Promotion Path of National Agricultural Science and Technology Park Innovation Efficiency: Configuration Analysis Based on QCA

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Abstract: Taking 30 national agricultural science and technology parks as research samples, this paper uses fuzzy set qualitative comparative analysis method, and selects five representative variables from three dimensions of resources, subject and environment to explore the conditional configuration and paths that affect the improvement of innovation efficiency of agricultural science and technology parks. The results show that (1) The innovation efficiency of the park has multiple concurrent relations, and any single dimension and condition cannot achieve high innovation efficiency. (2) Resource-driven, comprehensive and alternative configuration is a realistic reflection of the park's choice of its own innovative development mode and path. (3) The conditions affecting the innovation efficiency of the park are asymmetrical, and there are three reasons leading to non-high innovation efficiency: low investment in research and development, non-comprehensive development and insufficient service support for innovation and entrepreneurship.

Keywords: National agricultural science and technology park; Innovation efficiency; fs QCA; Innovation ecosystem;

1 Introduction

The innovation of agricultural science and technology is the key to the transformation from traditional agriculture to modern agriculture. Agricultural science and technology parks, as the carrier of innovative resources agglomeration, continuously release innovation benefits and scale benefits, and become the highland of innovation-driven development of modern agriculture. However, the parks have different abilities in the process of gathering innovation resources, producing innovation results, and finally realizing innovation output, resulting in uneven overall efficiency levels of each park. In essence, the park is an institutional arrangement adopted by innovation subjects to cope with system innovation based on the limited innovation ability and the scarcity of innovation resources. In this context, to study how to build an innovation ecosystem of agricultural science and technology parks with multi-subject cooperation, efficient integration of multiple resources and strong environmental support to achieve high innovation efficiency has become the key to solve the problem.

Based on this, from the perspective of configuration, focusing on the issue of how to improve innovation efficiency of parks, this paper uses fsQCA to analyze the configuration of 30 national agricultural science and technology parks from three dimensions of resources, subjects and environment, to reveal the internal mechanism of improving innovation efficiency of parks by

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describing the configuration path that leads to high innovation efficiency of parks. This paper provides a reference for the park to allocate innovation elements to improve its innovation efficiency.

2 Literature review and theoretical framework

2.1 The two-stage chain process

According to the innovation value chain theory, innovation starts from basic research. Through application research and technology development, basic elements such as scientific research projects and patent achievements are first produced; then through product development, design and manufacturing of technological innovation subjects represented by high-tech enterprise groups, new products are produced; and through brand and other market operation means, new products are pushed to the final destination of innovation — market[1]. Innovation activities in the park have obvious features of intermediate output and input. In this way, the park can be divided into technology research and development stage and achievement transformation stage[4], see Fig1.

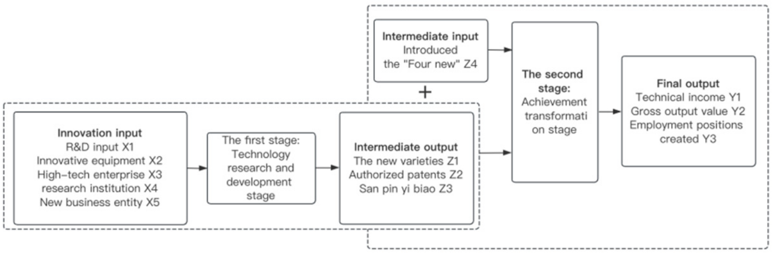

Fig. 1. The innovation activities of the park are divided into two stages

2.2 Innovation ecosystem theory and theoretical model

Innovation ecosystem is an open and complex system with dynamic evolution formed through the connection and conduction of material flow, energy flow and information flow between different innovation subjects and innovation environment in a region [2] . The theory of innovation ecosystem points out that three basic elements, namely innovation subject, innovation resource and innovation environment, are the basis for the healthy operation, evolution and growth of innovation ecosystem . In accordance with the theoretical framework, this paper carries out the theoretical framework of constructing the innovation ecosystem of agricultural science and technology park from three dimensions of "resources-subject-environment". three levels of innovation subject, innovation resources and internal environment are interconnected and matched, and the three levels present a non-cross-complementary state, which together constitute the basic element group of the innovation ecosystem of the park ,Among them, R&D investment[4], large instruments and equipment, technological innovation subjects[3], knowledge innovation subjects[3], and innovation and entrepreneurship services are all important factors affecting the two-stage innovation process of the park, and determine the two-stage innovation efficiency of the park. Based on the above analysis, this paper establishes the analysis framework as shown in Fig2:

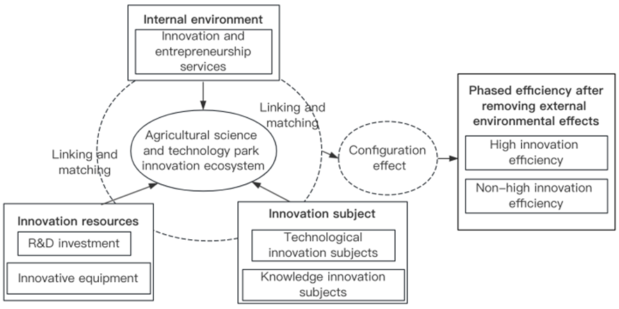

Fig. 2. The theoretical model of park innovation ecosystem

3 Research methods and data processing

3.1 Data processing

Case selection.

In this paper, 30 national agricultural science and technology parks were randomly selected as case samples, and the data obtained were all first-hand data from field surveys and questionnaires. All the total input-output indicators were the sum of the parks from 2019 to 2020, and the time-point indicators were the data at the end of December 2020. Data information is accurate and reliable.

Stage efficiency measurement.

In order to eliminate the influence of random interference such as location factors on production efficiency, this paper stripped away the external environmental interference of the park and adopted three-stage DEA model to measure the efficiency of technology research and development and the efficiency of results transformation[5].It provides data basis and analysis basis for further analyzing how to promote the balanced and efficient development of parks by matching their own resource endowment, innovation subjects and internal environmental conditions. In terms of index processing of location factors, per capita GDP, as an important indicator to measure economic development, is adopted by most studies. Specifically, the per capita GDP of the region where the park is located in 2020 is selected to measure the location factor of the park.

Variable description.

Based on the above analysis, the result variables and antecedent variables of this paper are described as Table 1.

Table 1. Description of conditions and results

Variable	Variable Description
R&D investment	Total R&D investment of in two years (RMB 100 million)
Innovation Equipment	The original value of large instruments and equipment in the Innovation Equipment Park (ten thousand yuan)

Technological innovation subjects	Numbers of agriculture-related high-tech enterprises in the park
Knowledge innovation subjects	Numbers of universities and research institutes that cooperated
Innovation and entrepreneurship services	Numbers of innovation and entrepreneurship services at or above provincial level
Efficiency1	The adjusted technical efficiency value of R&D stage
Efficiency2	The adjusted technical efficiency value of transformation stage

3.2 Data calibration.

In fsQCA, calibration is the process of assigning a membership score to a case. In this paper, 3 calibration points with 5 conditions and 1 result completely subordinated, intersecting point and completely unsubordinated point were set as the upper quartile (75%), the mean of the upper and lower quartile and the lower quartile (25%) of the sample data, respectively.

4 Results

4.1 Necessity analysis

First, test whether a single condition (including its non-set) constitutes a necessary condition for high or low innovation efficiency of the park. Consistency is an important criterion to measure the necessary condition. When the consistency level is greater than 0.9, it can be considered as the necessary condition for the result. The results show that the necessity level of each factor affecting the two-stage innovation efficiency is not more than 0.9. Therefore, no factor can constitute the necessary conditions for the two stage outcome variables (high innovation efficiency and low innovation efficiency).

4.2 Adequacy analysis

Then the adequacy analysis of conditional configuration is further carried out. This paper sets PRI at 0.7, case frequency threshold is set as 1. As can be seen from Table 2 and Table 3,in two stages the consistency level of both the single solution and the overall solution is higher than 0.8. the overall coverage is 0.528 and 0.443, indicating that the four configurations explain respectively more than 52% and 44% of the reasons for the high R&D efficiency and high conversion efficiency.

Table 2. Configuration results of high R&D efficiency in the parks

Configuration	results			
	H1a	H1b	H1c	H1d
rd	●	●		●
sb	⊗	⊗	●	•
ht	•		●	⊗
it		•	⊗	●
fw	⊗	⊗	⊗	
raw coverage	0.165894	0.161170	0.192870	0.231143
unique coverage	0.035466	0.029304	0.121939	0.178013
consistency	0.836671	0.873794	0.975416	0.844422

solution coverage	0.528013
solution consistency	0.869252

Note: ●and respectively represent the appearance of core condition and does not appear, •and respectively represent the appearance of edge conditions and does not appear. The space indicates that the occurrence of the antecedent condition has no effect on the result.

Table 3. High conversion efficiency configuration results of the parks

configuration	results			
	H2a	H2b	H2c	H2d
rd	●	●	⊗	•
sb	⨂	⨂	⊗	●
ht	⨂	⨂	⨂	●
it	•	⊗	●	●
fw	⊗	•	●	⨂
raw coverage	0.0694636	0.0866575	0.169188	0.125172
unique coverage	0.0412655	0.065337	0.110041	0.0832187
consistency	0.827869	0.812903	0.806557	0.8125
solution coverage	0.442916			
solution consistency	0.803995			

Note: ●and respectively represent the appearance of core condition and does not appear, •and respectively represent the appearance of edge conditions and does not appear. The space indicates that the occurrence of the antecedent condition has no effect on the result.

4.3 Configuration analysis

High innovation efficiency.

Basis for configuration nomenclature.

Four configurations with high R&D efficiency and four with high conversion efficiency of national agricultural science and technology parks were obtained respectively, and the configurations were classified and named. The consideration of configuration classification and naming in this paper is not only to extract more configuration features, but also to show the differences between configurations through comparison.

this paper observes that there are three types of configuration. The first type is the resource-boosting, which is manifested by the existence of only two conditions, namely core existence and edge existence, and the absence of other conditions or no influence on the results. As the core conditions of each configuration meet the requirements, one of R&D investment and innovation equipment appears, indicating that the innovation of the park cannot be separated from the high level of investment of innovation resources. The second type is the comprehensive, the existence of the two conditions are the core existence, the other conditions are missing or do not affect. The third type is the substitution type, which is represented by the absence of a conditional core and the existence of other conditions.

Configuration analysis for high R&D efficiency

So, the four configurations with high R&D efficiency were named as resource-boosted enterprise R&D type, resource-boosted knowledge R&D type, resource enterprise comprehensive R&D type and resource knowledge comprehensive R&D type.

In resource-boosted enterprise R&D type, R&D investment plays a core role, the technological subjects, which represented by high-tech enterprises, exists with auxiliary conditions, parks with the above factor endowment can use R&D funds to cultivate and introduce high-tech enterprises, promote industrial agglomeration, promote the leverage effect of R&D funds and enterprise strength complement each other, and further improve the R&D efficiency. Likewise, resource-boosted knowledge R&D type through strong capital investment as the basis and leading factor, supplemented by strong strength and active cooperation between the research institutions and the former, the mutual promotion and mutual win, powerful replacement of innovation equipment, innovation and entrepreneurship services and other conditions, jointly promote the park. Then in resource enterprise comprehensive R&D type, both innovative equipment and technology subjects play a central role, parks with insufficient R&D investment and few cooperative research institutions can consider this path. Finally, parks with knowledge innovation subjects and R&D investment, efficient resource integration of R&D platform conditions but lack of technological innovation subjects, can adopt resource knowledge comprehensive R&D path to achieve the same effect.

Configuration analysis for high conversion efficiency

Likewise, the four high conversion efficiency configurations can be named as resource-boosted knowledge type, resource-boosted service type, service knowledge comprehensive type and service substitution type. Resource-boosted knowledge type indicates that encouraging scientific and technological achievements of research institutes to be transformed in the park can play a key role in promoting technological progress, production increase and income of enterprises; Resource-boosted service type parks actively establishes innovation and entrepreneurship service institutions that provide public technical support services for small and medium-sized enterprises to cooperate on key technologies and improve production processes in the form of enterprise alliances with the aid of financial guidance and policy support, which also achieve high conversion efficiency; In service knowledge comprehensive parks, the comprehensive service platform for the transformation of scientific and technological achievements based on the idea of "intellectual property + technology docking + resource integration", has cooperated with universities and enterprises to actively explore the technology market during the promotion and demonstration of new varieties and new technologies, and significantly improved the transfer and transformation ability of technological achievements in the park. Unlike other configurations, service substitution transformation type indicates that in the parks with weak and imperfect entrepreneurial incubation, technology transfer and science and technology service functions, other conditions must be met to promote the realization of high achievement conversion rate, which means higher costs. In the construction of parks, it is necessary to avoid using this configuration to achieve high conversion efficiency.

Non-high innovation efficiency.

In this paper, the configurations that generate non-high R&D efficiency and non-high conversion efficiency are tested respectively, and 3 and 4 configuration paths are obtained respectively

(N1a, N1b, N1c; N2a, N2b, N2c, N2d). Firstly, it's found that High-efficiency and non-efficient paths are not symmetrical. Next, by comprehensive comparison of seven paths, it is found that "non-high R&D input" is the core condition. Compared with N1a, N1b, N2a and N2b do gather outstanding elements, but when the existing core conditions do not cross multiple dimensions, it is impossible to achieve the collaborative matching of each condition and to promote the park to achieve high efficiency. In addition, "non-high innovation entrepreneurship service" is the core condition of N2a, N2a and N2c, indicating that the lack of innovation environment support is the important reason for the park's inability to realize high conversion.

4.4 Robust test

This study raised the consistency threshold value from 0.8 to 0.85 to observe whether the results are consistent. The results show that the single consistency and overall consistency of the new model are still higher than 0.8, and the configuration result is a subset of the original model, which indicates that the research results pass the robustness test and meet the reliability requirements.

5 Conclusions

Through the process of necessity detection, adequacy and configuration naming and analysis, the following conclusions are obtained:(1) No single dimension or condition can determine the high innovation efficiency of any stage of the park. (2) The path of high innovation efficiency can be analyzed as resource-boosting type, comprehensive type and alternative type. which reflect that the park adapts to local conditions and selects its own innovative development mode and path by exploiting strengths and avoiding weaknesses.(3) The configurations leading to high R&D efficiency can be divided into four types: resource-boosted enterprise R&D, resource-boosted knowledge R&D, resource enterprise comprehensive R&D and resource knowledge comprehensive R&D. The configurations leading to high conversion efficiency can be divided into resource-boosted knowledge transformation, resource-boosted service transformation, service knowledge comprehensive transformation and service substitution transformation.(4) The conditions affecting the innovation efficiency of the park are asymmetrical. There are three reasons leading to non-high efficiency: low investment in research and development, non-comprehensive development and insufficient service support for innovation and entrepreneurship.

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