Innovation Subsidy of Industrial Generic Technology Based Knowledge Niche Debugging

Yue Long, Qinzhou Zeng and QiHao Chen[1]

***Abstract*— To explore the dual regulatory role of government subsidies in the aspect of industrial generic technology innovation, and given the factor of knowledge-ecological debugging, the subsidy pattern of industrial generic technology innovation is designed. Then, a modality model of knowledge niche based on Cobb-Douglas function and a knowledge-ecological debugging model based on an improved Lotka-Volterra model were constructed. Combining with qualitative and numerical examples, this paper analyzes the dual regulation mechanism of government about knowledge input and ecological interaction under decentralized and centralized decision-making. Fundings: through the knowledge ecological chain with multi-subject participation, the government subsidies are used to regulate the knowledge input of various organizations in the midst of industrial generic technological innovation and promote the interaction of knowledge ecology, and adjust the ecological positions of different knowledge, and boost the bidirectional flow, transfer and transformation of knowledge between different disciplines, and realize endogenous development. These are conducive to improving the efficiency of knowledge resource allocation in the technology innovation chain. It is expected to improve the effectiveness of industrial generic technology innovation.**

***Index Terms*—Knowledge Interaction; Industrial Generic Technology Innovation; Knowledge Ecology; Subsidy**

I. INTRODUCTION

IN the new normal background, Chinese economy needs to strengthen the supporting role of industry. The industry generic technology innovation is a significant constituent of the country-level innovation strategy. Meanwhile, the innovation development is conducive to the integration of the industrial generic technology innovation resources and guides the innovation elements to the enterprise agglomeration [1]. It can form a complete technological innovation chain and promote the industrial technological innovation. This is an effective way to enhance the core of industrial competitiveness [2-3]. For example, the structure and evolution of matter can be deconstructed through the construction of a super transient large scientific experiment device, which can solve the common technical problems in the field of advanced manufacturing industry. Consequently, the industry generic technology innovation has a certain quasi-public nature. More importantly, government regulation has important influences on the development of industrial technological innovation. As one of the public policies, the subsidy policy (such as financial direct appropriation, tax preference, government procurement, etc.) as an important measure to regulate the "market failure" has become a necessary mean and important power in guiding the industry generic technology innovation [4-6].

However, with the advent of knowledge economy, knowledge plays a fundamental role and has become one of the most important elements of the industry generic technology innovation. In the process of the industry generic technology innovation, knowledge interaction (it refers to the transfer, exchange, sharing and innovation processes of information and knowledge among knowledge owners) is the core attribute and the main activity of cooperative innovation among organizations. Meanwhile, it is also the key link for obtaining competitive advantage [7]. Knowledge interaction includes knowledge storage (cognition) and interaction process (behavior), and the existing researches mainly focus on the latter [8-9].

From the perspective of knowledge management and government subsidy, the distribution of knowledge resources in the across-organization relationship presents the following new characteristics: (1) the innovation power is double wheeled. The aims of the industry generic technology innovation are to solve the important and key technology (or generic technology) issues. Innovation activities emphasize the main body status of enterprise and have a certain quasi-public. As a "post-fat" country, in China, industrial technology reserves are relatively inadequate. In many industries (such as strategic emerging industries and traditional industries), technology innovation that relies on the market to carry on the resource allocation exists the insufficient capacity in helping the technological innovation. Therefore, this proposed innovation activity has a double-wheel drive characteristic with the government guidance and the market leading. (2) The knowledge

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interaction ecology. In the innovation process, knowledge has become the key factor to promote the industry generic technology innovation. Through the investments of tacit knowledge and explicit knowledge, the different interest entities will change the knowledge structure and function in the whole innovation chain. Knowledge can be evolved through constructing the knowledge ecological chain and using the knowledge ecology interaction (including knowledge transfer, transformation, etc.). To optimize the allocation of knowledge resources and promote the knowledge economization, it is necessary to realize the allocation of knowledge resources across organizations in the industry generic technology innovation. (3) Leverage of government subsidy. The industry generic technology innovation is devoted to the construction of technological innovation chain to promote the developments of the whole industry, and gain economic and social benefits. Government subsidy will play the lever value in the enterprise-led knowledge input and knowledge interaction process.

Thus, considering the aforementioned new characteristics about the distribution of knowledge resources in the across-organization relationship, studying the knowledge ecology debugging in the industrial generic technology innovation and the regulation mechanism of government subsidy is widely concerned. However, previous researches are few about this question. Some researches discussed the knowledge interaction behavior of the actors of institutional innovation from different perspectives [10-11]. Meanwhile, researches about the knowledge ecosystem interplay in the industrial technological innovation and regulation mechanism of government subsidy were widely concerned [12-13]. The characteristics of resource allocation are the knowledge ecology interaction that is guided by government subsidy in the industrial technology innovation. A “two-wheel drive” mode refers to government guidance and enterprise orientation, which will generate knowledge ecology chain and technology innovation chain. An uncertain equilibrium will appear when the government regulates both chains, and this state has a significantly effect on the efficiency of knowledge resource cross-organization assignment What is the coordination mechanism for each subject to make decisions based on these new features, especially, the regulatory role of the government in the progress of knowledge input and knowledge transformation has not yet been reflected.

We will research the following two specific questions:

(i) What is the dual regulatory mechanism of the government regarding knowledge input and knowledge ecology interaction.

(ii) How does government subsidy promote the interaction of knowledge ecology in the process of regulating knowledge input? In this latter research question, it is necessary to design a model of the industry generic technological innovation subsidy grounded on knowledge ecology debugging.

By answering the aforementioned research questions, the current research enhances the understanding of the new traits of the industry generic technological innovation, which is the knowledge ecological debugging guided by government subsidy. Specifically, this paper will replenish to this field in four ways. (i) Providing the industry generic technology innovation, knowledge debugging and government subsidy, which will help to be clarify the connection between the concepts. (ii), Building on such definitions and previous researches in the field, the knowledge is divided into explicit knowledge and implicit knowledge, and then a conceptual model of government subsidy in the industrial technological innovation is proposed. (iii) Two models are proposed, and one is the input-output utility framework of knowledge grounded on the Cobb-Douglas function, and the other is a knowledge ecology interaction model based on Lotka-Volterra. Subsequently, we can get the equilibrium state of subsidy under decentralized and centralized decision-making models. (iv) Further research and practical implications, and the conceptual development of government-guided knowledge chain and technology innovation chain are expanded.

Our research have huge scientific values. Academically, this study will reveal the dual regulation mechanism of government subsidy in the course of allocating knowledge assets, which expands the theory research about the coordinated advancement of knowledge chain and technological innovation chain. Moreover, the methods of the traditional input-output utility model and the knowledge ecology debugging model are expanded. In practice, the two-way regulation mechanism of the government accelerates the knowledge transfer from one organization to another, which is conducive to improving the efficiency of knowledge asset allocating in the industrial technology innovation process.

II. LITERATURE REVIEW

Industrial technology innovation is a new form of traditional organization cooperation innovation. Domestic and foreign scholars have carried on continuous researches about the knowledge interaction and government subsidy in the organization cooperation innovation aspect. In the aspect of knowledge interaction, regarding the first dimension, the process of organizational cooperative innovation depends on its dynamic capabilities, and its core is knowledge interaction. A variety of knowledge innovation activities (such as knowledge absorption, knowledge innovation, knowledge sharing, etc.) would promote the generation and development of dynamic capabilities [14-16]. In terms of knowledge ecological interaction, Long and Liu [17] construct an ecological relationship of "mutualism + favoritism", which was expected to promote the efficient and balanced evolution of knowledge interaction. In addition, the process about integrating knowledge into technology transfer was realized by the knowledge sharing among the open innovation partners [18]. Knowledge management as the content of strategic learning boosted the organizational cooperation and innovation [4]. Knowledge interaction was static and dynamic in the process of organizational innovation cooperation as described by Wang et al. [20] and Tödtling et al. [19-20]. Wang and Li [20] pointed out that knowledge transfer and knowledge spillover in the background of R&D alliance should comprehensively consider R&D alliance and knowledge innovation. Ma et al. [21] pointed out that the matching of partner members had an impact on the performance of knowledge sharing and organizational innovation cooperation in the context of industry-university-research cooperation. Regarding the second dimension, Zhao and Sui [22] pointed out that the knowledge environment, content, carrier and channel were fusing into an organic whole, meanwhile, it showed a kind of ecological characteristics. Chen et al. [23] put forward that the knowledge ecology was formed by knowledge transfer and knowledge flow among the knowledge nodes (the nodes taking knowledge as the innovation source). Knowledge ecology also showed the characteristics of ecological energetics [24]. It would affect the innovation behavior by influencing the innovation performance of the innovation organization. Zhan and Wang [25] pointed out that knowledge ecology was an innovative activity of innovation organization in the metropolitan circle, which had the relationships about factor coupling and mechanism synchronization. Thus, it can interpret the innovation and development of metropolitan circle innovation system.

Based on the aforementioned analyses, we can draw a conclusion that knowledge interaction study from the ecological perspective gradually received attention.

In the aspect of the government subsidy, due to the distinctive dynamic characteristics of the institutional environment for industrial technological innovation in China, government intervention played an important role. Weber and Rohracher [26] pointed out that government intervention was mainly to solve "transformative system failure", such as creating more opportunities for innovation through government subsidy [27-28]. Government subsidy was used as one of an efficient government intervention mechanism to co-evolve with organizational innovation behavior, and it would effectively promote the increase in the number of organizational innovations [18,29,30] and efficiently achieve continuous innovation in industrial technology[30]. Then, Meng et al. [31] and Weber et al. [26] constructed the cooperation game model of the manufacturer and the supplier with the condition of government subsidy. Li et al. [32] constructed the multistage game model and analyzed the research and development subsidy of government and supplier, and then pointed out that the government subsidy was advantageous to improve social welfare and promoted the R&D investment to achieve the market equilibrium. Considering the intrinsic production cost and the external innovation subsidy, Sheng and Zhang [33] analyzed the influences of government subsidy or enterprise innovation product subsidy on the innovation mode choice. Liu and Zhao [34] used the multi-agent Blanhe platform to implement the simulation experiment, and then pointed out that the market-side subsidies should timely exit and technical subsidies should increase. Through the empirical evidence, Zhang and Chen [35] proposed that the government subsidy, in the appropriate interval, promoted enterprise R&D investment. If the subsidy was too much, it would squeeze the other R&D inputs and could not play a role in promoting enterprise innovation. Li [36] proposed that R&D was positively promoting the output of technological innovation in the new energy vehicle industry. He [37] proposed that the imitative capability and learning efficiency of local firm was negatively related to technology transfer speed. The research also showed that game theory was suitable for the analysis of multi-agent competition and cooperation [38], such as enterprise could accounting resource sharing behavior [39], the cooperative efficiency of all parties in emergency rescue [40].

By analyzing the existing results, we get that: (i) existing studies on government subsidies and knowledge interaction aimed at inter-organizational cooperative innovation mostly taken knowledge as a single organizational variable, and rarely combined the characteristics of knowledge niche guided by government subsidies to analyze its influence mechanism on knowledge chain and innovation chain, and revealed the value of government dual regulation on knowledge resource allocation. (ii) The existing researches mainly adopted game theory and empirical research. Combining game theory and ecology to study the integrated growth of knowledge chain and technology innovation chain was few under government regulation.

Grounded on the above analyses, we will combine the utility theory, knowledge management, knowledge ecology and the government subsidy of industrial innovation in technology to guide the dynamic properties of knowledge chain, then exploring the influence mechanism of government subsidy about knowledge investment decisions and ecological interactive evolution in industrial technological innovation process. It will provide a theoretical reference for the government to formulate subsidy policy and promote industrial technology innovation

III. Model Design about Industrial Generic Technology Innovation Rooted in Knowledge Ecology Debugging

Based on the definition of the industry generic technology innovation, to break the common features of industrial development and key technology, and then achieve the spontaneous establishment of the technological innovation chain with complementary advantages, we set up an the industry generic technology innovation including core organizations (such as, enterprises, input knowledge) and node organizations (such as, universities and research institutes, etc., input knowledge). By blending the explicit knowledge and tacit knowledge, we can implement the technology R&D and product development (see Fig. 1).

To improve efficiency in configuring knowledge resources across organizations, based on the theory of knowledge chain, the untapped knowledge resources, knowledge ecology debugging and the conventional paradigm of the industry generic technological innovation (see Fig. 1), we constructed a new subsidy model of industrial generic technology innovation (see Fig. 2). It can be described as: (1) interaction subject. In the process of the industry generic technology innovation, the "double wheel drive" (namely, government guidance and market-oriented) is the driving force of the construction and the development of the technology innovation chain. Therefore, its main body not only includes the enterprises in the traditional market main body, the research institutes, the universities and other related interest subjects (called the innovation main body), but also includes the government. Each subject realizes the interaction through the constructing knowledge chain. In this chain, each body owns different knowledge potential, and knowledge will flow from the higher potential body to the lower potential subject. Namely, knowledge transfer (such as Fig. 2 in ①, ②). (2) Knowledge interaction strategy. During the process of industrial technology innovation, the main body in the technology innovation chain will put into the tacit and explicit knowledge to change the structure and function of knowledge resource configuration within the technology innovation chain. Based on the SECI knowledge transformation model [41], because of the differences of each subject in knowledge potential and knowledge transformation ability, these differences will affect each subject to implement different interaction strategies.

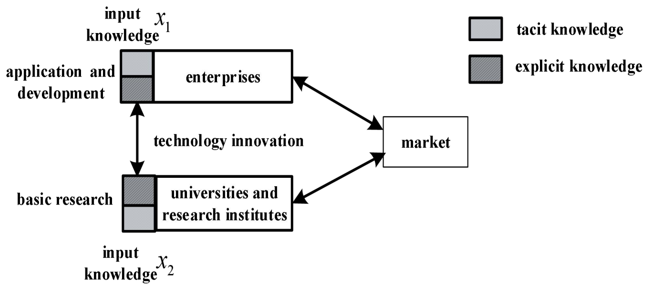


Fig.1. the traditional mode of the industry generic technology innovation

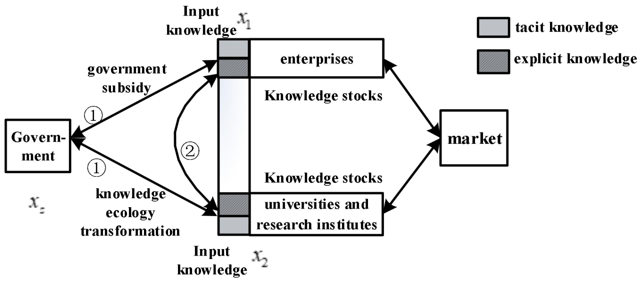


Fig.2. Model of the industrial generic technology innovation subsidy based on knowledge ecology debugging

These interactive strategies are embodied in the knowledge chain differences between the inputs regarding the tacit knowledge and the explicit knowledge. Based on the input knowledge type of each subject within the technological innovation chain, the interactive strategy could be summed up as follows: The decentralized decision-making under the government regulation (the innovation subject invests in the tacit knowledge, and has the exclusive nature. In addition, there is not a knowledge chain between the main body.) and the centralized decision under the government control (the innovation subject invests in the explicit knowledge, and has the commonness, and the innovation main body has formed the knowledge chain and the knowledge resource disposition relation). (3) Interaction results. Different evolutionary equilibrium results will be formed under different interactive strategies. In the decentralized decision-making of government regulation, it often constructs a high knowledge ecological potential through government, and regulates knowledge transfer or knowledge transformation. These can promote the knowledge stock change of various subjects. In the centralized decision-making, the innovation subject is a leader in adjusting the knowledge ecological posture and coordinating the entire knowledge resource allocation. Government subsidies are supplemented.

IV. Knowledge Input-Output Utility and Ecological Interaction Model Construction and Analysis

A. Theoretical basis, variables and assumptions

Based on the analyses of the subsidy model about the industrial generic technology innovation, to facilitate the discussion and simplify the operation, we set up the main body of the model (one core organization and one node organization, forming the technological innovation chain) and the regulation subject (the government undertakes)

Based on the model description and the previous researches [42], we set the following assumptions and the related description about parameters see table I.

TABLE I
DESCRIPTION ABOUT PARAMETERS

Parameters	Description
π_{x_i}	The profit that the innovation main body obtains through the input knowledge x_i.
L	The knowledge of the core organization input x_1 (covering tacit knowledge and explicit knowledge) and is expressed in equilibrium, and its elasticity coefficient α reflects the individual attribute of knowledge in the process of innovation. C_L indicates the cost of the core organization to operate each unit of knowledge.
K	The knowledge x_2 of the organization input (covering tacit knowledge and explicit knowledge) and is expressed in equilibrium, and its elasticity coefficient β reflects the individual attribute of knowledge in the process of innovation. C_K indicates the cost of the core organization to operate each unit of knowledge.
D	The impact of knowledge input on market demand, and Q indicates the promotion of knowledge input to product quality, and λ indicates the marginal demand rate of quality (i.e., the enlarged market demand of unit quality).
ρ_{x_i}	The marginal benefit that the member obtains in the progress of industrial technology innovation and is the income embodiment of the transformation of the innovation result.
A	The ability of each member to transform knowledge resources into value, which is a constant of more than zero in the process of innovation.
δ_1, δ_2	The government subsidy coefficient from the core organization and the node organization in the innovation chain, respectively. Both of them are greater than zero.
Δn_{x_i}	The knowledge growth of knowledge x_i at moment t ($t > 0$).
r_{x_i}	The rate of growth of knowledge stock x_i at moment t ($t > 0$)
$\eta_{x_i x_j}$	The ability factor of knowledge transformation from knowledge x_i to knowledge x_j (which represents the ability of a subject owning knowledge to learn and transform knowledge in the course of knowledge interaction).
N_{x_i}	The maximum knowledge stock that the knowledge x_i needs to invest under the influence of other knowledge, which is the expression of the knowledge potential of the main body.
θ_{x_i}	The knowledge transfer proportional coefficient in the process of knowledge interaction, which mainly refers to the proportion of knowledge stock change caused by knowledge transfer and is a comprehensive concept.
n_{x_1}, n_{x_2}, n_{x_z}	The core organization input knowledge, the node organization input knowledge and the government input knowledge quantity, respectively. It uses L to express the input quantity when n_{x_1} equilibrium, and uses K to express the input quantity when n_{x_2} equilibrium.

(1) Based on the definition of the industry generic technology innovation [2], the core organization and the nobe organization use their own knowledge input (covering implicit knowledge and explicit knowledge) to adjust the quality and quantity of knowledge, and carry out technology research and development, production and other activities to enlarge market share. Assuming that the data exchange between the core organization and the node organization is completely symmetrical. The government releases the policy of innovation subsidy. In addition, the innovation main body carries out the implicit knowledge input, the explicit knowledge input, and the government subsidizes. Based on the previous researches [43], assuming there is a linear relationship between product quality and market demand. Based on the improved Cobb-Douglas production function, the product quality function and the market demand function were constructed. E.g., $D=\sigma+\lambda Q$ and $Q=AL^{\alpha}K^{\beta}$, here, σ is the inherent demand of the market before new product development. The profit functions of the core organization and the node organization are as follows, respectively.

$$\pi_{x_1}=\rho_{x_1}D-C_L L(n_{x_1},n_{x_2},n_{x_z})+\delta_{x_1}C_L L(n_{x_1},n_{x_2},n_{x_z}) \tag{1}$$

$$\pi_{x_2}=\rho_{x_2}D-C_K K(n_{x_1},n_{x_2},n_{x_z})+\delta_{x_2}C_K K(n_{x_1},n_{x_2},n_{x_z}) \tag{2}$$

For the discussion convenience, we use L to represent $L(n_{x_1},n_{x_2},n_{x_z})$ and use K to represent $K(n_{x_1},n_{x_2},n_{x_z})$.

(2) Based on the previous researches [31], setting up the main body of the innovation chain should first do the input and allocation of the knowledge resource. The government subsidies are to make up the shortfall about the innovation activities of R&D and production in the industry generic technology innovation. Through the development of new technologies, the new product production can improve enterprise efficiency and market competitiveness. To facilitate the impact analyses of government subsidies, the utility value π_{x_i} is defined as the innovation effects achieved by each subject in the technological innovation chain minus the amount of government subsidy, such as formula (3).

$$v(\delta_{x_1},\delta_{x_2})=(\rho_{x_1}+\rho_{x_2})D-C_L L-C_K K \tag{3}$$

(3) Based on these theories (i.e., knowledge potential, knowledge transfer and knowledge stock), we think that it is suitable to adopt Lotka-volterra paradigm to reflect the knowledge interaction relationship and its evolution process in the innovation chain [8]. In the setting up process of the industry commom technological innovation and through establishing the knowledge ecological chain, the organizations can realize the trans-organization knowledge interconnectivity and flow. Different kinds of knowledge will increase the knowledge in a certain threshold value. For the knowledge input x_1 of the core organization, Δn_{x_1} expresses the instantaneous knowledge growth. The instantaneous growth rate under the single kind of knowledge closed environment is $r_{x_1}=\Delta n_{x_1}/n_{x_1}$, and n_{x_1}/N_{x_1} is the knowledge density and $(1-n_{x_1}/N_{x_1})$ shows the factor of knowledge growth rate with the accumulation of input knowledge. The knowledge growth rate is $\Delta n_{x_1}/n_{x_1}=r_{x_1}(1-n_{x_1}/N_{x_1})$. When $n_{x_1}=N_{x_1}$, the knowledge growth rate tends to be zero. Considering the influences of the input knowledge x_2 on the knowledge x_1 growth, the model was modified to the formula (4).

$$\frac{\Delta n_{x_1}}{n_{x_1}}=r_{x_1}(1-\frac{n_{x_1}}{\theta_{x_1}N_{x_1}}+\eta_{x_2x_1}\frac{n_{x_2}}{\theta_{x_1}N_{x_2}}),\eta_{x_2x_1}>0 \tag{4}$$

In the formula (4), $\theta_{x_1}N_{x_1}$ and $\theta_{x_1}N_{x_2}$ represent the knowledge transfer (from the original stock knowledge transfer) and the increase of the corresponding knowledge stock at knowledge interaction, respectively. Considering the government input knowledge π_{x_i} , the core organization knowledge growth model was modified as formula (5):

$$\frac{\Delta n_{x_1}}{n_{x_1}}=r_{x_1}(1-\frac{n_{x_1}}{\theta_{x_1}N_{x_1}}+\eta_{x_1x_2}\frac{n_{x_2}}{\theta_{x_2}N_{x_2}}+\eta_{x_1x_z}\frac{n_{x_z}}{\theta_{x_z}N_{x_z}}),\eta_{x_1x_2}>0,\eta_{x_1x_z}>0 \tag{5}$$

Similarly, it can describe the growth process in which the government and the node organizations investing in knowledge.

B. Analysis of subsidy equilibrium under decentralized decision and centralized decision

In this paper, we described this model as following. In the course of the industry generic technological innovation, the core organization and the node organization decided and cooperated according to their respective advantages. To promote their own quality, putting into the tacit knowledge (such as proprietary knowledge), taking into account the importance of the tacit knowledge, implicit and so on. The input main body is unwilling to flow (or the implicit knowledge of investment is difficult to flow effectively among the innovation subjects).

The organizations carry out innovative activities through decentralized decision-making (e.g., in the early stage of the new industry development, the node organizations lack the relevant theoretical knowledge reserves) to do the related basic theory and method research. The core organizations (such as enterprises) lack production, management and other experiences, the corresponding management exploration, the formation of experience accumulation. Taking into account the innovative actions, the organization achievements will promote the industry development. It has a certain quasi-public nature. To encourage innovation input, the government issued subsidy policy and committed to subsidize the organizations undertaking innovative activities. The unit subsidy rate is δ_{x_1} and δ_{x_2} .

The organization of industrial generic technology innovation will do investment decision according to the level of government subsidy knowledge input. Its essence is that the input knowledge of the main body is not connected. Through the distribution of subsidies will achieve knowledge inter-connectivity between the government and the organization in the technology innovation chain, and then use the building knowledge chain to promote knowledge flow. At this time, the organizations will input according to their own benefits, based on formulas (2) and (3), setting $\partial\pi_{x_1}/\partial K=0$ and $\partial\pi_{x_1}/\partial L=0$. Then, we get $K=C_L\beta\rho_{x_2}\left(1-\delta_{x_1}\right)L/C_K\alpha\rho_{x_1}\left(1-\delta_{x_2}\right)$. To further calculate the balance of two organizations, the knowledge input is:

$$\begin{cases} L^{'} = (A\lambda)^{\frac{1}{1-\alpha-\beta}}[\alpha\rho_{x_1} / C_L\left(1-\delta_{x_1}\right)]^{\frac{1-\beta}{1-\alpha-\beta}}[\beta\rho_{x_2} / C_K\left(1-\delta_{x_2}\right)]^{\frac{\beta}{1-\alpha-\beta}} \\ K^{'} = (A\lambda)^{\frac{1}{1-\alpha-\beta}}[\alpha\rho_{x_1} / C_L\left(1-\delta_{x_1}\right)]^{\frac{\alpha}{1-\alpha-\beta}}[\beta\rho_{x_2} / C_K\left(1-\delta_{x_2}\right)]^{\frac{1-\alpha}{1-\alpha-\beta}} \end{cases} \quad (6)$$

The formula (6) expresses the amount of knowledge infusion of the core organization and the node organization under the equilibrium state, then, putting it into the government subsidy utility function $v(\delta_{x_1}, \delta_{x_2})$ and making $\partial v/\partial\delta_{x_1} = 0$ and $\partial v/\partial\delta_{x_2} = 0$, we can obtain the subsidy proportion of the each organization under the decentralized decision (see formula (7)).

$$\begin{cases} \delta_{x_1}^{'} = [\rho_{x_2} + (1-\lambda)\rho_{x_1}] / \left(\rho_{x_1} + \rho_{x_2}\right) \\ \delta_{x_2}^{'} = [\rho_{x_1} + (1-\lambda)\rho_{x_2}] / \left(\rho_{x_1} + \rho_{x_2}\right) \end{cases} \quad (7)$$

The formula (7) reflects the government subsidy rate under the Nash equilibrium when the organizations disperse the decision. It is not difficult to find that, at this time, the subsidy rate will depend on the quality of marginal demand rate λ, as well as the technological innovation chain in the marginal benefits ρ_{x_1} and ρ_{x_2}.

The above research shows: (1) Improving quality is an important factor affecting the market demand. If the marginal demand rate of quality is greater (i.e., $\lambda \to 1$), the technological level will have a greater impact on the market (i.e. the higher the technological level of innovation subjects, the greater the market share, and the lower the government subsidy obtained by individual organizations). When λ is certain and the subsidy is in equilibrium, the government subsidy rate is related to the return marginal rate and the return marginal rate of the other parties. Under this kind of investment mode, the function of government subsidy is to make up the insufficiency of the main body of the technological innovation chain, and then promote the innovation investment. At this time, through the government subsidy and increasing the social welfare, the return marginal rate of the organization will receive a higher subsidy, and the return marginal rate of the organization will receive a lower subsidy to promote the development of all aspects of the balanced growth in the industry generic technology innovation.

(2) If the marginal demand rate of quality is small ($\lambda \to 0$), it shows that the level of technology has a less impact on the market. Investment will become an important factor to expand the market. The main innovation chain and the government input are conducive to the market demand development. When the input is balanced, the government subsidy rate $\delta_{x_1}^* = \delta_{x_2}^* = 1$. However, this also indicates that government subsidy has become a substitute for the innovation input of various organizations. The government investment will make the knowledge input of the main body of the technological innovation chain cause the incentive dislocation and the subsidy dependence. It will fail to play the subsidy "lever" function and produces the positive public resource allocation.

In addition, the above discussions are based on the assumption that the knowledge chain members constructed by the government and the innovation chain are not effective knowledge transfer and transformation in the knowledge investment process. However, in the practical knowledge chain operation process, the knowledge as an intangible resource, the value and the overflow is coexist through the knowledge interaction. Each knowledge subject's knowledge quantity will take place the transfer and the transformation. It will affect the equilibrium knowledge input quantity L and K. Next, we will analyze the knowledge input process, the government input knowledge and the core organization input knowledge mutual influence, and reveal the knowledge transformation and the transfer mechanism.

Combining with the preliminary research foundation [8] and based on the SEIC model [41], the government input knowledge (at this time, the government input knowledge can be understood that obtaining knowledge by the finance) and each innovation subject in the knowledge input process will carry on the knowledge interaction. The knowledge input total of each main body in the innovation chain is the input knowledge function of $n_{x_1}, n_{x_2}, n_{x_z}$. It can be expressed as $L(n_{x_1}, n_{x_2}, n_{x_z})$ and $K(n_{x_1}, n_{x_2}, n_{x_z})$. According to the previous analyses and preliminary research results, when the knowledge input achieves a balance, we get the equation set (8).

In the formula (7), the evolution process of the government input knowledge is expressed as $\phi_1(n_{x_z})$. $\omega_1(n_{x_1}, n_{x_z})$ indicates the evolution process when the core organization inputs knowledge. $\varphi_1(n_{x_2}, n_{x_z})$ represents the node organization input knowledge evolution process. Based on the preliminary researches [8] and the ternary equation group (8), we get $A_2(0, \theta_{x_z} N_{x_z})$ and $A_4(\theta_{x_1} N_{x_1}(1+\eta_{x_1 x_z}), \theta_{x_z} N_{x_z})$ (such as Fig. 3).

$$\begin{cases} \phi_1(n_{x_z}) = 1 - \dfrac{n_{x_z}}{\theta_{x_z} N_{x_z}} = 0 \\ \omega_1(n_{x_1}, n_{x_z}) = 1 - \dfrac{n_{x_1}}{\theta_{x_1} N_{x_1}} + \eta_{x_1 x_z} \dfrac{n_{x_z}}{\theta_{x_z} N_{x_z}} = 0 \\ \varphi_1(n_{x_2}, n_{x_z}) = 1 - \dfrac{n_{x_2}}{\theta_{x_2} N_{x_2}} + \eta_{x_2 x_z} \dfrac{n_{x_z}}{\theta_{x_z} N_{x_z}} = 0 \end{cases} \quad (8)$$

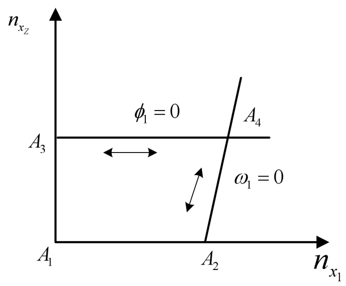


Fig.3. Evolution Trend of the core organization knowledge under government subsidy

The equilibrium points A_2 and A_4 are the feasible solutions of the evolution process $\phi_1 = 0$ and $\omega_1 = 0$. Combining with the previous research foundation [8], we get when $\eta_{x_1 x_z} > 0$, the steady state evolves into A_4, at this time $N_{x_1}^{'} = N_{x_1}(1+\eta_{x_1 x_z})$. Because $\eta_{x_1 x_z} > 0$, $N_{x_1}^{'} > N_{x_1}$. Similarly, the equilibrium value $N_{x_2}^{'} > N_{x_2}$ can be obtained after the interaction and transformation of knowledge inputs by government and the node organization (socialization activity between tacit knowledge). Namely, due to the knowledge transformation, the government creates new knowledge and produces synergy multiplier effects after the interaction between the core organization and the node organization.

This indicates that through government subsidies, we can build a knowledge ecological chain and then transfer the knowledge from the government at a higher knowledge position (such as knowledge obtained through government subsidies or purchase) to each node in the technology innovation chain, so as to promote the knowledge transformation and transfer of each subject in the industrial generic technological innovation chain. It is beneficial to make up for the lack of knowledge input in the aspect of industrial generic technology innovation. In addition, it shows that the knowledge transformation capacity coefficient η of each innovation subject is an important factor in influencing the transformation and evolution of government and the core organization. Based on these, by adjusting the knowledge transformation ability coefficient of the main body, it is projected to boost the knowledge transformation of the innovative subjects in the technological innovation chain and achieve the high efficiency value of knowledge.

C. Analysis of subsidy equilibrium under concentration decision

In this paper, we described the model as follows. Considering the quasi-public nature of the industry generic technology innovation and to make up the insufficiency of the innovation investment, the core organization and the node organization invest in the explicit knowledge (for each innovation subject, have commonness, can replace). As the core organization of the main body (such as enterprise) plays the leading role, we can coordinate the knowledge resources of each organization in the technological innovation chain. We can use the centralized decision-making, and integrate the innovative resources, and integrate the knowledge resources into a whole, and establish the knowledge ecological chain, and then pursue the maximization of the common interests. At this time, the government undertakes the subsidy pledge, and the technical innovation chain members carry on the knowledge resources disposition. After the community observes the subsidy proportion to carry on the knowledge investment, and then it will obtain the profit maximization. Therefore, the objective function in the process of the industry generic technology innovation can be expressed as the formula (9):

$$Max[v(\delta_{x_1},\delta_{x_2})]=(\rho_{x_1}+\rho_{x_2})D-(1-\delta_{x_1})C_L L-(1-\delta_{x_2})C_K K \quad (9)$$

The formula (9) is derivative (The calculation of the formula (9) is similar to that of B). Let $\partial v/\partial\delta_{x_1}=0$ and $\partial v/\partial\delta_{x_2}=0$, and we get when $\rho_{x_1}(1-\alpha)+\rho_{x_2}(1-\beta)=0$, the knowledge input achieves a balance, at this time $\alpha+\beta>1$. It shows that through innovation to expand the scale of market share is advantageous. No matter what value $\delta^*_{x_1}$ and $\delta^*_{x_2}$ are, it does not have an impact on the equilibrium value (namely, through the allocation of market resources, we achieve the innovation chain of "own hematologists" function). It can be seen that, under the centralized decision, if the marginal benefits of each members innovation and the knowledge individual attribute are under certain conditions, the government does not provide subsidy, it will also form Pareto equilibrium and realize the optimal investment.

The above research shows that by building the knowledge chain among the main body to realize the arrangement of knowledge resources across organizations is beneficial to exert the regulative function of the market subject in the resource allocation, and it will promote the industry generic technology innovation. The purpose of government subsidy is to provide social welfare. When the organizations in the technological innovation chain can reach the allocation of market resources through market regulation, government subsidy is not required. If the government subsidy is carried out at this time, it will affect the innovation input enthusiasm of the market subject, and produce the "extrusion" effects, and will not produce the positive public resource allocation values.

Similar to section A in chapter IV, the above analyses have not considered the knowledge transformation and transfer in the two kinds of knowledge interaction. Next, to reveal the mutual influence mechanism of various kinds of knowledge, we will further analyze the interaction process of the knowledge input amount L and K at knowledge equilibrium. Based on the research process in section A in chapter IV, the knowledge interaction and evolution equation of the core organization and the node organization are constructed (see formula (10)).

$$\begin{cases}\omega_2(n_{x_1},n_{x_2})=1-\dfrac{n_{x_1}}{\theta_{x_1}N_{x_1}}+\eta_{x_1x_2}\dfrac{n_{x_2}}{\theta_{x_2}N_{x_2}}=0\\ \varphi_2(n_{x_1},n_{x_2})=1-\dfrac{n_{x_2}}{\theta_{x_2}N_{x_2}}+\eta_{x_2x_1}\dfrac{n_{x_1}}{\theta_{x_1}N_{x_1}}=0\end{cases} \quad (10)$$

In the formula (10), $\omega_2(n_{x_1},n_{x_2})$ represents the input knowledge evolution progress of the core organization. $\varphi_2(n_{x_1},n_{x_2})$ represents the evolution process of the input knowledge of the node organization. Then, we get $A_2(\theta_{x_1}N_{x_1},0)$, $A_3(0,\theta_{x_2}N_{x_2})$ and $A_4(\frac{\theta_{x_1}N_{x_1}(1+\eta_{x_2x_1})}{1-\eta_{x_1x_2}\eta_{x_2x_1}},\frac{\theta_{x_2}N_{x_2}(1+\eta_{x_1x_2})}{1-\eta_{x_1x_2}\eta_{x_2x_1}})$ (see Fig. 4).

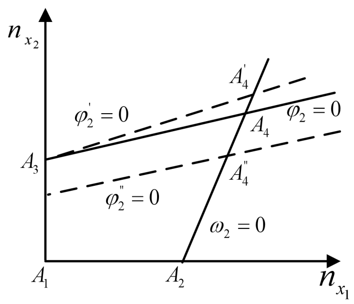


Fig. 4. Evolution trend of knowledge transformation between organizations in knowledge ecology chain

Fig. 4 reflects the relationships between the transformation and knowledge evolution, where line $\omega_2=0$ and line $\varphi_2=0$. Combining with the previous research results [8], this paper discussed the influences of the knowledge transformation ability coefficient, the coefficient for knowledge transfer rate and the maximum capacity for knowledge retention on the growth and stability of knowledge stock. When $\eta_{x_1x_2}>0$ and $\eta_{x_2x_1}>0$, after the knowledge transformation, the points on line $\omega_1(n_{x_1}, n_{x_2}) = 0$ and line $\varphi_2(n_{x_1}, n_{x_2}) = 0$ are respectively evolved along the stable condition. It will achieve a stable state at point A_4. This shows that the knowledge transformation is realized through knowledge interaction among chain members (such as through meeting and file, realizing the knowledge combination of explicit knowledge). In the process of knowledge transformation, if the knowledge transformation ability coefficient $\eta_{x_1x_2}$ is larger, x_1 contributes more to the growth of x_2 knowledge stock (as A_4 and $A_4^{'}$ shown in Fig. 4). Similarly, we can analyze the influences of stock knowledge on knowledge transformation (as A_4 and A_4^{*} shown in Fig. 3). Thus, by adjusting the knowledge transformation ability coefficient and the knowledge stock, we can promote the harmonious relationships between the interactive subjects of the technological innovation chain (i.e., $\eta_{x_1x_2}$ and $\eta_{x_2x_1}$ are both large and knowledge stock is larger too). This will help to establisht the knowledge ecosystem chain, and then improve the symbiotic evolution of the knowledge ecological chain and realize the high efficiency evolution equilibrium. At the same time,the equilibrium point value $\dfrac{\theta_{x_1} N_{x_1}(1+\eta_{x_2x_1})}{1-\eta_{x_1x_2}\eta_{x_2x_1}}$ also implies that the equilibrium value is connected to the knowledge transfer ratio coefficient θ. The greater the coefficient, the greater the coefficient for knowledge transfer rate and the maximum capacity for knowledge retention (the discussion of knowledge transfer and evolution equilibrium has been studied in the earlier period [37]).

In summary, the symmetry and balance of these factors (i.e., the coefficient of knowledge transformation ability, the maximum knowledge stock and the coefficient of knowledge transfer ratio in the knowledge ecological chain) are important conditions for the evolution of knowledge interaction and the realization of sustainable development. When the above three factors are symmetrical and large, it will form a symbiotic relationship of mutual benefit and reciprocity. Based on these, we can construct an efficient knowledge ecological chain, and improve bidirectional flow and innovation among the subjects of innovation and the growth of knowledge stock. Conversely, if the interaction of the above three factors is less or asymmetrical, the knowledge transformation of various organizations in the knowledge ecological chain lacks the effective impetus. It easily causes the knowledge chain to be unstable, distorts and even interrupts, and then affects the knowledge operation of the cross organization and the effects of the industry generic technology innovation.

D. The discussion on the equilibrium result formation of different input knowledge

By comparing and analyzing the impacts of government subsidy on the innovation inputs in section IV, we can find the following results.

(1) The government subsidy can stimulate the technical innovation chain organizations to increase knowledge inputs. The government subsidy has the double regulation function to the knowledge investment and the ecology transformation. Under the decentralized decision-making, the government subsidy is the biggest. Under the centralized decision-making, the government subsidy is smaller. The higher the individual subjects in the technological innovation chain, the higher the government subsidy and the total profit. This also indicates that different knowledge inputs will affect the government subsidy strategy.

(2) The allocation differences of the knowledge ecological chain will impact the government subsidy strategy in the technology innovation chain. In the process of the industry generic technology innovation, through government subsidy, we can construct knowledge chain and realize the flow of knowledge in different subjects. The subject of knowledge "gap" always acquires knowledge through the connected knowledge body to make up for its insufficiency. Under the decentralized decision-making, the government subsidy knowledge potential is higher. Through the appropriate knowledge flow, it makes up the problem that the individual organization's knowledge allocation is insufficient in the technological innovation chain. The knowledge ecological potential of the innovative subject is pulled up from the whole level. The knowledge flow is made up by coordinating the relevant innovation subjects in the centralized decision-making.

(3) The knowledge transformation relationship between the main body of the knowledge chain and the balance of equilibrium contributes. In the process of the construction and evolution of the knowledge ecological chain, the coefficient of knowledge transformation ability and the knowledge stock of the innovation subject are the important conditions that will affect the evolution and equilibrium of the knowledge ecological chain. Then, it will form the equilibrium symbiosis relationship by adjusting the factors such as the coefficient for knowledge transfer rate and the capacity for knowledge retention This will help to promote knowledge transformation and evolutionary equilibrium in the knowledge ecological chain, and realize the adjustment of the knowledge ecological potential of each innovative subject.

V. NUMERICAL EXAMPLES AND ANALYSIS

Based on the relevant theoretical research [44] and field investigation, we present the following cases. The super-transient experimental device project includes two types of microprobes, one is the super-transient advanced synchrotron radiation source, and the other is super-transient electronics. Meanwhile, Chongqing Science City of China uses the super-transient experimental device project to build a multi-dimensional science and technology industry infrastructure. Moreover, the industrial infrastructure can solve problems of generic technology innovation for the strategic emerging industries, such as advanced manufacturing, advanced materials, new energy, information technology, and biomedicine, etc.. Thus, we developed a mathematical simulation to show the impacts of government subsidies on the knowledge inputs and ecological interaction of innovative subjects. We will also consider the core organization (such as enterprises in Chongqing Science and Technology City and other high-tech enterprises) input knowledge x_1, the node organization (including Chongqing University, the research institutes of Chongqing, etc.) input knowledge x_2 and the government input knowledge x_z. Assigning values for α, β, C_L, C_K and λ, and then calculating the amount of knowledge input L and K, the government subsidy rate δ'_{x_1} and δ'_{x_2}, and the incomes of innovation subject π_{x_1} and π_{x_2}. Thus, all parameters are defined in Table 2.

TABLE 2
TWO NUMERICAL SIMULATION RESULTS OF KNOWLEDGE INPUT-OUTPUT UNDER DIFFERENET DECISION

		1a	2a	2b	3b
Index	α	0.3	0.3	1.2	1.2
	β	0.2	0.2	0.2	0.2
	A	1	1	0.1	0.1
	L	16	16	110	99
	K	21	21	11	4
	C_L	2	2	2	2
	C_K	1	1	1	1
	ρ_{x_1}	10	10	10	10
	λ	0.3	0.1	0.1	0.1
	σ	10	10	10	10
	C_M	1	1	1	1
	ρ_{x_2}	15	25	2.5	2.5
Subsidy rate	δ'_{x_1}	0.88	0.88	0.5	0.5
	δ'_{x_2}	0.82	0.94	0.8	0.6
Yield rate	π_{x_1}	109	165	/	/
	π_{x_2}	103	156	/	/
	$v(\delta_{x_1},\delta_{x_2})$			125	125

In the table 2, by analyzing columns 1a and 2a, we get that in the decentralized decisions, when the marginal demand rate λ for quality is in equilibrium with knowledge input, Its influence on the rate of government subsidy (δ'_{x_1} and δ'_{x_2}) and the income of innovation subjects (π_{x_1} and π_{x_2}). Based on table 2, we can get that, with the decrease of λ, the government subsidies δ'_{x_1} and δ'_{x_2} will increase, and then it will drive the growth of the innovation main body incomes π_{x_1} and π_{x_2}. Similarly, we can adjust parameters ρ_{x_1} and ρ_{x_2} to analyze the influences of subsidy coefficient on income, and then we can verify the results of section B in chapter IV.

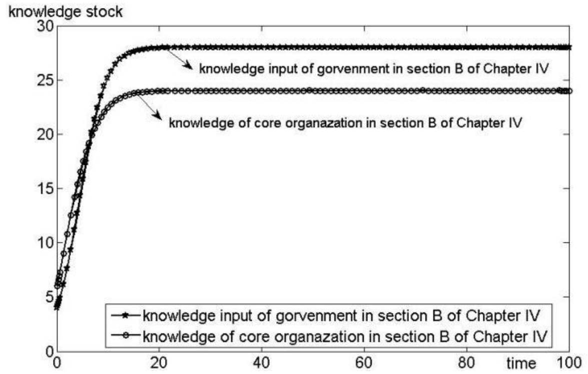
In table 2, by analyzing columns 2b and 3b, we get that under the centralized decision, when $\rho_{x_1}(1-\alpha)+\rho_{x_2}(1-\beta)=0$, the government subsidy utility $v(\delta_{x_1},\delta_{x_2})$ hasn't relationship with the value of δ'_{x_1} and δ'_{x_2} (namely, the adjustment subsidy value and the government subsidy effect $v(\delta_{x_1},\delta_{x_2})$ will not change). Thus, the inference results in section C in chapter IV are verified.

In addition, to further examine the knowledge ecological chain construction and its evolution progress caused by the knowledge inputs of government, the core organization and the node organization, this paper uses MATLAB r2013a software to simulate. Based on the previous hypotheses, we set $\theta_{x_1}=\theta_{x_0}=\theta_{x_z}=1$ (the effect of knowledge transfer is not considered). $N_{x_1}=16$ expresses the utmost limit of the input knowledge of the core organization (take the input amount in decentralized decision-making as an example). According to the previous calculations, the government input is $N_{x_2}=\delta_{x_1}C_L L(n_{x_1},n_{x_2},n_{x_z})=28$. Setting the knowledge growth rate $r_{x_z}=0.4$, $r_{x_1}=0.5$, $\eta_{x_z x_1}=0.4$ and $\eta_{x_1 x_z}=0.5$. The initial state value of the two knowledge stocks are $n_{x_z}=4$ and $n_{x_1}=6$, respectively. The simulation results are shown in Fig. 5 (a). Setting the maximum value of the core organization input knowledge in the process of industrial technology innovation as $N_{x_1}=110$ and $N_{x_2}=11$ (take the input amount in centralized decision-making as an example). Set the knowledge growth rate as $r_{x_1}=0.4$, $r_{x_2}=0.5$, $\eta_{x_1x_2}=0.4$ and $\eta_{x_2x_1}=0.5$. The initial state values of two knowledge stock are $n_{x_1}=4$ and $n_{x_2}=6$, respectively. The simulation results are as shown in Fig. 5 (b). After the adjustment of the knowledge conversion ability coefficient, $\eta_{x_2x_1}=0.8$ and $\eta_{x_1x_2}=0.7$ the results see Fig. 5 (c) as follows:

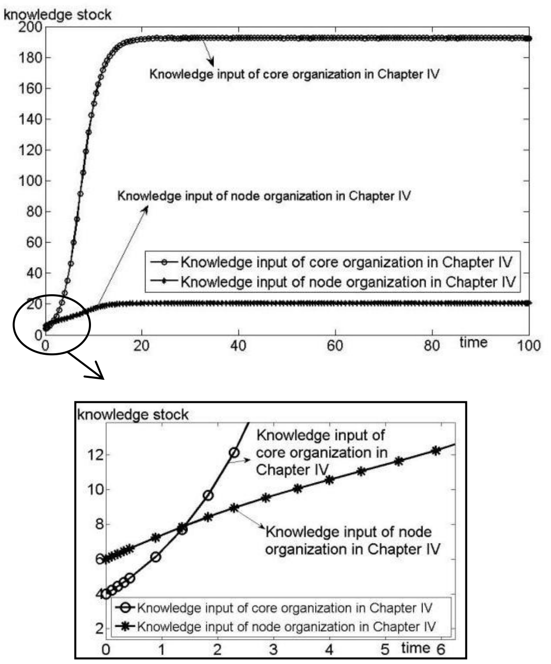
From (a), (b) and (c) in Fig. 5, we get that the knowledge transformation ability coefficient of the main body is the key factor to realize the rapid and efficient evolution. By adjusting the knowledge transformation ability coefficient and the input knowledge quantity, the balance of power symbiosis will form. This will help to pull up the knowledge stock. It also shows that when the knowledge stock of various subjects is low, knowledge transformation will be in a low efficiency equilibrium. Through the relationship construction about mutually beneficial equilibrium symbiotic, it is helpful to accelerate knowledge transformation and achieve high efficiency and balance. In the decentralized decision-making, by interacting with the knowledge in the process of government engagement and transformation, when the input amount $n^*_{x_1}=11$, it can reach the equilibrium amount of knowledge input $n_{x_1}=16$.

Similarly, the knowledge infusions of the core organization and the node organization are less than that of non-conversion in the centralized decision. This shows that through the effective knowledge transformation, the knowledge innovation is achieved. It can also analyze the influences of the knowledge transformation ability coefficient of the core organization and the node organization on the knowledge interaction and the evolution equilibrium. Thus, we can verify the analysis results in sections B and C in chapter IV. In addition, we can adjust the knowledge transfer ratio coefficient to analyze its influence on knowledge interaction evolution equilibrium.

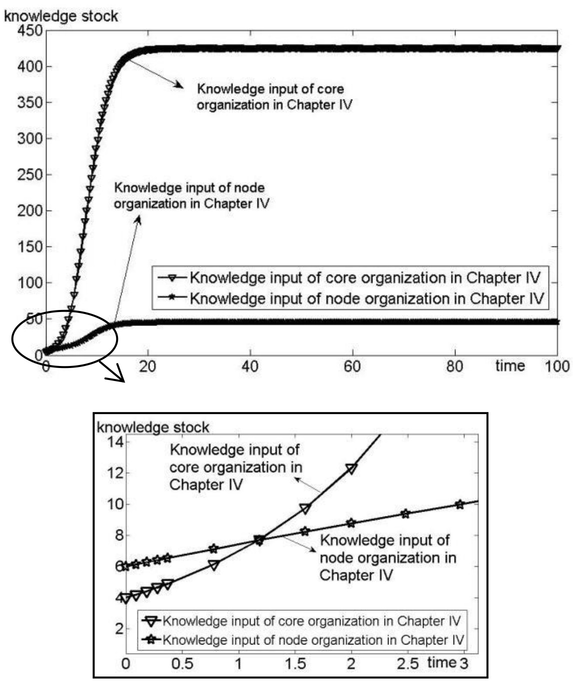
In summary, the above examples prove the government subsidy strategy research conclusions, when the explicit knowledge and the tacit knowledge are invested in the industry generic technological innovation. It also verifies the influence mechanism of knowledge transformation ability coefficient, the knowledge transfer ratio coefficient and knowledge stock on knowledge interaction and evolution. These will provide a theoretical enlightenment for government to make double regulation strategy.



(a) The evolution of knowledge ecology niche under decentralized decision



(b) the evolution of knowledge ecology niche under centralized decision



(c) Influence of knowledge transformation ability coefficient on the debugging evolution of knowledge ecology under decentralized decision

Fig. 5. Simulation analysis of knowledge niche evolution trend

VI. RESEARCH CONCLUSION AND ENLIGHTENMENT

A. Research Conclusions

Government-guided knowledge-ecological debugging is a new trait of the industry generic technological innovation. In this paper, we combined the utility theory, knowledge management and niche to design the subsidy mode of industrial generic technology innovation based on knowledge ecology debugging. Obtaining the following conclusions.

(1) Combining government subsidy to guide knowledge ecological debugging is a new trait of the industry generic technology innovation. This article subdivided the knowledge of generic industrial technology into tacit knowledge and explicit knowledge, and designed the new model of subsidy for the industry generic technology innovation, and expanded the knowledge chain of government guidance. Finally, we researched the integration and development of technology innovation chain theory and deepened the new understanding of the value of government subsidies, and promoted the integration and development of knowledge input and output and ecology theories [14,17].

(2) According to the new subsidy model of the industry generic technology innovation and the improved knowledge in-put-output utility model, the convential input-output profit model and the lotka-Volterra model were grafted and fused. This paper constructed a knowledge ecology debugging model, and then revealed the double regulation mechanism of government subsidy in the progress of knowledge resource allocation, and expanded the traditional input-output utility model and the knowledge ecology debugging modeling method [8, 39].

(3) Through expanding the role of government subsidies and the construction of the government-guided knowledge ecological chain, the symbiotic relationship of equilibrium can be obtained. Adjusting the knowledge input of various organizations by government subsidy in the industry generic technology innovation can supplement and enhance the knowledge chain, and promote knowledge ecology interaction, and adjust different knowledge ecological potentials, and foster the reciprocal flow, and transfer and knowledge transmutation among different subjects, and then realize endogenous development. These are helpful to improve the efficiency of knowledge resource deployment in the industry generic technolog y innovation.

B. Management Revelation

The research process and conclusions of this paper have a certain enlightenment on the role of government subsidies in technological innovation and promoting the development of industrial generic technology innovation, which is shown as follows.

(1) This paper compared and analyzed the different knowledge chains formed by explicit knowledge and implicit knowledge input, and revealed the different regulatory effects of government subsidies. Thus, in comparison to the developed countries, in China, a large

number of traditional industries and strategic emerging industries should focus on the value and differences of tacit knowledge and dominant knowledge when carrying out the technology innovation. With government investment, we should construct different knowledge chains, and promote the ecological position of knowledge, and improve the knowledge transfer and transformation of the main body of the knowledge ecological chain, and realize the allocation of knowledge resources across organizations.

(2) Given that the input knowledge of industrial generic technological innovation is tailored to specific industries, in the innovation process, it is crucial to synchronize the knowledge transformation ability coefficient and the knowledge stock of the core organization and the node organization, and adjust all kinds of knowledge to form equilibrium symbiosis, and build knowledge ecological chain, and improve knowledge convertion ability, and enhance the two-way transformation and innovation of knowledge among innovation subjects, and promote knowledge transformation to achieve efficient and balanced, and then form synergistic multiplier effects, so as to optimize the efficiency of cross-organizational knowledge asset assignment

(3)Through the "knowledge ecological chain + technology innovation chain" guided by the government, putting the knowledge chain and innovation chain into the overall framework, and using the collaborative development of knowledge input, transfer and transformation to realize the value-added of knowledge and release the key driving value of knowledge as an innovation element. These can play the two-wheel drive of government guidance and enterprise leading to promote industrial generic technology innovation.

C. Research Prospects

In this paper, a knowledge input-output utility model was established based on an improved Cobb-Douglas function and a knowledge niche model was established based on improved a Lotka-Volterra model. However, only the implicit knowledge and the explicit knowledge were taken into account in the technological innovation chain. In addition, the equilibrium results under decentralized and centralized decisions were formed. In the future, how to subdivide the input knowledge type and the transformation mode will be analyzed. The knowledge resource allocation mode of the technology innovation chain and revealing the influence of different knowledge chains on the technological innovation chain will be the focus of further research.

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