Research on Knowledge Fusion Process Based on Knowledge Potential in Collaborative Innovation Network

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Abstract

The lack of knowledge fusion efficiency directly hinders the improvement of regional independent innovation and the formation of independent innovation ability. By introducing the characteristics of knowledge potentials and analyzing the motivation and resistance conditions of knowledge elements flowing between networks, this paper proposes a model of collaborative innovation network, and then by analyzing the impact of innovation network on the potential of knowledge, in order to enhance the strength of knowledge flow between networks, this paper also discusses the optimization conditions of the innovation network.

Keywords

Knowledge flow intensity, knowledge position, regional innovation network.

1. Introduction

Collaborative innovation network is constituted by the formation of vertical or horizontal nodes which formed by the business and customers, suppliers, intermediaries, etc[1]. In the environment of network economy and enterprise collaborative innovation, a single innovation entity generally does not have all the necessary knowledge resources for the innovation process to face the problem of knowledge gap, and objectively forms the need of knowledge fusion between innovation entities[2]. Knowledge fusion is the process of innovation main body constantly obtaining, cumulating and sharing knowledge from the co-innovation network based on its own knowledge gap according to certain rules. This process manifests itself as the knowledge flow of the innovation network[3].

In the practice of regional collaborative innovation, the process of knowledge flow in the innovation network is restricted by the social network structure of the innovation subject, and the knowledge flow in the network presents the state of knowledge redundancy or disorderly flow of knowledge. The lack of efficiency of the innovation network not only affects the formation of the center-level characteristics of the regional innovation network and the realization of the value of the knowledge supply chain, but also affects the industrialization process of the innovation achievements and leads to the overall low-level of the regional independent innovation process[4-5]. Therefore, to strengthen knowledge flow control and promote the orderly flow of knowledge among networks is the key to enhance the ability of collaborative innovation.

Domestic and foreign scholars have conducted useful discussions on the problem of the cooperative innovation network from the perspectives of knowledge organization and management, knowledge engineering and knowledge innovation. In the field of knowledge organization and management, based on the definition of knowledge flow process of innovation network, Professor Dang Xinghua and others introduced the knowledge flow coupling process control model by introducing two variables: learning ability and coupling degree between nodes[6]. In the field of knowledge engineering, Professor Yao Min and others studied the algorithm of enterprise knowledge flow control and explored the knowledge management and information technologies that knowledge flow control may involve[7]. Professor Zhang Xiaogang proposed a knowledge flow modeling method

based on workflow and studied the problem of knowledge flow control with the change of knowledge demand and time constraint[8].

Due to the lack of attention to the dynamic factors of the process of knowledge flow in enterprises, the relevant research lacks a clear definition of the process of the process of financial innovation among the innovation entities. In fact, the characteristics of co-innovation network structure, especially the state of knowledge fusion among innovation subjects, not only affect the process of knowledge exchange of subjects, but also are closely related to the formation of knowledge-based efficiency and innovation ability[9]. To minimize the obstacles to the knowledge flow of nodes and to strengthen the control over the knowledge flow among the networks is the core issue of the collaborative innovation process optimization. Therefore, this study analyzes the characteristics of innovation flow and its interaction with the optimization process, aiming at the difference of knowledge endowments and the topological structure of collaborative innovation network, introduces the characteristics of knowledge innovation of innovation network and set up the collaborative innovation model of the network, to discover the law of fusion of knowledge between networks to achieve an overall improvement of regional innovation ability.

2. The characteristics of knowledge flow in innovation network

Knowledge fusion is the process of the innovation main body building, acquiring and accumulating and sharing knowledge from its related innovative enterprises based on its own knowledge gap and constructing an adaptive network. The basic motivation for knowledge fusion among innovation subjects is to provide a continuous source of knowledge for collaborative innovation, which is macroscopically the two-way flow of knowledge formed by the dynamic adjustment of innovative service relationships among the nodes associated with the knowledge chain[10]. Thus, the knowledge fusion of collaborative innovation process is closely related to the state of knowledge flow[11].

In the regional collaborative innovation network, the relevant innovators play different functions such as knowledge transformation, transmission, service and application based on their own knowledge endowments, and in the collaborative innovation practice, they form a structure with different joint strengths relationship. Among them, the strong connection between nodes represents a strong knowledge flow between nodes and related trust, while the weak connection represents a relatively weak state of knowledge flow[12]. The connection between the strength of the innovation nodes objectively promoted the cohesion of the innovation nodes in the process of regional co-innovation, and then formed a number of related local networks. This is the topological structure of the innovation network[13].

In essence, the knowledge flow relationship or connection relationship among innovation nodes ultimately determines the basic trend of knowledge fusion process in the process of regional co-innovation. The innovation network in Figure 1 is composed of innovation entities $\{x_1,x_2,x_3,\ldots,x_9\}$ and their associated regional networks I, II, III, IV, of which the solid lines represent the strong linkages and the dotted lines represent the weak linkages. Due to the topological structure, the innovation network shows different connection relations, and thus presents different characteristics of knowledge flow: (1) There is no direct connection between innovation areas Ⅰ, Ⅱ and Ⅲ, and the strong connection is maintained through the x_1 innovation nodes. Therefore, these three Structural holes exist between innovation networks. However, nodes x_1 and innovative regional networks Ⅰ, Ⅱ and Ⅲ all maintain a strong connection, and the equivalence redundant links formed between them bring a large amount of repeated flows of homogeneous knowledge in the flow of knowledge elements. (2) In regional network II, since innovation node B maintains strong ties with the rest of the innovation nodes, the knowledge elements between the innovation node B and the rest of the innovation nodes are more redundant. (3) Innovative region II and region IV are only weakly connected by innovation nodes x_4 and x_6. This holistic structural hole across groups will have a binding effect on the heterogeneous knowledge transfer between different networks, resulting in heterogeneity between the innovative elements in the network Order flow.

Under this background, the knowledge redundancy and the disordered state of knowledge flow among innovation subjects are the external manifestations of the failure of regional innovation resource integration, which directly restrict the formation of regional independent innovation strength and independent innovation capability[14]. In the practice of regional collaborative innovation, the lack of financial efficiency and the disordered flow of innovation knowledge not only affect the formation of the centrality of regional innovation network and the realization of the value of knowledge supply chain, but also affect the industrialization process of innovation achievements and lead to the regional autonomy the overall process of innovation low-grade. Therefore, it is the core of knowledge innovation and knowledge coordination management that the knowledge of the process of regional co-innovation is known. On the other hand, the optimization of the knowledge flow path and process among the networks is the key to improve the efficiency of the overall innovation of the innovation network.

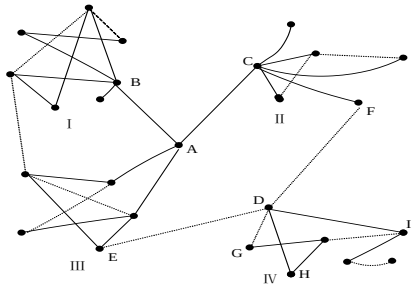

Fig.1 Knowledge Fusion in Collaborative Innovation Node

3. The mechanism of knowledge fusion in innovative network

The theory of knowledge potential holds that all enterprises that carry out technological innovation cooperation under the network environment make up a common knowledge field, and each of them is regarded as a subject of knowledge[15]. There is a difference in the depth and breadth of the innovative knowledge held among the various knowledge subjects, resulting in the inevitable gap between the knowledge positions among the knowledge subjects. This gap in knowledge is the natural force that facilitates the flow, diffusion and integration of knowledge among knowledge subjects. By defining the relationship between nodes' knowledge and potential and the state of multi-dimensional knowledge flows, the knowledge gap and knowledge flow state transition constraints in the process of knowledge fusion are adjusted so as to increase the incremental of innovative knowledge, enhance the time-critical knowledge flow and promote the optimization of regional innovation intensity[16].

The basic motivation for knowledge fusion in collaborative innovation network comes from the discovery of knowledge gap and the profit-taking characteristics of innovative nodes. However, in terms of the process of knowledge exchange in innovation networks, on the one hand, the dynamic factor of knowledge elements' flow needs to be known, that is, the knowledge potential gap of knowledge subjects; on the other hand, the flow patterns of diffusion, aggregation, transformation and application are inevitable will be hindered by many factors such as node connection strength, social network structure and organizational learning model.

In the practice of regional innovation, based on different knowledge potentials and topological features of innovation network, knowledge subjects objectively have significant potential differences in knowledge elements and knowledge gap constraints, and thus determine the knowledge flow of knowledge fusion process among innovation networks strength and direction[17].

In the innovation network of figure.1, nodes x_1,x_2,x_3,… are respectively different function nodes in the process of knowledge innovation, and figure.2 shows the process of knowledge fusion among

different agents. The colored points represent the main body's stock of knowledge. The greater the number, the more stock of knowledge elements, the higher the knowledge position. The process ① indicates that there are differences in knowledge potentials between knowledge entities A and B, which leads to the motivation for such knowledge elements to flow from node A to node B, and the motivation for the flow is indicated by F. The process ② indicates that the knowledge elements are affected by the resistance P that flows from node A to node B due to the blocking conditions such as link strength and knowledge absorption capacity. The process ③ shows that knowledge elements flow from node A to node B when their motivation is stronger than that of the received resistance, as F>P. On the contrary, the cost needed for financial disclosure is higher than the proceeds, and the knowledge elements in subjects A and B do not spread.

In the interest-oriented, knowledge-based, knowledge-based innovation network as a platform for knowledge exchange and sharing process, the differences in the knowledge of the relevant nodes provide the dynamic premise of the flow of knowledge elements, and its obstacles such as social networks, The knowledge elements in the innovation networks are encouraged to flow along the routes with the highest returns so as to ensure the orderliness of the knowledge flows in the innovation networks.

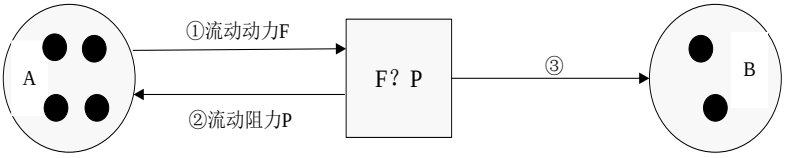

Fig.2 Innovation network knowledge elements flow process

4. The knowledge fusion model of innovation network

In collaborative innovation network, knowledge subject $x_i(i=1,2,\ldots,n)$ is based on its own endowment of knowledge, and its potential for a certain type of innovative knowledge element k is denoted as m_{ik}, while node x_j in the same innovation network has a higher k knowledge factor endowment, The potential is expressed as m_{jk}, then the potential difference between nodes for the knowledge element k is represented as $\Delta m_k=m_{jk}-m_{ik}$. In this case, if there is a knowledge gap for the element k in the node x_i, then Δm_k becomes the basic motivation for the diffusion of the knowledge element k from the node x_j to the node x_i.

The larger the potential difference Δm_k of the knowledge element kbetween nodes, the more motivation of the flow. The flow motivation is represented by the knowledge flow potential $\prod(\Delta m_k)$ between nodes. Only when the momentum $\prod(\Delta m_k)>0$, innovation nodes have the premise of knowledge flow, and the size of the flow potential $\prod(\Delta m_k)$ directly determines the speed of knowledge elements flow $v_k(t)$ [18].

On the other hand, the flow of knowledge element k from node x_j to x_i is restricted by the social network topology in which the node is located. This structural constraint manifests itself as a difference in joint strength between nodes. If the joint strength between nodes is expressed as r, the smaller the value of r, the weaker the joint relationship between nodes, and the breakthrough of the knowledge elements at the cost of this structural constraint also higher. In addition, the absorptive capacity of innovation node x_i based on its own knowledge endowment characteristics for knowledge element k will also affect the flow velocity $v_k(t)$ to a certain extent. If the absorption capacity of node x_i to knowledge element k is denoted as a_k, then the diffusion constraint on knowledge element k, which is determined by the coupling strength r and the absorptive capacity a_k, is shown as a correction of the flow velocity $v_k(t)$ of the knowledge element k.

Affected by this, with the constant flow of knowledge elements between nodes, the potential difference Δm_k of knowledge elements k between nodes tends to decrease continuously during the Δt time interval of knowledge flow, and thus the induced flow potential $\prod(\Delta m_k)$ also tends to decrease.

Therefore, the flow based on k is a non-linear process from strong to weak. Therefore, in the Δt time, the diffusion average speed v_k of knowledge element k can be expressed as:

$$v_k = \int_t^{t+\Delta t} r * a_k * \pi(\Delta m_k) dt \quad (1)$$

Among them, $\theta = r * ak$ represents the coupling strength and absorptive capacity of knowledge elements dialysis speed correction factor.

5. The optimization conditions of network innovation

Based on knowledge endowment characteristics, each knowledge body x_i has its own knowledge position m_{ik} in the network, m_{ik} represents the knowledge area x_i formed by a knowledge body x_i in a particular knowledge area[19]. Because the gap between the main bodies of knowledge is not proportional to the pressure caused by the natural flow of knowledge, the process of financial innovation between the main bodies of innovation must be within a certain threshold of knowledge. If there is a great disparity between the high and low potential, the connection strength between the corresponding knowledge subjects will not be too high, and the cost of the knowledge elements flowing in the network will be too high, which will affect the learning enthusiasm of the low potential knowledge subjects. At the same time, the high-potential knowledge subjects do not have the motivation and motivation to spread knowledge with the low-potential knowledge subjects[20].

In addition, by analyzing the potential characteristics of the main body of knowledge and constraints, innovative nodes on the one hand, not only enhance the motivation of knowledge elements to enhance the flow of knowledge elements, on the other hand, excessive knowledge Potential differences can also lead to differences between the main body is too large, resulting in lower connection strength. On the contrary, too high difference of knowledge position will also strengthen the flow restriction of knowledge elements, and objectively require the exploration of the specific restriction relationship between the knowledge position and the flow of knowledge elements[21].

In order to observe the dynamic process of knowledge flow and knowledge flow of innovation network, according to Riemann's generalized integral definition, this paper formula (1) is:

$$v_k = -\lim_{a \to -\infty}^{b \to +\infty} \int_a^b \theta(\Delta m_k) \times \pi(\Delta m_k) d\Delta m_k \quad (2)$$

Equation (2) describes the relationship between the growth rate of knowledge flow v_k and the difference of knowledge potentialΔm_k. Further expansion of formula (2) according to the definition of Riemann integral gives:

$$v_k = -\lim_{a \to -\infty}^{b \to +\infty} \lim_{\lambda \to 0} \sum_{i=0}^{n-1} \Delta m_k \times \theta(\Delta m_k) \times \pi(\Delta m_k)(y_{i+1} - y_i) \quad (3)$$

Wherein, $y_1, \ldots, y_i, y_{i+1}, \ldots, y_n$ is the division point in the interval [a,b], and $a = y_0 < y_1 < \ldots < y_i < y_{i+1} < \ldots < y_n = b$. The t_i is any point in each small interval $[y_i, y_{i+1}]$, which can be expressed as $y_i \leq t_i \leq y_{i+1}$. Assume that λ is the maximum of $\Delta y_i = y_{i+1} - y_i$, that is $\lambda = \max_{0 \leq i \leq n} (\Delta y_i)$.

The above equation shows that there is an inverted non-linear relationship between the knowledge potential gap Δm_k and the flow rate v_k of gap knowledge, and there is an extreme point v_0 (see Figure 3).

It can be seen from figure.3 that before the gap knowledge flowing rate v_k reaches the v_0, with the increase of the knowledge potential difference Δm_k in the process of knowledge sharing, the knowledge fusion power among the nodes dominates. At this time, a large number of gap knowledge elements at the node between the flow and the gap knowledge flow rate v_k showed a significant growth trend, and after reaching the threshold tends to be stable. However, as the knowledge flow rate v_k reaches the extreme point v_0, with the increase of knowledge differenceΔm_k, the joint strength

between nodes is also gradually weakened, and the flow costs of knowledge elements are also increasing. The gap knowledge flow rate v_k is presented the trend does not increase down. Therefore, when choosing the target of knowledge matching for the subject of knowledge, we should consider the motivation and resistance factors in the process of financial amelioration, so as to maximize the gap flow of knowledge.

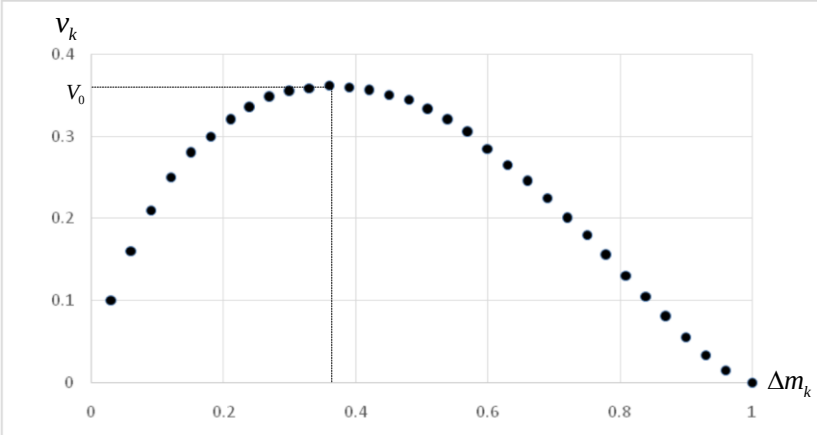

Fig.3 Gap knowledge flow rate increase and decrease trend map

6. Conclusion

Knowledge fusion is the basic motivation for collaborative innovation of knowledge flow in network. The orderliness of the flow of knowledge elements in the network affects the efficiency of knowledge fusion among nodes. By defining the knowledge base of innovation networks, we can help us understand the knowledge endowment characteristics of all the agents in the network and find out the corresponding knowledge gap needs effectively. Influenced by the poor knowledge situation, the gap knowledge elements have the tendency and motivation to flow from the high potential nodes to the low potential nodes on the one hand. On the other hand, the problem of financial constraints caused by the high potential differences can not be neglected. Judgment of the relationship between the magnitude of the knowledge and the resistance will eventually affect the decision-making of knowledge flow among the innovation networks. Therefore, the knowledge position is of great significance to optimize the flow of knowledge in the innovation network and enhance the efficiency of financial knowledge fusion.

In the management practice of the innovation network, firstly, we should provide the innovative enterprises with the direction of financial information according to the knowledge potential characteristics of the financial information network to help them define the characteristics of the knowledge gap, and then guide the node enterprises to make the decision of the financial selection path to help them Matching with the target of the financially-informed target with relatively low profit and high profit; Secondly, it is necessary to strengthen knowledge acquisition and exchange awareness of innovation nodes and strive to improve the knowledge connection status of node entities so as to provide a good communication platform for cross-enterprise information and innovation, Reduce the cost of knowledge discovery and innovation communication. In the course of collaborative innovation among enterprises in each node, it is a win-win or win-win to realize the profit and efficiency of enterprises in innovation node that the expected goal of network optimization and external guidance platform construction is learned.

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