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The Dynamics of Innovation Synergy of Emerging Technology Industries in Guangdong-Hong Kong-Macao Greater Bay Area

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Abstract

Under the complex and changing domestic and international environment, is the innovation cooperation of emerging technology industry between cities in the Guangdong-Hong Kong-Macao Greater Bay Area in a status of differentiation or bridging? To answer this question, this paper uses the model of synergy degree of composite system and the panel data of cities in the Guangdong-Hong Kong-Macao Greater Bay Area from 2009 to 2018 to measure the innovation synergy degree of emerging technology industries in the Guangdong-Hong Kong-Macao Greater Bay Area from the perspective of innovation and resource allocation. The results of data analysis show that the innovation synergy degree of emerging technology industries in the Greater Bay Area has an overall trend of increasing year by year. However, the synergy level is still in the medium level, in which the reasonable degree of resource allocation fluctuates greatly and the order degree is low, which affects the overall synergy degree. Finally, according to the analysis result, this paper puts forward to strengthen emerging in the process of the architectural technology innovation system and orderly development, especially improve the allocation of resources, reasonable norms between the innovation main body mode of resource integration, so as to promote a large bay area of Guangdong industrial technology innovation system in the direction of highly coordinated development policy recommendations.

Keywords

Innovation of emerging technology industry; Coordination degree; Guangdong-Hong Kong-Macao Greater Bay Area.

1. Introduction

Emerging technology is the trend of future development, but it lacks mature market positioning and has many uncertainties. In the process of research, development and promotion, there are problems such as high cost and high risk.At present, it is a reasonable measure to help the development of emerging technologies by obtaining rich and high-quality information resources through industrial innovation.In 2009, the state called for strengthening the cultivation and development of strategic emerging industries, since then, the emerging technology is the focus of attention at home and abroad.In the process of development, many high-tech one after another mature, to speed up the process of regional technology innovation provides a good opportunity.

Emerging technology innovation network is made up of many main body participation, is due to competition and cooperation, the innovation main body with nonlinear interaction, adjust the relationship between innovation network subject, then use of fluctuation wave from local to whole, decided to innovation within the system of the allocation of resources and knowledge transfer, and makes the system evolution in the direction of the order. Achieve innovative goals for the development of emerging technologies.

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Research on innovation in emerging technology networks originated at Wharton's Mack Center for Technology Innovation.Day (2000) showed through their research that emerging technologies are not only fundamentally innovative technologies, such as biopharmaceuticals and micro-robots, but also innovative technological achievements integrating multiple research achievements, such as Internet and electronic finance. And the degree of synergy refers to the degree of element coordination, organizational evolution and finally reaching the level of coordination among the major innovation subjects and non-innovation subjects in the innovation network of emerging technology industry.Persaud (2010) measured the degree of collaboration from four dimensions: strategic research and development collaboration, management and operation collaboration, knowledge management collaboration and innovation Chengdu collaboration.Using the synergistic degree model, KOCH, M., & FRITZ, M. (2014) compared and analyzed the indicators of macro-structural welfare and sustainability of 30 countries, and studied whether clusters largely followed the synergistic effect hypothesis.Ren, H. (2009) also used the synergy degree model to measure the synergy between businesses.Ma, T. & Liu, C. (2021) believed that green innovation complicates the traditional innovation model and its functions and promotes the development of economy. The molecular system was used to construct a theoretical analysis framework, and the synergistic degree was calculated to analyze the current status and characteristics of green innovation system in China's manufacturing industry.

However, regarding the measurement, status quo and trend of the innovation network synergy degree of emerging technology industries in the Guangdong-Hong Kong-Macao Greater Bay Area, in particular, under the complex and changing domestic and foreign environment, is the innovation network cooperation of emerging technology industries in the Guangdong-Hong Kong-Macao Greater Bay Area in a state of differentiation or bridging?At present, there is still a lack of convincing quantitative analysis and empirical research on the above issues.In view of this, this article will use of complex system coordination degree model, to a large bay area emerging technology of the Guangdong collaborative innovation of industrial innovation goal realization degree and the allocation of resources the reasonable degree of measure and the measure, and according to the analysis of the coordination degree of difference, the coordinated development of the network for a large bay area of the Guangdong hi-tech innovation provide some referential suggestions to enhance the synergy of the innovation network of emerging technology industries in theGuangdong-Hong Kong-Macao Greater Bay Area.

2. The Mechanism Analysis

2.1. The General Mechanism Analysis

Emerging technology industry innovation process is involved in the process of more than a subject mainly include government, business, scientific research departments, scientific research institutes of colleges and universities, etc., in the process of innovation research and development, if you can make the main body to maintain consistent message, rational allocation of resources, reasonable personnel allocation, fund input, it will help the reciprocal cooperation, efficient and orderly innovation chain. This will bring positive effect to the collaborative development of emerging technology innovation network.Therefore, the collaborative process of innovation network of emerging technology industry is the formation of cooperation and competition between multiple subjects. They are linked together through the non-linear effect, and the collaborative degree of innovation system of emerging technology industry is improved through the process of realizing innovation goals and solving effective allocation of resources.From the point of view of the evolution process, it is from disorder to order, from low to high evolution, and may even make a qualitative leap in the field of technology, which has a

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great substantial help to the improvement of the subsequent production competitiveness.The evolution process is shown in Figure 1.

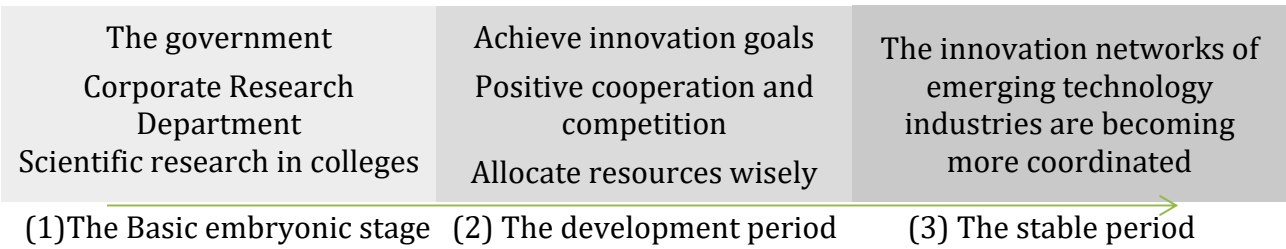

Figure 1. The collaborative development and evolution process of innovation in emerging technology industries

In essence, the measurement of the synergy degree of the innovation network of the emerging technology industry is a measure of the global synergy effect of the innovation subject on the resources, elements, funds and other factors in the process of participating in collaborative innovation.Therefore, in the process of evolution, more attention should be paid to the integration and full use of innovation resources of all parties, and the realization of maximum innovation information and resource sharing will be more conducive to the formation of 1+1>2 synergistic effect of innovation and development.This kind of synergistic effect includes internal and external synergistic effect. Internal synergistic effect refers to the overall effect produced by a certain subject using the same resource in different stages, different links or different aspects.The external synergistic effect refers to the effect that the overall efficiency is improved due to the mutual cooperation and sharing of resources and information among various subjects.The rational investment and effective allocation of resources is an important link in this evolutionary process, which will constitute the material basis of innovation.Under the guidance of the innovation goal and with the help of the reasonable flow of resources, the complementarity of advantages can be formed among various subjects to ensure the consistency of actions, which will greatly improve the synergy degree of innovation in emerging technology industries.Then the degree of the realization of the innovation goal is used to measure the size of the synergistic effect in turn, forming a cyclic echo system.The cycle flow is shown in Figure 2.

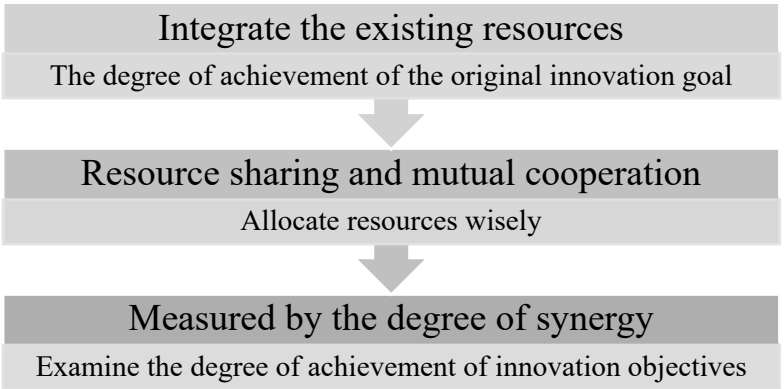

Figure 2. The collaborative circulation process of innovation networks in emerging technology industries

2.2. The Mechanism Analysis in Specific Situations

In the face of unprecedented changes in the past century, it is a great opportunity to promote the coordinated development of the innovation network of emerging technology industries in the Greater Bay Area.On one hand, through synergism, national large-scale high-tech

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enterprises can be truly embedded in the scientific research and innovation platform of the Greater Bay Area, and play an effective role in providing new options and space for the development of the innovation level of the Greater Bay Area.On the other hand, synergy can effectively connect innovation infrastructure and various innovative resources of emerging technology industries in the Greater Bay Area, and solve the above imbalance problem through effective integration of innovation data, so as to optimize the use of scientific research and innovation resources and improve innovation efficiency.Therefore, this paper will focus on the realization of innovation objectives and the degree of reasonable allocation of resources to establish a subsystem for analysis.The degree of achievement of innovation goals subsystem is mainly used to measure the effect of resource input and output in the innovation system of emerging technology industry, that is, the degree is measured by the order degree of subsystem.The resource allocation subsystem is used to measure the integration effect of each innovation subject on the resources after each major subject has invested the innovation resources, that is, to measure the efficiency of resource allocation by the degree of resource allocation rationality.

3. The Empirical Analysis

3.1. Data Source Description

For the completeness and availability of data, this paper collected the technological innovation data of some cities (Guangzhou, Shenzhen, Foshan, Jiangmen and Hong Kong) in the Guangdong-Hong Kong-Macao Greater Bay Area from 2009 to 2018 for analysis.The data are from China Science and Technology Statistical Yearbook, China High-tech Industry Statistical Yearbook, regional statistical Yearbook and Hong Kong innovation activity statistical data.

3.2. The Empirical Model

The empirical model entropy method is a mathematical method used to judge the degree of dispersion of an index.The greater the degree of dispersion, the greater the influence of the index on the comprehensive evaluation, so the entropy value can be used to judge the degree of dispersion of an index.In this paper, the weight will be measured according to the entropy value. The smaller the entropy value of an index is, the more information it can provide, and the greater the weight it has. According to this theory, the entropy calculation steps and formula of the innovation system of emerging technology industry are as follows:

$$\mathrm{E}_j = -\mathrm{K}\sum_{i=1}^{m}(P_{ij}\ln P_{ij}) \tag{1}$$

$$\mathrm{K} = \frac{1}{\ln m} \tag{2}$$

$$P_{ij} = x'_{ij}/\sum_{i=1}^{m} x'_{ij} \tag{3}$$

Note: E_j is the entropy value of the j, $0 \le E_j \le 1$; K is the average disorder coefficient of this index; P_{ij} represents the proportion of the j in subsystem I. If subsystem I s disordered and has the condition of$\sum Y_{ij} = 1$, then its utility value can be calculated by the following formula:

$$d_j = 1 - E_j \tag{4}$$

$$W_j = d_j/\sum_{j=1}^{n} d_j \tag{5}$$

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Note :(4) In the formula, the change direction of the entropy value of the index and the benefit value is just opposite, that is, the greater the entropy value of the index, the smaller the utility value and the less information the index contains.W_j in this system refers to the importance of the j, namely the weight.

Through calculation, we find that in subsystem I of high-tech industry R&D, the weight of personnel equivalent to full-time equivalent is the least, and the weight of research and development funds in cooperation with universities accounts for the largest proportion of research funds, which to a certain extent indicates that university talents have a greater influence on enterprise research and development work.

The e_{ij} is the order parameter of the collaborative development of the major sub-systems in the innovation system of emerging technology industry. I s the subsystem, and j is the various elements of the subsystem.According to the positive and negative effects of order parameters on the order degree of innovation of emerging technology industry, they are divided into positive order parameters and negative order parameters.If the value of the positive order parameter is larger, it means that the order degree of the innovation network system of emerging technology industry is higher, and the order degree is lower.The larger the value of the negative order parameter is, the lower the order degree of the innovation network system of the emerging technology industry is, and the higher the order degree is on the contrary.

If e_{ij} is a positive order parameter, then

$$u_i(e_{ij}) = \frac{e_{ij}-b_{ij}}{a_{ij}-b_{ij}} \tag{6}$$

If e_{ij} is a negative order parameter, then

$$u_i(e_{ij}) = \frac{a_{ij}-e_{ij}}{a_{ij}-b_{ij}} \tag{7}$$

$$u_i(e_i) = \sum_{i=1}^{n} u_i(e_{ij}) \cdot \omega_i \tag{8}$$

The synergy degree model of composite system:

$$\mathrm{LC} = \theta \cdot \sqrt[n]{\prod_{i=1}^{n} |[u_i^1(e_i) - u_i^0(e_i)]|} \tag{9}$$

$$\theta = \frac{min_i[u_i^1(e_i)-u_i^0(e_i)]}{|min_i[u_i^1(e_i)-u_i^0(e_i)]|} \tag{10}$$

Note: In this paper, the base period is set as T0, the order degree index of the innovation target subsystem I is $u_I^0(e_i)$, and the order degree index of the resource allocation subsystem R is$u_R^0(e_i)$. Wen the whole system evolves to T1, the order degree index of the innovation target subsystem I is$u_I^1(e_i)$.The order degree index of resource allocation subsystem R is $u_R^1(e_i)$.

Table 1. Classification criteria for innovation synergy degree of emerging technology industries

LC	<0	0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0
The collaborative degree	no	low	lower	medium	higher	high

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According to the above model, this paper calculates the synergy degree as shown in Figure 3. According to the statistics in the chart, taking 2009 as the base period, the synergy degree of the innovation network of emerging technology industries in the Guangdong-Hong Kong-Macao Greater Bay Area from 2010 to 2018 is generally low, and it is still at a low level until 2018.Among them, the level of collaborative development of Guangzhou is in the leading position, followed by Shenzhen, which is mainly related to their high degree of realization of innovation goals and high degree ofrational resource allocation.Although the reasonable degree of resource allocation is relatively stable in Hong Kong, the degree of innovation goal realization fails to keep up with the common development of resource allocation and strength, so the degree of synergy is relatively low.

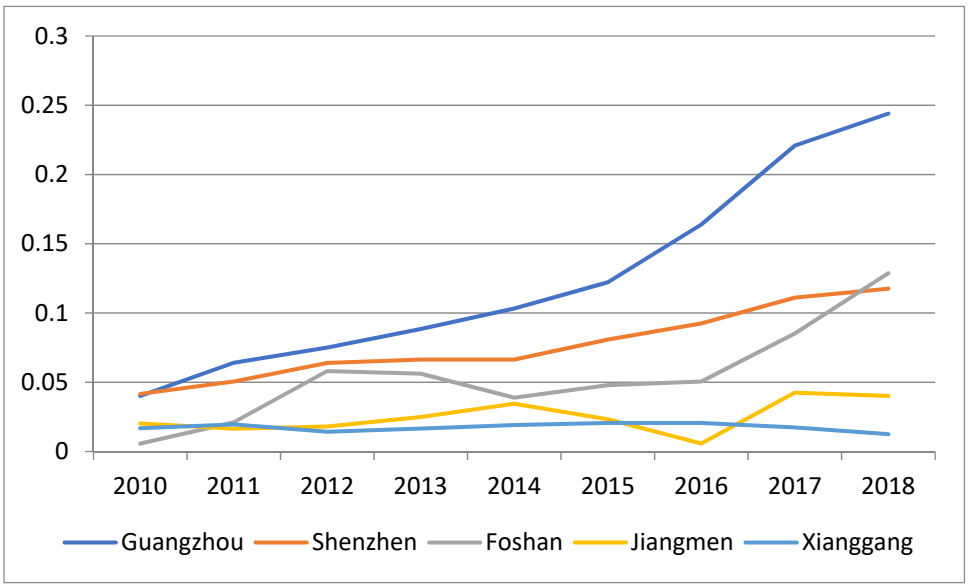

Figure 3. Change trend of innovation synergy degree of emerging technology industries from 2010 to 2018

4. Conclusions

To sum up, the total system synergy degree is closely related to the development of subsystems. According to the order degree analysis of subsystem I and subsystem R, the order degree of innovation goal realization degree is generally high and develops stable, while the order degree of subsystem of reasonable resource allocation degree is low and fluctuates greatly.Therefore, in recent years, the innovation synergy degree of emerging technology industries in the Guangdong-Hong Kong-Macao Greater Bay Area has not tended to a medium or high level as a whole due to the lack of coordinated development between the two subsystems.Through the above empirical analysis and summary analysis, we can clearly see that the medium degree of innovation network synergy of emerging technology industries in the Guangdong-Hong Kong-Macao Greater Bay Area is largely due to the unstable order degree of the resource allocation subsystem.

Therefore, in the future development, we can focus on improving the reasonable level of resource allocation. By reintegrating the resources among innovation subjects, we can form an innovation chain with complementary advantages, rapid sharing of information resources and strong targeting of scientific research and technology majors, which is also the development trend of bridging proposed in this paper at the beginning.

To better promote the colleges and universities, research institutes, scientific research and development between enterprises and government cooperation and exchange of experience

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and make scientific research and development of resources and experience in the field of scientific research of circulation, and development of new technology industry innovation system of high efficiency, reasonable structure, to promote a large bay area of the Guangdong areas of scientific research and development on new step.

5. Suggestions

(1) Achieve effective flow of factors and resources and promoting overall innovative development.According to the analysis of the synergy degree of the innovation network of emerging technology industries in the Guangdong-Hong Kong-Macao Greater Bay Area, the overall synergy degree shows a trend of growth, but the synergy degree is still at a low level, and different cities are in differences in development.So through innovation system orderly flow of resources, rational utilization, through the cooperation between research and development, technology innovation main body and information resource sharing, to improve the degree of order internal subsystems, and thus enhanced the synergy degree of system as a whole, Hong Kong and Macao to promote the whole bay big emerging technology innovation network synergy degree of improve.

(2) Improve the development status of the subsystem of achievement degree of innovation goals. From the analysis of basic data, from 2009 to 2018, the Guangdong-Hong Kong-Macao Greater Bay Area has paid more in innovation investment. The expenditure of funds, talent investment and infrastructure construction investment have played a fundamental role in ensuring the promotion of innovation research and development, which is also the key factor for the steady rise in the realization of innovation goals in the past decade.In addition, innovation output is also very critical, which not only depends on innovation input, but also is largely related to the subsystem of resource allocation.Therefore, to refresh the innovation achievements of emerging technology industries through increasing innovation input will promote the overall innovation system to move forward in a coordinated and orderly direction.

(3) Optimize the allocation of resources and realize the effective integration of resources among innovation subjects. The incentive mechanism is used to promote the efficiency of resource integration among research enterprises. For example, small research and development enterprises can provide more auxiliary work for large research enterprises and help large research enterprises to form innovative achievements.Large scientific research enterprises can provide more fund support and technical resources sharing benefits for small scientific research and development enterprises, so as to realize the transformation from small scientific research and development enterprises to large and medium-sized ones.Committed to optimize the reasonable degree of the subsystem of resource allocation, improve the efficiency of innovation main body resource allocation.

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