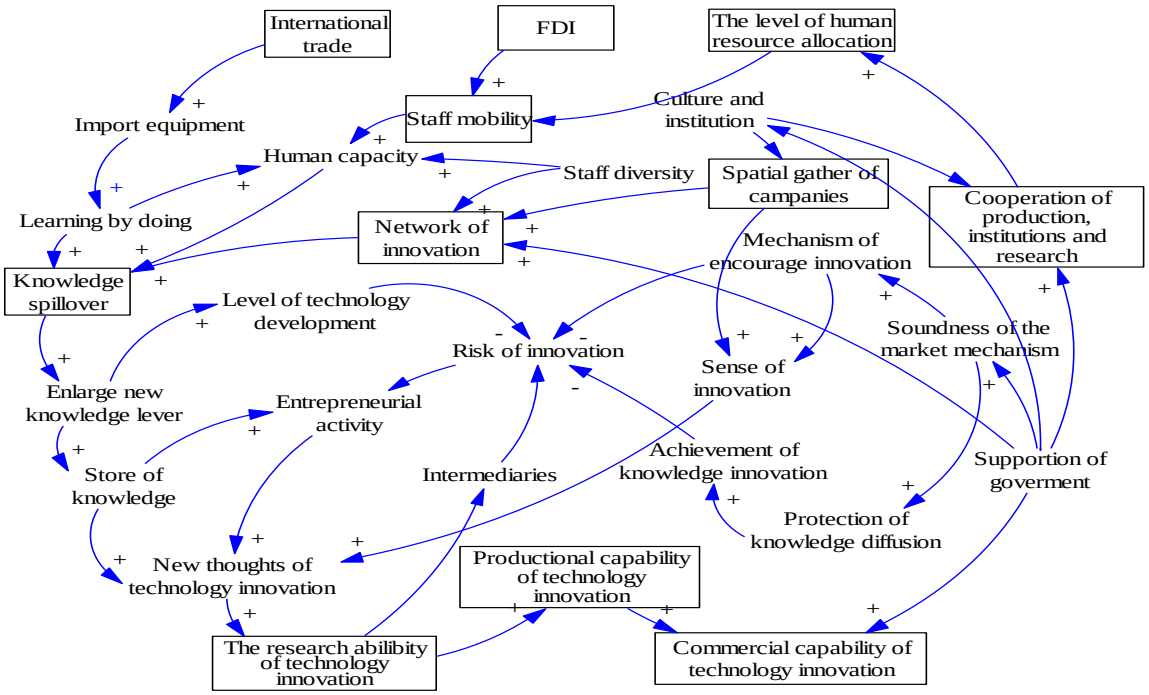


Fig. 1 The affect of knowledge spillover to the technological innovation ability

## VI. Conclusion

Based on the analysis of connotation relationship between knowledge spillovers and technological innovation capability, the essay gave the model based on the influencing factors for knowledge spillovers on technological innovation capability. According to the model, it systematically revealed the factors of knowledge spillovers that affect some aspects of technological innovation capability and interpret how knowledge spillovers affect the technological innovation capability and their intrinsic link. The paper gave the theoretical foundation for further study into technological innovation capability and provided a theoretical reference.

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