Study on the Green Innovation Industry-University-Research Cooperation under the International Technology Spillover

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Abstract: International technology spillover effect brought new opportunities for domestic green technology upgrade, the effect of green innovation and steady development of "industry-university-institute" cooperation have to delve into the role of value based on the bounded rationality of evolutionary game theory, the paper introduced the international technology spillover coefficient of absorption coefficient of ability to build the international technical overflow out of the green innovation evolutionary game model of "industry-university-institute" cooperation, with the aid of Matlab to explore international technology spillover effect under the action of absorptive capacity evolution behavior and at the specific results show that: International technology spillover effect has a significant influence on the convergence speed and direction of green innovation industry-University-Research cooperation. However, whether the effect brought by international technology spillover can be used by both the producer and the university-research institute depends on the technology absorption capacity of both sides.

1. Introduction

At present, China's economic development has made remarkable achievements, has entered from the driving factors of investment-driven vulgar development pattern innovation to drive the dynamic factors of connotative development mode change in the new normal but drive investment drive model of development have caused more serious to China's economic and social development of resources and environment problems at the same time, the international competitive environment increasingly complex and intensifying competition, domestic Labor and land costs rise, have forced the domestic enterprises must find new sustainable development direction of green and new, however, most of the domestic enterprise green, the deficient of the capability of independent innovation Green innovation is hard to carry out. Therefore, seek knowledge intensive technology resources of colleges and universities and scientific research institutes as innovation partners, through produces study grinds the cooperation innovation mode of green innovation is an effective way to rapidly promote green innovation can force, however the current our country local green technology innovation ability is limited, use of international technology spillover is the important

way to realize China's green technology upgrade, therefore, this article embarks from the perspective of international technology spillovers study of green innovation manufacture-learning-research cooperation, can make better use of existing international green technology in China improve the cooperative innovation efficiency.

2. Literature Review

Industry-university-research cooperative innovation refers to an innovation mode in which enterprises, universities and scientific research institutions realize output transformation of innovation results according to their own advantages and the principle of sharing risks and benefits, sharing advantages and complementing each other and developing together [1]. Cui, Jingbo [2] believes that the motivation for enterprises to seek cooperation is to reduce r&d costs and obtain technology spillover. Zhang, Guoxing [3] believed that Industry-University-Research cooperation promoted technological innovation of enterprises, and deeply analyzed the phenomenon of technology transfer in the Industry-University-Research cooperation. Wang, JiayiJin [4] adopted a top-down and bottom-up approach to establish a set of industry-university-research cooperation innovation performance evaluation index system. Yu, BinbinHe [5] constructed the Industry-University-Research collaborative innovation model of triple interaction of strategic knowledge organization, and believed that strategic knowledge collaboration and organizational collaboration are trinity. Purchase et al. made a detailed analysis of the Industry-University-Research Innovation network system and found that the scale-free network growth and preferred connectivity could explain the formation mechanism of the Industry-University-Research cooperation innovation network. Liu Mingguang analyzed in detail the dynamic stability and influencing factors of strategy selection behavior of Industry-University-Research Institute cooperative game players, and then constructed the Industry-University-Research Institute cooperative innovation evolution game model under the mode of joint development. The research shows that the evolution direction of evolutionary stability strategy mainly depends on the initial state of the system.

Along with the unceasingly thorough research, some more detailed factors considered by scholars in brand value industry maturity and knowledge transfer of production-study-research cooperation innovation behavior main body changes significant stable strategy, and how these factors change determines the system stable state trust is to maintain the important link of "industry-university-institute" cooperation, opportunistic behavior and defaults caused a lot of "industry-university-institute" cooperation is the important original cause, Xue Kelei in-depth study trust relationship, collaborative innovation The results show that the probability of industry-University-Research cooperation trust relationship is positively correlated with synergies, and negatively correlated with speculative returns. In view of the short-termism of Industry-University-Research cooperation caused by speculative behaviors, the producers and the universities and research institutes can reduce the occurrence of speculative behaviors by improving the supervision level and adopting measures such as default fines. Government is the intermediary in the production and research cooperation cannot be neglected, reasonable government punishment strength can improve the enthusiasm of production-study-research cooperation can make the system to reach equilibrium faster, such as from the market mechanism and administrative supervision mechanism two aspects carries on the analysis, the study shows that under the market mechanism, reasonable government subsidies and penalty due to breach of contract has played a positive role in promoting, under the administrative supervision mechanism, reasonable tax and administrative punishment is advantageous to the political stability of "industry-university-institute" cooperation.

Above all, the current academic research on influence of production-study-research cooperation into fruit, as in this paper, the production, explore laid a solid foundation of this article is based on

evolutionary game theory to build the green innovation under the international technology spillovers of production-study-research cooperation game model, and through the analysis of the model with the aid of Matlab to carry on the numerical simulation, explores the following questions: (1) considering the reality of production technology absorption capacity of the double side, analyzing differences between international technology spillover effect on the stability of the evolution of green innovation industry-university-institute cooperation; (2) Considering the change of international technology spillover and game group absorptive capacity, how will the system stable state be affected.

3. An Evolutionary Game Model of Green Innovation Industry-University-Research Cooperation under International Technology Spillover

The players in the industry-University-Research cooperation game are the producer and the university-research party. The producer refers to the manufacturing enterprise with high energy consumption, high pollution and high emission. The term "university, university and research institute" refers to the situation in which both universities and research institutes choose to cooperate or not cooperate, and the strategic combination is (cooperation, non-cooperation) or (non-cooperation, cooperation), indicating that there is a breach of contract during the cooperation between enterprises, universities and research institutes on green innovation

In the open market environment, international technology spillover will play a positive role in promoting the upgrading of domestic green technologies, and the coefficient of international technology spillover is α.

However, due to the strength gap between domestic and foreign R&D subjects, the enterprises, universities and research institutes cannot fully absorb the spillover technology, β_1, β_2 is the coefficient of technology absorption capacity.

The spirit of contract is the link of industry-university-research collaborative innovation. Under the guidance of the spirit of contract, the players can clarify the rights, obligations and responsibilities of both parties during the cooperation. Any party who breaches the contract should pay T to the other party as the price of breach.

The success of green innovative products can reduce the cost of environmental protection for the manufacturer. E represents the environmental protection tax that the manufacturer needs to pay before the success of green innovation. After the success of green innovation, the manufacturer only needs to pay e as the cost of environmental protection.

If both parties choose not to cooperate, they can only obtain the profit v_1, v_2; under normal circumstances. Game after production, the two sides reached a cooperation agreement, both parties can complementary advantages so as to realize green technology upgrade, the resulting extra income for ΔV, Both production, according to $\zeta_1 : \zeta_2$ distribution of profits, $\zeta_1 + \zeta_2 = 1$; If the producer believes that it has sufficient strength to carry out technical research and development during the performance of the agreement, and successfully introduces the green product into the market and becomes the pioneer of the new market, the producer may break the contract and develop the product by itself, at which time the producer will obtain excess profits V_1; The excess return obtained by the halfway betrayal by the student research party is V_2.

The total cost agreed by the industry, the university and the research institute to complete the project is C and accordance with $\eta_1 : \eta_2$ sharing $\eta_1 + \eta_2 = 1$, with the η_1 representing the cost sharing ratio; When industry breach after or at the party, the default party need to separate into ΔC_1, ΔC_2 continue to research and development of the technology, assuming default when the two sides have C_0 cost.

Based on the above hypothesis, the payment matrix of green Innovation industry-University-Research Cooperation under international technology spillover 2×2 asymmetric Game (Table 1).

Table 1: Payment matrix of Industry-University-Research Cooperation in Green Innovation under international Technology Spillover

Strategy		University-research	
		cooperation	*Defend*
Industry	Cooperation	$v_1 + \zeta_1 \Delta V - (1 - \alpha\beta_1)\eta_1 C - e,$ $v_2 + \zeta_2 \Delta V - (1 - \alpha\beta_2)\eta_2 C$	$v_1 - \eta_1 C_0 + T - E,$ $v_2 + V_2 - \eta_2 C_0 - (1 - \alpha\beta_2)\Delta C_2 - T$
	Defend	$v_1 + V_1 - \eta_1 C_0 - (1 - \alpha\beta_1)\eta_1 C - T - e,$ $v_2 - \eta_2 C_0 + T$	$v_1 - E,$ v_2

Suppose the ratio of the game group of the producer to choose the cooperative strategy is *x*, then the ratio of the game group to choose the non-cooperative strategy is $1 - x$; The proportion of the game group that chooses cooperative strategy accounts for *y*, and the proportion of the game group that chooses non-cooperative strategy accounts for $1 - y$. According to the Malthusian dynamic equation, the assumptions adopted a strategy of growth rate is equal to its relative adaptability, just take the strategy of adaptability than the group of the average fitness of body, then the strategy will gradually be more game group participants with industry choose cooperation strategy and cooperation strategy of expected return and the average expected return, respectively:

$$u_1' = y[v_1 + \zeta_1 \Delta V - (1 - \alpha\beta_1)\eta_1 C - e] + (1 - y)(v_1 - \eta_1 C_0 + T - E) \tag{1}$$

$$u_1'' = y[v_1 + V_1 - \eta_1 C_0 - (1 - \alpha\beta_1)\Delta C_1 - T - e] + (1 - y)(v_1 - E) \tag{2}$$

$$u_1 = xu_1' + (1 - x)u_1'' \tag{3}$$

Similarly, the expected return and average expected return of cooperative strategy and non-cooperative strategy selected by the research party are respectively

$$u_2' = x[v_2 + \zeta_2 \Delta V - (1 - \alpha\beta_1)\eta_2 C] + (1 - x)(v_2 - \eta_2 C_0 + T) \tag{4}$$

$$u_2'' = x[v_2 + V_2 - \eta_2 C_0 - (1 - \alpha\beta_2)\Delta C_2 - T] + (1 - x)v_2 \tag{5}$$

$$u_2 = xu_2' + (1 - x)u_2'' \tag{6}$$

According to the solution method of the replication dynamic equation in evolutionary game theory, the replication dynamic equation of the cooperative strategy selected by the producer and the academic and research parties over time is obtained respectively.

4. Numerical Simulation

By constructing the evolutionary game model of Industry-University-Research Institute cooperation in green innovation under the international technology spillover, the above paper obtained the complex dynamic equation of industry-university-Research Institute cooperation from the theoretical level, but it could not directly reflect how parameter changes affect the evolutionary behavior of the

industry-university-research institute and the university-research institute. Therefore, this part made an in-depth analysis of the model with the help of Matlab.

A. Only the influence of the change of international technology spillover coefficient on system evolution is considered

Contrast Industry low amplitude technology spillovers in general and the evolution track of high as you can see, three evolutionary trajectory almost overlap and the increase of technology spillover coefficient of Industry convergence speed did not have much of an impact, presumably, in the case of Industry technology absorptive capacity is weak, the increase of international technology spillovers have less effect on the Industry separately, observe Industry evolution path can find an interesting change, namely Industry evolutionary trajectory is first down and then quickly rise to stable state, therefore, at the beginning of the manufacture-learning-research cooperation, need to adopt corresponding according to specific circumstances The measures make the producer restrain the occurrence of its default behavior and make it more determined to choose the cooperative strategy.

B. The influence of the change of international technology spillover coefficient and absorption capacity coefficient on the evolution trend of the system is considered

when the international technology spillover and absorption capacity are both low, measures should be taken to strengthen the cooperative relationship between the two parties, so as to make the system evolve into a cooperative strategy. International technology spillover effect, under the action of production-study-research cooperation main body can be the forefront of green technology, digestion, absorption, and translated into their own technology, reduce the development risk and cost, and according to the characteristics of the domestic market will be the green technology localization, successfully open a new market but in reality the situation is very difficult to reality now, foreign enterprise technology blockade of the research and development strength of the gap at home and abroad have made this state of affairs is difficult to achieve.

5. Conclusion and Recommendation

Evolutionary game theory, this article is based on bounded rationality to build the green innovation under the international technology spillover evolutionary game model of "industry-university-institute" cooperation, and in-depth analysis of international technology spillover and the absorptive capacity of production-study-research cooperation game in groups of influence mechanism, with the help of Matlab numerical simulation to explore the technology spillover coefficient and absorption coefficient change on the influence of the game model of the evolution and evolution speed get the following conclusion:

Considering the sensitive degree of international technology spillover effects on the at party significantly greater than industry, weak absorption ability in industry (beta 1 = 0.2), the international technology spillover effects of enhanced industry impact is not obvious, at this time obviously improve the speed at will converge to a steady state in addition, the game to participate in the selection of the initial proportion of cooperation strategy group of body x0, y0 affect the convergence direction and the convergence speed of the system, with the increase of initial proportion system converges to accelerated with the evolutionary stable status.

Whether the international technology spillover effect can be used by the Industry-University-Research Institute cooperation parties is not only related to the spillover amplitude, but also depends on the technology absorption capacity of the industry-university-research Institute cooperation parties I. When the international technology spillover coefficient is large, it can converge to the ideal state rapidly only when both the industry, the university and the research institute have strong absorptive capacity.

Based on the above analysis, this paper gives the following suggestions:

International technology spillover effect provides an opportunity for the Industry-University-Research institute cooperation to realize the success of green innovation more quickly. To seize this opportunity depends on the technical strength of both the industry-university-research institute and the university-research Institute. If the industry-university-research Institute and the university-research Institute are committed to enhancing the innovation strength of green technology, the development of green technology can be realized in a shorter period of time. If the producers and the universities and research institutes lack the awareness of green technology innovation, they will waste the opportunity to realize the green technology upgrading. In addition, the absorptive capacity of technology is also the capital to choose excellent partners, and choosing the appropriate industry, universities and research institutes partners can get twice the result with half the effort.

Cultivate the spirit of contract construction of legal system of social economic development, social order build crucial penalty due to breach of contract in the process of cooperation set reminders or be subject to contract with fear, cultivate the spirit of contract low default gold on the opportunistic and no deterrent effect, it is only in agreement with definite certain penalty due to breach of contract to guarantee the stability of production-study-research cooperation innovation is not an easy goal, in the long-term cooperation between the parties shall promptly communicate, avoid industry-university-institute cooperation relationship breach caused by asymmetric information not only damage the interests of the partners, will also destroy its reputation, the most main is this kind of undesirable The ethos will lead to more and more renunciations of covenants in the society.

Industry-university-institute cooperation law can not only motivate specification, also play a deterrent punishment role the government should perfect the contract system, improve the success rate of cooperation, improve the system of intellectual property protection of scientific and technological achievements, improve the system of reward, encourage the industry-university-institute cooperation was carried out on the law of "industry-university-institute" cooperation blank filling, refine the related regulations, make it more fair for effectively produces study grinds the cooperation innovation service system of such perfect can effectively promote the development of production and research cooperation green innovation.

References

[1] *Wu, Haitao; Hao, Yu,"How do environmental regulation and environmental decentralization affect green total factor energy efficiency: Evidence from China",Energy Economics, vol. 91, September 2020.*

[2] *Cui, Jingbo,Moschini, GianCarlo, "Firm internal network, environmental regulation, and plant death", Journal of Environmental Economics and Management, vol. 101, May 2020.*

[3] *Zhang, Guoxing, Liu, Wei, "Environmental regulation policies, local government enforcement and pollution-intensive industry transfer in China",Computers and Industrial Engineering, vol. 148, October 2020.*

[4] *Wang, Jiayi, Lei, Ping,"A new tool for environmental regulation? The connection between environmental administrative talk policy and the market disciplinary effect", Journal of Cleaner Production, vol. 275, 1 December 2020.*

[5] *Yu, Binbin, hen, Chen, "Environmental regulation and industrial capacity utilization: An empirical study of China", Journal of Cleaner Production, vol. 246, 10 February 2020.*