

# Analysis of Factors Affecting Inter-regional Technology Flow in Universities

## --From the Perspective of Network Reciprocity

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### Abstract

As an important source of technical personnel cultivation and scientific and technological innovation, universities play a vital role in the cross-regional technology flow. However, the data show that the number of patent transfer in universities is small, which is not conducive to technology flow, which undoubtedly causes a waste of scientific and technological resources. Based on the perspective of network reciprocity, this paper analyzes the influencing factors such as institutional environment, university resources and innovation, partners and networks, geography and culture, and puts forward relevant policy suggestions to better promote the cross-regional technology flow of universities.

### Keywords

Universities; Technology flow; Influencing factor.

## 1. Introduction

With the rapid development of economic globalization and informatization, technological innovation has become one of the core competitiveness of various countries' economic development. In recent years, universities have made great progress in scientific and technological innovation, and their technological research in some fields has reached the world's advanced level, and some major achievements with international influence have been achieved. As the main carrier of scientific and technological innovation and the main position of personnel training, universities have natural advantages for technology flow. However, the data show that the number of patent transfer in universities is small, and most technology patents are shelved in the hands of individual inventors, which is not conducive to the rapid development of scientific and technological innovation and industry. Due to differences in regional, cultural and other factors, there are various constraints on technology mobility among universities. Therefore, from the perspective of network reciprocity, this paper analyzes the influencing factors of cross-regional technology flow of universities, and puts forward corresponding solutions, so as to provide reference for promoting technology flow of universities.

## 2. Theoretical Foundation and Literature Review

### 2.1. The Connotation of Reciprocity

The concept of "reciprocity" was first put forward in the field of biology. Biologists found that some social organisms had altruistic behaviors in the process of living in groups, which could not be explained by the natural selection theory of the survival of the fittest proposed in classical Darwin's theory. Therefore, scholars put forward the reciprocal altruism theory to try to explain the causes of such altruism. With the reciprocity preference is widely used in

sociology, economics, management and other disciplines. Trivers (1971) found through repeated game tests that individuals can maintain a long-term reciprocal cooperative relationship[1]. Rabin (1998) introduced the theory of reciprocity into the study of behavioral economics, believing that the acquisition of individual interests not only depends on their own economic behaviors, but also plays a role in maximizing their own interests through interactive behaviors with other individuals[2]. Zhang et al. (2010) believed that individuals' reciprocal preference includes two processes, namely, reciprocal motivation and reciprocal behavior [3]. Before the concept of reciprocity was introduced into the field of economic research, the theoretical hypothesis of economic research was always based on the hypothesis of economic man, that is, in the case of limited resources, economic agents are pursuing the maximization of interests. The theory of reciprocity breaks the hypothesis of "economic man" in classical economics and makes up for the limitation of the hypothesis of "economic man". With the continuous development of reciprocity theory, reciprocity has broken through the limitation of research at the individual level and gradually become an important part of scholars' research on inter-organizational network relations.

## **2.2. Network Reciprocity**

Network reciprocity refers to the interdependent peer-to-peer relationship between network actors[4]. Some scholars have found that due to the higher degree of interdependence and resource sharing among reciprocal ties, the relationship between subjects with reciprocal ties shows the characteristics of stability and equality. Previous scholars evaluated the level of network reciprocity mainly by calculating the proportion of the number of reciprocal ties in the total number of ties[5]. In the process of studying network reciprocity, early scholars regarded reciprocity and as one of the important criteria to judge the strong and weak ties. Subsequently, many scholars have conducted more detailed studies on network reciprocity. The network reciprocal ties are considered as the "strong-strong" ties between subjects.

## **2.3. Research on Technology Flow in Universities**

### **2.3.1. Connotation of Technology Flow in Universities**

Technology flow is a process in which technology is transferred between different fields and subjects. The process of technology flow can realize the interaction between subjects, break the restrictions of region and field, and realize the flow of knowledge. The flow of university technology mainly includes three modes, namely, the export-oriented transfer represented by direct technology transfer and technology licensing, the inward-oriented transfer represented by university spin-offs, and the cooperative transfer through university-enterprise cooperation[6]. Since the previous mode of technology transfer in universities is mainly based on industry-university-research, scholars' research on the issue of technology transfer in universities is mostly focused on the inward-looking and cooperative transfer mode. (2) Research on university science parks and university spin-offs; (3) Research on school-enterprise cooperation mode; (4) Research on innovation policies and transfer intermediaries in universities; (5) Research on the performance of technology transfer in universities[7].

### **2.3.2. Research on University Technology Flow Network**

Since the process of technology flow is accompanied by the flow and diffusion of knowledge, the social network analysis method, as a common method to explore knowledge flow, has also been widely used in the study of technology flow. For example, Lei et al. (2011) used the social network analysis method to analyze the evolution of the school-enterprise joint application network from 1985 to 2008 from three levels: region, university and technology category[8]. Ma et al. (2011) measured the network structure such as the scale, density, centrality and centrality of the cooperative network of patent application by constructing the cooperative network graph of Chinese university-enterprise patent application[9]. Chen, Qin and Li (2019)

used the cross-regional cooperation patent data of “211 universities” in the Beijing-Tianjin-Hebei region from 2002 to 2016 to build a directed network of knowledge flow based on the patent cooperation relationship between universities and enterprises in the province where they are located, and discussed the dynamic changes of regional innovation capacity and knowledge flow under the background of the integration of industry and education in the Beijing-Tianjin-Hebei region[10]. Wang et al. (2014) revealed the patent network construction and governance issues between ICT enterprises and universities, research institutes and industrial chain partners through the construction of enterprise patent cooperation network model[11]. Li, Yang and Chu(2022) studied the patent citation and innovation knowledge flow of biomedical industry in Jiangsu Province through network feature analysis, and found that universities occupy an important position in the flow of biomedical innovation knowledge[12]. Many studies have found that university technology mobility is important for regional innovation and economic development. The research on technology flow in universities has been transferred from the macro level to the micro level, and the research scope of technology flow has been expanded by using the visualization method.

### **2.3.3. Research on the Influencing Factors of Technology Flow**

As for the influencing factors of technology flow, scholars have carried out some studies and found that the evolution of technology flow is determined by many factors, and the differences in language, culture and social system may all play a key role, such as the compatibility between new technology and regional culture[13,14,15], the digestion and absorption capacity of technology demanders[16], and the development of technology demanders. Knowledge potential difference, knowledge similarity, scientists' flow, scientific research cooperation intensity, and network position of relations between countries[17], as well as economic level, geographical distance, R&D investment, alternative technology, etc.[18].

### **2.4. Evaluation of the Current Research Status**

At present, scholars have carried out a lot of research on the technology flow network of universities and its influencing factors, but there are still few studies on the cross-regional technology flow of universities from the perspective of network reciprocity. This provides an idea for the research in this paper.

## **3. Analysis of the Influencing Factors of Inter-Regional Technology Flow of Universities**

### **3.1. Institutional Environment Factors**

(1)Policy support and encouragement. The government can provide support and encouragement for technology mobility in universities by formulating and enforcing technology flow and intellectual property protection policies.

(2)Legal and regulatory environment. Technology flow in universities involves intellectual property rights, technology contracts and other legal matters.

### **3.2. University Resources and Innovation Factors**

(1)Scientific research strength. The scientific research strength, R&D ability and scientific and technological achievements output of universities play a key role in the attractiveness and influence of technology flow. High-level research institutions and teams can attract more technology demanders and partners, thus enhancing the attractiveness and influence of technology flow.

(2)Awareness of intellectual property rights. The attention paid by universities to intellectual property rights and the ability of intellectual property management play an important role in the smooth progress of technology flow and flow. Universities should have clear intellectual

property policy and reasonable intellectual property distribution mechanism, and strengthen the protection and application of intellectual property.

### **3.3. Partner and Network Factors**

(1) Industry-university-research cooperative relationship. Whether the cooperative relationship between universities and enterprises and other universities is close, the willingness to cooperate and the establishment of cooperation mechanism will affect the degree and effect of technology flow.

(2) Network structure and connection. The network structure characteristics of technology flow in universities have an important impact on the spread and influence of technology flow. Factors such as network stability, density, and centrality of nodes will affect the effect of technology flow. Whether the cooperation network among universities has the characteristics of reciprocity, and the key nodes and important paths in the network will have an impact on the effect of technology flow.

### **3.4. Geographical and Cultural Factors**

(1) Geographical distance and contact frequency. Geographical distance has an impact on the ease and cost of technology mobility. It may be easier for regions that are closer to each other to achieve technology mobility and cooperation, while there may be barriers to exchange and cooperation in regions that are farther away.

(2) Cultural differences and willingness to cooperate. Cultural differences (including values and trust) between different regions will have an impact on the formation of cooperation willingness and cooperation mode.

## **4. Policy Recommendations**

### **4.1. Improve the Institutional Environment**

(1) Increase policy support. The government can further increase policy support for technology flow and mobility, and provide more incentives and incentive mechanisms to encourage universities to actively participate in technology mobility. For example, special funds are set up to support technology flow projects in universities, preferential policies and tax reduction and exemption policies are formulated to provide economic support and convenient conditions for technology flow.

(2) Establish legal and regulatory protection. The government should establish and improve the intellectual property protection system and the legal guarantee mechanism of technology flow contract, and strengthen the protection and enforcement of intellectual property rights. Universities can strengthen the publicity and training of intellectual property laws and regulations, and improve the awareness of teachers and students on intellectual property protection. The government has strengthened IPR enforcement to combat infringement and provide legal protection for technology flows.

### **4.2. Improving the Resources and Innovation Ability of Universities**

(1) Enhance scientific research strength. Universities can further strengthen research investment and innovation ability training, improve the quality and quantity of research results, and enhance the attractiveness of technology flow; Increase the application and undertaking of scientific research projects, provide more research funds and experimental equipment, encourage teachers and students to actively participate in scientific research activities, and cultivate innovative awareness and ability.

(2) Strengthening intellectual property management. Establish a scientific intellectual property management system, strengthen the protection and application of intellectual property, improve the awareness and management ability of intellectual property in

universities. Universities can formulate clear IPR policies and rules and regulations, strengthen IPR education and training, set up specialized IPR management departments, strengthen the application, protection and operation management of IPR, and provide good IPR protection for technology flow.

### 4.3. Strengthen Partner and Network Construction

(1) Strengthen industry-university-research cooperation. Universities can actively establish cooperative relations with enterprises and other scientific research institutions, deepen industry-university-research cooperation, and strengthen technological exchanges and technology flow. Universities and enterprises can carry out cooperation mechanisms such as joint laboratories and R&D centers to promote the transformation of scientific research achievements and the application of technologies.

(2) Establish a reciprocal cooperation network. Universities can advocate reciprocal cooperation in technology flow, establish a stable cooperation network, and strengthen technology flow and cooperation links among universities. For example, through the establishment of technical exchange platforms, the organization of academic conferences and exchange visits, the cooperation and communication between universities can be promoted to establish long-term and stable cooperative relations.

### 4.4. Overcoming Geographical and Cultural Barriers

(1) Strengthening cross-regional exchanges and cooperation. Universities are encouraged to strengthen exchanges and cooperation with universities in other regions, break through geographical and cultural barriers, and achieve barrier-free technology flow. For example, cross-regional cooperation projects and joint research institutions should be established to carry out joint scientific research and technology flow activities.

(2) Enhance the awareness of cultural integration. Universities should strengthen cultural exchanges and understanding, enhance the willingness and ability to cooperate across regions, and promote cultural integration and sharing of technology flows. Universities can organize cultural exchange activities, carry out multicultural education and training, and enhance cultural exchange and understanding between teachers and students in universities in different regions.

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