



Research Article

Evaluation of Interest Balance of Low-carbon Collaborative Innovation Subjects

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The most important subsystem of regional low-carbon innovation capability is low-carbon technology innovation system. It is necessary to objectively evaluate the balance of interest among low-carbon technology innovation subjects. This paper constructs the theoretical framework model of benefit balance evaluation of low-carbon collaborative innovation (LCCI). It also explores the main content and index system of evaluation and makes a specific evaluation with TOPSIS method. Our study shows the follow conclusions: ① The interest balance of the subjects of LCCI includes not only the interest balance among subjects, but also the balance of interests within the subject. ② Subjects have different motivations for cooperation. ③ The benefit distribution of LCCI includes the distribution of all tangible and intangible benefits. ④ The equilibrium state is dynamic. When it is unbalanced, it can be adjusted according to the evaluation results to achieve equilibrium. Finally, according to the research conclusions, three suggestions are put forward for LCCI management practice.

1. Introduction

Globalization has an uncertain impact on carbon emissions, which will affect climate change [1]. And climate change caused by carbon emissions has received great attention from countries around the world [2, 3]. Many countries and regions around the world have taken positive measures to reduce carbon emissions, among which regional low-carbon innovation capability is one of the important indicators [1, 4]. The most important subsystem of regional low-carbon innovation capability is low-carbon technology innovation system. The subject of low-carbon technological innovation refers to the social organization or role that participates in the whole process of low-carbon technological innovation activities, occupies a leading position, and plays a leading role in technological innovation activities. It mainly includes enterprises, universities, and research institutions [5].

The Low-carbon Collaborative Innovation (LCCI) is to transform the industry in the direction of social,

environmental, and economic sustainable development [6, 7]. This kind of cooperation is based on the different resource advantages and interest needs of different subjects [8]. Among them, the advantage of research institutions (including universities and research institutes) is their rich R & D resources, equipment, and talent. At the same time, the advantages of firms are capital and market demand [9]. In Yong [10]'s research on LCCI, it shows that the most significant benefit realized by firms is an increased access to new university research and discoveries, and the most significant benefit by faculty members is complementing their own academic research by securing funds for graduate students and lab equipment, and by seeking insights into their own research. This cooperative innovation mode based on complementary advantages can not only increase the innovation level of firms [11, 12] and the competitive advantage of enterprises [13], but also promote the national regional innovation ability [14] and the reform of national innovation system [15]. As a result, it has been rapidly popularized since its emergence.

According to the Bulletin of China's National Economic and Social Statistics, the turnover of granted patents and technology contracts in China increased by 31.9 and 35.32 times, respectively, in the 20 years from 2001 to 2020 (China). Thus, the LCCI has become one of the mainstream modes of modern innovation [16].

LCCI can create more benefits. However, it involves different subjects, and it will involve the issue of interest distribution. Surely, different subjects participate in cooperation with different purposes and invest different resources [17–19]. If the subject is not satisfied with their interest distribution, he will withdraw from the cooperation, or even no longer participate in such a cooperation [20]. This will not be conducive to the development of LCCI. Therefore, ensuring the rationality of interest distribution is the basis of LCCI.

If we do not know the real attitude of the main body to the distribution of interests, we will not be able to judge its willingness to participate in such projects. This will inevitably affect the sustainable development of low-carbon collaborative innovation, regional low-carbon innovation capacity [21], and even strategic objectives such as “carbon peak” and “carbon neutralization” [22].

Therefore, this paper is a study on the evaluation of the balance of interest distribution of LCCI subjects, which is instructive for the rational participation of LCCI project subjects in cooperation and the rational distribution of cooperation interests. Make an objective evaluation of the specific situation of the main interest. The evaluation results are fed back to the corresponding subjects to help them cooperate more stably in the next step. We first build the theoretical framework model of evaluation, and then use specific cases for research. The arrangement of the rest of this paper is as follows. Literature review is given in Section 2. Theoretical basis and research design in Section 3. Case application and analysis are described in Section 4. Discussion is conducted in Section 5. Conclusions and future work are presented in Section 6.

This study can guide the evaluation of low-carbon collaborative innovation projects and the balance of subject interest distribution.

2. Literature Review

2.1. Research on Low-Carbon Collaborative Innovation (LCCI). There are many studies related to low-carbon collaborative innovation. In summary, they are mainly reflected in the following aspects:

2.1.1. The Research on the Cooperation Motivation of the Main Body. McKelvey et al. [23] finds that the cooperation effect between universities and enterprises is better than that between enterprises, and better than that between universities. Fernández López et al. [24] studies 375 companies in Spain, Portugal, and France through semi structured interviews. It shows that more innovative enterprises tend to cooperate with universities. However, the motivation of cooperation between high-tech enterprises and non-high-tech enterprises is different.

Beath et al. [25] believes that the basic goal of the university is to carry out basic research, followed by applied research. However, the research of Banal-Estañol et al. [26] indicates that cooperation to a certain extent will help the research subjects obtain more research innovation and funding sources. However, excessive cooperation will seriously hinder the research and innovation output by reducing a large amount of research time. Freitas and Verspagen [27] study the relevant data of the Netherlands and show that the different motives of the main body have an impact on the organizational structure design of the project. Moreover, the specific organizational structure and technical objectives do not always have advantages, but only have advantages under specific institutions [28].

Clearly, different subjects have different motives to participate in LCCI.

2.1.2. The Research on the Influencing Factors of Cooperation.

Kazuyuki [15] find that the scale of cooperative enterprises will affect the performance. Generally, small-scale companies have stronger investment and better performance in cooperation. Bodas Freitas et al. [29] studies that the cooperation performance of enterprises in different industry stages will be different. And the coordination of the relationship between members is also crucial to performance. Hemmert [30] studies the close interaction among various subjects in collaborative innovation projects, which has an impact on the effect of subject participation in cooperation.

Fischer et al. [31] and others study that the level and quality of school enterprise cooperation have an impact on cooperation performance. Williams and Allard [32] shows that a well-educated and skilled labor force contributes to the promotion of industry university research and collaborative innovation projects. Maietta [33] uses multivariate probity model to study the driving factors of a collaborative innovation projects.

There are also researches on the influence of collaborative innovation atmosphere [34], resource dependence among subjects [35], incentive mechanism [36] on low-carbon collaborative innovation.

Therefore, the influencing factors of low-carbon collaborative innovation involve many aspects and perspectives.

2.1.3. The Research on the Stability of Cooperation.

Lee et al. [37] takes the school enterprise cooperation in Tokyo as an example and shows that culture and organization are the biggest obstacles to the stability of cooperation. Hemmer et al. [38] shows that deep-rooted cultural differences lead to the instability of cooperation by influencing the mutual trust between subjects. Musio and Vallanti [39] studies 197 collaborative innovation projects in Italy, which show that perceived barriers from the main body will cause instability of cooperation. Guzzini and Iacobucci [9] show that the larger the scale, the worse the stability of cooperation. At the same time, the stability of collaborative innovation cooperation is also worse for enterprises with innovative nature.

Jasmina et al. [40] show that normative contracts and effective and reasonable policies can better deal with intellectual property rights, conflicts of interest, copyright, and other issues, which is an important guarantee for stable cooperation. The research of Estrada et al. [41] shows that the specific cooperation mode should be adjusted with the progress of cooperation, otherwise it will lead to the instability of cooperation. Liu [42] shows that an effective way of interest distribution will increase the stability of cooperation and the willingness of re-cooperation among subjects, while an unbalanced way of interest distribution will lead to the rupture of cooperation.

From the above literature, there are many perspectives to explore the low-carbon collaborative innovation.

However, there are few studies on the evaluation of the balance of interest distribution in low-carbon collaborative innovation.

2.2. Research on Benefit Distribution of Low-Carbon Collaborative Innovation. The benefit is the key for the university-industry collaborative innovation to keep a long-term stable relationship [42]. While benefit distribution is beneficial to the performance of collaborative innovation, and can improve the efficiency by influencing the incentive mechanism [42] in the same time, the most critical factors for benefits "realization are: "strategic", "inter-relational" and "cultural" [43].

Freitas and Verspagen [27] rely on in-depth data on 30 university-industry collaborations in the Netherlands, and provide preliminary evidence that the effective cooperation between UIC is to create different institutional incentives by targeting different individual motivations.

Sivadas et al. [44] point out that the complexity of the interest relations, the differences of each organization unit goal, and the lack of constraint mechanism inevitably lead to the interest conflict between different organizations, which causes the instability of cooperation and the failure of the innovation cooperation. Establishing an appropriate and clear benefit distribution mechanisms is the guarantee of successful collaborative innovation.

Therefore, Jasmina et al. [40] point out that effectively coordinating the distribution interests of innovation cooperation is the key to achieve "win-win" before launching innovation cooperation activities. Li et al. [45] show that according to the different needs of alliance members, the profit distribution model can fully encourage alliance members to participate in collaborative innovation and improve the performance of collaborative innovation.

Reasonable distribution of interests can not only meet the reasonable needs of individuals, but also optimize the overall interests [46]. It can also improve the willingness to innovate, which has a positive role in promoting environmental and economic development [47].

2.3. Research on Evaluation Methods. There are a lot of research on different evaluation methods and their applications, which are summarized as follows:

2.3.1. Data Envelopment Analysis (DEA). After Charnes and Cooper (1980) introduced DEA into accounting related evaluation, Tomkins et al. [48] apply it to the efficiency evaluation of university departments.

Subsequently, Sherman and Gold [49] and Chen and Yeh [50] use DEA to evaluate the operation efficiency of banks. The evaluation results are divided into two categories: low efficiency and high efficiency. And put forward the path from low efficiency optimization to high efficiency. Boles et al. [51] evaluate the performance of sales staff with DEA. Donthu and Yoo [52] evaluate the production efficiency of retail industry.

However, any random error can be calculated as the efficiency difference by DEA, which will lead to lower average efficiency. This is the deficiency of DEA for evaluation [53].

2.3.2. Key Performance Indicators (KPI). KPI is the basic element of an organization's ability to monitor its strategic health, which helps to ensure the realization of the organization's strategic objectives [54]. Pan and Wei [55] add KPI evaluation index system to the optimization of enterprise business process framework, which accelerates the dynamic structure of the process to quickly adapt to market changes. Trompet et al. [56] compare the performance differences between urban bus operators in maintaining the regularity of high frequency line service with KPI. Chan and Chan [57] use KPI to measure and evaluate the success of construction projects, put forward the views of stakeholders in emerging countries, and evaluate the performance of intermediaries in a specific ITT project [58].

However, the evaluation and improvement of key performance indicators is often a temporary and consultant-driven process, rather than a process using scientific principles [59].

2.3.3. Balanced Scorecard (BSC). BSC is not only a measurement system, but also a management system, which can achieve long-term strategic goals [60]. Krylov [61] uses BSC in the long-term, medium-term, and short-term management decision-making of distribution activities. Cooper et al. [62] make further research on the extended application of BSC, which is based on the actor network theory (ANT). Akkermans and Oorschot [63] shows that BSC only focuses managers' attention on a few indicators for performance evaluation, which is not conducive to the quality of evaluation.

2.3.4. Segmentation Evaluation. Zhang [64] shows that this kind of evaluation method usually divides the evaluation objects into three groups: analysis group, experience superiority group, and experience difference group for comparative evaluation, and then makes strategies according to the evaluation ability level. Prabha and Kumar [65] makes a comparative study of segmentation evaluation from both objective and subjective aspects and believed that objective evaluation would be more scientific. Wang et al. [66]

evaluate the quality of grouping evaluation methods from two perspectives: unsupervised and supervised.

2.3.5. Multi Criteria Decision Making Method (MCDMM). TOPSIS is a multicriteria evaluation method. It identifies solutions from a limited set of alternatives based on simultaneously minimizing the distance from the ideal point and maximizing the distance from the lowest point [67]. TOPSIS can be used for ranking evaluation [68] and is widely used in supply chain management and logistics [69], human resource management, energy management, water resource management and other fields [70].

Indeed, the general idea of the evaluation method is to compare the efficiency of input and output with the reference or standards. There are many methods for evaluation, and each has its own advantages and disadvantages and adaptability. From the review of the above literature, we can see that there are many research perspectives on low-carbon collaborative innovation. There are also many research papers on evaluation methods. The authors of these papers have contributed a lot to the theoretical development in the field. However, the shortage is that the literature of evaluating the balance of interest distribution of LCCI subjects is relatively scarce.

Therefore, this manuscript focuses on how to evaluate the interest balance of low-carbon collaborative innovation subjects and to make up for the lack of existing theoretical research. In this way, it can fill the shortage of existing evaluation research on the benefit distribution of low-carbon project subjects, and the rational distribution research of project subjects.

We use literature research method [71] and case analysis method [72] to carry out the research. Firstly, we build a theoretical framework model to evaluate the interest balance of the main body, based on the existing literature research and the practice of low-carbon collaborative innovation. Then it is used in specific cases to verify the feasibility of the theoretical model.

3. Theoretical Basis and Research Design

3.1. definition of Related Concepts and Principles

3.1.1. Defining Low-Carbon Collaborative Innovation. The carrier of LCCI is the project, which is the Low-carbon Collaborative Innovation (LCCI). LCCI is a kind of project that firms cooperate with universities, research institutes, and other enterprises to develop new technologies and new processes [73]. In addition to the most important forms of University-Industry Collaborative Innovation, there are also different forms of cooperation between universities and colleges, universities and research institutes, enterprises, and enterprises. Like this, Wu et al. [74] describe the Cooperative innovation Projects(CIP): specific projects in which companies and public research institutions or other companies cooperate to create new technologies, products, materials, systems, or manufacturing processes.

3.1.2. Defining the Subject of LCCI. LCCI is a multiparty cooperation project, including universities (including scientific research institutions), enterprises, governments, and other multibody, which are carried out for scientific and technological innovation or transformation of scientific and technological innovation achievements.

Each participant has different knowledge, culture, resources, technology, and other backgrounds. They have a different understanding of the value of technology and market expectations. Then the subject includes two levels: the subject between subjects and the subject within subjects.

The subject subjects refer to the cooperative members composed of universities, enterprises, and governments. The subject within the subjects refers to the internal members of the university and the internal members of a firm. The main body of the internal universities refers to University Core R & D personnel and general participants. The main body of the internal enterprises refers to firm, key technical personnel, and general participants.

3.1.3. Defining the Interest Balance among the Subjects of LCCI. Referring to the idea of literature [75], the balance of interest distribution among subjects refers to the balance of all interests including all kinds of tangible and intangible interests.

It is only after a comprehensive economic calculation that the payment is equal to the harvest that it can be regarded as achieving equilibrium. Therefore, the balance of interest among the subjects refers to the balance of distribution among all subjects participating in the project cooperation. Therefore, the key point of interest distribution equilibrium is that the interest requirements of each subject can be met.

From the definition of the subject of LCCI, we can see that the interest balance among the subjects of LCCI should include two levels: the balance between subjects and the balance within subjects. Therefore, only when the balance can be achieved between subjects and within the subjects, it means that the profit distribution of LCCI is balanced.

3.2. Determining the Content of Evaluation. If we want to evaluate the effect of interest balance among the subjects of LCCI, we should consider the balance of all participants [76]. This is obvious from the above definition. It includes not only the balance of interest distribution among subjects, but also the balance within subjects. The balance within subjects includes the internal balance of universities and enterprises.

Therefore, according to the above analysis, we determine the evaluation content of interest balance of low-carbon collaborative innovation subjects as shown in Figure 1.

3.3. Construct an Evaluation Index System. The index system is determined according to the evaluation content. Then, the index system to evaluate the benefit balance of LCCI should be divided into three levels.

It includes the interest balance index between subjects and the interest balance index of the internal subjects, which

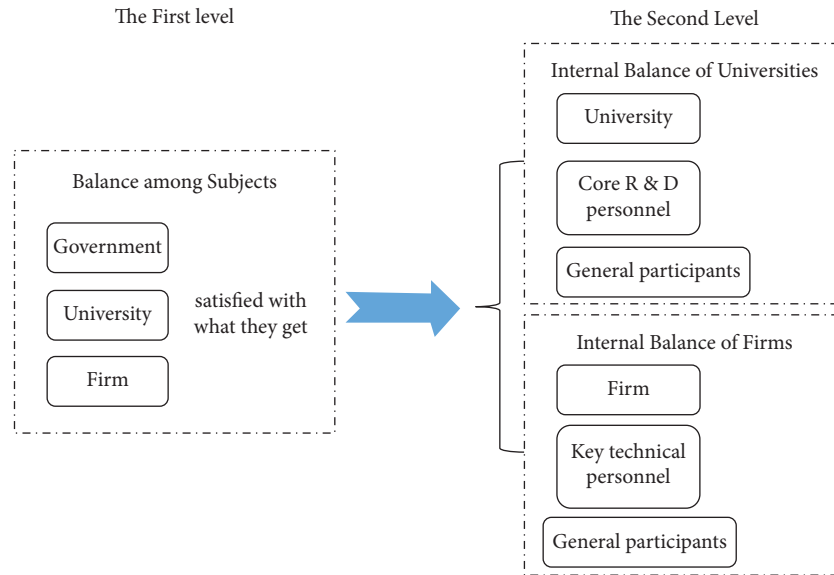


FIGURE 1: The content of evaluating the balance of benefit distribution of LCCI.

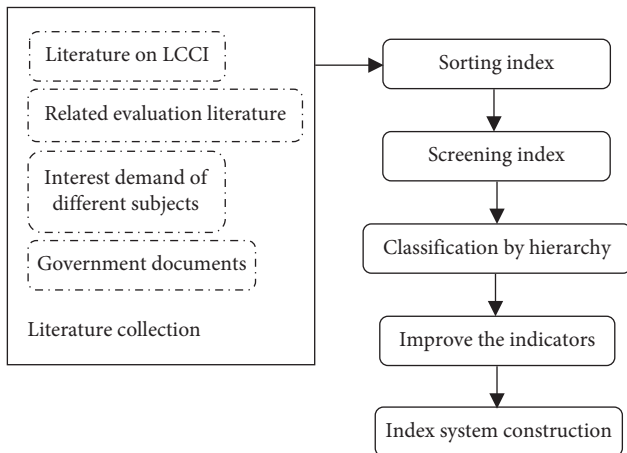


FIGURE 2: Construction of the benefit balance evaluation index system of LCCI.

includes the internal interest balance index of the university subject and the internal interest balance index of the enterprise subject.

Design the evaluation index according to the following steps. The first is the combination of literature research methods, collecting relevant literature, sorting out the literature, and specific analysis and extraction [77]. The second is based on the project practice survey. Finally, sorting, screening, and determine the final index system.

The specific index system construction process is shown in Figure 2.

Based on the process of Figure 2, the index system for evaluating the interest balance of LCCI is finally constructed as shown in Table 1.

3.4. Determination of Evaluation Method. The evaluation object of this paper is the balance of interest distribution of collaborative innovation project subjects. It includes the

balance of interest distribution between subjects and the balance of interest distribution within subjects.

The primary purpose of LCCI is to pursue the maximum of total income, which is the premise to seek the maximum of individual income. This is the principle of balanced distribution [20]. This determines that the evaluation of the main interest's balance is a moderate qualitative description. Therefore, the evaluation method can deal with qualitative analysis more accurately.

Because the index weight of the evaluation index system constructed in the previous paper is unknown. Therefore, the evaluation method is needed to deal with the problem of multiindex and uncertain weight information.

Compared with the evaluation method described above, it is not difficult to determine that TOPSIS evaluation method is more suitable. Therefore, TOPSIS is selected as the specific evaluation method of this paper.

Olson [90] makes a comparative study of different methods for determining weights in TOPSIS and finds that their accuracies for TOPSIS are very close. This shows that the weight determination method in TOPSIS is flexible.

In addition, TOPSIS has the following advantages:

- (1) It can ensure the diversity of evaluation data forms and help to build a reasonable evaluation model [91].
- (2) There are no strict restrictions on the data distribution and the number of indicators. It has a good effect on processing small sample data and multi-index data. It can also be used for longitudinal and transverse comparison [92].

Therefore, this paper selects TOPSIS for a specific evaluation calculation and then expands the evaluation results in the adjustment link.

Firstly, we construct the mathematical model. And then calculate the weight coefficient and the degree of closeness to

TABLE 1: Index System of interest balance of LCCI.

Target	First level indicators	Secondary indicators	Assessment element	Evaluation criteria	References
Benefit balance effect among subjects in LCCI	Balance of interests among subjects A	Enhancing regional innovation capability A1	Enhancing regional influence to promote regional development	Satisfaction of improving regional innovation capability	[78]
		Universities get funding A2	The foundation for supporting more theoretical innovation	The satisfaction degree of university funds income	[79]
		The opportunity of training talents in universities A3	Cultivating talents with the combination of theory and practice	Satisfaction with training talents	[31]
		Transformation of knowledge achievements in universities A4	Transforming theory into practice and sublimating theory	Satisfaction with university scientific research achievements	[11]
		Universities enhance their influence A5	Enhance the reputation of the university	Satisfaction with the construction of university reputation	[80]
		Enterprises get technical support A6	Overcome technical problems	Satisfaction with enterprise development	[81]
		Enterprises enhance innovation ability A7	Upgrade the existing core technology and process	Satisfaction with the improvement of enterprise innovation	[82]
		Enterprises are expected to gain more market opportunities A8	Successful cooperation can enter the market earlier	On the satisfaction degree of improving the competitiveness of enterprises	[14]
		Enterprise strategy implementation, competitiveness promotion A9	Enhance the core competitiveness	Satisfaction with the implementation of enterprise strategy	[83]
	The internal interest balance of universities B	Project and funding of the team B1	Project funding income	On the success of team building	[84]
		Improvement of core R & D personnel B1	The increase of core R & D personnel's ability	Satisfaction with ability improvement	[36]
		Commission B3	Increase of funds for core R & D personnel	Satisfaction with the use of funds	[33]
		Get more intellectual property or monograph B4	Number and level of published papers	Satisfaction with scientific research output	[85]
		Accumulation of experience B5	General participants accumulate experience	Satisfaction with experience accumulation	[86]
		Increase contacts C1	Value added of network through the project	Satisfaction with resource accumulation	[36]
The internal interest balance of enterprise C	Improve management ability C2	Management ability and team building ability improvement	Construction of organizational atmosphere	[87]	
	Improving skills is conducive to career development C3	The promotion of the comprehensive ability of the core technical personnel	Improve satisfaction with growth	[88, 89]	
	Complete the project and get the reward C4	Project success and reward	Fairness of material reward	[85]	
	Complete the assessment task arranged by the organization C5	Complete the task	Salary satisfaction	[33]	

complete the evaluation of the collaborative innovation benefit balance.

Based on this evaluation, the variance of closeness degree is calculated, and the variances are sorted. By sorting the variances, we can determine the overall satisfaction of the allocation scheme under different criteria and determine the objects to be adjusted to realize the scheme optimization.

3.5. Optimized TOPSIS Evaluation Idea

3.5.1. *Determination of Criteria.* According to the designed index system, combined with specific cases, ask experienced experts to make a preliminary score. The design of expert scoring is based on the research idea of right triangle fuzzy function scale proposed in literature [93]. Expert scoring

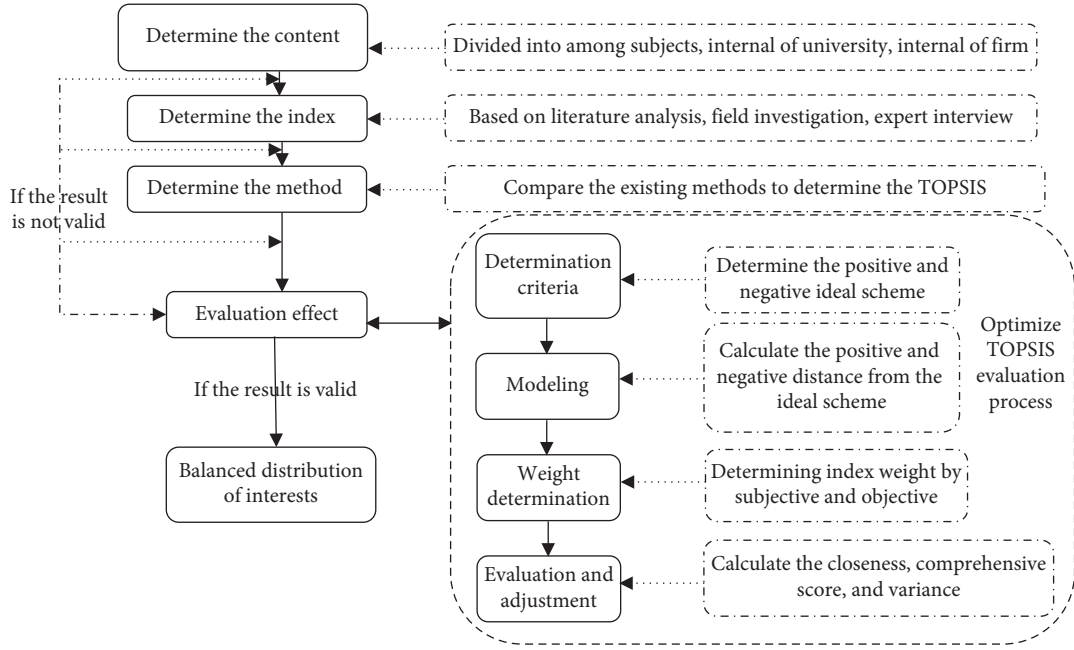


FIGURE 3: Research theoretical framework for evaluating the balance of main interests of LCCEI.

includes lower limits, approximate values, upper limits, membership degree, and nonmembership degrees.

Then we deal with the expert's score and calculate the ideal scheme and negative ideal scheme. The ideal scheme G^+ refers to the minimum uncertainty and higher degree of excellence under this criterion. The negative ideal scheme G^- refers to the maximum uncertainty and lower degree of excellence under this criterion [94]. The calculation formula is as follows:

$$G = \begin{cases} G^+ = (G_1^+, G_2^+, \dots, G_n^+), \\ G^- = (G_1^-, G_2^-, \dots, G_n^-), \end{cases} \quad (1)$$

where

$$\begin{cases} G_j^+ = \left[\left(\max_{1 \leq i \leq m} a_{ij}^U, \max_{1 \leq i \leq m} a_{ij}^V, \max_{1 \leq i \leq m} a_{ij}^L \right); 1, 0 \right], j = 1, 2, \dots, n, \\ G_j^- = \left[\left(\min_{1 \leq i \leq m} a_{ij}^U, \min_{1 \leq i \leq m} a_{ij}^V, \min_{1 \leq i \leq m} a_{ij}^L \right); 0, 1 \right], j = 1, 2, \dots, n. \end{cases} \quad (2)$$

3.5.2. Building Model. Gap D refers to the distance between the evaluation object A_i and the ideal scheme G^+ and the negative ideal scheme G^- [67, 94]. It is given by

$$\begin{aligned} D &= \begin{cases} D^+ = D_i^+ = \sum_{j=1}^n \omega_j D(A_{ij}, G_j^+), i = 1, 2, \dots, m, D^- \\ = D_i^- = \sum_{j=1}^n \omega_j D(A_{ij}, G_j^-), i = 1, 2, \dots, m. \end{cases} \end{aligned} \quad (3)$$

It is not difficult to know from the definition principle that the smaller D_i^+ , the better the evaluation effect, and the larger the D_i^- , the better the evaluation effect.

The specific calculation formula of D is based on the formula in reference [95]:

$$\begin{aligned} DA, B = \frac{1}{6} \{ & [(1 + v_a - w_a)u_a^U - (1 + v_B - w_B)u_b^U] \\ & + [(1 + v_a - w_a)u_a^V - (1 + v_B - w_B)u_b^V] \\ & + [(1 + v_a - w_a)u_a^L - (1 + v_B - w_B)u_b^L] \}. \end{aligned} \quad (4)$$

for

$$\begin{aligned} A &= [u_a^U, u_a^V, u_a^L, v_a, w_a], \\ B &= [u_b^U, u_b^V, u_b^L, v_b, w_b]. \end{aligned} \quad (5)$$

Using the idea of the integration of subjective and objective weighting method [96] for reference, the index is weighted as follows. The weight coefficient of the optimal criterion is calculated according to the integrated weight principle of the maximum comprehensive evaluation target value. The weight calculation formula is given by

$$\omega_j = \frac{\sum_{i=1}^m A_{ij}}{\sum_{j=1}^n \sum_{i=1}^m A_{ij}}, \quad (6)$$

$$\sum_{j=1}^m \omega_j = 1, \quad 0 \leq \omega_j \leq 1.$$

3.5.3. Discussion of Results. Total considerate closeness d_i [97] and comprehensive score γ_i are calculated by

$$d_i = \frac{D_i^+}{D_i^+ + D_i^-}, \quad (7)$$

$$\gamma_i = d_i * \omega_j. \quad (8)$$

TABLE 2: Decision matrix transpose matrix of Expert 1.

Index hierarchy	Assessment element	Subject 1 (Government)	Subject 2 (University)	Subject 3 (Enterprise)
Balance of interests among subjects	Enhancing regional influence to promote regional development	[(10,9,7),0.65,0.35]	[(7,5,3),0.74,0.26]	[(6,4,2),0.74,0.26]
	The foundation for supporting more theoretical innovation	[(10,9,7),0.65,0.35]	[(7,5,3),0.74,0.26]	[(6,4,2),0.74,0.26]
	Cultivating talents with the combination of theory and practice	[(10,8,6),0.67,0.33]	[(7,5,3),0.74,0.26]	[(6,4,2),0.74,0.26]
	Transforming theory into practice and sublimating theory	[(10,8,6),0.67,0.33]	[(7,5,3),0.74,0.26]	[(6,4,2),0.74,0.26]
	Overcome technical problems	[(10,9,7),0.65,0.35]	[(7,5,3),0.74,0.26]	[(6,4,2),0.74,0.26]
	Upgrade the existing core technology and process	[(10,9,7),0.65,0.35]	[(7,5,3),0.74,0.26]	[(6,4,2),0.74,0.26]
	Enhance the core competitiveness	[(10,9,7),0.65,0.35]	[(7,5,3),0.74,0.26]	[(6,4,2),0.74,0.26]
		Subject 1 (university)	Subject 2 (main R & D personnel)	Subject 3 (general participants)
The internal interest balance of universities	Project funding income	[(10,9,7),0.65,0.35]	[(8,6,4),0.71,0.29]	[(3,1,1),0.82,0.18]
	The increase of core R & D personnel's ability	[(10,8,6),0.67,0.33]	[(7,5,3),0.74,0.26]	[(4,2,0),0.79,0.21]
	Increase of funds for core R & D personnel	[(9,7,5),0.70,0.30]	[(6,4,2),0.76,0.24]	[(5,3,1),0.77,0.23]
	Number and level of published papers	[(9,7,5),0.70,0.30]	[(7,5,3),0.74,0.26]	[(3,1,1),0.82,0.18]
		Subject 1 (enterprise)	Subject 2 (main technical personnel)	Subject 3 (general participants)
The internal interest balance of enterprise	Value added of network through the project	[(10,8,6),0.67,0.33]	[(10,8,6),0.66,0.34]	[(3,1,1),0.82,0.18]
	Management ability and team building ability improvement	[(8.5,6.5,4.5),0.71,0.29]	[(7.5,5.5,3.5),0.73,0.27]	[(3,1,1),0.82,0.18]
	The promotion of the comprehensive ability of the core technical personnel	[(9,7,5),0.70,0.30]	[(8,6,4),0.71,0.29]	[(4,2,0),0.79,0.21]
	Project success and reward	[(7.5,5.5,3.5),0.73,0.27]	[(6.5,4.5,2.5),0.75,0.25]	[(3,1,1),0.82,0.18]

The comprehensive score value γ_i is ranked from small to large, and the specific value indicates the comprehensive performance of the evaluation object. The smaller the value of d_i , the better the performance of the scheme. After ranking the scores of each subject in different indicators, we can get the satisfaction of different subjects in different indicators. This is the subject's satisfaction with the distribution of interests.

One of the purposes of this paper is to evaluate the balance of interests of the subjects of LCCI. Another one is to put forward the adjustment scheme for the imbalance index of the evaluation results. Therefore, we further study how to determine the adjustment scheme after the completion of the comprehensive score and ranking.

According to the value of d_i , we can judge the satisfaction degree of the relevant subjects to the allocation scheme under the corresponding criteria. However, we cannot judge the overall satisfaction of the allocation schemes under this criterion. We can make a horizontal comparison on the satisfaction of subjects under the same criteria, but we cannot make a vertical comparison between different criteria.

Therefore, according to the idea of variance in specific references [98], the variance of allocation scheme based on population closeness under each criterion is calculated. In this way, the stability of the scheme can be judged. At the

same time, the schemes under different criteria are sorted and compared. This is also a longitudinal comparison between different criteria.

The variance s_i^2 is calculated by

$$\bar{d}_{ij} = \frac{\sum_{j=1}^n d_{ij}}{n}, \quad (9)$$

$$s_i^2 = \frac{1}{n} \sum_{j=1}^n (d_{ij} - \bar{d}_{ij})^2. \quad (10)$$

The smaller the variance s_i^2 is, the more stable the interest equilibrium state is under the corresponding criteria. On the contrary, the larger the scale, the more adjustable the space of the interest equilibrium state under the corresponding criteria.

3.6. *Research Theoretical Framework.* Based on the above analysis, the theoretical framework model for evaluating the benefit balance of LCCI is constructed in Figure 3.

4. Case Study and Analysis

4.1. *Background.* Taking the LCCI of "development and industrialization of new peach varieties" as the specific case

TABLE 3: Decision matrix transpose matrix of Expert 2.

Index hierarchy	Assessment element	Subject 1 (Government)	Subject 2 (University)	Subject 3 (Enterprise)
Balance of interests among subjects	Enhancing regional influence to promote regional development	[(9,7,5),0.73,0.27]	[(9,7,5),0.69,0.31]	[(9,7,5),0.69,0.31]
	The foundation for supporting more theoretical innovation	[(8,6,4),0.75,0.25]	[(8,6,4),0.71,0.29]	[(10,8,6),0.66,0.34]
	Cultivating talents with the combination of theory and practice	[(7,5,3),0.77,0.23]	[(10,8,6),0.66,0.34]	[(10,8,6),0.66,0.34]
	Transforming theory into practice and sublimating theory	[(9,7,5),0.73,0.27]	[(9,7,5),0.69,0.31]	[(9,7,5),0.69,0.31]
	Overcome technical problems	[(7,5,3),0.77,0.23]	[(8,6,4),0.71,0.29]	[(10,8,6),0.66,0.34]
	Upgrade the existing core technology and process	[(7,5,3),0.77,0.23]	[(8,6,4),0.71,0.29]	[(10,8,6),0.66,0.34]
	Enhance the core competitiveness	[(8,6,4),0.75,0.25]	[(9,7,5),0.69,0.31]	[(9,7,5),0.69,0.31]
		Subject 1 (university)	Subject 2 (main R & D personnel)	Subject 3 (general participants)
The internal interest balance of universities	Project funding income	[(9,7,5),0.73,0.27]	[(10,8,6),0.66,0.34]	[(8,6,4),0.71,0.29]
	The increase of core R & D personnel's ability	[(9,7,5),0.73,0.27]	[(10,8,6),0.66,0.34]	[(8,6,4),0.71,0.29]
	Increase of funds for core R & D personnel	[(10,8,6),0.70,0.30]	[(10,8,6),0.66,0.34]	[(8,6,4),0.71,0.29]
	Number and level of published papers	[(9,7,5),0.73,0.27]	[(9,7,5),0.69,0.31]	[(8,6,4),0.71,0.29]
		Subject 1 (enterprise)	Subject 2 (main technical personnel)	Subject 3 (general participants)
The internal interest balance of enterprise	Value added of network through the project	[(10,8,6),0.70,0.30]	[(9,7,5),0.69,0.31]	[(7,5,3),0.74,0.26]
	Management ability and team building ability improvement	[(10,8,6),0.70,0.30]	[(9,7,5),0.69,0.31]	[(7,5,3),0.74,0.26]
	The promotion of the comprehensive ability of the core technical personnel	[(9,7,5),0.73,0.27]	[(9,7,5),0.69,0.31]	[(8,6,4),0.71,0.29]
	Project success and reward	[(10,8,6),0.70,0.30]	[(10,8,6),0.66,0.34]	[(8,6,4),0.71,0.29]

of this paper. It is used to verify the feasibility of the theoretical framework model.

Professor A of Z University and his research team rented the experimental base of Z University to cultivate and improve a new peach variety.

The development funds come from the government funded projects applied by Professor A. They initially mastered the cultivation technology of this new peach variety.

After the completion of the laboratory research stage, Professor A and the township garden cooperatives (B small enterprises) carried out the research on expanding the yield of new peach varieties. The purpose is to make the new varieties stable in quality and quantity for a long time.

Enterprise B has ¥800,000 of Industrial Science and technology poverty alleviation fund provided by the government, which is used to develop the local planting industry. It is in S County, Hunan Province, China, which is a poor county.

The initial cooperation agreement is as follows.

- (1) Professor A will cooperate with enterprise B on behalf of University Z. The cooperation is divided into three stages.

- (2) The trial period is two years, and the land area is 5 mu. Enterprise B paid ¥80000 for research and development. Employ one farmer to plant at the price of 100 yuan per day.
- (3) The pilot phase lasted for 3 years, with more than 100 mu of land. The cooperative paid ¥200,000 and employed 10 farmers to grow it.
- (4) The stage of large-scale production lasts for 10 years and covers an area of 2,000 mu. Enterprise B pays 1 million yuan (estimated) for research and development, including ¥300,000 in advance for start-up. The number of employed farmers is to be determined (The government gives enterprise B a start-up capital of ¥300,000, and the rest of the capital is bank loans at this stage).
- (5) If the new variety cultivation technology is completely successful, the new technology and the expected income generated will be converted into shares, with Z university accounting for 30% and B enterprise accounting for 70%.

Other relevant information in the pilot and pilot stages is as follows:

TABLE 4: Decision matrix transpose matrix of Expert 3.

Index hierarchy	Assessment element	Subject 1 (Government)	Subject 2 (University)	Subject 3 (Enterprise)
Balance of interests among subjects	Enhancing regional influence to promote regional development	[(10,9,7),0.70,0.30]	[(10,9,7),0.68,0.32]	[(10,8,6),0.74,0.26]
	The foundation for supporting more theoretical innovation	[(10,10,8),0.68,0.32]	[(10,8,6),0.71,0.29]	[(10,9,7),0.71,0.29]
	Cultivating talents with the combination of theory and practice	[(10,10,8),0.68,0.32]	[(10,9,7),0.68,0.32]	[(10,8,6),0.74,0.26]
	Transforming theory into practice and sublimating theory	[(10,9,7),0.70,0.30]	[(10,9,7),0.68,0.32]	[(10,9,7),0.71,0.29]
	Overcome technical problems	[(10,9,7),0.70,0.30]	[(10,9,7),0.68,0.32]	[(10,9,7),0.71,0.29]
	Upgrade the existing core technology and process	[(10,9,7),0.70,0.30]	[(10,9,7),0.68,0.32]	[(10,9,7),0.71,0.29]
	Enhance the core competitiveness	[(10,9,7),0.70,0.30]	[(10,9,7),0.68,0.32]	[(10,9,7),0.71,0.29]
		Subject 1 (university)	Subject 2 (main R & D personnel)	Subject 3 (general participants)
The internal interest balance of universities	Project funding income	[(10,8,6),0.72,0.28]	[(10,8,6),0.71,0.29]	[(8,6,4),0.79,0.21]
	The increase of core R & D personnel's ability	[(10,9,7),0.70,0.30]	[(10,8,6),0.71,0.29]	[(8,6,4),0.79,0.21]
	Increase of funds for core R & D personnel	[(10,9,7),0.70,0.30]	[(10,9,7),0.68,0.32]	[(8,6,4),0.79,0.21]
	Number and level of published papers	[(10,9,7),0.70,0.30]	[(10,8,6),0.71,0.29]	[(8,6,4),0.79,0.21]
		Subject 1 (enterprise)	Subject 2 (main technical personnel)	Subject 3 (general participants)
The internal interest balance of enterprise	Value added of network through the project	[(10,9,7),0.70,0.30]	[(10,8,6),0.71,0.29]	[(10,9,7),0.71,0.29]
	Management ability and team building ability improvement	[(10,9,7),0.70,0.30]	[(10,8,6),0.71,0.29]	[(10,9,7),0.71,0.29]
	The promotion of the comprehensive ability of the core technical personnel	[(10,9,7),0.70,0.30]	[(10,9,7),0.68,0.32]	[(10,9,7),0.71,0.29]
	Project success and reward	[(10,9,7),0.70,0.30]	[(10,9,7),0.68,0.32]	[(10,9,7),0.71,0.29]

- (1) 15% of the project management fee. The students who participated in the project received a total of ¥30000 labor allowance.
- (2) If the project is successful, the managers of enterprise B will get a bonus of ¥80,000, and the planters will get 30,000 yuan in addition to their daily salary.

We only consider the balance of interest in the pilot and pilot stages because the large-scale production stage is not over.

4.2. Specific Evaluation Process

4.2.1. Establish the Standard of Interest Distribution Balance in LCCI. Drawing on the idea of the literature [93], we invited five experts to set up a panel. They give specific comments on the above evaluation indicators, combined with the actual interests of the main requirements. Then the decision matrix and its transpose matrix are constructed (see Appendix A (Tables 2-6)). We calculate the arithmetic mean decision transpose matrix of five experts (see Appendix B (Table 7)).

According to formulas (1) and (2), the criteria for calculating the equilibrium of interest distribution (i.e., ideal solution and negative ideal solution) in LCCI are shown in Table 8.

4.2.2. Calculate the Distance, Closeness d_i , And the Optimal Weight Coefficient ω_j of Each Index. The total considerate closeness d_i and comprehensive score γ_i were calculated.

According to the distance formula (3), G^+ , G^- under each criterion index are calculated. The results are shown in Table 9.

The weight ω_j is calculated according to formula (4). According to formula (5), we calculate the closeness degree d_i . The results are shown in Table 10.

4.2.3. Determine and Rank the Comprehensive Score γ_i . According to formula (8), calculate the comprehensive scores γ_i of each index, and sort them out. The results are shown in Table 11.

It can be seen from Table 11 that the relative closeness degree of the ideal state of income and interest balance of different subjects in LCCI is $\gamma_3 < \gamma_2 < \gamma_1$. This shows that:

- (1) In the interest distribution among the subjects, the government has the highest degree of interest realization, followed by universities, and finally enterprises.
- (2) In the internal benefit distribution of university, the degree of benefit realization of university is the highest, followed by the core R & D personnel, and finally the general participants.

TABLE 5: Decision matrix transpose matrix of Expert 4.

Index hierarchy	Assessment element	Subject 1 (Government)	Subject 2 (University)	Subject 3 (Enterprise)
Balance of interests among subjects	Enhancing regional influence to promote regional development	[(10,8,6),0.77,0.23]	[(10,9,7),0.72,0.28]	[(10,8,7),0.74,0.26]
	The foundation for supporting more theoretical innovation	[(10,8,6),0.77,0.23]	[(8,6,4),0.80,0.20]	[(10,9,8),0.71,0.29]
	Cultivating talents with the combination of theory and practice	[(10,8,6),0.77,0.23]	[(8,6,4),0.80,0.20]	[(10,8,6),0.74,0.26]
	Transforming theory into practice and sublimating theory	[(10,9,7),0.75,0.25]	[(8,6,4),0.80,0.20]	[(10,9,7),0.71,0.29]
	Overcome technical problems	[(10,9,7),0.75,0.25]	[(10,9,7),0.72,0.28]	[(7,5,7),0.82,0.18]
	Upgrade the existing core technology and process	[(10,9,7),0.75,0.25]	[(10,9,7),0.72,0.28]	[(7,5,7),0.82,0.18]
	Enhance the core competitiveness	[(10,9,7),0.75,0.25]	[(10,9,7),0.72,0.28]	[(7,5,8),0.82,0.18]
		Subject 1 (university)	Subject 2 (main R & D personnel)	Subject 3 (general participants)
The internal interest balance of universities	Project funding income	[(10,8,6),0.77,0.23]	[(10,8,6),0.75,0.25]	[(6,4,6),0.85,0.15]
	The increase of core R & D personnel's ability	[(10,9,7),0.75,0.25]	[(10,8,6),0.75,0.25]	[(6,4,8),0.85,0.15]
	Increase of funds for core R & D personnel	[(10,9,7),0.75,0.25]	[(10,9,7),0.72,0.28]	[(4,2,6),0.90,0.10]
	Number and level of published papers	[(10,9,7),0.75,0.25]	[(10,8,6),0.75,0.25]	[(3,1,5),0.93,0.07]
		Subject 1 (enterprise)	Subject 2 (main technical personnel)	Subject 3 (general participants)
The internal interest balance of enterprise	Value added of network through the project	[(10,9,7),0.75,0.25]	[(10,8,6),0.75,0.25]	[(7,5,7),0.82,0.18]
	Management ability and team building ability improvement	[(10,9,7),0.75,0.25]	[(10,8,6),0.75,0.25]	[(6,4,7),0.85,0.15]
	The promotion of the comprehensive ability of the core technical personnel	[(10,9,7),0.75,0.25]	[(10,9,7),0.72,0.28]	[(4,2,7),0.90,0.10]
	Project success and reward	[(10,9,7),0.75,0.25]	[(10,9,7),0.72,0.28]	[(5,3,7),0.88,0.12]

(3) In the internal interest distribution of enterprises, the realization degree of the enterprise's interest is the highest, followed by the core technical personnel, and finally the general participants.

calculated. And they are sorted by variance. The results are shown in Table 12.

The following conclusions can be drawn from Table 12:

- (1) The balance of interest distribution among subjects is the best, followed by the balance within enterprises, and finally the balance within colleges and universities.
- (2) Specifically, the three indicators of the optimal distribution equilibrium state are the satisfaction of the main body to cultivate talent, the satisfaction of enterprise strategy implementation, and the satisfaction of enterprise development. The three worst indicators of distribution equilibrium are the satisfaction of the research output, the success of team building, and the satisfaction of the use of funds.
- (3) In this case, the key object to be adjusted is the internal distribution of colleges and universities.

After determining the adjustment object, the specific adjustment scheme is determined as follows:

- (1) The analysis results are objectively reflected to the corresponding subjects.
- (2) Relevant subjects measure the specific distribution scheme and take the corresponding specific adjustment measures.

5. Discussions

According to the ranking results of the above cases, the total considerate progress of the interest distribution of different levels of subjects and their ideal interest balance state is $\gamma_3 < \gamma_2 < \gamma_1$ in this LCCI.

The specific analysis shows that although the realization degree of interest balance of some subjects is higher than that of other subjects, there is still a gap with the ideal state.

Then, the gap between the ideal state and other subjects with weak realization degree of interest balance is larger. This means that there is a certain degree of imbalance in the distribution of interests in the LCCI.

The imbalance of interest distribution will inevitably lead to the instability of cooperation [99]. The subject who is not satisfied with the distribution of their own interests, can put forward adjustment requirements. Then we need to adjust the plan according to the evaluation results. Thus how to adjust the plan according to the evaluation results? The comparison can be made according to the closeness D in Table 11.

In addition, according to formulas (9) and (10), the variance s_i^2 of each criterion distribution scheme is

TABLE 6: Decision matrix transpose matrix of Expert 5.

Index hierarchy	Assessment element	Subject 1 (Government)	Subject 2 (University)	Subject 3 (Enterprise)
Balance of interests among subjects	Enhancing regional influence to promote regional development	[(10,10,5),0.73,0.27]	[(10,8,3),0.75,0.25]	[(10,9,2),0.66,0.34]
	The foundation for supporting more theoretical innovation	[(8,6,4),0.82,0.18]	[(10,8,3),0.75,0.25]	[(6,4,2),0.80,0.20]
	Cultivating talents with the combination of theory and practice	[(9,7,3),0.80,0.20]	[(10,9,3),0.72,0.28]	[(10,8,2),0.69,0.31]
	Transforming theory into practice and sublimating theory	[(10,9,5),0.75,0.25]	[(10,10,3),0.70,0.30]	[(10,9,2),0.66,0.34]
	Overcome technical problems	[(10,8,3),0.77,0.23]	[(9,7,3),0.78,0.22]	[(10,9,2),0.66,0.34]
	Upgrade the existing core technology and process	[(10,8,3),0.77,0.23]	[(8,6,3),0.80,0.20]	[(10,9,2),0.66,0.34]
	Enhance the core competitiveness	[(7,5,3),0.84,0.16]	[(7,5,3),0.83,0.17]	[(10,10,2),0.63,0.37]
		Subject 1 (university)	Subject 2 (main R & D personnel)	Subject 3 (general participants)
The internal interest balance of universities	Project funding income	[(10,10,5),0.73,0.27]	[(10,10,4),0.70,0.30]	[(10,8,0),0.69,0.31]
	The increase of core R & D personnel's ability	[(10,8,5),0.77,0.23]	[(10,9,3),0.72,0.28]	[(10,10,0),0.63,0.37]
	Increase of funds for core R & D personnel	[(8,6,5),0.82,0.18]	[(10,8,2),0.75,0.25]	[(10,8,0),0.69,0.31]
	Number and level of published papers	[(10,8,3),0.77,0.23]	[(10,9,3),0.72,0.28]	[(9,7,0),0.72,0.28]
		Subject 1 (enterprise)	Subject 2 (main technical personnel)	Subject 3 (general participants)
The internal interest balance of enterprise	Value added of network through the project	[(10,9,6),0.75,0.25]	[(10,8,5),0.75,0.25]	[(9,7,0),0.72,0.28]
	Management ability and team building ability improvement	[(10,9,4,5),0.75,0.25]	[(9,7,3),0.78,0.22]	[(10,8,0),0.69,0.31]
	The promotion of the comprehensive ability of the core technical personnel	[(10,10,5),0.73,0.27]	[(9,7,3),0.78,0.22]	[(10,8,0),0.69,0.31]
	Project success and reward	[(9,7,3,5),0.80,0.20]	[(10,9,2,5),0.72,0.28]	[(8,6,0),0.74,0.26]

- (3) Then invite the same experts to reevaluate the adjusted scheme according to the above procedures. Such a cycle, until the adjustment is balanced.

6. Conclusions, Contributions, And Suggestions

6.1. Conclusions and Theoretical Contributions. Based on the characteristics of literature research and practice, this paper first constructs a theoretical framework model to evaluate the interest balance of LCCI. Then, specific cases are selected for application analysis to verify the feasibility of the evaluation model.

Specifically, the innovations of this paper are as follows:

- (1) In the evaluation content, besides the interest balance among subjects, the interest balance within subjects is also considered.
- (2) TOPSIS is used to evaluate the LCCI. We not only use the closeness degree d_i to compare the equilibrium satisfaction of different subjects under the same criterion horizontally, but also design each criterion based on the variance s_i^2 of closeness degree to compare the satisfaction of the overall allocation scheme under different criteria vertically. Based on the horizontal comparison, we can judge the

satisfaction of different subjects to the scheme under the same criteria. Based on the vertical comparison, we can judge the concentration degree of all subjects' satisfaction with the scheme under different criteria. This means that we can judge the difference between the main body and the scheme under the criterion.

This is beneficial to the LCCI, the evaluation of its interest balance, and the application of TOPSIS evaluation method.

Specifically, this paper has the following conclusions and theoretical contributions:

- (1) The equilibrium of the benefit of LCCI includes not only the distribution equilibrium among subjects, but also the internal interest balance of the subjects.

Interest balance is not the state of one subject's interest maximization, but the realization of each subject's interest under the whole interest maximization.

This conclusion is consistent with the research conclusions of Ankrah et al. [20] and Patra [46], However, the difference is that this paper not only evaluates the interest balance among subjects, but also evaluates the interest balance within the subjects.

TABLE 7: Transpose matrix table of expert arithmetic average decision matrix.

Index hierarchy	Assessment element	Subject 1 (Government)	Subject 2 (University)	Subject 3 (Enterprise)
Balance of interests among subjects	Enhancing regional influence to promote regional development	[(9.8,8.6,6),0.72,0.28]	[(9.2,7.6,5),0.72,0.28]	[(9,7.2,4.4),0.71,0.29]
	The foundation for supporting more theoretical innovation	[(9.2,7.8,5.8),0.73,0.27]	[(8.6,6.6,4),0.74,0.26]	[(8.4,6.8,5),0.72,0.28]
	Cultivating talents with the combination of theory and practice	[(9.2,7.6,5.2),0.74,0.26]	[(9,7.4,4.6),0.72,0.28]	[(9.2,7.2,4.4),0.71,0.29]
	Transforming theory into practice and sublimating theory	[(9.8,8.4,6),0.72,0.28]	[(8.8,7.4,4.4),0.72,0.28]	[(9,7.6,4.6),0.70,0.30]
	Overcome technical problems	[(9.4,8,5.4),0.73,0.27]	[(8.8,7.2,4.8),0.73,0.27]	[(8.6,7.4,8),0.72,0.28]
	Upgrade the existing core technology and process	[(9.4,8,5.4),0.73,0.27]	[(8.6,7,4.8),0.73,0.27]	[(8.6,7.4,8),0.72,0.28]
	Enhance the core competitiveness	[(9,7.6,5.6),0.74,0.26]	[(8.6,7,5),0.73,0.27]	[(8.4,7.4,8),0.72,0.28]
		Subject 1 (university)	Subject 2 (main R & D personnel)	Subject 3 (general participants)
The internal interest balance of universities	Project funding income	[(9.8,8.4,5.8),0.72,0.28]	[(9.6,8,5.2),0.71,0.29]	[(7,5,3),0.77,0.23]
	The increase of core R & D personnel's ability	[(9.8,8.2,6),0.73,0.27]	[(9.4,7.6,4.8),0.72,0.28]	[(7.2,5.6,3.2),0.76,0.24]
	Increase of funds for core R & D personnel	[(9.4,7.8,6),0.73,0.27]	[(9.2,7.6,4.8),0.72,0.28]	[(7,5,3),0.77,0.23]
	Number and level of published papers	[(9.6,8,5.8),0.73,0.27]	[(9.2,7.4,4.6),0.72,0.28]	[(6.2,4.2,2.8),0.80,0.20]
		Subject 1 (enterprise)	Subject 2 (main technical personnel)	Subject 3 (general participants)
The internal interest balance of enterprise	Value added of network through the project	[(10,8.6,6.4),0.72,0.28]	[(9.8,7.8,5.6),0.71,0.29]	[(7.2,5.4,3.6),0.76,0.24]
	Management ability and team building ability improvement	[(9.7,8.3,5.8),0.72,0.28]	[(9.1,7.1,4.7),0.73,0.27]	[(7.2,5.4,3.6),0.76,0.24]
	The promotion of the comprehensive ability of the core technical personnel	[(9.6,8.4,5.8),0.72,0.28]	[(9.2,7.6,5.2),0.72,0.28]	[(7.2,5.4,3.6),0.76,0.24]
	Project success and reward	[(9.3,7.7,5.4),0.74,0.26]	[(9.3,7.9,5),0.71,0.29]	[(6.8,5.3,8),0.77,0.23]

The results we obtained further extend the previous literature and show that in the evaluation of the interest balance of LCCI, while evaluating the interest balance among subjects, the interest balance within the subjects should also be evaluated.

Because the internal individual satisfaction of the main body will affect the stability of the cooperation among the main body by affecting the internal stability of the main body. This shows that the evaluation content should be determined comprehensively and hierarchically to carry out the benefit balance evaluation of LCCI.

- (2) The interest balance among subjects and within subjects will have different satisfaction with different indicators. It means that the d_i value of different subjects and different indicators is different.

This shows that different subjects have different interests or different motives to participate in LCCI. This is consistent with the conclusions of Beath et al. [25], Freitas and Verspagen [27] and Freitas and Verspagen [27]. However, the difference is that these papers show that not only the motives of the participants are not the same, but also the motives of the

internal individuals are not the same. This is an extension of previous studies.

This shows that the research on the subject motivation and interest balance of LCCI should not only consider the motivation among the subjects, but also consider the individual motivation within the subject, as well as the emphasis of the indicators involved.

- (3) The distribution of benefits in LCCI includes both tangible benefits that can be measured by money and intangible benefits that are lagging and lack of fixed measurement standards.

Defining the category of interests is one of the bases for the balanced distribution of interests in LCCI. A comprehensive definition of interest is the guarantee for the rational formulation of distribution strategies and the realization of interest balance. This is consistent with the conclusion of Liu [42], Jasmina et al. [40]. However, the difference is that this paper considers the interest, needs, and realization of the government participating in such projects. However, previous studies only considered the conventional interests of universities and enterprises.

TABLE 8: Positive and negative ideal solutions under each criterion.

Index hierarchy	Assessment element	G^+	G^-
Balance of interests among subjects	Enhancing regional influence to promote regional development	[(10,10,5),1,0]	[(6,4,2),0,1]
	The foundation for supporting more theoretical innovation	[(10,10,4),1,0]	[(6,4,2),0,1]
	Cultivating talents with the combination of theory and practice	[(10,10,3),1,0]	[(6,4,2),0,1]
	Transforming theory into practice and sublimating theory	[(10,10,5),1,0]	[(6,4,2),0,1]
	Overcome technical problems	[(10,9,3),1,0]	[(6,4,2),0,1]
	Upgrade the existing core technology and process	[(10,9,3),1,0]	[(6,4,2),0,1]
The internal interest balance of universities	Enhance the core competitiveness	[(10,10,3),1,0]	[(6,4,2),0,1]
	Project funding income	[(10,10,5),1,0]	[(3,1,0),0,1]
	The increase of core R & D personnel's ability	[(10,10,5),1,0]	[(4,2,0),0,1]
	Increase of funds for core R & D personnel	[(10,9,5),1,0]	[(5,2,0),0,1]
The internal interest balance of enterprise	Number and level of published papers	[(10,9,5),1,0]	[(3,1,0),0,1]
	Value added of network through the project	[(10,9,6),1,0]	[(3,1,0),0,1]
	Management ability and team building ability improvement	[(10,9,4,5),1,0]	[(3,1,0),0,1]
	The promotion of the comprehensive ability of the core technical personnel	[(10,10,5),1,0]	[(4,2,0),0,1]
	Project success and reward	[(10,9,3,5),1,0]	[(3,1,0),0,1]

For example, the government needs to help the poor and promote regional development in the case of this study. By supporting and promoting the project, the purpose of solving part of the employment problem has been achieved to a certain extent. It can also help enterprises develop, expand, and enhance their influence, to achieve the goal of regional poverty alleviation and regional development.

This shows that the interests of LCCI should be considered completely. We should not only examine the common tangible and intangible interests, but also examine the uncommon, tangible and intangible interests according to the actual situation.

- (4) The interest balance of LCCI is a dynamic process and an ideal state. In practice, it is difficult for the subjects to be balanced all time, and most of the time they are unbalanced.

Therefore, scientific and reasonable evaluation is necessary. This can help the subject know the current situation in real time and adjust it. In this way, measures can be taken to reduce the instability of cooperation before the crisis. The degree of satisfaction among the subjects of this study can be calculated by the degree of closeness d_i .

This is consistent with the research conclusions of Lai et al. [67], Liang et al. [97].

However, the difference is that this study also calculates the variance s_i^2 of each criterion based on the closeness degree d_i . The variance is used to rank the distribution schemes under different criteria. To judge and select the criteria with great differences in the subject's attitude towards the scheme and adjust them. This can further optimize the equilibrium state and increase the stability of cooperation.

6.2. Practical Contribution. Combined with the above research conclusions, we can know that the evaluation of the interest balance of LCCI aims to provide an indication for the current interest state of each subject. And the balance of interests is a dynamic and ideal state. The long-term

imbalance of interest balance will affect the stability of cooperation and even lead to project failure. Through the evaluation, an appropriate intervention can be carried out to prevent this situation.

Therefore, the following suggestions are put forward for the practice management of LCCI.

- (1) Establish a comprehensive and systematic cognitive concept and establish a standard distribution plan and inspection process.

The interest balance of LCCI includes not only the interest balance among subjects, but also within subjects. At the same time, the definition of interest includes not only the common, tangible, and intangible interests, but also the uncommon but practical interests that cannot be ignored.

Therefore, in the management practice, we should establish a comprehensive and systematic cognition and establish a set of standardized inspection process to facilitate different subjects to inspect their own situation and take reasonable actions. To reduce the risk of cooperation failure, we should alleviate contradictions and avoid blind action.

- (2) Pay attention to targeted management adjustment, strengthen the protection of vulnerable groups.

Participants have different motivations and interests. And the subjects are in different positions in the project, so the discourse power of subjects will be different.

Therefore, in the practice of LCCI management, we should pay attention to targeted management according to the different interests of different subjects. At the same time, it is easy to be ignored because of the relatively low position of the general participants and technicians in the organizational structure.

Therefore, we should strengthen the protection mechanism of the interests of vulnerable groups, avoid the cooperation in trouble, and ensure the balance of interests.

TABLE 9: Calculated distances.

Index hierarchy	Assessment element	Subject 1		Subject 2		Subject 3	
		D_i^+	D_i^-	D_i^+	D_i^-	D_i^+	D_i^-
Balance of interests among subjects	Enhancing regional influence to promote regional development	2.51	5.82	3.13	5.20	3.44	4.89
	The foundation for supporting more theoretical innovation	2.42	5.58	3.25	4.75	3.13	4.87
	Cultivating talents with the combination of theory and practice	2.25	5.42	2.62	5.05	2.73	4.94
	Transforming theory into practice and sublimating theory	2.52	5.81	3.38	4.95	3.38	4.95
	Overcome technical problems	1.79	5.55	2.30	5.04	2.45	4.88
	Upgrade the existing core technology and process	1.79	5.55	2.36	4.98	2.45	4.88
	Enhance the core competitiveness	2.20	5.47	2.64	5.02	2.84	4.83
The internal interest balance of universities	Project funding income	2.57	5.77	2.97	5.36	4.47	3.87
	The increase of core R & D personnel's ability	2.53	5.80	3.13	5.20	4.30	4.03
	Increase of funds for core R & D personnel	2.32	5.68	2.84	5.16	4.13	3.87
	Number and level of published papers	2.31	5.69	2.90	5.10	4.50	3.50
The internal interest balance of enterprise	Value added of network through the project	2.37	5.97	2.84	5.50	4.22	4.11
	Management ability and team building ability improvement	2.10	5.74	2.75	5.08	3.72	4.11
	The promotion of the comprehensive ability of the core technical personnel	2.62	5.72	3.08	5.25	4.22	4.11
	Project success and reward	2.00	5.50	2.26	5.24	3.48	4.02

TABLE 10: Calculation of d_i and ω_j .

Index hierarchy	Assessment element	d_i			ω_j		
		Subject 1	Subject 2	Subject 3	Subject 1	Subject 2	Subject 3
Balance of interests among subjects	Enhancing regional influence to promote regional development	0.301	0.376	0.413	0.071	0.068	0.079
	The foundation for supporting more theoretical innovation	0.302	0.406	0.391	0.064	0.059	0.075
	Cultivating talents with the combination of theory and practice	0.293	0.341	0.356	0.063	0.067	0.079
	Transforming theory into practice and sublimating theory	0.302	0.406	0.406	0.069	0.067	0.084
	Overcome technical problems	0.244	0.313	0.335	0.066	0.065	0.077
	Upgrade the existing core technology and process	0.244	0.321	0.335	0.066	0.063	0.077
	Enhance the core competitiveness	0.286	0.345	0.370	0.063	0.063	0.077
The internal interest balance of universities	Project funding income	0.308	0.357	0.536	0.069	0.072	0.055
	The increase of core R & D personnel's ability	0.304	0.376	0.516	0.068	0.068	0.062
	Increase of funds for core R & D personnel	0.290	0.356	0.517	0.064	0.068	0.055
	Number and level of published papers	0.288	0.363	0.563	0.066	0.067	0.046
The internal interest balance of enterprise	Value added of network through the project	0.284	0.340	0.506	0.071	0.070	0.059
	Management ability and team building ability improvement	0.268	0.352	0.475	0.068	0.064	0.059
	The promotion of the comprehensive ability of the core technical personnel	0.314	0.370	0.506	0.069	0.068	0.059
	Project success and reward	0.266	0.301	0.464	0.063	0.071	0.055

(3) Implement flexible management measures and set up a special regulation department.

Interest balance is a dynamic process, so it is necessary to monitor the state of interest distribution in real time, deal with the imbalance crisis in time, and make appropriate adjustments.

Therefore, in the practice of management, we should pay attention to the flexibility of management and set up a special regulatory agency. Timely inspect the realization of

the interests of all parties. And feedback to senior management to implement intervention to eliminate the crisis and take precautions.

6.3. *Research Prospects.* In theory, this paper is based on related research. And the conclusion will contribute to the research of LCCI, benefit distribution, index design, and benefit balance evaluation, which can enrich the theoretical literature in the corresponding fields.

TABLE 11: Comprehensive sorting results.

Index hierarchy	Assessment element	Subject 1	Subject 2	Subject 3	sort
Balance of interests among subjects	Enhancing regional influence to promote regional development	0.021	0.026	0.033	$\gamma_3 < \gamma_2 < \gamma_1$
	The foundation for supporting more theoretical innovation	0.019	0.024	0.029	$\gamma_3 < \gamma_2 < \gamma_1$
	Cultivating talents with the combination of theory and practice	0.018	0.023	0.028	$\gamma_3 < \gamma_2 < \gamma_1$
	Transforming theory into practice and sublimating theory	0.021	0.027	0.034	$\gamma_3 < \gamma_2 < \gamma_1$
	Overcome technical problems	0.016	0.020	0.026	$\gamma_3 < \gamma_2 < \gamma_1$
	Upgrade the existing core technology and process	0.016	0.020	0.026	$\gamma_3 < \gamma_2 < \gamma_1$
The internal interest balance of universities	Enhance the core competitiveness	0.018	0.022	0.029	$\gamma_3 < \gamma_2 < \gamma_1$
	Project funding income	0.021	0.026	0.030	$\gamma_3 < \gamma_2 < \gamma_1$
	The increase of core R & D personnel's ability	0.021	0.026	0.032	$\gamma_3 < \gamma_2 < \gamma_1$
	Increase of funds for core R & D personnel	0.019	0.024	0.028	$\gamma_3 < \gamma_2 < \gamma_1$
The internal interest balance of enterprise	Number and level of published papers	0.019	0.024	0.026	$\gamma_3 < \gamma_2 < \gamma_1$
	Value added of network through the project	0.020	0.024	0.030	$\gamma_3 < \gamma_2 < \gamma_1$
	Management ability and team building ability improvement	0.018	0.022	0.028	$\gamma_3 < \gamma_2 < \gamma_1$
	The promotion of the comprehensive ability of the core technical personnel	0.022	0.025	0.030	$\gamma_3 < \gamma_2 < \gamma_1$
	Project success and reward	0.017	0.021	0.026	$\gamma_3 < \gamma_2 < \gamma_1$

TABLE 12: Calculation and ranking of variance of each criterion.

Index hierarchy	Assessment element	$\overline{d_{ij}}$	s_i^2	sort
Balance of interests among subjects	Enhancing regional influence to promote regional development	0.363	0.22%	6
	The foundation for supporting more theoretical innovation	0.367	0.21%	5
	Cultivating talents with the combination of theory and practice	0.330	0.07%	1
	Transforming theory into practice and sublimating theory	0.371	0.24%	7
	Overcome technical problems	0.297	0.15%	3
	Upgrade the existing core technology and process	0.300	0.16%	4
The internal interest balance of universities	Enhance the core competitiveness	0.334	0.12%	2
	Project funding income	0.400	0.96%	14
	The increase of core R & D personnel's ability	0.398	0.78%	11
	Increase of funds for core R & D personnel	0.387	0.91%	13
The internal interest balance of enterprise	Number and level of published papers	0.405	1.34%	15
	Value added of network through the project	0.377	0.89%	12
	Management ability and team building ability improvement	0.365	0.72%	9
	The promotion of the comprehensive ability of the core technical personnel	0.397	0.65%	8
	Project success and reward	0.344	0.74%	10

In practice, this paper selects an actual case to do the evaluation analysis. We carry out the empirical analysis based on a certain number of LCCI. The management suggestions based on the conclusions can boost the management needs of LCCI.

At the same time, the paper also has some limitations and prospects.

- (1) The evaluation index of this paper is designed according to the general practice needs of LCCI and related literature.

However, LCCI in practice will have different interests due to different fields.

Therefore, in practice, evaluation evaluators should consider not only the general interest evaluation indexes, but also more special indexes with practical significance.

- (2) The case of this paper is a LCCI of agricultural product R & D, in which the subjects are relatively simple.

Among the subjects, there are only government, single university, and single enterprise. In the internal distribution of the subject, only the main managers, core technical personnel, and general participants.

In the actual LCCI, many cooperation subjects are more complex.

For example, the main body of a university may include multiple universities and research institutions. The main body representing an enterprise may include the cooperation of multiple enterprises, and these enterprises may also have different sizes. The size of the enterprise will also have a certain impact on the cooperation [100]. Therefore, in the

follow-up research, we can choose LCCI with complex subjects as a case to evaluate the interest balance.

Appendix

A. Decision Matrix of Five Experts

Decision matrix transpose matrixes of Experts 1, 2, 3, 4, and 5 are shown in Tables 2–6, respectively.

B. Expert Arithmetic Means Decision Matrix

Transpose matrix table of expert arithmetic average decision matrix is shown in Table 7.

Data Availability

Data generated or analyzed during the study are available from the corresponding author on request.

Conflicts of Interest

The authors declare no conflict of interests.

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